

COLUMBIA COUNTY BOARD OF COMMISSIONERS

COLUMBIA COUNTY DETENTION FACILITY

ISSUED FOR PERMIT Documents – July 24, 2020

COLUMBIA COUNTY DETENTION CENTER

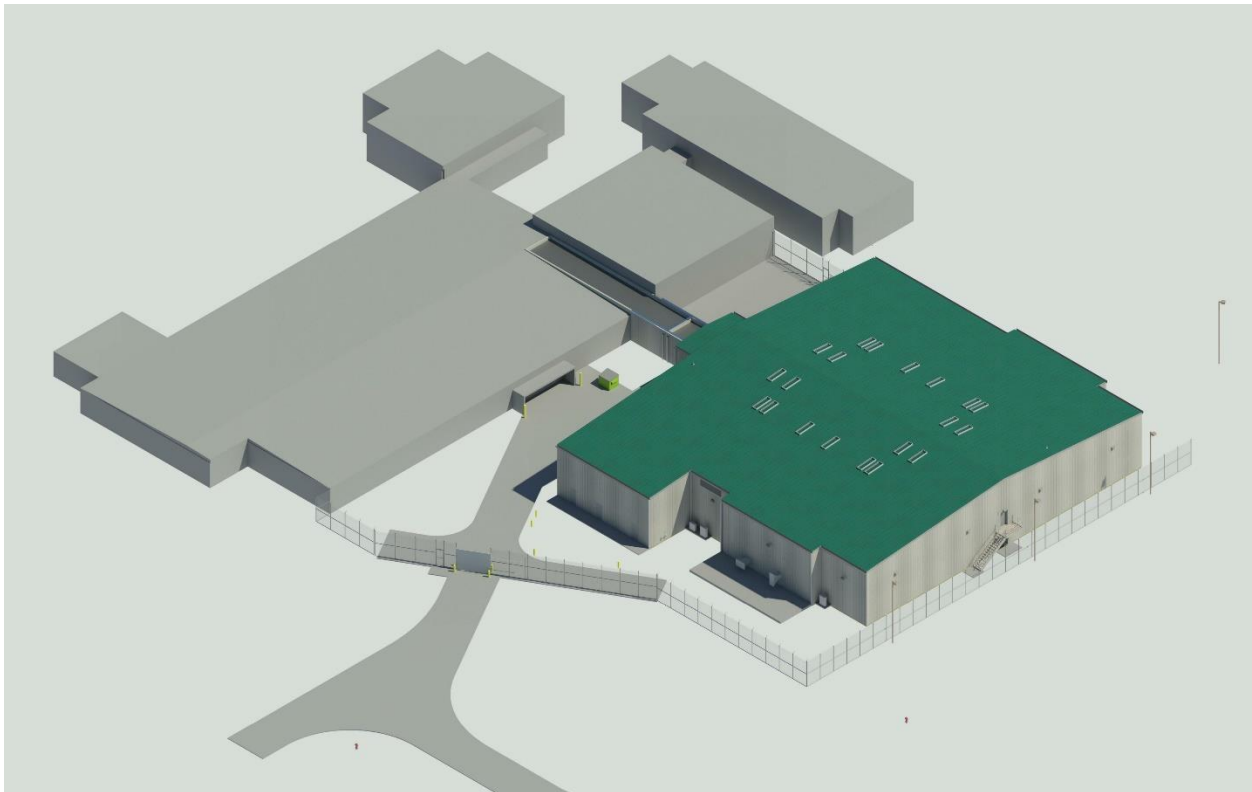
389 QUINTEN ST. LAKE CITY FLORIDA 32055

VOLUME 2

ISSUED FOR PERMIT SPECIFICATIONS

JULY 24, 2020

PROJECT # 50101397



SEALS PAGE - COLUMBIA COUNTY DETENTION FACILITY

Dewberry Project Number: 50101397 / ISSUED FOR PERMIT – July 24, 2020

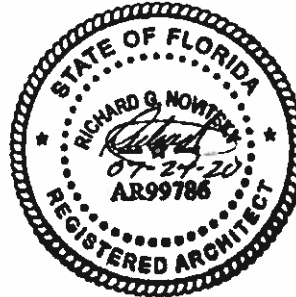
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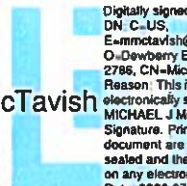
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SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Basic Requirements: Requirements of the Contract Forms, Conditions of the Contract, Specifications, Drawings, and Addenda and Contract Modifications (the Contract Documents), apply to the requirements of each Section of Division 23.
- B. Conflicts: Nothing contained in this Section shall be construed to conflict in any way with other provisions or requirements of the Contract documents. The intent is that this Section will take precedence. Where differences arise, the Architect shall decide which directions or instructions take precedence.

1.2 SUMMARY

- A. General: Unless an item is specifically mentioned as being provided by others, the requirements of Division 23 Contract Documents shall be completed. The systems, equipment, devices and accessories shall be installed, finished, tested and adjusted for continuous and proper operation. Any apparatus, material or device not shown on the Drawings but mentioned in these Specifications, or vice versa, or any incidental accessories necessary to make the project complete and operational in all respects, shall be furnished, delivered and installed without additional expense to the Owner. Include all materials, equipment, supervision, operation, methods and labor for the fabrication, installation, start-up and tests necessary for complete and properly functioning systems.

1.3 APPLICABLE STANDARDS

- A. Code Compliance: Refer to Division 1. As a minimum, unless otherwise indicated, comply with all rules, regulations, standards, codes, ordinances and laws of local, state and federal governments and the amendments and interpretation of such rules, regulations, standards, codes, ordinances and laws of local, state and federal governments by the authorities having lawful jurisdiction.
- B. ADA: Comply with the requirements of the Americans with Disabilities Act (ADA).
- C. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards as adopted by the Local Authority having Jurisdiction.
- D. Comply: With the National Fire Protection Association (NFPA) Standards and other Codes and Standards indicated.
- E. Florida Building Code 2017: Conform in strict compliance to the Florida Building Code (FBC) and the amendments which are enforced by the local authority having jurisdiction.

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1. Florida Building Code – Mechanical
2. Florida Building Code – Plumbing
3. Florida Building Code – Fuel Gas
4. Florida Building Code – Energy Conservation

F. NATIONAL FIRE PROTECTION (NFPA) Standards:

1. NFPA-1, Uniform Fire Code™, 2006 Revision
2. NFPA-10, Standard for Portable Fire Extinguishers, 2002 Revision
3. NFPA-13, Standard for the Installation of Sprinkler Systems, 2002 Revision
4. NFPA-14, Standard for the Installation of Standpipe and Hose Systems, 2003 Revision
5. NFPA-15, Standard for Water Spray Fixed Systems for Fire Protection, 2001 Revision
6. NFPA-20, Standard for the Installation of Stationary Pumps for Fire Protection, 2003 Revision
7. NFPA-24, Standards for the Installation of Private Fire Service Mains and Their Appurtenances, 2002 Revision
8. NFPA-30, Flammable and Combustible Liquids Code, 2003 Revision
9. NFPA-31, Standard for the Installation of Oil Burning Equipment, 2001 Revision
10. NFPA-54, National Fuel Gas Code, 2006 Revision
11. NFPA-58, Standard for Storage and Handling of Liquefied Petroleum Gases, 2004 Revision
12. NFPA-70, National Electrical Code, 2005 Revision
13. NFPA-72, National Fire Alarm Code, 2002 Revision
14. NFPA-75, Standard for the Protection of Information Technology Equipment, 2003 Revision
15. NFPA-88A, Standard for Parking Structures, 2002 Revision
16. NFPA-90A, Standard for the Installation of Air Conditioning and Ventilation Systems, 2002 Revision
17. NFPA-90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems, 2006 Revision
18. NFPA-91, Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids, 2004 Revision
19. NFPA-92A, Recommended Practice for Smoke-Control Systems, 2006 Edition
20. NFPA-92B, Guide for Smoke Management Systems in Malls, Atria, and Large Areas, 2005 Edition
21. NFPA-101A, Guide to Alternative Approaches to Life Safety, 2004 Revision
22. NFPA-101B, Standard on Means of Egress for Buildings and Structures, 2002 Revision
23. NFPA-704, Standard System for the Identification of the Fire Hazards of Materials for Emergency Response, 2001 Revision
24. NFPA-780, Installation of Lightning Protection Systems, 2004 Revision
25. NFPA-1962, Standard for Inspection, Care and Use of Fire Hose including Couplings and Nozzles; and the Service Testing of Fire Hose, 2003 Revision
26. NFPA-1963, Standard for Fire Hose Connections, 2003 Revision

G. Notification: Comply with all of the requirements of the Federal "Right-To-Know" Regulations and the Florida "Right-To-Know" Law and provide notification to all parties concerned as to the use of toxic substances.

H. Florida Model Jail Standards: Comply with all the requirements of the latest Florida Model Jail Standards.

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- I. Owner Design Guidelines: Comply with all the requirements of the latest Owner MEP Engineering Design Guidelines and the latest Owner Architectural Construction Standards.

1.4 DRAWINGS AND SPECIFICATIONS

- A. Intent: The intent of the drawings and specifications is to establish minimum acceptable quality standards for materials, equipment and workmanship, and to provide operable mechanical systems complete in every respect.
- B. Equipment Placement: The drawings are diagrammatic, intended to show general arrangement, capacity and location of various components, equipment and devices. Each location shall be determined by reference to the general building plans and by actual measurements in the building as built. Reasonable changes in locations ordered by the Architect prior to the performance of the affected Work shall be provided at no additional cost to the Owner.
- C. Drawing Scale: Due to the small scale of the drawings, and to unforeseen job conditions, all required offsets, transitions and fittings may not be shown but shall be provided at no additional cost.
- D. Conflict: In the event of a conflict, the Architect will render an interpretation in accordance with the General Conditions.

1.5 DEFINITIONS

- A. Provide/Install: The word "provide" shall mean furnish, install, connect, test, complete, and leave ready for operation. The word "install" where used in conjunction with equipment furnished by the Owner or under another contract shall mean mount, connect, complete, and leave ready for operation.
- B. Concealed: The surface of insulated or non-insulated piping, ductwork or equipment is concealed from view when standing inside a finished room, such as inside a chase or above a ceiling.
- C. Exposed: The surface of insulated or non-insulated piping, ductwork or equipment is seen from inside a finished room, such as inside an equipment or air handling unit room.
- D. Protected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building but protected from direct exposure to rain by an overhang, eave, in an unconditioned parking garage or building crawl space.
- E. Unprotected: The surface of insulated or non-insulated piping, ductwork or equipment on the exterior of the building and exposed to rain.
- F. Abbreviations: Abbreviations, where not defined in the Contract Documents, shall be interpreted to mean the normal construction industry terminology, as determined by the Architect. Plural words shall be interpreted as singular and singular words shall be interpreted as plural where applicable for context of the Contract Documents.

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1.6 SHOP DRAWINGS

A. General: Refer to paragraph entitled "SUBMITTAL" in this section. Include the following data:

1. Shop Drawings:

a. Submit shop drawings for the following:

- 1) Each piping system
- 2) Ductwork systems
- 3) Coordination drawings

1.7 RECORD DRAWINGS

A. Production: Maintain one set of black or blue line on white project record "as-built" drawings at the site. At all times the set shall be accurate, clear, and complete, indicating the actual installation. Record drawings shall be updated weekly to record the present stage of progress. These drawings shall be available to the Architect at all times. Equipment schedules, control diagrams, sequences of operation shall also be updated.

B. Completion: Prior to substantial completion, transfer onto an unmarked second set of drawings all changes, marked in colored pencil, and submit them to the Architect. Upon completion of all punch lists, transfer all "As-Built" conditions to the AutoCAD drawing files, package three (3) print sets of full size drawings and two (2) CDs of the AutoCAD drawing files with associated reference files and submit them to the Architect for review and approval.

1.8 SUBMITTAL

A. General: The provisions of this section are supplemental to the requirements in Division 1, and only apply to the material and equipment covered in Division 23.

B. Time: Submit manufacturer's literature, performance data and installation instructions covered in each Section of Division 23 under an individual letter of transmittal within 30 days after Notice to Proceed unless otherwise indicated.

C. Submitter's Review: All items required for each section shall be reviewed before submittal. Submittal information for each item shall bear a review stamp of approval, indicating the name of the Contractor and Subcontractor (where applicable), the material suppliers, the initials of submitter and date checked. Responsibility for errors or omissions in submittals shall not be relieved by the Architect's review of submittals. Responsibility for submittals cannot be subrogated to material suppliers by Contractors or Subcontractors.

1. Review of the submittal data, whether indicated with "APPROVED" or with review comments, does not constitute authorization for or acceptance of a change in the contract price.

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- D. Architect's Review: The submittal data shall be reviewed only for general conformance with the design concept of the project and for general compliance with the Contract Documents. Any action indicated is subject to the requirements of the Contract Documents. Reviews of submittal data review shall not include quantities; dimensions (which shall be confirmed and correlated at the job site); fabrication processes; techniques of construction; and co-ordination of the submittal data with all other trades. Copies of the submittal data will be returned marked "ACCEPTED AS SUBMITTED", "ACCEPTED AS NOTED", "REVISE AS NOTED AND RESUBMIT", "REJECTE, REVISED AS NOTED AND RESUBMIT".
- E. Submittal Items: Submittal items shall be inserted in a Technical Information Brochure. Mark the appropriate specification section or drawing reference number in the right hand corner of each item. All typewritten pages shall be on the product or equipment manufacturer's printed letterhead.
1. Manufacturer's Literature: Where indicated, include the manufacturer's printed literature. Literature shall be clearly marked to indicate the item intended for use.
 2. Performance Data: Provide performance data, wiring and control diagrams and scale drawings which show that proposed equipment will fit into allotted space (indicate areas required for service access, connections, etc.), and other data required for the Architect to determine that the equipment complies with the Contract Documents. Where noted, performance data shall be certified by the manufacturer at the design rating points.
 3. Installation Instructions: Where requested, each product submittal shall include the manufacturer's installation instructions. Generic installation instructions are not acceptable. Instructions shall be the same as those included with the product when it is shipped from the factory.
 4. Written Operating Instructions: Instructions shall be the manufacturer's written operating instructions for the specified product. If the instructions cover more than one model or type of product they shall be clearly marked to identify the instructions that cover the product delivered to the project. Operating Instructions shall be submitted immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
 5. Maintenance Instructions: Information shall be the manufacturer's printed instructions and parts lists for the equipment furnished. If the instructions cover more than one model or type of equipment they shall be marked to identify the instructions for the furnished product. Submit maintenance instructions immediately after the product or equipment submittal has been returned from the Architect marked "APPROVED" or "APPROVED AS NOTED".
- F. Substitutions:
1. General: Refer to Division 1. Substitutions may be considered for any product or equipment of a manufacturer. See paragraph entitled "MANUFACTURER" in this Section. Any product or equipment may be submitted for review; however, only one substitution per item will be considered. If a substituted product or equipment item is rejected, provide the specified product or equipment.
 - a. Submittal shall include the name of the material or equipment to be substituted, equipment model numbers, drawings, catalog cuts, performance and test data and any other data or information necessary for the Architect to determine that the

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- equipment meets the specification requirements. If the Architect accepts any proposed substitutions, such acceptance will be set forth in writing.
- b. Substituted equipment with all accessories installed or optional equipment where permitted and found acceptable, must conform to space requirements. Substituted equipment that cannot meet space requirements, whether accepted or not, shall be replaced at no additional expense to the Owner. If the substituted item affects the work of other trades, the Request for Substitution form shall include a list of the necessary modifications.
2. Deviations: The Request for Substitution form shall include a complete list of deviations from the scheduled item stating both the features and functions of the scheduled item and the comparable features and functions of the proposed substitution.
 - a. Any deviation not indicated in writing will be assumed to be identical to the specified item even if it is shown otherwise on the submittal data.
 - b. If a deviation not listed is found anytime after review and acceptance by the Architect and that deviation, in the opinion of the Architect, renders the substituted item as unacceptable, the item shall be removed and replaced by the scheduled item at no additional cost to the Owner.
 - c. The Architect shall retain the right to specify modifications to the substituted item, correcting or adjusting for the deviation, if the Architect deems it to be in the best interest of the Owner.
 3. Scheduled Item: A scheduled item is a product or item of equipment indicated in the Contract Documents by manufacturer's name and model number identifying a single item. The manufacturer's trade name for a group of products that does not signify a single item including type, style, quality, performance, and sound rating shall not be classified as a scheduled item. Where more than one manufacturer and product model number are indicated, each shall be considered as a scheduled item.
 4. Form: When a product or item of equipment is proposed as a substitution a "REQUEST FOR SUBSTITUTION" form shall be completed and submitted with the required data. A copy of the form is included after the end of this section.
 5. Rejection: Substituted products or equipment will be rejected if, in the opinion of the Architect, the submittal does not meet any one of the following conditions or requirements:
 - a. The submittal data is insufficient or not clearly identified. The Architect may or may not request additional information.
 - b. The product or equipment will not fit the space available and still provide the manufacturers published service area requirements.
 - c. The product or equipment submitted is not equivalent to or better than the specified item. Products or equipment of lesser quality may be considered provided an equitable financial rebate, satisfactory to the Architect, is to be returned to the Owner.
 - d. The product or equipment submitted has less capacity, efficiency and safety provisions than the specified item.
 - e. The product or equipment submitted does not have warranty, service and factory representation equivalent to that specified.
 - f. The Owner prefers not to accept the submitted product.

G. Technical Information Brochure:

1. Binder: Include binders with the first submittal for the Technical Information Brochure. Each binder shall be size 3 inch, hardcover, 3-ring type for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on spine of each binder, i.e., MECHANICAL SUBMITTAL DATA, MECHANICAL OPERATION INSTRUCTION and MECHANICAL MAINTENANCE INSTRUCTIONS.
2. Number: Submit not less than five sets of binders for each of the three mechanical brochures indicated above. Each set shall consist of a minimum of two binders for submittal data and 1 binder each for operating instructions and for maintenance instructions. Additional binders shall be submitted at the request of the Architect. One set of binders shall be retained by the Architect. Three sets of binders shall be maintained for the Owner and the remaining set shall become the property of the Engineer.
3. Index: First sheet in each brochure shall be a photocopy of the "Division 23 Index" of the specifications. Second sheet shall list the firm name, address, phone number, superintendent's name for the contractor and all major subcontractors and suppliers associated with the project.
4. Dividers: Provide reinforced separation sheets tabbed with the appropriate specifications Section reference number for each Section in which submittal data or operation and maintenance instructions is required.
5. Specifications: Insert a copy of the specifications for each Section and all addenda applicable to the Section between each of the Section dividers.

1.9 SHOP DRAWINGS FOR PIPING SYSTEMS

- A. Requirements: Make Shop Drawings for piping systems at a minimum scale of 1/4 inch per foot in AutoCAD Version 2010 (or later) and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 2. Fabrication and erection dimensions.
 3. Arrangements and sectional views.
 4. Necessary details, including complete information for making connections to equipment.
 5. Descriptive names of equipment.
 6. Modifications and options to standard equipment required by Contract Documents.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and equipment connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.

- D. Additional Requirements: See specific Sections for additional requirements.

1.10 SHOP DRAWINGS FOR DUCT SYSTEMS

- A. Requirements: Make Shop Drawings for duct systems at a minimum scale of 1/4 inch per foot in AutoCAD Version 2010 (or later) and print on reproducible transparencies to verify clearances and equipment locations. Show required maintenance and operational clearances. Identify Shop Drawings by project name and include names of Architect, Engineer, Contractors, Subcontractors and supplier, date in Shop Drawing title block. Number drawings sequentially and indicate:
1. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
 2. Fabrication and erection dimensions.
 3. Arrangements and sectional views.
 4. Necessary details, including complete information for making connections to air distribution devices and air handling equipment.
 5. Kinds of materials and finishes.
 6. Descriptive names of equipment.
 7. Modifications and options to standard equipment required.
- B. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp. The acceptance of a shop drawing by indicating "APPROVED" does not relieve the contractor from full compliance with the sizes and connections shown on the contract documents unless the changes are specifically indicated on the shop drawing.
- C. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- D. Ceiling Plans: Provide Shop Drawings, using sepias of architectural reflected ceiling plans, which indicate locations of exposed air distribution devices, sprinkler heads, lights and access panel.
- E. Additional Requirements: See specific Sections for additional requirements.

1.11 COORDINATION DRAWINGS

- A. General: Provide detailed (minimum 1/4 inch per foot) scaled coordination drawings showing locations and positions of all architectural, structural, (FF&E) equipment, electrical, plumbing, fire protection and mechanical elements for all installations. Provide overlay drawings, prior to beginning work, indicating work in and above ceilings and in mechanical and electrical rooms with horizontal and vertical dimensions, to avoid interference with structural framing, ceilings, partitions and other services. Accommodate phasing and temporary conditions indicated on the contract drawings as necessary to complete the work without disruption to the Owner's use of the existing occupied areas of the building(s).
- B. Coordination of Space:

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1. Coordinate use of project space and sequence of installation of mechanical and electrical work which is indicated diagrammatically on drawings. Follow routings shown for pipes, ducts and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
 2. In finished areas except as otherwise shown, conceal pipes, ducts, and wiring in construction. Coordinate locations of fixtures and outlets with finish elements. Contractor shall provide background drawings showing partitions, ceiling heights, and structural framing locations and elevations, and existing obstructions. Contractor shall resolve major interferences at initial coordination meeting prior to production of coordination drawings.
- C. Precedence of Services: In event of conflicts and interferences involving location and layout of work, use the following priority to resolve interferences:
1. Structure has highest priority.
 2. Walls systems.
 3. Ceiling grid/light fixtures.
 4. Gravity drainage lines.
 5. Large pipe mains.
 6. Ductwork/diffusers, registers and grilles.
 7. Sprinkler heads.
 8. Small piping and tubing/electrical conduit.
 9. Access panels.
- D. Drawings shall be developed on AutoCAD Version 2010 (or later), and utilize AIA Standard layering conventions. At the completion of the project construction, the Contractor shall provide two (2) full-sized print sets and two (2) CDs of all drawing files with related reference files representing as-built installations for Architect review. Upon approval that the submitted information is complete, a similar submittal shall be provided to the Owner.
- E. Stamp Area: Leave 4 inch by 2-1/2 inch blank area near title block for Architect's shop drawing stamp.
- F. Reference Key: Indicate by cross-reference the Contract Drawings, notes, or Specification paragraph numbers where item(s) occur in the Contract Documents.
- G. Additional Requirements: See specific Sections for additional requirements.
- 1.12 MANUFACTURER'S CHECKOUT
- A. Start-up and Checkout: At completion of installation and prior to performance verification, a factory-trained representative of the manufacturer shall provide start-up and checkout service. After the performance verification the manufacturer's representative shall examine performance information and check the equipment in operation, and sign "Check-Out Memo" for the record. Submit a copy of Memo on each item of equipment where indicated in individual sections of these specifications for inclusion in each Technical Information Brochure. The "Check-Out Memo" shall be included with the performance verification data. Do not request "Instruction in

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Operation Conference" or request final inspection until Memos have been submitted and found acceptable.

1.13 INSTRUCTION TO OWNER

- A. General: Instructions to the Owner shall be by competent representatives of the manufacturers involved, with time allowed for complete coverage of all operating procedures. Provide classroom instruction and field training in the design, operation and maintenance of the equipment and troubleshooting procedures. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar provisions of the systems. On the date of substantial completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel.
- B. Training Period: Unless otherwise indicated, training periods shall encompass the following number of hours of classroom and hands-on instructions with a maximum period of 4 hours per day for either. Mixing classroom instructions and hands on training in the same day is unacceptable.
 - 1. Training periods:
 - a. 8 hours Classroom
 - b. 8 hours Hands-on
- C. Scheduling: Submit any remaining required items for checking at least one week before final inspection of building. When submittal items are found acceptable, notify Owner in writing that an "Instruction in Operation Conference" may proceed. Conference will be scheduled by the Owner. After the conference, copies of a memo certifying that the "Instruction in Operation Conference" and "Completed Demonstration" have been made will be signed by Owner and the instructors, and one copy will be inserted in each Technical Information Brochure.

1.14 ALLOWANCES

- A. General: Division 1.

1.15 ALTERNATES

- A. Refer to Division 1.

1.16 STRUCTURAL CALCULATIONS FOR ROOF-MOUNTED EQUIPMENT

- A. All roof-mounted devices, equipment and systems shall be constructed, designed and fastened to withstand wind loads of velocities up to 155 mph, as applicable to the wind zone of the project. Structural calculations for roof-mounted equipment shall be completed in accordance with Florida Building Code requirements and Florida Administrative Code Rule 9B-72 and submitted by a structural engineer registered in the State of Florida.

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Specified Products: Manufacturer's names and product model numbers indicated on the drawings and in these specifications establish the type, style, quality, performance, and sound rating of the desired product. Listing of other manufacturers indicates that their equivalent products would be acceptable if they meet the specification requirements, the specific use and installation shown on the drawings, including space and clearance requirements, and the energy consumption and efficiency of the specified product. The listing of additional manufacturers in no way indicates that the manufacturer can provide an acceptable product.
- B. Space Requirements: All manufactured products furnished on this project must have the required space and service areas indicated in the manufacturer's printed literature or shown on their shop drawing. When the manufacturer does not indicate the space required for servicing the equipment, the space shown on the drawings or as required by the Architect must be provided.

2.2 MATERIAL AND EQUIPMENT

- A. General: Material and equipment used shall be produced by manufacturers regularly engaged in the production of similar items, and with a history of satisfactory use as judged by the Architect.
- B. Specified Equipment: Equipment shall be the capacity and types indicated or shall be equivalent in the opinion of the Architect. Material and equipment furnished and installed shall be new, recently manufactured, of standard first grade quality and designed for the specific purpose. Equipment and material furnished shall be the manufacturer's standard item of production unless specified or required to be modified to suit job conditions. Sizes, material, finish, dimensions and the capacities for the specified application shall be published in catalogs for national distribution. Ratings and capacities shall be certified by a recognized rating bureau. Products shall be complete with accessories, trim, finish, safety guards and other devices and details needed for a complete installation and for the intended use and effect.
- C. Compatibility: Material and equipment of one and the same kind, type or classification and used for identical or similar purposes shall be made by the same manufacturer. Where more than one choice is available, select the options which are compatible with other products already selected. Compatibility is a basic general requirement of product selection.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be done in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a first-quality installation. Personnel who install materials and equipment shall be qualified by

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training and experience to perform their assigned tasks. All materials and equipment shall be installed per the manufacturer's written requirements.

- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function which conforms to applicable standards of building system construction and exhibits a degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.
- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship in the opinion of the Architect, shall be removed and reinstalled by qualified craftsmen at no change in the contract price.

3.2 AIR CONVEYANCE SYSTEM MECHANICAL CLEANING (NEW DUCT INSTALLATION)

- A. General: The following criteria shall be used for the installation of all new HVAC air conveyance systems (ACS).
- B. Qualifications: The enhanced air conveyance system cleaning procedures shall be performed by the Contractor. Microbiological analysis shall be performed by a firm which is acceptable to the Architect and which can demonstrate their ability to conduct the required analysis and reporting according to the NADCA and National Institute for Occupational Safety and Health (NIOSH) Methods. Submit for review and acceptance by the Architect the proposed procedure methodologies to be utilized, a listing of the proposed equipment to be used, and the proposed chemical agents to be used. A mock-up cleaning station and procedural presentation of cleaning process shall be performed at least three months prior to any ductwork installation for review by the Architect
- C. Cleaning Procedure: All ductwork transported to the project shall be protected from weather and debris. Each HVAC duct section shall, prior to installation, be cleaned and disinfected at an approved cleaning station established on-site. Exhaust ductwork shall only require surface preparation from Note 1 below. All air distribution devices (diffusers, grilles, registers) including backpans of supply devices in critical areas, as defined by AIA, shall be decontaminated pursuant to Note 3 below. Four stages of ACS cleaning shall occur:
 - 1. Surface dirt shall be removed by mechanical means, HEPA filtered vacuum and washed down with disposable cleaning cloths and 1:200 solution of trisodium phosphate (TSP) detergent.
 - 2. Wipe down surface with TSP solution again, frequently disposing contaminated cloths.
 - 3. Decontaminate duct section with a diluted solution (4-6 tablespoons per gallon or as directed by manufacturer for use) of chlorhexidine diacetate, similar to Aveco Company Nolvasan, for an appropriate contact period then wipe down and rinse with clean cloths per the application processes defined by manufacturer guidelines.
 - 4. Cap ducts with a 6 mil. plastic fastened completely to duct openings.

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- D. Cleaning Station: Provide a conditioned, positively pressurized, ventilated temporary enclosure to perform duct cleaning procedures. Perform all work and use protective measures as prescribed by cleaning, decontaminating solution manufacturer guidelines.
- E. Sterilization, Occupied Facility: After the ACS has been cleaned and installed, provide surface sampling shall be performed by firm to confirm absence of *Aspergillus fumigatus*. Upon installation of a zone, the entire ACS shall then be flooded with Bioclean, or another low-odor dual quaternary ammonium compound, EPA registered for use in HVAC systems, and acceptable to the Architect, to sterilize the ACS. The ACS shall be tested in compliance with NADCA Level III sampling protocol until all air samples indicate a colony forming unit (CFU) count of 1.0 CFU per cubic meter or less; re-clean, re-sterilize and retest until all samples achieve results at or below this threshold level.
- F. Reporting: Provide a complete report detailing the above processes. The report shall contain, as a minimum, the procedure methodologies utilized; the listing of the equipment used; a description of the portions of the ACS which were treated; the chemical agents which were used; the test results from the analysis.

3.3 CLEANING AND PROTECTION

- A. General: Refer to Division 1.
- B. Emergency Contacts: Prior to the beginning of the project, provide the Owner with a list of names, emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period if leaks, equipment failure or other damages occur. Update the list throughout installation and warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- C. Emergency Contacts: Along with the operating and maintenance manual submittal, provide the Owner with a list of the names and emergency telephone and beeper numbers of individuals who can be contacted during working and non-working hours, including weekends, for assistance throughout the warranty period should leaks, equipment failure or other damage occur. Update the list throughout warranty to provide continuous availability of responsible parties to the Owner. If the Owner cannot contact the responsible party during an emergency situation, the Owner may effect emergency repairs through other means and may backcharge for the costs of repair material and labor incurred.
- D. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Close open ends of piping and ductwork at all times throughout the installation. Install 30% efficient filter media over each return air grille and open return duct opening; change media regularly during construction when dirty to keep duct interiors clean. Prevent dust, debris and foreign material from entering the piping and ductwork.

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- E. Equipment Protection: Protect fan motors, switches, equipment, fixtures, and other items from dirt, rubbish and foreign matter. Do not operate air-handling equipment if the building is not clean or if dust can enter the coils or the fan housings.
- F. Equipment Cleaning: Thoroughly clean equipment and entire piping systems internally upon completion of installation and immediately prior to final acceptance. Open dirt pockets and strainers, blow down each piping system and clean strainer screens of accumulated debris. Remove accumulated dirt, scale, oil and foreign substances. Thoroughly wipe clean internal surfaces of ductwork and air handling units prior to request for substantial completion. (See para. 3.2 above.)
- G. Building Cleanup: Remove debris, rubbish, leftover materials, tools and equipment from work areas and site. Clean tunnels and closed off spaces of packing boxes, wood frame members and other waste materials used in the installation. Final acceptance shall not be approved until site is cleaned.
- H. Fixture Cleanup: Remove temporary labels, stickers, etc., from fixtures and equipment. Do not remove permanent nameplates, equipment model numbers, ratings, etc.
- I. Filter Replacement: Provide filters, with the same efficiency rating as required for the final installation, for the protection of the air moving equipment and ductwork continuously throughout the construction phase. Provide a new set of clean filters for the test and balance of the air side equipment.
- J. Protection of Finished Installation: Where installation is required in areas previously finished by other trades, protect the area from marring, soiling or other damage.
- K. Air Handling Unit Operation During Construction Phase: Do not operate air handling equipment during building construction phase unless filter fabric is fastened to all duct systems' inlets and all specified and scheduled air filters are installed to minimize dirt entry into ductwork and air moving equipment. When running air handling units to dry out the building, control the building temperature to drop very slowly, and verify all HVAC insulation is completed and doors and windows are installed and closed, to prevent condensation of water from humid air on building interior surfaces, equipment, materials and ductwork.

3.4 CORRECTION OF WORK

- A. General: At no additional cost to the Owner, rectify discrepancies between the actual installation and contract documents when in the opinion of the T&B Agency or the Architect the discrepancies will affect system balance and performance.
- B. Drive Changes: Include the cost of all pulley, belt, and drive changes, as well as balancing dampers, valves and fittings, and access panels to achieve proper system balance recommended by the T&B Agency.

3.5 COORDINATION AND ASSISTANCE

- A. General: Provide all labor, equipment, tools and material required to operate the equipment and systems necessary for the testing and balancing of the systems and for the adjustment, calibration or repair of all electric or pneumatic automated control devices and components. These services shall be available on each working day during the period of final testing and balancing.
- B. Drawings and Specifications: Provide to the T&B Agency a complete set of project record drawings and specifications and an approved copy of all HVAC shop drawings and equipment submittals. The T&B Agency shall be informed of all changes made to the system during construction, including applicable change orders.
- C. Coordination: Coordinate the work of all trades and equipment suppliers to complete the modifications recommended by the T&B Agency and accepted by the Architect. Cut or drill holes for the insertion of air measuring devices as directed for test purposes; repair to as-new condition, inserting plastic caps or covers to prevent air leakage. Repair or replace insulation and re-establish the integrity of the vapor retardant.

3.6 PREPARATIONS FOR PERFORMANCE VERIFICATION

- A. Verification: Prior to commencement of the balancing by the T&B Agency, the Contractor shall verify in writing:
 - 1. That air filters have been replaced and are in clean condition.
 - 2. That linkages between dampers and their actuators are secure, non-overloading and non-binding.
 - 3. That ductwork specialties are in their normal operating positions.
 - 4. That fans are operating at the correct rotation and specified RPM.
 - 5. That ductwork has been pressure tested and accepted.
 - 6. That strainers have been removed, cleaned and replaced, and that temporary construction strainers have been removed.
 - 7. That compression or expansion tanks have been inspected, are not air-bound or water-logged and are pre-charged, and that the piping systems have been completely vented and filled with water.
 - 8. That air vents at coils and high points of the piping systems have been inspected and installed and operating freely.
 - 9. That automatic valves, hand valves, and balancing valves have been placed in a fixed open position for full flow through all devices.
 - 10. That linkages between valves and their actuators are secure, non-overloading and non-binding.
 - 11. That pressures for hydronic reducing valves have been set.
 - 12. That operating temperatures have been set for chillers, regulating valves, etc.
 - 13. That pumps are operating at the correct rotation and specified horsepower.
 - 14. That piping has been pressure tested and accepted and piping systems have been cleaned, flushed, sterilized and refilled with chemicals and prescribed treated water and vented.
 - 15. That the operating safeties (thermal overloads, firestat/freezestats, smoke detectors, relief valves, etc.), are installed and fully functional.
 - 16. That equipment has been lubricated and can be operated without damage.

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17. That the systems are operational and complete.
18. That no latent residual work remains to be completed.

3.7 ACCEPTANCE TESTING PROCEDURE

- A. General: Each HVAC system shall be tested to confirm proper operation and function in accordance with the construction documents and control sequence of operations.
- B. The enclosed checklists shall be completed for each system and signed off by the mechanical sub-contractor project representative, then verified and signed-off by the mechanical sub-contractor project supervisor and the construction manager systems engineer. All checklists shall be incorporated into the project's close-out manuals submitted for Owner record.
- C. On-site testing by the Architect and Engineer shall be performed at the discretion of the Architect/Engineer for any or all systems to confirm test results and system function.
- D. The Contractor is responsible to provide adequate time in the completion of the construction to perform these system tests prior to final inspections in the affected areas/systems.
- E. The Contractor is responsible for ensuring all required system tests are conducted successfully and recording associated test data and results.
- F. The Contractor is responsible for contacting the Architect and Engineer at least two weeks prior to system test availability and schedule acceptable to Architect/Engineer for on-site testing.
- G. If, in the Architect's and Engineer's opinion, the test results indicate that the systems' installation is not adequately complete for testing, the testing shall be re-scheduled and the Contractor shall be responsible to prepare for such re-test.
- H. Prior to Owner occupancy, all system testing shall be completed and approved.

3.8 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Requirements: Do not store fiberglass insulation or any equipment within the building until it has been "dried in". If dry space is unavailable and the insulation and equipment must be installed or stored before the building is "dried in" and completely enclosed, provide polyethylene film cover for protection.
- B. Replacement of Damaged Stored Material and Equipment: Any material and equipment that has been wet or otherwise damaged prior to installation, in the opinion of the Architect, shall be replaced with new material regardless of the condition of the material and equipment at the time of installation.
- C. Repair of Damaged Installed Material and Equipment: After installation correct or repair dents, scratches and other visible blemishes. At the direction of Architect replace or repair to "as new" condition equipment which has been damaged during construction.

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- D. During construction, all piping and ductwork system openings shall be capped with at least two layers of polyethylene film, fastened tightly in place with banding material or foil tape until connection of the continuation of such piping or ductwork is occurring.

3.9 ASBESTOS AND HAZARDOUS MATERIALS

- A. General: Should asbestos or other hazardous material be encountered during execution of the work, or should the presence of asbestos or other hazardous material be suspected, immediately notify the Architect and suspend work in the affected area. The Owner will initiate a study to determine if asbestos or other hazardous materials are present and will determine what action will be taken. Removal of asbestos or other hazardous materials will be done under a separate contract.

3.10 CLEAN-UP

- A. General: Debris and rubbish shall not be disposed into the Owner's containers.

END OF SECTION 230010

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ACCEPTANCE TESTING CHECKLIST		
1. AIR HANDLING UNIT # _____	OK	N/A
FANS AND CASING SECTIONS:		
1. Spring isolators installed and not bottomed out.		
2. Motor rotation correct and free fan wheel rotation.		
3. Motor belts aligned and properly tensioned.		
4. Proper starter/VFD installed and labeled.		
5. Bearing races secured tight to fan shaft.		
6. Bearing grease cert fitting accessible and lubricated.		
7. All bolts, fasteners, and set screws checked & tightened.		
8. At full speed, fans have no unusual noise or vibration.		
9. All safety guards are properly installed.		
10. Access doors close tightly, door gaskets installed.		
11. Casing/duct sealed with proper sealant.		
12. Proper insulation installed on casing and duct, and joints sealed.		
13. No evidence of air escaping unit or insulation ballooning w/fans on.		
14. No evidence of negative machine room pressure with fans operating.		
15. Fan air volume measuring device installed.		
16. Duct static pressure control sensor installed at proper location.		
17. Duct safety static pressure sensor installed at proper location.		
18. Flex connection at fan discharge installed.		
19. Condensate drain trapped properly and run to floor drain.		
20. Manufacturer's required clearances for unit/components maintained.		
21. Dampers/actuators properly installed & close tightly.		
22. Damper linkage checked for binding, min. play & right blades.		
23. Required maintenance clearances maintained.		
24. Filters installed tightly and checked for no bypass.		
25. Metal spacers installed in filter rack.		
26. Filter manometers installed and calibrated.		
27. Air Handler control system operational.		
CHILLED WATER COILS:		
1. Coils clean and fins in good condition.		
2. No open area around coil for air bypass.		
3. Coil piped for counter flow.		
4. Chilled water pipe complete and piping properly supported.		
5. Chilled water pipe is properly insulated and labeled.		
6. Chilled water pipe pressure test complete and no leaks.		

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7. Air bleed valves with caps installed.		
8. Strainers, drain valve, hose bib and cap installed.		
9. Dirt leg drain valve w/hose bib connections & caps installed.		
10. Piping, valves, and clearances accommodate coil removal.		
11. Balance valve properly installed.		
12. Control valves properly installed.		
13. Pilot positioner installed on control valve actuator.		
14. Thermometers, PT plugs, pressure gages properly installed.		
15. Condensate pan, drain, and trap drains condensate properly.		

Air Handling Unit Comments:

Approvals:

_____ Date _____ Date _____
Mech. Contractor Signature GC PM/Sys. Engineer Signature

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2. TERMINAL BOX #_____	OK	N/A
1. At least 1 & 1/2 box inlet diameter of hard duct attached to box inlet.		
2. Run out from lateral is the correct size.		
3. Required clearance for servicing box.		
4. Electrical connections complete.		
5. Box properly located and supported.		

Terminal Box Comments:

Approvals:

Mech. Contractor Signature

Date

GC PM/Sys. Engineer Signature

Date

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REQUEST FOR SUBSTITUTION (Must be Submitted Prior to Bid)

Project Name: _____ Location: _____

Date of Request: _____

Name of Party Requesting Substitute:

Reason for Substitution Request:

<u>Drawing</u>	<u>Spec. Sect. No.</u>	<u>Paragraph</u>	<u>Specified Item</u>	<u>Manu</u>	<u>Model</u>
_____	_____	_____	_____	_____	_____

Proposed Substitute: _____

Manufacturer and Model Number:

Deviations from the Specified Item: (See paragraph entitled "Deviations".)

Reason for Substitution:

Changes to Other Systems to Permit Use of Proposed Substitute:
(List changes. Submit drawings if required for clarity.)

Technical Data to Support Request for Acceptance:
(List ASTM or other standards designations, testing laboratory reports, experience records, etc.)

Other Supporting Data:
(Submit brochures, samples, drawings, etc.)

REQUEST FOR SUBSTITUTION (Continued)

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Certification: In making request for substitution, the party whose authorized signature appears below, certifies that all of the following statements are correct and are accepted without exception:

- The proposed substitution has been personally investigated and is equal or superior in all significant respects to the product specified for the specific applications required;
- The proposed substitution will be warranted under the same terms required for the specified product;
- Coordination aspects necessitated by the proposed substitution will be accomplished in a complete and proper fashion by the party signing this form without any additional cost to the Owner; and
- Claims against the Owner for additional costs related to the proposed substitution which subsequently become apparent after acceptance by the Architect are hereby waived.

Credit: If this substitution is acceptable the following credit shall be given to the Owner;

\$ _____

CERTIFICATION OF EQUIVALENT PERFORMANCE AND ASSUMPTION OF LIABILITY FOR EQUIVALENT PERFORMANCE

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted by:

Signature

Title

Typed Name

Company

Signature shall be by person having authority to legally bind his firm to the above terms. Failure to provide a legally binding signature will invalidate this request.

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.
- B. Division 23 Contractors shall be responsible to carry out the commissioning requirements specified in the commissioning sections, and all other sections where related to commissioning. Provide all necessary labor, materials, and coordination required for successful completion of the commissioning requirements.
- C. It is the responsibility of each individual trade to provide access doors and frames of the appropriate size and locations to allow access to their respective equipment, valves, dampers, pull boxes, etc.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

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- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
 - 1. CPVC: Chlorinated polyvinyl chloride plastic.
 - 2. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Dielectric fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.

- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

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1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- 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.
 - 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.
 - 2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, 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, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

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2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
- E. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 - 1. Sealing Elements: EPDM 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. Include two for each sealing element.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

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- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated.
- D. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.
- E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

2.7 VIBRATION AND SOUND CONTROL

- A. Contractor shall provide hanging and support in compliance with Specification Section 230548.13 VIBRATION CONTROL FOR HVAC.

2.8 EXPOSED DUCTWORK AND EQUIPMENT

- A. All exposed ductwork and equipment shall be installed with attention to aesthetic details. System shall be installed in a logical method.
 - 1. Equipment shall be systematically laid out. Exposed piping, ductwork, etc. that is visually undesirable to the architect/engineer shall be reinstalled at the contractor's sole expense.
 - 2. Exposed Ductwork in the space that is visually undesirable to the architect/engineer shall be reinstalled at the contractor's sole expense.

2.9 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. 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.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

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- 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 to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and screw set.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed or exposed-rivet hinge and set screw or spring clips.
 - h. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - i. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with set screw or spring clips.
 - j. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 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. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

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2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
 - b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
 3. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- 3.2 PIPING JOINT CONSTRUCTION
- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
 - B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

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- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. 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.
- E. 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.
- F. 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.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PIPING CONNECTIONS

- A. 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. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

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3.5 PAINTING

- A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. 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 the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi , 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 5 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.

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G. Place grout around anchors.

H. Cure placed grout.

3.9 COMMISSIONING

A. Division 23 Contractors shall be responsible to carry out the commissioning requirements specified in the commissioning sections, and all other sections where related to commissioning. Provide all necessary labor, materials, and coordination required for successful completion of the commissioning requirements.

3.10 ACCESS DOORS AND FRAMES

A. Provide access doors and frames of the appropriate size and locations to allow access to mechanical equipment, valves, dampers, etc. All locations are to be field verified with the Architect prior to installation.

3.11 INSTALLATION OF HVAC EQUIPOMENT SUPPLIED BY OTHER DIVISIONS

A. Division 23 Contractors shall be responsible to provide all necessary labor, materials, and coordination required for successfully installation of equipment provided by other divisions but vital for successful operation of HVAC equipment. Equipment and materials vital for successful operation of HVAC equipment include but are not limited to the following:

1. Control Dampers
2. Control Valves
3. Thermowells
4. Pipe Taps
5. Water Sensors and Switches

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes general requirements for single-phase and poly-phase, 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.

1.3 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

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 104 deg F and at altitude of 3300 feet above sea level.

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- 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.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15, unless noted otherwise.
- 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.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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5. Shaft Grounding Rings:

- a. All motors controlled by Variable Frequency Controllers shall be equipped with Shaft Grounding Ring kits. Kits shall be installed by motor or equipment manufacturer or installed in the field by contractor in accordance with NEMA MG-1 31.4.4.3. Shaft Grounding Ring kits shall be manufactured by AEGIS or approved equal.
- b. Ensure Shaft Grounding Kit is installed on motors in accordance with the manufacturer's recommendations.
- c. Motors shall be NEMA Premium® and inverter duty and have class F, G or H insulation and have the capability to install Shaft Grounding Ring. Motors shall be Marathon (Mod Central), Baldor (Mod Express) or approved equal.

B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 1. Permanent-split capacitor.
- 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 230513

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SECTION 230514 - VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION

- A. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use with a standard NEMA Design B induction motor.
- B. The drive manufacturer shall supply the drive and all necessary options, specified. The manufacturer shall have been engaged in the production of this type of equipment for a minimum of ten years. All VFDs installed on this project shall be from the same manufacturer.

1.3 SUMMARY

- A. Related Sections:
 - 1. Section 237314 – Indoor Central-Station Air-Handling Units
 - 2. Section 233423 - HVAC Power Ventilators
 - 3. Section 232123 - Hydronic Pumps
 - 4. Section 230900 – Instrumentation and Control For HVAC
- B. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers
 - 1. IEEE C62.41 – Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association
 - 1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. NEMA FU 1 – Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 7 – Industrial Control and Systems: Adjustable Speed Drives.
 - 4. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems.
- C. International Electrical Testing Association

1. NETA ATS – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- B. Product Data: For each type and rating of VFC indicated. Include the following features:
 1. Performance
 2. Electrical Ratings
 3. Operating Characteristics
 4. Dimensioned outline drawing
 5. Schematic diagram
 6. Component list
 7. Power and control connection diagram(s).
 8. Bacnet Interface Controller
9. Compliance to IEEE 519 – harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
 - a. The VFD manufacturer shall provide calculations; specific to this installation, showing total harmonic voltage distortion is less than 5%. Input filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors.
- C. Test Reports: Indicate field test and inspection procedures and test results.
- D. Manufacturer's Field Reports: Indicate start-up inspection findings.
- E. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD (V) at each VFC to specified levels.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 - Execution and closeout requirements.
- B. Provide final equipment submittal information with all noted corrections incorporated.
- C. Field quality-control reports
- D. Operation and Maintenance Data: Submit instructions complying with NEMA ICS 7.1. Include procedures for starting and operating controllers, and describe operating limits possibly resulting in hazardous or unsafe conditions. Include routine preventive maintenance schedule.

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip setting.
 2. Manufacturer's written instructions for setting field-adjustable overload relays.
 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
 4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
- E. Load Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motor to be protected.

1.7 QUALITY ASSURANCE

- A. Refer to calculation and additional testing requirements located within Division 26 and Part 3 of this Section.
- 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. QUALITY ASSURANCE

1. Referenced Standards:
 - a. Institute of Electrical and Electronic Engineers (IEEE)
 - 1) Standard 519-1992, IEEE Guide for Harmonic Content and Control.
 - b. Underwriters laboratories
 - 1) UL508C
 - c. National Electrical Manufacturer's Association (NEMA)
 - 1) ICS 7.0, AC Adjustable Speed Drives
 - d. IEC 16800 Parts 1 and 2
 - e. National Electric Code (NEC)
 - 1) NEC 430.120, Adjustable-Speed Drive Systems
2. Qualifications:
 - a. VFDs and options shall be UL listed as a complete assembly. VFD's that require the customer to supply external fuses for the VFD to be UL listed are not acceptable. VFDs with red label UL stickers, requiring additional branch circuit protection are not acceptable. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Section 01 – Product Requirements: Product storage and handling requirements.
- B. Store in clean, dry space. Maintain factory wrapping and provide additional plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions:
 - 1. Ambient Temperature: Not less than 14 deg. F. and not exceeding 104 deg. F.
 - 2. Ambient Storage Temperature: Not less than minus 4 deg. F. and not exceeding 140 deg. F.
 - 3. Humidity: Less than 95 percent (noncondensing).
 - 4. Altitude: Not exceeding 1000 feet.
- B. Conform to NEMA ICS 7 service conditions during and after installation of variable frequency controllers.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within the specified warranty period.
- B. Furnish five year manufacturer warranty for variable frequency controller.

1.11 TRAINING

- A. Contractor shall provide 16 hours of training to Owner divided into 4 sessions.
- B. Training shall be video taped by a licensed videographer. One DVD copy shall be provided to the owner and one DVD copy shall be provided to the commissioning agent for issuance into the commissioning report.

1.12 MAINTENANCE SERVICE

- A. Section 01 – Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of variable frequency controller for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY CONTROLLER

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. ABB
 2. Danfoss
 3. Yaskawa

2.2 VARIABLE FREQUENCY CONTROLLER

- A. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, exceeding NEMA enclosure design criteria (enclosures with only NEMA ratings are not acceptable), completely assembled and tested by the manufacturer in an ISO9001 facility. The VFD tolerated voltage window shall allow the VFD to operate from a line of +30% nominal, and -35% nominal voltage as a minimum.
1. Environmental operating conditions: VFDs shall be capable of continuous operation at 0 to 500 C (32 to 1220 F) ambient temperature as per VFD manufacturers documented/submittal data or VFD must be oversized to meet these temperature requirements. Not acceptable are VFD's that can only operate at 40° C intermittently (average during a 24 hour period) and therefore must be oversized. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
- B. All VFDs shall have the following standard features:
1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
 2. The keypad shall include Hand-Off-Auto selections and manual speed control. The drive shall incorporate "bumpless transfer" of speed reference when switching between "Hand" and "Auto" modes. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
 3. There shall be a built-in time clock in the VFD keypad. The clock shall have a battery backup with 10 years minimum life span. The clock shall be used to date and time stamp faults and record operating parameters at the time of fault. If the battery fails, the VFD shall automatically revert to hours of operation since initial power up. Capacitor back-up is not acceptable. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter sets and output Form-C relays. The VFD shall have a digital input that allows an override to the time clock (when in the off mode) for a programmable time frame. There shall be four (4) separate, independent timer functions that have both weekday and weekend settings.
 4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time. The VFD shall have two user macros to allow the end-user to create and save custom settings.

5. The VFD shall have cooling fans that are designed for easy replacement. The fans shall be designed for replacement without requiring removing the VFD from the wall or removal of circuit boards. The VFD cooling fans shall operate only when required. To extend the fan and bearing operating life, the VFD shall cycle the cooling fans on and off as required.
6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to set point without tripping or component damage (flying start).
7. The VFD shall have the ability to automatically restart after an over-current, over-voltage, under-voltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between attempts shall be programmable.
8. The overload rating of the drive shall be 110% of its normal duty current rating for 1 minute every 10 minutes, 130% overload for 2 seconds. The minimum FLA rating shall meet or exceed the values in the NEC/UL table 430.250 for 4-pole motors.
9. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD's with only one DC reactor shall add an AC line reactor.
10. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120. Input and output current ratings must be shown on the VFD nameplate.
11. The VFD shall include a coordinated AC transient surge protection system consisting of 4-120 joule rated MOV's (phase to phase and phase to ground), a capacitor clamp, and 5% impedance reactors.
12. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
13. The VFD shall have user programmable underload and overload curve functions to allow user defined indications of broken belt or mechanical failure / jam condition causing motor overload
14. The VFD shall include multiple "two zone" PID algorithms that allow the VFD to maintain PID control from two separate feedback signals (4-20mA, 0-10V, and / or serial communications). The two zone control PID algorithm will control motor speed based on a minimum, maximum, or average of the two feedback signals. All of the VFD PID controllers shall include the ability for "two zone" control.
15. If the input reference (4-20mA or 0-10V) is lost, the VFD shall give the user the option of either (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The drive shall be programmable to signal this condition via a keypad warning, Form-C relay output and / or over the serial communication bus.
16. The VFD shall have programmable "Sleep" and "Wake up" functions to allow the drive to be started and stopped from the level of a process feedback signal.

C. All VFDs to have the following adjustments:

1. Three (3) programmable critical frequency lockout ranges to prevent the VFD from operating the load continuously at an unstable speed. The lockout range must be fully adjustable, from 0 to full speed.
2. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The VFD shall have 250 ma of 24 VDC auxiliary power and be capable of loop powering a transmitter supplied by others. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus. There shall be two independent parameter sets for the PID controller and the capability to switch between the parameter sets via a digital input, serial communications or from the keypad. The independent parameter sets are typically used for night setback, switching between summer and winter set points, etc.
3. There shall be an independent, second PID loop that can utilize the second analog input and modulate one of the analog outputs to maintain the set point of an independent process (ie. valves, dampers, etc.). All set points, process variables, etc. to be accessible from the serial communication network.
4. Two (2) programmable analog inputs shall accept current or voltage signals.
5. Two (2) programmable analog outputs (0-20ma or 4-20 ma). The outputs may be programmed to output proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power (kW), DC Bus voltage, Active Reference, Active Feedback, and other data.
6. Six (6) programmable digital inputs for maximum flexibility in interfacing with external devices. All digital inputs shall be programmable to initiate upon an application or removal of 24VDC or 24VAC.
7. Three (3) programmable, digital Form-C relay outputs. The relay outputs shall include programmable on and off delay times and adjustable hysteresis. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 A at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating of 2 amps RMS. Outputs shall be true Form-C type contacts; open collector outputs are not acceptable.
8. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display "start enable 1 (or 2) missing". The safety input status shall also be transmitted over the serial communications bus.
9. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
10. Seven (7) programmable preset speeds.
11. Two independently adjustable accel and decel ramps with 1 – 1800 seconds adjustable time ramps.

12. The VFD shall include a motor flux optimization circuit that will automatically reduce applied motor voltage to the motor to optimize energy consumption and reduce audible motor noise. The VFD shall have selectable software for optimization of motor noise, energy consumption, and motor speed control.
 13. The VFD shall include a carrier frequency control circuit that reduces the carrier frequency based on actual VFD temperature that allows higher carrier frequency settings without derating the VFD.
 14. The VFD shall include password protection against parameter changes.
- D. The Keypad shall include a backlit LCD display. The display shall be in complete English words for programming and fault diagnostics (alpha-numeric codes are not acceptable). All VFD faults shall be displayed in English words. The keypad shall include a minimum of 14 assistants including:
1. Start-up assistant.
 2. Parameter assistants:
 - a. PID assistant
 - b. Reference assistant
 - c. I/O assistant
 - d. Serial communications assistant
 - e. Option module assistant
 - f. Panel display assistant
 - g. Low noise set-up assistant
 3. Maintenance assistant
 4. Troubleshooting assistant
 5. Drive optimizer assistants
- E. All applicable operating values shall be capable of being displayed in engineering (user) units. A minimum of three operating values from the list below shall be capable of being displayed at all times. The display shall be in complete English words (alpha-numeric codes are not acceptable):
1. Output Frequency
 2. Motor Speed (RPM, %, or Engineering units)
 3. Motor Current
 4. Motor Torque
 5. Motor Power (kW)
 6. DC Bus Voltage
 7. Output Voltage
- F. Serial Communications
1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be ASHRAE 135 - BACnet. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" BTL Listed for BACnet. Use of non-certified protocols is not allowed.

2. The BACnet connection shall be an EIA-485, MS/TP interface operating at 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
 - a. Data Sharing – Read Property – B.
 - b. Data Sharing – Write Property – B.
 - c. Device Management – Dynamic Device Binding (Who-Is; I-Am).
 - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
 - e. Device Management – Communication Control – B.
3. If additional hardware is required to obtain the BACnet interface, the VFD manufacturer shall supply one BACnet gateway per drive. Multiple VFDs sharing one gateway shall not be acceptable.
4. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible.
5. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible.
6. The VFD / bypass shall allow the DDC to control the drive and bypass digital and analog outputs via the serial interface. This control shall be independent of any VFD function. The analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive and bypass' digital (Form-C relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive and bypass' digital inputs shall be capable of being monitored by the DDC system. This allows for remote monitoring of which (of up to 4) safeties are open.
7. The VFD shall include an independent PID loop for customer use. The independent PID loop would be used for chilled water value control. Both the VFD PID control loop and the independent PID control loop shall continue functioning even if the serial communications connection is lost. As default, the VFD shall keep the last good set point command and last good DO & AO commands in memory in the event the serial communications connection is lost and continue controlling the process.

- G. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted level with up to 100 feet of motor cable. No Exceptions. Certified test reports shall be provided with the submittals confirming compliance to EN 61800-3, First Environment.
- H. All VFD's through 25HP at 480 V shall be protected from input and output power mis-wiring. The VFD shall sense this condition and display an alarm on the keypad. The VFD shall not sustain damage from this power mis-wiring condition.
- I. ADDITIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
 - 1. Fieldbus adapters - BACnet MS / TP, shall be provided by adding of an optional card.
- J. BYPASS CONTROLLER
 - 1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses are required. UL Listed motor overload protection shall be provided in both drive and bypass modes.
 - 2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
 - 3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
 - 4. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs which have no such fuses, or that incorporate fuses common to both the VFD and the bypass, will not be accepted.
 - 5. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
 - 6. The bypass shall maintain positive contactor control through the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
 - 7. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
 - 8. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for standalone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.

9. Serial communications – the bypass shall be capable of being monitored and controlled via serial communications. Communication shall be through BACnet MS / TP.
10. Serial communication capabilities shall include, but not be limited to; bypass run-stop control; the ability to force the unit to bypass; and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the DDC to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The DDC shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output – keypad “Hand” or “Auto” selected, bypass selected, and broken belt indication. The DDC system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications. A minimum of 50 field serial communications points shall be capable of being monitored in the bypass mode.
11. The bypass serial communications shall allow control of the bypass’ digital outputs via the serial interface. This control shall be independent of any bypass function or operating state. The bypass’ digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the bypass’ digital inputs shall be capable of being monitored by the DDC system.
12. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the building automation protocol and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause only a warning or a fault and / or system shutdown.
13. The digital inputs for the system shall accept 24VAC or 24VDC. The bypass shall incorporate an internally sourced power supply and not require an external control power source. The bypass power board shall supply 250 ma of 24 VDC for use by others to power external devices.
14. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open (motor does not operate). When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman’s override / smoke control mode.
15. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to fire a Form-C relay output, and / or over the serial communications protocol.
16. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.

17. There shall be a keypad adjustment to select manual or automatic transfer bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to the bypass mode and which faults require a manual transfer to bypass. The user may select whether the system shall automatically transfer from drive to bypass mode on the following drive fault conditions:
 - a. Over current
 - b. Over voltage
 - c. Under voltage
 - d. Loss of analog input
18. The following operators shall be provided:
 - a. Bypass Hand-Off-Auto
 - b. Drive mode selector
 - c. Bypass mode selector
 - d. Bypass fault reset
19. The bypass shall include a two line, 20 character LCD display. The display shall allow the user to access and view:
 - a. Energy savings – in US dollars
 - b. Bypass motor amps
 - c. Bypass input voltage– average and individual phase voltage
 - d. Bypass power (kW)
 - e. Bypass faults and fault logs
 - f. Bypass warnings
 - g. Bypass operating time (resettable)
 - h. Bypass energy (kilowatt hours – resettable)
 - i. I/O status
 - j. Parameter settings / programming
 - k. Printed circuit board temperature
20. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
 - a. Power-on (Ready)
 - b. Run enable
 - c. Drive mode selected
 - d. Bypass mode selected
 - e. Drive running
 - f. Bypass running
 - g. Drive fault
 - h. Bypass fault
 - i. Bypass H-O-A mode
 - j. Automatic transfer to bypass selected
 - k. Safety open
 - l. Damper opening
 - m. Damper end-switch made

21. The Bypass controller shall have six programmable digital inputs, and five programmable Form-C relay outputs. This I/O allows for a total System (VFD and Bypass) I/O count of 24 points as standard. The bypass I/O shall be available to the BAS / DDC system even with the VFD removed.
 - a. The on-board Form-C relay outputs in the bypass shall be programmable for any of the following indications:
 - 1) System started
 - 2) System running
 - 3) Bypass override enabled
 - 4) Drive fault
 - 5) Bypass fault
 - 6) Bypass H-O-A position
 - 7) Motor proof-of-flow (broken belt)
 - 8) Overload
 - 9) Bypass selected
 - 10) Bypass run
 - 11) System started (damper opening)
 - 12) Bypass alarm
 - 13) Over temperature
22. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.
23. Class 10, 20, or 30 (programmable) electronic motor overload protection shall be included.

K. Enclosures:

1. Provide the VFD and bypass panels with the appropriate NEMA rated enclosure for the following applications:
 - a. Indoors: NEMA 1.
 - b. Indoors (mechanical rooms): NEMA 12.
 - c. Outdoors (Protected by overhang): NEMA 3R enclosure.
 - d. Outdoors (exposed to windblown dust or water): NEMA 4
2. Provide appropriate ventilation of VFD cabinetry to maintain ambient temperature rating of the drive based upon application. On outdoor installations appropriate ventilation shall be provided by ventilation fan(s) and external 12"x12"x1" paper filter arranged so as to not allow paper filter to be exposed to rain.

2.3 SOURCE QUALITY CONTROL

- A. Shop, inspect and perform standard production tests for each controller.
- B. Make completed controllers available for inspection at manufacturer's factory prior to packaging for shipment. Notify the Owner at least seven days before inspection is allowed.

- C. Allow witnessing of factory inspections and tests at manufacturer's test facility. Notify the Owner at least seven days before inspections and tests are scheduled.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 01300 – Administrative Requirements: Coordination and project conditions.
- B. Verify that building environment can be maintained within the service and ambient temperature and humidity ratings required by the VFD manufacturer

3.2 INSTALLATION

- A. Installation shall be the responsibility of the mechanical contractor. The contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD installation manual.
- B. Power wiring shall be completed by the electrical contractor, to NEC code 430.122 wiring requirements based on the VFD input current. Caution: VFDs supplied without internal reactors have substantially higher input current ratings, which may require larger input power wiring and branch circuit protection. The contractor shall complete all wiring in accordance with the recommendations of the VFD manufacturer as outlined in the installation manual.
- C. Install in accordance with NEMA ICS 7.1.
- D. Verify that mounting surface for VFDs are ready to receive work. Mount VFDs on the wall or at supports in locations identified on the drawings.
- E. Tighten accessible connections and mechanical fasteners after placing controller.
- F. Install fuses in fusible switches.
- G. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- H. Install engraved plastic nameplates in accordance with Section 23 05 53.
- I. Neatly type label inside controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.
- J. Ground and bond controller in accordance with Section 26 05 26.
- K. Controls installer shall provide all wiring and conduit associated with the control signals into and out of the VFD to the DDC EMS and as required for any motor control interlocks.

3.3 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.

- B. Perform inspections and tests listed in NETA ATS, Section 7.16 and NEMA ICS 7.1.
- C. Perform power quality analysis per warranty requirements.

3.4 MANUFACTURER'S FIELD SERVICES

- A. VFD Start-up: Provide certified factory start-up for each drive by a factory authorized service center representative. A certified start-up form shall be filled out for each drive with a copy provided to the Owner, and a copy kept on file at the manufacturer. The following VFD start-up services are to be provided as a minimum:
 - 1. Service center technician shall be responsible for verifying correct installation, power and control wiring connections, starting-up the drive, and checking out for proper operation.
 - 2. Service center technician shall also provide all final adjustments to meet the specified performance requirements.

3.5 DEMONSTRATION AND TRAINING

- A. Provide 16 hours of instruction to be conducted at the project site with manufacturer's representative. The training shall be conducted at 4 hour maximums. Contractor to also provide two sets of VFD operation manuals for use at the training session and then provide to the Owner after completion of the session.

3.6 VARIABLE FREQUENCY DRIVE START-UP SERVICE

- A. Provide start-up commissioning of variable frequency drive and optional circuits by factory certified service technician experienced in start-up and repair services. Commissioning personnel shall be the same personnel that will provide factory service and warranty repairs at site. Sales personnel and other agents who are not factory certified technicians for drive field repair not acceptable.
- B. Include checking for verification of proper operation and installation and interface wiring to building automation system. Include as a minimum:
 - 1. Verify contractor wire terminations to VFD optional circuitry.
 - 2. Verify proper operation and reliability of VFD, motor being driven and building automation system.
 - 3. Provide up to one hour of Owner/operator training on operation and service diagnostics during commissioning.
 - 4. Measure to verify proper operation on:
 - a. Motor voltage and frequency. Verify proper motor operation.
 - b. Control input for proper building automation system interface and control calibration.
 - c. Calibration check for:
 - d. Minimum speed.
 - e. Maximum speed.
 - f. Acceleration and deceleration rates.
 - g. Adjust as necessary.

- C. Configure VSD for automatic restart after a power failure or after an external fault is cleared.

3.7 COMMISSIONING

- A. Refer to Commissioning Specifications, Section 019113, for related commissioning requirements.
- B. Contractor shall provide all necessary support to the commissioning team to implement commissioning plan as outlined in Section 019113.

END OF SECTION 230514

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 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.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

- B. 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.

2.3 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Presealed Systems.
- B. 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.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 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.

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- 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 079200 "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."

3.2 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 076200 "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 078413 "Penetration Firestopping."

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3.3 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.

3.4 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.

3.5 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: Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
 - 2. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
 - 3. 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 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 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 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.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated 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. Piping: One-piece, floor-plate type.

END OF SECTION 230518

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Steel pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Pipe stands.
 - 7. Equipment supports.

- B. Related Sections:

- 1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
 - 3. Division 23 Section "Vibration Controls for HVAC" for vibration isolation devices.
 - 4. Division 23 Section "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 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.

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- B. Structural Performance: Hangers and supports for HVAC 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.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code—Steel."
 - 2. AWS D1.3, "Structural Welding Code—Sheet Steel."
 - 3. AWS D1.4, "Structural Welding Code—Reinforcing Steel."

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PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
 - 1. AAA Technology & Specialties Co., Inc.
 - 2. B-Line Systems, Inc.; a division of Cooper Industries.
 - 3. Grinnell Corp.
 - 4. National Pipe Hanger Corporation.
 - 5. PHD Manufacturing, Inc.
- C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 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 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
 - a. Cooper B-Line, Inc.

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- b. Flex-Strut Inc.
 - c. GS Metals Corp.
 - d. Thomas & Betts Corporation.
 - e. Unistrut Corporation; Tyco International, Ltd.
- 3. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
 - 4. Standard: MFMA-4.
 - 5. Channels: Continuous slotted steel channel with inturned lips.
 - 6. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
 - 8. Metallic Coating: Hot-dipped galvanized .

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
 - 1. Carpenter & Paterson, Inc.
 - 2. PHS Industries, Inc.
 - 3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 - 4. Rilco Manufacturing Co., Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 553, Type I calcium silicate with vapor barrier.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. 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.
 - 1. Manufacturers:
 - a. B-Line System, Inc.; a division of Cooper Industries.
 - b. Hilti, Inc.
 - c. MKT Fastening, LLC.
 - d. Powers Fasteners.

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2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 1. Manufacturers:
 - a. ERICO/Michigan Hanger Co.
 - b. MIRO Industries.
 - c. Portable Pipe Hangers.
 - 2. Base: Plastic.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- C. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 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

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.
- F. 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.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. 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.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - 2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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- K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
- L. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 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.

3.3 HANGER AND SUPPORT INSTALLATION

- A. Steel 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. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

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- G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. 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.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. 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.
- L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- M. 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.
- N. 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.
- 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.

3.4 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.

3.5 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.

3.6 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.

3.7 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.

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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 are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230548.13 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained-spring isolators.
 - 4. Spring hangers.
 - 5. Vibration isolation equipment bases.

1.3 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:
 - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - 2. 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.
- C. Delegated-Design Submittal: For each vibration isolation device.
 - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, wind forces required to select vibration isolators, wind restraints, and for designing vibration isolation bases.

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- a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Division 23 Sections for equipment mounted outdoors.
- D. 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.
- E. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Wind Restraint devices shall comply with the wind rating as specified within this section. Restraint devices shall be suitable for the specific application and have a Florida structural engineering seal for compliance.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS (TYPE A)

- A. Elastomeric Isolation Pads:
 - 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following:
 - a. Amber/Booth Company, Inc.
 - b. Kinetics Noise Control, Inc.
 - c. Mason Industries.
 - 2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area. Sandwich cork with two layers of neoprene waffle.
 - 3. Size: Factory or field cut to match requirements of supported equipment.
 - 4. Pad Material: Oil and water resistant with elastomeric properties.
 - 5. Surface Pattern: Waffle pattern.
 - 6. Minimum ½ inch thickness.
 - 7. Load-bearing metal plates adhered to pads.

2.2 ELASTOMERIC ISOLATION MOUNTS (TYPE B)

- A. Double-Deflection, Elastomeric Isolation Mounts:
 - 1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type ND or comparable product by one of the following:

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- a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED-SPRING ISOLATORS (TYPE F)

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:

1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. – Type SLR or comparable product by one of the following:
 - a. Amber-Booth
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - b. Top plate with threaded mounting holes.
 - c. Internal leveling bolt that acts as blocking during installation.
3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.4 RESTRAINED SPRING HANGERS (TYPE H)

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

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1. Manufacturer: Subject to compliance with requirements, provide product by Mason Industries, Inc. - Type DNHS or comparable product by one of the following:
 - a. Amber Booth.
 - b. Kinetics Noise Control, Inc.
 - c. Vibro-Acoustics
2. 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.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.5 VIBRATION ISOLATION EQUIPMENT BASES (TYPE K)

- A. Manufacturers: Subject to compliance with requirements, provide products by Mason Industries, Inc or comparable product by one of the following:
 1. Kinetics Noise Control.
 2. Vibro-Acoustics
- B. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete. Mason Industries, Inc. – Type K - (TYPE M)
 1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

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2.6 FLEXIBLE PIPE CONNECTORS AND GUIDES

- A. Manufacturers: Subject to compliance with requirements, provide products by Mason Industries, Inc or comparable product by one of the following:
 - 1. Proco
 - 2. Amber Booth
- B. (TYPE N) Flexible Pipe Connector: Flexible stainless steel hose constructed of stainless steel braid and carbon steel fittings. Connections: Male threaded ends for piping 2-1/2 inches and smaller and flanged ends for piping 3 inches and larger. Lengths as recommended by manufacturer. Mason Industries, Inc. – Type FFLSS
- C. (TYPE O) Non-ferrous single arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. – Type SFEJ
- D. (TYPE P) Non-ferrous twin arch expansion joint connector fabricated of multiple plies of nylon cord, fabric and neoprene; furnished with metallic flanges which are independent of the casing and retained by beaded ends which fit into machined grooves, forming a liquid tight seal without gasketing. Provide bolted stabilizing/control rods to maintain anchoring where required, due to size or operating pressure. Mason Industries, Inc. – Type SFDEJ
- E. (TYPE Q) Pipe Guide: stainless steel wrapping the carbon steel foot where it passes through horizontal U guides similarly lined to prevent corrosion. The baseplate shall have multiple holes for bolting to beam flanges or flat surfaces. Bases may be welded in position in lieu of bolting. Height must be adjustable to accept different thicknesses of insulation. Guides shall be professionally load rated for bottom, overhead, side mounted or riser positioning to provide both load bearing and guiding capabilities. Mason Industries, Inc. – Type ASG
- F. (TYPE R) Pipe Guide: Spider type, using stainless steel ring and mounting plate, with a pipe ring and guide shield sized to accept the pipe insulation thickness. Mason Industries Type SPG
- G. (TYPE S) Pipe Anchor: All directional acoustical pipe anchor, consisting of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2 inch thickness of heavy duty neoprene and duck or neoprene isolation material. Vertical restraints provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolator material not to exceed 500 PSI and the design balanced for equal resistance in any direction. Mason Industries Type ADA.

PART 3 - EXECUTION

3.1 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.

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- 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.

3.2 PIPING IN MECHANICAL EQUIPMENT AND AIR HANDLING UNIT ROOMS

A. General:

1. Isolators for equipment and piping are described elsewhere in this division. The vibration isolation manufacturer shall coordinate the selection of piping supports with equipment supports to provide a carefully engineered system designed to accommodate expansion and contraction without excessive stress or misalignment at equipment connections or in the piping.
2. Temporary anchors, where required, shall be installed to permit pre-adjustment of springs in risers.
3. Permanent limit stops shall be installed to prevent excessive vertical motion of risers in the event water is drained from system. Locations and other details of these limit stops shall be submitted to the Architect for acceptance.
4. Piping connected to vibration isolated equipment shall not strain or force out of alignment the vibration isolators supporting the basic equipment, nor shall pipes restrict such equipment from "floating" freely on its respective vibration isolation system.
5. Piping connected to vibrating equipment shall not physically contact any building construction or non-isolated systems or components.
6. The weight of the pipe shall not be carried by walls through which the pipe passes.

B. At Equipment Connections:

1. At the pump outlet, provide isolator TYPE N.
2. At the chilled supply and return connections to the air handler, provide isolator TYPE M.

3.3 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 033000 "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.

3.4 VIBRATION ISOLATION EQUIPMENT BASES 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 033000 "Cast-in-Place Concrete."

3.5 VIBRATION ISOLATION SCHEDULE

- A. Provide mechanical equipment with vibration isolation according to the following schedule:

<u>EQUIPMENT</u>	<u>ISOLATOR TYPE</u>
Base mounted pumps	A, and P
Air handling units – floor mounted	A
Fans - Suspended	H
Chiller	A

- B. Provide the following piping systems with vibration isolation according to PART 3 of this Section:

1. Chilled Water Piping

END OF SECTION 230548.13

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SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Valve numbering scheme.
- C. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- 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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:

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1. Material and Thickness: Aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
3. 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.
4. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White
3. Background Color: Black
4. Maximum Temperature: Able to withstand temperatures up to 160 deg 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 or self-tapping screws.
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), plus 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), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

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- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, 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: At least 1-1/2 inches high.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black
- C. Background Color: White
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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- H. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

- 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both direction, or as separate unit on each duct label to indicate flow direction.
- 2. Lettering Size: At least 1-1/2 inches.

2.5 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: Aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
- 2. Fasteners: Brass wire-link or 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

3.1 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.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.
- C. All mechanical equipment, located above the ceiling and requiring maintenance or accessibility shall also be labeled on the ceiling or ceiling grid, directly below the indicated equipment. Examples of mechanical equipment include, but are not limited to, FCUs, VTUs, valves, actuators, dampers, etc.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Section 099123 "Interior Painting."

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- B. 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.
- C. Pipe Label Color Schedule:
 - 1. Chilled-Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 - 2. Refrigerant Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.

3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - 1. Blue: for cold-air supply ducts.
 - 2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 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:

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1. Valve-Tag Size and Shape:
 - a. Chilled Water: 2 inches, square.
 - b. Refrigerant: 2 inches, square.
2. Valve-Tag Color: Natural Metal
3. Letter Color: Black.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 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.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

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- D. Certified TAB reports.
- E. Sample report forms.
- F. 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.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- B. TAB Conference: Meet with Architect Owner, Construction Manager or Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect .
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

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1.6 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 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 systems for installed 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 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 meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts " and 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.

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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 filters and verify that bearings are greased, belts are aligned and tight, 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 are replaced by permanent screens with indicated perforations.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. 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.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
 1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 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", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- 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. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC 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.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck 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 Division 23 Section "Metal Ducts."

3.5 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. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. 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.
 - 6. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. 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 will occur. 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 within specified tolerances.

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1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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.
 3. Measure total system airflow. Adjust to within indicated airflow.
 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

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5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
 8. Record final fan-performance data.
- C. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
 2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 3. Set terminal units at full-airflow condition.
 4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 5. Adjust terminal units for minimum airflow.
 6. Measure static pressure at the sensor.
 7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.

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2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- A. Systems installed with pressure independent control valves shall not require hydronic system balancing. Flow shall be verified and adjusted for the pressure independent valve assembly for field conditions using the pressure independent control valve manufacturer's documentation procedure for 25% of the total installed product. Exact locations of tested product to be coordinated with the commissioning agent.

3.9 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. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

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. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.

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4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. Verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.12 TOLERANCES

A. Set HVAC system's air flow 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.

3.13 REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to

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facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.14 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.

- 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 contractor.
 - 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.

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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 air flow 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. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

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- 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. Air flow 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. Air flow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg 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):

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- 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 and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
- 1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow 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. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

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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.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.15 INSPECTIONS

A. Initial Inspection:

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1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 25 percent of air outlets.
 - b. Measure water flow of at least 10 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect Construction Manager and or .
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect, Construction Manager, and or Commissioning Authority.
3. Architect or 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.
4. 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."
5. 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.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.16 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.

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- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

3.17 COMMISSIONING

- A. Refer to Commissioning Specifications, Division 01, for related commissioning requirements.
- B. Test and Balance contractor shall provide necessary support to complete necessary Pre-functional testing, Functional Testing, and any retesting required as required to complete the commissioning process.

END OF SECTION 230593

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Fire Rated Wrap Insulation
- 2. Adhesives.
- 3. Mastics.
- 4. Sealants.
- 5. Factory-applied jackets.
- 6. Field-applied jackets.
- 7. Tapes.

- B. Related Sections:

- 1. Division 22 Section "Plumbing Insulation."
- 2. Division 23 Section "Metal Ducts" for duct liners.

1.3 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.

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- C. 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.
- D. Fire Wrap submittal each different firestopping configuration, provide the following:
 - 1. Listing agency's detailed drawing showing opening, penetrating items, and firestopping materials, identified with listing agency's name and number or designation, fire rating achieved, and date of listing.
 - 2. Identify which rated assembly each system is to be used in.
 - 3. Any installation instructions that are not included on the detailed drawing.
 - 4. For proposed systems that do not conform strictly to the listing, submit listing agency's drawing marked to show modifications and stamped approved by firestop system manufacturer's fire protection engineer.
 - 5. Submit listing agency's test report showing compliance with requirements, based on testing of current products.
 - 6. Product Certificates: Submit certificates signed by firestop system manufacturer certifying that materials furnished comply with requirements.
 - 7. Product Data: Manufacturer's data sheets on each material to be used in firestop system systems, including:
 - a. Product characteristics and Material Safety Data Sheets.
 - b. Listing numbers of systems in which each product is to be used.
 - c. Preparation instructions and recommendations.
 - d. Storage and handling requirements and recommendations.
 - e. Installation methods.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per 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 and inspecting agency.
 - 1. Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 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.

1.6 FIRE WRAP INSULATION PERFORMANCE REQUIREMENTS

- A. Listing Agency: Provide products that are listed by at least one the following:
 - 1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory" category XHEZ or XHBN as appropriate.
 - 2. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- B. Furnish products identical to those tested for classification by listing agency.
- C. Mark product packing with classification marking of listing agency.
- D. Firestopping Exposed to View: Provide products with flame spread index of less than 25 and smoke developed index of less than 450, when tested in accordance with ASTM E 84.
- E. Firestopping Exposed to View, Traffic, Moisture, or Physical Damage: Provide products that after curing do not deteriorate when exposed to those conditions during and after construction.
- F. Materials: Use only products specifically listed for use in listed systems.
- G. Compatibility: Provide products that are compatible with each other, with the substrates forming openings, and with the items, if any, penetrating the firestopping, under the conditions represented by this project, based on testing and field performance demonstrated by manufacturer.
- H. Firestopping material must be asbestos-free and capable of maintaining an effective barrier against flame, smoke and gases in compliance with the requirements of ASTM and UL standards cited in this section.
- I. Firestopping materials must meet and be acceptable for use by all building codes and NFPA codes cited in this section.
- J. Materials must be suitable for the firestopping of penetrations made by steel, glass, plastic and insulated pipe.
- K. Firestop Listings: The following is only a partial list of ASTM E 814 tested through-penetration designs. Consult with the manufacturer for more information.
 - 1. UL: W-L-7180, W-J-7104, C-AJ-7096, F-C-7054.
- L. Fire Rating: All duct wraps must be One (1) hour rated, but in no case less than the rating of any time-rated assemblies which are penetrated.
- M. Fire Rating: All duct wraps must be Two (2) hour rated, but in no case less than the rating of any time-rated assemblies which are penetrated.

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1.7 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 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.

1.9 WARRANTY

- A. At project closeout, provide to Owner or Owners Representative an executed copy of the manufacturer's warranty against manufacturing defect for the duration of two years from substantial completion, outlining its terms and conditions.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 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.

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- F. 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. Products: Subject to compliance with requirements, provide the following:
 - a. Pittsburgh Corning Corporation; Foamglas Super K.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2. ASJ jacketing for all piping areas outside of mechanical rooms.
 6. Preformed Pipe Insulation with Field-Applied PVC jacketing: Comply with ASTM C 552, Type II, Class 2. PVC jacketing for all piping areas inside mechanical rooms.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
 2. Flexible Elastomeric Permitted Locations
 - a. Pump housing.
 - b. 4'-0" piping runout to AHU's.
- H. 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.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation. For equipment applications, provide insulation. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:

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- a. CertainTeed Corp.; Commercial Board.
- b. Fibrex Insulations Inc.; FBX.
- c. Johns Manville; 800 Series Spin-Glas.
- d. Knauf Insulation; Insulation Board.
- e. Manson Insulation Inc.; AK Board.
- f. Owens Corning; Fiberglas 700 Series.

J. Fire Rated Insulation Wrap

1. Products: Subject to compliance with requirements, provide one of the following:

- a. 3M Fire Protection Products.
- b. Captiveaire.
- c. Certainteed
- d. Owens Corning

2. Scope/Application

- a. Provide fire protection to grease and air ducts as a shaft alternative.
- b. Provide installed firestopping that limits the spread of fire, heat, smoke, and gasses through otherwise unprotected openings in rated assemblies, including walls, partitions, floors, roof/ceilings, etc.

3. FIRE RATED DUCT WRAP INSULATION

- a. 3M Fire Barrier Duct Wrap 615+: Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches (38mm) for ventilation and grease duct applications.
 - 1) Color: White blanket, aluminum foil encapsulated.
 - 2) Weight: 0.9 psf (4.38 kg/m²).
 - 3) Density: 6 pcf nominal.
 - 4) Thermal Conductivity (k-value) at 500 Degrees F (260 Degrees C) (ASTM C411, ASTM C518): 0.48 Btu/(ft² × h × F) (0.07 W/(m × K)).
 - 5) R-Value per ASTM C 518 at ambient (77 F/ 25 C): at least 6.3 (F-ft²-hr / Btu)
 - 6) Service range up to 2000°F (1093°C)
 - 7) Fire Resistance: For use in 2 hour fire resistant systems.
 - 8) Product complies with ASTM E 2336 test standard.
 - 9) Product complies with ISO 6944 test standard.
 - 10) Through-penetration per ASTM E 814 (UL 1479)
 - 11) Non-combustible per ASTM E 136

4. Related Duct Wrap Products

- a. Tape:
 - 1) High performance filament tape, 3M No. 898 1 inch (25mm) wide.

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- 2) FSK Facing Tape with aluminum foil, fiberglass scrim, kraft paper backing: nominal 3 inches or 4 inches wide (for sealing cut blanket edges and seams), 3M No. 3320.
- b. Banding Material: Stainless or carbon steel banding: 1/2 inch wide X 0.015 inch thick, as stated in duct wrap Design Listing.
- c. Insulation pins and clips:
 - 1) Copper-coated steel pins, 12 gauge with a minimum length of 4 inches with square galvanized steel speed clips: 2.5 inch.
 - 2) 12 gauge insulated cup head steel pins.
- d. Through-penetration firestop materials:
 - 1) Packing materials: Pieces of 3M Fire Barrier Duct Wrap, or 4 pcf mineral wool.
 - 2) Sealants: 3M Fire Barrier: 1000 NS non-slump silicone sealant, 1003 SL self-leveling silicone sealant, 2000+ premium non-slump silicone sealant, or CP 25WB+ premium intumescent latex caulk, as stated in firestop Design Listing.

2.2 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: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aeroseal.
 - b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has 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 Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has 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. Products: Subject to compliance with requirements, provide one of the following:

- a. Dow Chemical Company (The); 739, Dow Silicone.
- b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
- c. P.I.C. Plastics, Inc.; Welding Adhesive.
- d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

C. For indoor applications, use mastic that has a voc content of 50 G/L or less when calculated according to 40 CFR 59, subpart D (EPA Method 24).

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1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements,,:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-45.
 - c. Pittsburgh Corning Corporation; Pittseal 444.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, use sealants that have a VOC content of 250 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. Products: Subject to compliance with requirements, provide the following:
 - a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 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.

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

- B. 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. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. 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.
5. Factory-fabricated tank heads and tank side panels.

- C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.

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- c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
- d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation 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.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and 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.

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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 as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and 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.

3.4 PENETRATIONS

- A. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. 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 Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. 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.

B. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 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.

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8. 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, vessels, and equipment. 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.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

- 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 but 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.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

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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.

3.9 MINERAL-FIBER INSULATION INSTALLATION

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 1 edge and 1 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 deg 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 2 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.

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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 1 edge and 1 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 deg 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 2 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.

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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.

3.10 FIRE RATED DUCT WRAP INSULATION (1 AND 2 HR. ENCLOSURES)

- A. Ventilation Air Duct: Install fire resistive duct wrap insulation in direct contact with ductwork to Manufacturer's instructions and referenced standards, including Listed penetration firestop system.
 1. Apply fire resistive duct wrap insulation continuously to ductwork as indicated on Drawings. For ventilation air ducts, provide one layer of 3M Fire Barrier Duct Wrap 615+ with 3 inch overlaps for 1 and 2 hour applications. Observe requirements for additional duct wrap material required at firestop, when required.
- B. Ventilation Ductwork: overlap perimeter and longitudinal joints 3 inches. If required, tape seams using minimum 3 inch wide aluminum foil adhesive tape.
- C. Filament tape may be used as a temporary securing measure during application of duct wrap. Finish installation using 1/2 inch wide by 0.015 inch steel banding on exterior layer of wrap. Spacing 10.5 inches on center and within 1.5 inches of all overlapped seams. Consult individual listings for approved banding type.
- D. Duct Widths Greater than 24 Inches: Weld insulation pins to bottom of horizontal ducts on a 12 inch by 10.5 inch maximum grid spacing. Welded insulation pins to one of the wider sides of all vertical ducts on a 12 inch by 10.5 inch maximum grid spacing. Impale duct wrap insulation over pins and secure with speed clips.
- E. Duct Access Doors: Install duct wrap to Manufacturer's instructions and procedures.
- F. Firestopping At Fire Separations:
 1. Firestop all wrapped ductwork penetrating fire rated concrete floors, gypsum board, block and concrete wall assemblies and gypsum board shaftwall assemblies using UL firestop system Listings appropriate for the applicable duct wrap system.
 2. Ventilation ducts: Fire resistive insulation may pass continuously through fire rated wall or floor penetrations or may tightly butt to both sides of fire rated separations. Minimum 1 inch, maximum 3 inch clearance permitted around unwrapped duct in opening or from edge of opening to outer layer of duct wrap. Consult individual Listed firestop systems for specific requirements.
 - a. Option A: Terminate wrap at fire separation. Fill space around unwrapped duct where it passes through a fire rated wall or floor with pieces of 3M duct wrap insulation or mineral wool insulation firmly packed into opening. Compress to the percentage stated in the firestop listing to full depth of floor or wall. Recess packing on both sides of walls or top side of floor to depth stated in firestop listing. Seal over packing material using 3M firestop sealant to depth stated in firestop listing, flush with top side of floor and both sides of wall surfaces. Tightly butt fire

resistive duct wrap insulation to each side of wall or floor assembly and seal interface with a continuous bead of 3M firestop sealant.

- b. Option B: Wrap continuous through fire separation. Fill space around continuously wrapped duct where it passes through fire rated wall or floor with pieces of 3M duct wrap insulation or mineral wool insulation firmly packed into opening and compress to the percentage stated in the firestop listing to a minimum depth of 4". Recess packing material below surface on both sides of wall or top side of floor to depth stated in firestop listing. Seal over packing material using 3M firestop sealant to depth stated in firestop listing, flush with top side of floor and both sides of wall surfaces.

3.11 FIELD-APPLIED JACKET INSTALLATION

- A. 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.
- B. 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.

3.12 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 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. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

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B. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three 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.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, 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.

3.14 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 air.
4. Indoor, exposed return air.
5. Indoor, concealed outside air.
6. Indoor, exposed outside air.
7. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
8. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
9. Indoor, concealed Type I commercial kitchen hood exhaust.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Flexible connectors.
4. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, supply-air, return-air, outside-air, and exhaust-air duct insulation shall be the following:

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1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
- B. Exposed, supply-air, return-air, outside-air, and exhaust-air duct insulation shall be the following:
 1. Mineral-Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
- C. Indoor, concealed Type I commercial kitchen hood exhaust duct insulation shall be the following:
 1. Fire Rated Duct Wrap Insulation.

3.16 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 equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:
 1. Flexible Elastomeric: 1 inch (25 mm) thick.
- D. Chilled-water pump insulation shall be the following:
 1. Cellular Glass: 2 inches (75 mm) thick.
- E. Chilled-water expansion/compression tank insulation shall be the following:
 1. Flexible Elastomeric: 1 inch (25 mm) thick.
- F. Chilled-water air-separator insulation shall be the following:
 1. Flexible Elastomeric: 1 inch (25 mm) thick.

3.17 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.

3.18 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water:
 1. All Pipe Sizes: Insulation shall be the following:

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- a. Flexible Elastomeric: 3/4 inch thick.
- B. Chilled Water:
 - 1. NPS 2 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - 2. NPS 2-1/2 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
- C. Refrigerant Suction and Hot-Gas Tubing/Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water:
 - 1. NPS 2 and Smaller: Insulation shall be the following:
 - a. Cellular Glass: 2 inches thick.
 - 2. NPS 2-1/2 and Larger: Insulation shall be the following:
 - a. Cellular Glass: 2-1/2 inches thick.
- B. Refrigerant Suction and Hot-Gas Tubing/Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.20 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:

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1. PVC: 20 mils thick.
2. Aluminum, Smooth: 0.016 inch thick.

3.21 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, Exposed:
 1. Aluminum, Smooth: 0.024 inch thick.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Related Sections: Refer to Division 01 Section 019113 "General Commissioning Requirements for additional commissioning scope and requirements. All testing and commissioning requirements of that section shall be met.
- C. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, Test and Balance Subcontractor, BAS Subcontractor and Commissioning Authority (CxA).
- D. Scope of Mechanical and HVAC equipment and systems commissioning
 - 1. All HVAC systems, including chillers, pumps, air handling units, terminal units, fan coil units, exhaust fans, unit heaters, and associate equipment.
 - 2. All building automation system controls, associated control terminal devices, and related controls and sensors, controls and components, energy recovery devices and systems and controls.
 - 3. All other HVAC and mechanical system components indicated on the drawings and / or in the commissioning plan

1.2 CONTRACTOR'S RESPONSIBILITIES

- A. Attend the Commissioning Kick-off meeting and other Commissioning meetings as required.
- B. Attend construction phase coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meetings.
- D. Submit completed manufacturer's start-up checklists for the equipment being commissioned.
- E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period. Provide meters, gauges and instruments for Functional Performance Testing.
- F. Perform all commissioning tests at the direction of the CxA.
- G. Complete tasks required to correct items noted by the CxA in the Deficiency Log.
- H. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

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- I. Provide O&M data including warranties, tables, recommended maintenance schedules, checklists, spare parts lists, wiring and parts diagrams, points of contact for service, for all equipment, systems and controls being commissioned.
- J. Provide training of the Owner's operations and maintenance personnel in accordance with the project's construction documents and commissioning plan.
- K. Provide information requested by the CxA for final commissioning documentation.

1.3 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Provide a Commissioning Plan.
- C. Provide Functional Performance Checklists.
- D. Direct commissioning testing.
- E. Maintain and distribute the deficiency logs.
- F. Verify that the training of the Owner's personnel is complete and documented.
- G. Provide a Preliminary Commissioning Summary Report.
- H. Provide a Final Commissioning Report.

1.4 PROCESS

- A. Functional Performance Testing will commence after preliminary punch list items are completed by the Contractor. Functional Performance Testing will not be scheduled until the completed Pre-Functional Checklists and the Draft TAB Report are received by the Commissioning Authority.

1.5 SUBMITTALS

- A. Certificate of Readiness indicating the HVAC systems are ready for Commissioning.
- B. Manufacturer's start-up checklists.
- C. Flushing and pressure test reports.
- D. Draft and Final Testing, Adjusting and Balancing (TAB) Reports.
- E. Sixty (60) days before any mechanical systems testing is conducted, provide an overall testing plan and schedule for HVAC equipment and BAS control systems that lists the equipment, modes to be tested, dates of testing and parties required to conduct the test. Put this information in to the master construction schedule. Keep the plan and schedule updated.

1.6 COMMISSIONING DOCUMENTATION

A. Provide the following information to the CxA:

1. Approved submittals with designer review comments of submittals resolved, operation and maintenance manuals, and assistance in drafting the systems manuals, and other documents and reports requested by the Commissioning Authority in searchable pdf format
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase on as built markup of the design documents (plans and specifications)
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for systems, assemblies, equipment, and components being commissioned.
4. Schedule indicating when HVAC systems, subsystems, equipment, and associated controls will be ready for functional testing. The date for permanent connection of power is required.
5. Provide, documentation of completion of flushing and pressure test reports and certificates.
6. Corrective action documents.
7. Approved Testing, Adjusting, and Balancing (TAB) Report.
8. The Contractor shall provide updated "As-Built" single line drawings for MEP systems and BAS systems. The drawings are to be provided in the electronic format requested by the CxA. The drawings are required for inclusion in the Systems Manual that will be prepared by the CxA.
9. The Contractor shall provide updated "As-Built" control system sequences of operation for inclusion in the Systems Manual.
10. Any additional information requested by the CxA.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and CxA.
- B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.
- C. Contractor shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 TESTING PREPARATION

- A. Certify in writing the HVAC systems, subsystems, and equipment and controls have been installed, calibrated, started and are operating per the Contract Documents.
- B. Certify in writing the Testing, Adjusting, and Balancing (TAB) procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- C. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- D. Inspect and verify the position of each device and interlock identified in the sequences, control schematics and or on checklists.
- E. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- F. Testing Instrumentation: Install measuring instruments and logging devices to record test data if directed by the CxA in the Commissioning Plan.

3.3 TESTING AND BALANCING VERIFICATION

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC systems at the direction of the CxA.
 - 1. The Contractor will notify the CxA 10 days in advance of the date of Test and Balance (TAB) field verification. Notice will not include data points to be verified.
 - 2. The same instruments (by model and serial number) that were used when original data were collected shall be used during the TAB verification with the CxA.
 - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.
- D. TAB verification is to be conducted using the same instruments used for the conduct of the initial Testing Adjusting and Balancing of the systems.

3.4 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
- B. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- C. The Contractor shall execute the detailed testing plans, procedures, and checklists (FPTs) prepared by the CxA for systems, subsystems, and equipment being commissioned.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered to achieve simulated conditions.
- G. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the CxA will document the deficiency and report it to the Owner. After deficiencies are resolved, the Contractor will reschedule the tests.
- H. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 INSTRUMENTATION

- A. Instrumentation for Functional Performance Testing and data recording shall be provided. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC Standards.
- B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC Standards.

3.6 INSTALLATION VERIFICATION

- A. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Owner's satisfaction.
- B. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiency before system start-up work proceeds.

3.7 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements, design intent, and Owner requirements.
- B. Functional Performance Testing begins after all manufacturer's start-up forms have been completed, submitted, and reviewed by the CxA, and after Test and Balance has been completed.
- C. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.
 - 1. Field testing plans and testing requirements are specified in Division 23 Sections and sequences on the mechanical control sheets. The BAS supplier installer may assist or provide suggestions to the CxA regarding preparation of testing plans.
 - 2. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 Sections. Perform pipe system cleaning, flushing, and hydrostatic testing. Provide cleaning, flushing, testing, and treating completion confirmation and final reports to the CxA.
 - 3. Provide technicians, instrumentation, tools, and equipment to test performance of HVAC and BAS systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item to be tested.
 - 4. Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC terminal equipment and unitary equipment.
 - 5. Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls as required in the Division Section "Testing and Balance."

3.8 NON-CONFORMANCE

- A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractor in a deficiency list or in a punch-list format.
- B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
- C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.
- D. Re-testing:
 - 1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractor. The systems will be re-tested until they pass the Tests.

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2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the Contractor or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.
3. Any required re-testing by any Contractor or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.9 OWNER STAFF TRAINING

- A. The Commissioning Authority will coordinate training with the Owner and Contractor. The Owner will provide direction on the level of training and training requirements as well as the personnel requiring training. The Contractor will coordinate the scheduling of training.
- B. The Contractor and associated manufacturer's representatives shall provide required training to operational staff. The Contractor training sessions shall provide a detailed analogy of systems operation and maintenance.
- C. Training shall be recorded by the Contractor and documentation shall be provided to the Commissioning Authority.

END OF SECTION 230800

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SECTION 230900 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Related Sections include the following:
 - 1. Division 23 Section "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.

1.3 DEFINITIONS

- A. BAS: Building Automation System
- B. DDC: Direct digital control.
- C. I/O: Input/output.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.

1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
 - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.

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7. Performance: Programmable controllers shall execute BAS PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 2 percent of full scale.
 - c. Water Pressure: Plus or minus 5 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Dew Point Temperature: Plus or minus 3 deg F.
 - h. Temperature Differential: Plus or minus 0.25 deg F.
 - i. Relative Humidity: Plus or minus 2 percent.
 - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - m. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - o. Electrical: Plus or minus 5 percent of reading.

1.5 SEQUENCE OF OPERATION

- A. See Control Diagrams on Design Documents for Sequences of Operations.

1.6 SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 1. BAS System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

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2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequence of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 7. Schedule of valves including flow characteristics.
 8. BAS System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points list.
 11. Equipment Allowance (Refer to Specification Section 2.3 A).
 12. PICS (Performance Interoperability Conformance Statements)
 - a. Contractor shall provide for each type of equipment being supplied by all contracting trades.
- C. Data Communications Protocol Certificates: Certify that each proposed BAS system component complies with ASHRAE 135.
- D. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
 5. Software license required by and installed for BAS workstations and control systems.
- E. Field quality-control test reports.

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- F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- 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 ASHRAE 135 for BAS system components.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

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1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 CONTROL SYSTEM

- A. Manufacturers:
 - 1. Automated Logic Controls
 - 2. Johnson Controls
 - 3. Siemens Controls
 - 4. Trane; Worldwide Applied Systems Group
- B. BTL listed products, if available, must be provided.
- C. Selected Controls System provider shall implement latest published revision of controller, server, and workstation firmware and software. This includes all work for updates and/or changes that are necessary or required to vendor's existing control equipment.
- D. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- E. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- F. The BAS shall be a web-enabled system with a secure interface.
- G. Control system shall include the following:

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1. Building lighting control system specified in Division 26 Section "Network Lighting Controls."
 - a. BMS contractor shall provide a digital signal to the network lighting controllers for operation of all lighting systems for the facility.
 - b. BMS contractor shall provide a 7 day/365 days a year schedule for programming the operation of the lighting system.
2. Power Monitoring of Electric Water Heaters.
3. Domestic and Reclaim Water Metering.
4. Trending and Alarming required to implement the measurement and verification required by Part D of the IMPMV guidelines and measurement and verification plan.

2.3 BAS EQUIPMENT

- A. Operator Workstation: One PC-based microcomputer(s) with minimum configuration as follows:
 1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 2. Processor: Intel Xeon Dual Core 2.8 GHz (64 bit)
 3. Random-Access Memory: 32 GB, 1333 MHz, DDR3 SDRAM.
 4. Graphics: Video adapter, minimum 1800 x 1200 pixels, 512 MB video memory, dual-monitor capable.
 5. Monitor: 24 inches, LCD color, widescreen.
 6. Keyboard: QWERTY, 105 keys.
 7. Hard-Disk Drive: 1024 GB.
 8. Optical Drive: 16X DVD+/-RW.
 9. Media Drive: Internal 19-in-1 USB 2.0 Media Card reader
 10. Mouse: Three button, optical with wheel.
 11. Uninterruptible Power Supply: 2000 VA.
 12. Operating System: Microsoft Windows 7 Professional.
- B. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - d. Software applications, scheduling, and alarm processing.

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- e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
- 3. Standard Application Programs:
 - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, BAS with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - d. Remote communications.
 - e. Maintenance management.
 - f. Units of Measure: Inch-pound and SI (metric).
- 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- C. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
 - 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.
 - 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 - 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- D. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.

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5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 7. Universal I/Os: Provide software selectable binary or analog outputs.
- E. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
1. Output ripple of 5.0 mV maximum peak to peak.
 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- F. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
1. Minimum dielectric strength of 1000 V.
 2. Maximum response time of 10 nanoseconds.
 3. Minimum transverse-mode noise attenuation of 65 dB.
 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- G. Third Party Devices: Third party devices shall be connected to building automation system through MS/TP communication bus at the fastest supported bps to the associated controller with the function in which they are being utilized.
1. The following devices shall be provided and connected to the Building Automation System with a BACnet Testing Laboratories BTL listed MS/TP communications card. If communication card is not available then an owner approved BTL Listed Proxy device or Non-BTL listed card may be used. Device object names must clearly indicate the object that is being represented or a proxy device may be required.
 - a. VFD's
 - b. Electrical Main Meter
 - c. Electrical Submeters
 - d. Lighting Control Panels
 - e. Chilled Water Energy Meters
 - f. Domestic Water Meter
 - g. Irrigation Water Meter

2.4 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:

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1. Manufacturers:
 - a. Ebtron, Inc.
 - b. I.T.M. Instruments Inc.
 - c. RDF Corporation.
2. Accuracy: Plus or minus 0.5 deg F at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Exposed.
 - b. Set-Point Indication: Concealed.
 - c. Thermometer: Concealed.
 - d. Color: White.
 - e. Orientation: Vertical.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - a. Set-Point Adjustment: Concealed.
 - b. Set-Point Indication: Concealed.
 - c. Color: White.
 - d. Orientation: Vertical.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

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6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F.
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

D. Pressure Transmitters/Transducers:

1. Manufacturers:
 - a. BEC Controls Corporation.
 - b. General Eastern Instruments.
 - c. MAMAC Systems, Inc.
 - d. ROTRONIC Instrument Corp.
 - e. TCS/Basys Controls.
 - f. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0- to 0.25-inch wg.
 - d. Duct Static-Pressure Range: 0- to 5-inch wg.
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

2.5 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

2.6 FLOW MEASURING STATIONS

- A. Air Flow Measuring Device: Provide where indicated multi-point thermal dispersion airflow traverse stations for continuous measurement of air volume. Each traverse station shall consist of a multiple array Dual "bead-in-glass" sensing locations. Air flow measurement station shall be sized to match actual duct size. Sensor density shall comply with manufacturer's recommendations (Density type) to insure specified accuracy in actual installation field conditions/location.

1. Air flow measurement station shall be + 2% of reading, with 0.25% repeatability.
 - a. Provide Bacnet interface for BMS system interface. BMS shall monitor the following points at each AFM location:
 - 1) Instantaneous Airflow
 - 2) Time weighted airflow average
 - 3) Temperature
 - b. Acceptable Manufacturer/Model:
 - 1) Ebtron Gold Series - GTN116-PD
 - 2) Or approved equal
2. Chilled Water Flow: Provide chilled water monitoring station consisting of a chilled water flow meter, chilled water supply and return water temperature sensors utilizing matching calibrated sensors.
 - a. The BCS shall monitor chilled water usage in "ton-hours" or "kiloton-hours", with an accuracy of plus or minus 0.75% with a turn down range from 0.1fps to 33 fps.
 - b. Acceptable Manufacturer/Model:
 - 1) Onicon F3200 with System 10 BTU Meter
 - 2) Or approved equal
3. Domestic Water Flow:
 - a. Pulse Width Modulating Type
 - b. Provide Bacnet interface for BMS system interface. BMS shall monitor the following points:
 - 1) Total Flow
 - c. Acceptable Manufacturer:
 - 1) Badger Meters, E-Series Meter with Bacnet Interface.
 - 2) Or approved equal
4. Reclaimed Water Flow:

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- a. Pulse Width Modulating Type
- b. Provide Bacnet interface for BMS system interface. BMS shall monitor the following points:
 - 1) Total Flow
- c. Acceptable Manufacturer:
 - 1) Badger Meters, Recodall
 - 2) Or approved equal

2.7 THERMOSTATS

A. Manufacturers:

- 1. Erie Controls.
- 2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
- 3. Heat-Timer Corporation.
- 4. Sauter Controls Corporation.
- 5. tekmar Control Systems, Inc.
- 6. Theben AG - Lumilite Control Technology, Inc.

B. Thermistor Temperature Sensor:

- 1. Prerential rate control to minimize overshoot and deviation from setpoint.
- 2. Short-cycle protection.
- 3. Sensor operating temperature From 32°F to 122°F (0°C to 50°C)
- 4. Storage temperature From -40°F to 185°F (-40°C to 85°C)
- 5. Storage/operating humidity range 5% to 95% relative humidity (RH), noncondensing
- 6. Thermistor accuracy 0.36°F at calibration point, 1%
- 7. Setpoint functional range 45°F to 90°F (7.2°C to 32.2°C)
- 8. Setpoint thumbwheel markings
- 9. 50°F to 85°F (in 5°F increments) with */** icons on thumbwheel
- 10. 11°C to 29°C (in 3°C increments) with */** icons on thumbwheel
- 11. Housing material Polycarbonate/ABS (suitable for plenum mounting), UV protection, UL 94: 5 VA flammability rating.
- 12. Local Ethernet connection.

2.8 HUMIDISTATS

A. Manufacturers:

- 1. MAMAC Systems, Inc.
- 2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

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2.9 CO2 SENSOR

A. Manufacturers:

1. Automated Logic Controls
2. Johnson Controls
3. Siemens Controls
4. Trane; Worldwide Applied Systems Group

B. CO2 effectively control CO2 levels within a 0-2000 ppm range.

C. Non-Dispersive InfraRed (NDIR) sensor.

D. CO2 sensor shall be equipped with the following options:

1. Accuracy at 25°C ± 30 ppm CO2 +3% of reading (includes repeatability)
2. Pressure dependence of output +1.6% of reading per kPa
3. Annual zero drift ± 10 ppm
4. Recommended calibration interval None (auto-calibrated)
5. Response time < 3 minutes
6. Operating temperature From 32°F to 122°F (0°C to 50°C)
7. Storage temperature From -40°F to 158°F (-40°C to 70°C)
8. Humidity range 0–85% relative humidity (RH)
9. Airflow range 0–33 ft/s (0–10 m/s)
10. Output signals • OUT1 (V): 0–10 VDC
11. Resolution of analog outputs 2ppm CO2
12. Automatic self-diagnostics Diagnostic tools

2.10 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

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- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc.
 - 2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - 3. Dampers: Size for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 7. Power Requirements (Two-Position Spring Return): 24-V ac.
 - 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 10. Temperature Rating: Minus 22 to plus 122 deg F.
 - 11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
 - 12. Run Time: 12 seconds open, 5 seconds closed.

2.11 PRESSURE INDEPENDENT CHARACTERIZED CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
 - 1. Pressure independent characterized ball control valves, Belimo or approved equal, shall be utilized for AHU's CHW coils and alternate HW coils.
- B. Manufacturer:
 - 1. Belimo, PICCV
 - 2. Danfoss, AB-QM
- C. Control Valves: Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

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D. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional (except as noted).

E. Pressure Independent Control Valves:

1. NPS 2 and Smaller: Forged brass body rated at no less than 400 PSI, chrome plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and TEFZEL characterizing disc.
2. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 PSID across the valve.
3. Flow Characteristics: Equal percentage characteristics.
4. Close-Off Pressure Rating: 200 PSI.
5. All actuators shall be electronically programmed by use of external computer software for the adjustment of flow. Programming using actuator mounted switches or multi-turn actuators are not acceptable. Actuators shall be provided with an auxiliary switch to prove valve position.
6. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
7. The control valve shall require no maintenance and shall not include replaceable cartridges.
8. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
9. The use of pressure independent valves piped in parallel to achieve the rated coil flow shall be permitted. Actuators shall be electronically programmed to permit sequencing the flow with a single control output point. The use of external devices to permit sequencing is not acceptable.

F. Characterized Control Valves:

1. NPS 2 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and flow characterizing disc.
2. NPS 2-1/2 and 3: GG25 cast iron body according to ANSI Class 125, standard class B, stainless steel ball and blowout proof stem, flange to match ANSI 125 with a dual EPDM O-ring packing design, PTFE seats, and a stainless steel flow characterizing disc.
3. Sizing:
 - a. Two-Position: Line size or size using a pressure differential of 1psi.
 - b. Two-Way Modulating: 5 psig or twice the load pressure drop, whichever is more.
 - c. Three-Way Modulating: Twice the load pressure drop, but not more than 5 psig.
4. Close-Off Pressure Rating: 100 PSI.
5. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory with a single screw on a four-way DIN mounting-base.
6. NPS 2" and smaller characterized control valves for individual coil control shall be provided as part of a pipe package supplied by the valve manufacturer. The return side of the coil shall contain a union fitting with a P/T port, characterized control valve, an integrated manual balancing valve/union/isolation ball valve/manual air vent with P/T

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port. Shut-off valves as an integrated part of the characterized control valve are prohibited

2.12 CONTROL VALVES

- A. Butterfly Valves: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

1. Body Style: Wafer.
2. Disc Type: Aluminum bronze.
3. Sizing: 1-psig maximum pressure drop at design flow rate.

2.13 DAMPERS

- A. Manufacturers:

1. Air Balance Inc.
2. TAMCO (T. A. Morrison & Co. Inc.).
3. United Enertech Corp.
4. Greenheck
5. Ruskin

- B. Dampers: AMCA-rated, parallel-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

2.14 CONTROL CABLE

- A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

1. Electronic and fiber-optic cables for control wiring shall meet the following low voltage wiring requirements:

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- a. Input/Output = Green jacket, plenum rated with shield.
 - 1) 18 awg, shielded, plenum rated 2-conductor.
 - 2) Loop powered devices should be implemented using (2) two cables.
- b. COMM = BACnet MS/TP Low Cap 100 ohm, 12.5pf/ft Blue jacket plenum rated with shield
 - 1) 24 awg, shielded, plenum rated 2-conductor
- c. Power (<50VAC/VDC) = Orange jacket plenum rated with shield
 - 1) 18 awg, shielded, plenum rated 2-conductor

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.

3.2 INSTALLATION

- A. Building Automation controllers can be organized into a hierarchy structure that allows for multiple IP addresses.
 - 1. The only devices allowed at the IP level shall be those that meet or exceed the minimum BIBB requirements of the latest BTL listed B-BC class PICS.
 - 2. All other devices must reside at a lower tier.
 - 3. Any device that is dependent on another device for emergency operation, life safety, etc. must have a means of a direct I/O for the needed points.
 - a. Reliance on the network backbone is not acceptable for these control strategies.
 - 4. All installations shall utilize one controller for each piece of equipment or system. Two AHU's cannot share a common controller. However, two pumps for a chilled water system can utilize a common controller.
- B. The following framework shall be utilized for device addressing (DEVICE Instance) and network number:
 - 1. Network number shall be comprised of 3 digit building number (551) followed by 2 digit network number. IP level devices shall be assigned a network number of 1.
 - 2. The device ID shall be comprised of the 3 digit building number (551) followed by 2 digit network number (IP devices use 00) followed by 2 digit device number.

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a. EXAMPLE: BLDG (XXX)

- 1) Devices on the IP level: xxx0001-xxx009
- 2) MSTP assignable network numbers: Xxx01-xxx99
- 3) MSTP assignable devices: xxx0101-xxx0199 for network xxx01
 - a) xxx0201-xxx0299 for network xxx02
 - b) xxx0301-xxx0399 for network xxx03 continuing to
 - c) xxx9901-xxx9999 for network xxx99
- 4) MS/TP physical address shall be set to match the last 2-digits of the device ID
- 5) Building Numbers greater than 418 will be assigned an owner specified unique 3-digit number.

- C. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- D. Connect and configure equipment and software to achieve sequence of operation specified.
- E. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above the floor.
 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- F. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- H. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- I. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 2. Install exposed cable in raceway.

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3. Install concealed cable in raceway.
 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- D. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 2. Test and adjust controls and safeties.
 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 6. Test each system for compliance with sequence of operation.
 7. Test software and hardware interlocks.
- C. BAS Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 2. Check instruments for proper location and accessibility.
 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 4. Check instrument tubing for proper fittings, slope, material, and support.
 5. Check installation of air supply for each instrument.
 6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 8. Check temperature instruments and material and length of sensing elements.
 9. Check control valves. Verify that they are in correct direction.

10. Check BAS system as follows:

- a. Verify that BAS controller power supply is from emergency power supply, if applicable.
- b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
- c. Verify that spare I/O capacity has been provided.
- d. Verify that BAS controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.

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8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. 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.

3.6 PROCEDURE FOR HYDRONIC SYSTEMS

A. Systems installed with pressure independent control valves shall not require hydronic system balancing. Flow shall be verified and adjusted for the pressure independent valve assembly for field conditions using the pressure independent control valve manufacturer's documented procedure for 25% of the total installed product. Exact locations of tested product to be coordinated with the commissioning agent.

3.7 MEASUREMENT & VERIFICATION

A. The following building systems will be measured and trended through the building automation. The contractor shall provide all necessary measuring devices and programming to accomplish the monitoring and trending of these systems. The monitoring and trending shall be polled every 5 minutes at a minimum.

1. Common area lighting systems shall be monitored with check meters at each lighting power panel at each floor.
2. Site lighting system is provided with check meters at the lighting power panel.
3. HVAC systems are provided with check meters at the each power panel at each floor.
4. Major motor loads are also trended through the BAS DDC. The hours of operation are recorded and the total power used is calculated by multiplying the operating hours by the measured brake horsepower noted in the commissioning and testing/balancing reports.
5. VAV box heaters are provided with check meters at the power panel at each floor. VAV box heaters are also trended through the BAS DDC system for operation and discharge air temperature to compare to the anticipated operation model.
6. VFD operation is trended through the BAS DDC as a percentage of full operation. At each unit with a VFD, the motor brake HP is recorded in the commissioning and testing/balancing reports. The energy reduction is calculated by multiplying the percentage of operation trend by the full load power.
7. Building cooling load is monitored through the BAS DDC through the building's BTU meter that will be provided. BTU meter will monitor flow in, by-pass flow, supply water temperature and return water temperatures.
8. Building cooling load will be trended through the BAS DDC for airside and waterside. The outside air temperatures and AHU discharge temperatures are recorded to document

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cooling loads within the building. The BTU meter information is trended to document cooling loads, also.

9. Building outside air is trended through the BAS DDC for outside air conditioning reductions. The outside air temperature/humidity, leaving ERU outside air temperature/humidity, stale air temperature/humidity and leaving ERU stale air temperature/humidity are all trended. Outside air flow and stale airflow are also trended. The airside BTU meter information is trended to document cooling/heating loads, also.
10. Hot water heating requires trending through the BAS system.
11. Domestic Water use is recorded by the main building water meter and trended by the BAS DDC system.
12. Reclaimed Water use is recorded by the reclaimed water meter to the building's plumbing system by the BAS DDC system.

3.8 DEMONSTRATION AND TRAINING

- A. Provide 32 hours of instruction to be conducted at the project site with manufacturer's representative. The training shall be conducted at 4 sessions at 8 hour a piece. Contractor to also provide two sets of control operation manuals for use at the training session and then provide to the Owner after completion of the session.

3.9 COMMISSIONING

- A. Refer to Commissioning Specifications, Section 019113, for related commissioning requirements.
- B. Contractor shall provide all necessary support to the commissioning team to implement commissioning plan as outlined in Section 019113.

END OF SECTION 230900

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Single-wall rectangular ducts and fittings.
 - 2. Single-wall round ducts and fittings.
 - 3. Sheet metal materials.
 - 4. Sealants and gaskets.
 - 5. Hangers and supports.

- B. Related Sections:

- 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
 - 2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. 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.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:
 - 1. Liners and adhesives.

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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.
13. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
14. Fabrication and erection dimensions.
15. Arrangements and sectional views.
16. Details, including complete information for making connections to equipment.
17. Materials and finishes.
18. Descriptive names of equipment.
19. Modifications and options to standard equipment required by Contract Documents.

C. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers. Submit shop drawings for duct systems at a minimum scale of 1/4 inch per foot to verify clearances and equipment locations. Show required maintenance and operational clearances. Include the following:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Size and location of initial access modules for acoustical tile.
3. Penetrations of smoke barriers and fire-rated construction.
4. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Piping
 - c. Air outlets and inlets.
 - d. Speakers.
 - e. Sprinklers.
 - f. Access panels.
5. Architectural and structural backgrounds with room names and numbers, etc., including but not limited to plans, sections, elevations, details, etc.
6. Fabrication and erection dimensions.

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7. Arrangements and sectional views.
8. Details, including complete information for making connections to equipment.
9. Materials and finishes.
10. Descriptive names of equipment.
11. Modifications and options to standard equipment required by Contract Documents.

D. Welding Certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."

C. During construction meet or exceed the recommended Control Measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 1995, Chapter 3.

PART 2 - PRODUCTS

2.1 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 1-4, "Transverse (Girth) 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 1-5, "Longitudinal Seams - Rectangular Ducts," 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 2, "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."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, and Flexible Duct," 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 3-2, "Transverse Joints - Round Duct," 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 3-1, "Seams - Round Duct and Fittings," 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. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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."

2.3 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: G90.
 - 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. 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.
- E. 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.

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2.4 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: 4 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 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
- C. 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.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Connection: Bolted
- F. Manufacturer:
 - 1. Ductmate Industries, Inc.
 - 2. Approved Substitution.

2.5 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 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

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- 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.

PART 3 - EXECUTION

3.1 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 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

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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 Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Where ducts pass through smoke-rated interior partitions and barriers, install smoke dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- M. Where ducts pass through secure partitions, install duct security bars. Comply with requirements in Division 23 Section "Air Duct Accessories" for duct security bars.
- N. 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."

3.2 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.

3.3 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 12 feet in horizontal ducts or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.
- C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- 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 or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "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.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. 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 intervals of 16 feet.
- F. 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.

3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 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 Division 09 painting Sections.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

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3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Perform leakage tests. See leakage test requirements below.
- 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.

3.9 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

- A. Ducts shall be constructed to the pressure class listed below unless connected to a system with equipment with a higher pressure scheduled.
- B. Ducts connected to a smoke control system shall be tested at 1.5 times the maximum design pressure.
- C. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, and Terminal Units:
 - a. Pressure Class: Positive 1-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - 3. Ducts Connected to Variable-Air-Volume Air-Handling Units (for the first 50 feet) upstream of terminals:

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- a. Pressure Class: Positive 4-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- 4. Ducts Connected to Variable-Air-Volume Air-Handling Units (beyond the first 50 feet) upstream of terminals:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- D. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, and Terminal Units:
 - a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- E. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting ASHRAE 62.1, Class 1 and 2 Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
 - 2. 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 3-inch wg
 - e. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - f. SMACNA Leakage Class: 3.
 - 3. Ducts Connected to Dishwasher Hoods:
 - a. Type 304, stainless-steel sheet.
 - b. Exposed to View: No. 4 finish.
 - c. Concealed: No. 2D finish.
 - d. Welded seams and flanged joints with watertight EPDM gaskets.
 - e. Pressure Class: Positive or negative 2-inch wg
 - f. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
 - g. SMACNA Leakage Class: 3.
 - 4. Ducts Connected to Fan Coil Units, and Terminal Units:

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- a. Pressure Class: Positive or negative 1-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- 5. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- 6. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
- G. Elbow Configuration:
 - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
 - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "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.

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- c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- 3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "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) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) 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 or Welded.

H. Branch Configuration:

- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
- 2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "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.

3.11 FLEXIBLE DUCTS

A. Installation:

- 1. Flexible duct shall be a maximum of 8 feet in length on inlets to diffusers and 3 feet on inlets to terminal units, unless otherwise indicated and shall be fully extended to smooth out internal corrugations, and shall be installed without kinks, compression or obstructions so that pressure drop is minimized. Install with a maximum equivalent of two 90 degree bends. No bend shall be made with centerline radius of less than one duct diameter for fiberglass ductwork, or four and one-half diameters for metal ductwork. No

additional flexible duct shall be provided for future relocation unless otherwise indicated; cut and remove excess length.

2. Flexible duct shall be supported at ends and at each 90 degree bend. Maximum permissible sag is 1/2 inch per foot of spacing between supports.
3. Hanger and saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 inch wide. Hanger shall be used in conjunction with a sheet metal saddle formed to cover one-half the circumference of the outside diameter of the flexible duct and shall be rolled to fit neatly around the lower half of the duct's outer circumference.
4. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturers recommended procedures are followed.
5. To prevent tearing of vapor retardant on fiberglass duct, do not support entire weight of flexible duct on any one hanger during installation. Avoid contact of flexible duct with sharp edges of hanger material. Damage to vapor retardant may be repaired with vapor sealant tape. If internal core is penetrated, replace flexible duct.
6. Connect flexible ductwork to collars on rigid ductwork and terminal devices with locking clamps and adhesive. Stainless steel ductwork shall be secured with stainless steel bands and clamps only.
7. Terminal devices connected to flexible duct shall be supported independently of the flexible duct.

3.12 LEAKAGE TESTING

A. General:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following duct systems:
 - a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - b. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 100 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.

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7. Duct systems shall be constructed so that leakage does not exceed 5.0 percent of the air quantity handled by the respective fans for systems to 3 inch w.g., and 1.0 percent of the total air quantity handled by fans in systems exceeding 3 inch w.g.
8. Leakage shall be measured during leakage test at a test pressure which is equal to the pressure rating of the duct system.

B. Test Procedure:

1. Test at the time of duct installation, prior to installation of any field-applied insulation and prior to any concealment in chases or similar enclosures.
2. Duct entry and outlet openings shall be capped or sealed prior to pressurizing the duct. The seal shall be of adequate strength and thickness to withstand the test pressures.
3. Use a fan having a minimum capacity of 300 cfm or 10 percent of the particular duct system design capacity, whichever is greater and which is capable of producing a static pressure equal to the duct test pressure.
4. Test fan shall be connected to a flow measuring assembly consisting of straightening vanes and an orifice plate mounted in a straight section with appropriately located pressure taps. Orifice assembly shall be calibrated with its own calibration curve. Pressures shall be measured with U-tube manometers and corresponding flow rates shall be obtained from the orifice performance curve.
5. Connect test fan and orifice flow measuring assembly to the duct to be tested with a section of flexible duct.
6. Test for audible leaks as follows:
 - a. Close off and seal all openings in the duct section to be tested.
 - b. Start the blower with its control damper partially closed.
 - c. Gradually open the control damper until the duct pressure reaches the designed duct operating pressure.
 - d. Survey all joints for audible leaks. Mark each leak and repair after shutting down blower. Do not apply a retest until sealing has been repaired and allowed to set.
7. After all audible leaks have been sealed, the remaining leakage should be measured with the orifice section of the test apparatus as follows:
 - a. Start blower and open damper until the pressure in duct reaches the designed duct operating pressure.
 - b. When partial sections (such as supply section, return section, etc.) of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
8. Correct any duct leaks which are detected either audibly or by touch regardless of whether leakage through duct system is less than allowable test leakage.

END OF SECTION 233113

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Backdraft and pressure relief dampers.
- 2. Manual volume dampers.
- 3. Fire dampers.
- 4. Smoke dampers.
- 5. Combination fire and smoke dampers.
- 6. Turning vanes.
- 7. Remote damper operators.
- 8. Duct-mounted access doors.
- 9. Flexible connectors.
- 10. Flexible ducts.
- 11. Duct accessory hardware.
- 12. Duct security bars.

- B. Related Requirements:

- 1. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 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.

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- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Duct security bars.
- f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 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

2.1 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.

2.2 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.

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- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and brushed 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.

2.3 BACKDRAFT DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Pottorff.
 - 4. Ruskin Company.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 1000 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.
- F. Blades: Multiple single-piece blades, center pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Aluminum.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Aluminum.
- K. Return Spring: Adjustable tension.

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L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: 20 gage minimum.
 - b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 MANUAL VOLUME DAMPERS

A. Low-Leakage, Steel, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. McGill AirFlow LLC.
 - c. METALAIRE, Inc.
 - d. Nailor Industries Inc.
 - e. Ruskin Company.
2. Low-leakage rating and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
 - a. U shaped.
 - b. Galvanized-steel channels, 0.064 inch thick.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.

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- d. Galvanized, roll-formed steel, 0.064 inch thick.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Oil-impregnated bronze.
 - 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.
- 8. Blade Seals: Felt.
- 9. Jamb Seals: Cambered aluminum.
- 10. Tie Bars and Brackets: Galvanized steel.
- 11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

2.5 FIRE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 555. Internal clear opening shall match or be greater than that of adjacent ductwork, taking into account internal angles associated with frame or sleeve, where this requires a larger external duct size, transition shall be provided.
- B. Fire Resistance: 1-1/2 hours and 3 hours as required by the Building Code to match allowable resistance for each penetrated construction's fire rating.
- C. Dynamic Closure Rating: Dampers classified for dynamic closure to 2000 fpm (10 m/s) and 4 inches wg (1 kPa) static pressure.
- D. Construction:
 - 1. Integral Sleeve Frame: Minimum 20 gage roll formed galvanized steel. Length: 16 inches.
 - 2. Blades:
 - a. Style: Curtain type.
 - b. Action: Spring or gravity closure upon fusible link release.
 - c. Material: Minimum 24 gage roll formed, galvanized steel.
 - 3. Closure Springs: Type 301 stainless steel, constant force type, if required.
- E. Fusible Link Release Temperature: 165°F (74°C).
- F. Mounting: Vertical or horizontal as indicated on Drawings.

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- G. Duct Transition Connection, Damper Style:
 - 1. A style - rectangular connection, frame and blades in air stream.
 - 2. CR style - round connection, sealed.

- H. Finish: Mill galvanized.

2.6 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Nailor Industries Inc.
 - 3. Pottorff.
 - 4. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: **No-flow rated smoke detector provided by the fire alarm contractor to be located within 5 feet of the damper.**
- D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners and mounting flange.
- E. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.
- F. Leakage: Class I.
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, 0.05-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- I. Damper Motors: Modulating action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or

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adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for fan control or position indication.
2. Test and reset switches, damper mounted.

2.7 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation.
 2. Nailor Industries Inc.
 3. Pottorff.
 4. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated. Dampers that are part of the smoke control system shall have a minimum rating of 250 deg F.
- G. Smoke Detector: **No-flow rated smoke detector provided by the fire alarm contractor to be located within 5 feet of the damper.**
- H. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel.
- I. Leakage: Class I.
- J. Rated pressure and velocity to exceed design airflow conditions.
- K. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- L. Master control panel for use in dynamic smoke-management systems.

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- M. Damper Motors: Modulating action.
- N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230900 "Instrumentation and Control for HVAC."
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
 - 6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
 - 7. Electrical Connection: 115 V, single phase, 60 Hz.
- O. Accessories:
 - 1. Auxiliary switches for fan control or position indication.
 - 2. Test and reset switches, damper mounted.

2.8 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Elgen Manufacturing.
 - 4. METALAIRE, Inc.
 - 5. SEMCO Incorporated.
 - 6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. 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.

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- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Double wall.

2.9 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Pottorff.
 - 2. Ventfabrics, Inc.
 - 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Brass.
- D. Cable: Stainless steel.
- E. Wall-Box Mounting: Recessed.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
- B. Fabrication:
 - 1. Hinged Rectangular Duct Access Door:
 - a. Model: Greenheck, HAD. Pottorff, HAD.
 - b. Frame: Min. 24 gauge steel frame. Galvanized steel for galvanized ductwork. 304 stainless steel for stainless steel ductwork.
 - c. Door: Min. 26 gauge steel double-wall with 1 inch fiberglass insulation. Galvanized steel for galvanized ductwork. 304 stainless steel for stainless steel ductwork.
 - d. Hinge: Continuous piano type hinge. Galvanized steel for galvanized ductwork. 304 stainless steel for stainless steel ductwork.
 - e. Gaskets: Foam gasket at door-to-frame and frame-to-duct.
 - f. Lock: Sash type. Up to 14 inches square: Furnish one lock. Above 14 inches square: Furnish two locks.

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- g. Maximum working pressure: 5 inches wg
- 2. Removable CAM type Rectangular Duct Access Door:
 - a. Model: Greenheck, CAD. Pottorff, CAD.
 - b. Frame: 22 gauge steel frame. Galvanized steel for galvanized ductwork. 304 stainless steel for stainless steel ductwork.
 - c. Door: 26 gauge steel double-wall with 1 inch fiberglass insulation. Galvanized steel for galvanized ductwork. 304 stainless steel for stainless steel ductwork.
 - d. Gaskets: Foam gasket at door-to-frame and frame-to-duct.
 - e. Lock: CAM type latches. Up to 14 inches square: Furnish two locks. Above 14 inches square: Furnish four locks.
 - f. Maximum working pressure: 5 inches wg
- 3. Hinged Circular Duct Access Door:
 - a. Model: Pottorff, RAD.
 - b. Door: 20 gauge steel roll formed.
 - c. Hinge: Continuous zinc plated steel.
 - d. Gaskets: 1/2 inch thick neoprene gasket at door-to-duct.
- 4. Lock: Spring bolt type. Furnish two locks.

2.11 FLEXIBLE CONNECTORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Connector: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
 - 2. Net Fabric Width: Approximately 6 inches wide.
 - 3. Metal: 3 inch wide, 24 gage galvanized steel.
- C. Connections shall be of fireproof material and manufactured for temperatures and pressures involved. Flexible connection overall length shall not be less than 3 inches nor more than 6 inches. Connections shall be flanged for attachment to fans and adjacent ductwork. Material shall be as follows:
 - 1. Fabric:
 - a. Heavy glass fabric, double-coated with Neoprene. Resistant to temperatures -20 to 200 deg. F. Shall comply with UL Standard 214. Ventfabrics, Ventglas.
- D. Leaded Vinyl Sheet: Minimum 0.55 inch thick, 0.87 lbs. per sq ft (4.2 kg/sq m), 10 dB attenuation in 10 to 10,000 Hz range.

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2.12 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Thermaflex
 - b. ATCO
 - c. Flexmaster U.S.A, Inc.
 - d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible ducts, Fiberglass: UL 181, Class 1, aluminized mylar core laminated to a corrosion resistant steel wire helix; fibrous-glass insulation; aluminize vapor-barrier film. Flexible duct shall be factory-fabricated pre-insulated type with seamless vapor barrier. Fiberglass insulation shall be nominal 1 inch thickness. Vapor retardant rating shall be 0.17 perm maximum per ASTM E96-A.
 - 1. Pressure Rating: minus 0.5 inch w.g. to plus 2 inch w.g.
 - 2. Maximum Air Velocity: 4000 fpm
 - 3. Temperature Range: up to 250 degree F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1

2.13 DUCT SECURITY BARS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Carnes.
 - 2. KEES, Inc.
 - 3. Lloyd Industries, Inc.
 - 4. Metal Form Manufacturing, Inc.
 - 5. Price Industries.
 - 6. Titus.
- B. Description: Factory-fabricated and field-installed duct security bars.
- C. Configuration: See the drawings for requirements.

2.14 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

2.15 STATIC PRESSURE GAGES

- A. Dial Gages: 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 233113 for duct construction and pressure class.
- B. Install control dampers on outside air intake and backdraft damper on exhaust discharges. Coordinate with Section 233423 to determine if backdraft dampers are already provided at the fan unit.
- C. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from control dampers, backdraft dampers, and equipment.
 - 6. 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.
 - 7. Upstream from turning vanes.
 - 8. Control devices requiring inspection.
 - 9. Elsewhere as indicated.
- D. Install access doors with swing against duct static pressure.
- E. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 6 inches.
 - 2. Two-Hand Access: 12 by 8 inches.
 - 3. Head and Hand Access: 18 by 12 inches.
 - 4. Head and Shoulders Access: 24 by 16 inches.
 - 5. Body Access: 24 by 24 inches.
 - 6. Body plus Ladder Access: 30 by 24 inches.
- F. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- G. Install permanent duct test holes as listed in the schedules below and as required for testing and balancing purposes.
- H. Install duct security bars at all ductwork penetrations through secure walls and floors. See the drawings for details. Refer to architectural drawings for secure wall and floor locations.

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- I. Install fire dampers, combination fire and smoke dampers and smoke dampers at locations as indicated on Drawings taking into account the matching of fire area to that of the adjacent level. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
 - 1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
 - 2. Install dampers square and free from racking with blades running horizontally.
 - 3. Do not compress or stretch damper frame into duct or opening.
 - 4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
 - 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
- J. Install flexible connectors to connect ducts to equipment.
- K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

3.2 INSTALLATION – FLEXIBLE DUCTS

- A. Flexible duct shall be a maximum of 8 feet in length on inlets to diffusers and 3 feet on inlets to terminal units, unless otherwise indicated and shall be fully extended to smooth out internal corrugations, and shall be installed without kinks, compression or obstructions so that pressure drop is minimized. Install with a maximum equivalent of two 90 degree bends. No bend shall be made with centerline radius of less than one duct diameter for fiberglass ductwork, or four and one-half diameters for metal ductwork. No additional flexible duct shall be provided for future relocation unless otherwise indicated; cut and remove excess length.
- B. Flexible duct shall be supported at ends and at each 90 degree bend. Maximum permissible sag is 1/2 inch per foot of spacing between supports.
- C. Hanger and saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of the internal diameter of the duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 1 inch wide. Hanger shall be used in conjunction with a sheet metal saddle formed to cover one-half the circumference of the outside diameter of the flexible duct and shall be rolled to fit neatly around the lower half of the duct's outer circumference.
- D. Factory installed suspension systems integral to the flexible duct are an acceptable alternative hanging method when manufacturers recommended procedures are followed.
- E. To prevent tearing of vapor retardant on fiberglass duct, do not support entire weight of flexible duct on any one hanger during installation. Avoid contact of flexible duct with sharp edges of

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hanger material. Damage to vapor retardant may be repaired with vapor sealant tape. If internal core is penetrated, replace flexible duct.

- F. Connect flexible ductwork to collars on rigid ductwork and terminal devices with locking clamps and adhesive. Stainless steel ductwork shall be secured with stainless steel bands and clamps only.
- G. Terminal devices connected to flexible duct shall be supported independently of the flexible duct.

3.3 INSTALLATION – DUCT TEST HOLES

- A. Duct test holes shall be provided as follows:
 - 1. Upstream and downstream of coils
 - 2. At each riser exit/entrance.
 - 3. Within the furthest-away branch of each system.
 - 4. Next to each duct mounted sensor connected to the building automation system.

3.4 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.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

3.5 DEMONSTRATION

- A. Demonstrate re-setting of fire, smoke, and combination fire-smoke dampers to Owner's representative.

END OF SECTION 233300

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. In-line centrifugal fans.
 - 2. Centrifugal roof ventilators.
 - 3. Mixed-flow fans.

1.3 PERFORMANCE REQUIREMENTS

- A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
- B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

- A. Shop Drawings: 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.
- B. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

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- C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- 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.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
- B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
- C. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.
- D. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.
- E. Accessories:
 - 1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.2 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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1. Greenheck Fan Corporation.
 2. Loren Cook Company.
 3. PennBarry.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Downblast Units: Provide removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
 2. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector.
 3. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Belt Drives:
1. Resiliently mounted to housing.
 2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
 5. Fan and motor isolated from exhaust airstream.
- E. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.
1. Vented Curb: Unlined with louvered vents in vertical sides for kitchen exhaust fans.

2.3 MIXED-FLOW FANS

- A. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:
1. Greenheck Fan Corporation.
 2. Loren Cook Company.
 3. PennBarry.
- B. Description: Fan wheel and housing, factory-mounted motor with belt drive, and accessories.
- C. Housings: Steel.
1. Inlet and Outlet Connections: Outer mounting frame and companion flanges.
 2. Guide Vane Section: Integral guide vanes downstream from fan wheel designed to straighten airflow.
 3. Mixed-Flow Outlet Connection: One flanged discharge(s) perpendicular to fan inlet.

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- D. Wheel Assemblies: Cast aluminum with airfoil-shaped blades mounted on cast-iron wheel plate keyed to shaft with solid-steel key.
- E. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 - 1. Service Factor Based on Fan Motor Size: 1.5.
 - 2. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 3. Fan Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.
 - 4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 - 6. Motor Mount: Adjustable base.
 - 7. Shaft Bearings: Radial, self-aligning bearings.
 - a. Ball-Bearing Rating Life: ABMA 9, L10 of 100,000 hours.
 - b. Roller-Bearing Rating Life: ABMA 11, L10 of 100,000 hours.
 - c. Extend lubrication lines to outside of casing and terminate with grease fittings.
- F. Accessories:
 - 1. Mounting Clips: Horizontal ceiling clips welded to fan housing, of same material as housing.
 - 2. Inlet and Outlet Screens: Wire-mesh screen on fans not connected to ductwork, of same material as housing.
 - 3. Backdraft Dampers: Butterfly style, for mounting with flexible connection to the discharge of fan or direct mounted to the discharge diffuser section, of same material as housing.
 - 4. Motor Cover: Cover with side vents to dissipate motor heat, of same material as housing.
 - 5. Inlet Bell: Curved inlet for when fan is not attached to duct, of same material as housing.
 - 6. Inlet Cones: Round-to-round transition, of same material as housing.
 - 7. Outlet Cones: Round-to-round transition, of same material as housing.
 - 8. Stack Cap: Vertical discharge assembly with backdraft dampers, of same material as housing.
 - 9. Direct-Driven Units: Encase motor in housing outside of airstream.
- G. Factory Finishes:
 - 1. Sheet Metal Parts: Prime coat before final assembly.
 - 2. Exterior Surfaces: Baked-enamel finish coat after assembly.
 - 3. Coatings: Powder-baked enamel.
 - a. Apply to finished housings.
 - b. Apply to fan wheels.

2.4 MOTORS

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- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed, fan cooled.

2.5 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 Section "Vibration Controls for HVAC."
- C. Install units with clearances for service and maintenance.
- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.

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- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 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. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - 3. Verify that cleaning and adjusting are complete.
 - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 - 5. Adjust belt tension.
 - 6. Verify lubrication for bearings and other moving parts.
 - 7. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 - 8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 - 9. Shut unit down and reconnect automatic temperature-control operators.
 - 10. Remove and replace malfunctioning units and retest as specified above.
- C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Adjust belt tension.
- B. Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

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3.5 COMMISSIONING

- A. Refer to Commissioning Specifications, Section 019113, for related commissioning requirements.
- B. Contractor shall provide all necessary support to the commissioning team to implement commissioning plan as outlined in Section 019113.

END OF SECTION 233423

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Registers and grilles
 - 2. Security registers and grilles
- B. Related Sections:
 - 1. Division 08 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents.
 - 2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 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. 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. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 REGISTERS AND GRILLES

A. Fixed Face Grille:

1. Material: Aluminum.
2. Finish: Baked enamel, white.
3. Core Construction: Integral.
4. Frame: 1 inch wide.
5. Mounting: Countersunk screw.

2.2 SECURITY REGISTERS AND GRILLES

A. Secure Distribution Devices, General Requirements

1. Maximum Security Sidewall Grilles (S1): 4.8 mm steel face plate interconnected to a 4.8 mm thick steel sleeve. The face plate shall have 4 mm diameter holes on 5.5 mm staggered centers. The sleeve shall be stitch welded to the face and along the entire length of the sleeve seams. An opposed blade damper (OBD) shall be constructed of heavy gauge steel and be available to be operated from the face of the register. Finish is to be white. Additional security barriers (Detail D1) are only required when the unit is greater than 610mm X 610mm.
2. Maximum Security Sidewall Grilles (S2): 4.8 mm steel face plate interconnected to a 4.8 mm thick steel sleeve. The face plate shall have 7.9 mm diameter holes on 11 mm staggered centers. The sleeve shall be stitch welded to the face and along the entire length of the sleeve seams. An OBD shall be constructed of heavy gauge steel and be available to be operated from the face of the register. Finish is to be white. Additional security barriers (Detail D1) are only required when the unit is greater than 610mm X 610mm.
3. Security Supply Air Grilles: 3.5 mm steel face plate, 1 mm steel frame and .6 mm louvers. The face plate shall have 14 mm square holes on 17 mm centers. All visible screws shall be break-off type. An OBD shall be available to be operated from the face of the register. Finish is to be white.
4. Security Diffusers: 4-way horizontal discharge pattern, 2.8 mm steel face plate and a 1 mm steel frame. The face plate shall have 20 mm square holes on 25 mm centers. All visible screws shall be break-off type. Finish is to be white.
5. Security Lattice Face Plates: 2.8 mm steel face plate with 20 mm square holes on 25 mm centers. Face plate shall be attached with break-off screws. Finish is to be white.
6. Security Transfer Grills: 4.8 mm steel face plates interconnected to a 2.8 mm thick steel sleeve. The face plate shall have 7.9 mm diameter holes on 11 mm staggered centers. The sleeve shall be stitch welded to the face and along the entire length of the sleeve seams. Finish is to be white. Length to be coordinated with wall thickness. Transfer grills larger than 610 mm X 610 mm require additional bars per Detail D1.
7. Grills and Diffusers shall be constructed of stainless steel in kitchen areas and in inmate showers areas.

2.3 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."

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PART 3 - EXECUTION

3.1 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.

3.2 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 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.

3.3 APPLICATION

- A. Provide maximum security risk resistant sidewall- and ceiling-grilles in all areas inside the secure perimeter. Examples include the following areas:
 - 1. Housing Unit Cells
 - 2. Holding Cells
 - 3. Medical Cells
- B. Provide non-secure grilles and diffusers in mechanical rooms, electrical rooms and other areas outside the secure perimeter.
- C. Provide stainless security barriers for dishwasher and shower exhausts.

3.4 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

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SECTION 237200 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Total Energy Wheels.

1.3 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.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air total energy recovery equipment to include in maintenance manuals.

1.5 MATERIALS MAINTENANCE 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 of each type of filter specified.
 - 2. Fan Belts: Two sets of belts for each belt-driven fan in energy recovery units.
 - 3. Wheel Belts: Two sets of belts for each heat wheel.

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1.6 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."

1.7 COORDINATION

- A. Coordinate layout and installation of air-to-air energy recovery equipment with custom unit manufacturer.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fails in materials or workmanship within 5 years from substantial completion.

PART 2 - PRODUCTS

2.1 TOTAL ENERGY WHEELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Energy Exchange, Inc.
 - 2. Daikin Applied
 - 3. Desiccant Rotors International
 - 4. Greenheck Fan Corporation
 - 5. Loren Cook Company.
 - 6. SEMCO Incorporated.

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7. Trane; American Standard Companies, Inc.

B. Casing (Shall Match Custom Unit Manufacturers Criteria):

1. Galvanized Steel: minimum 16 gauge.

a. Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on enamel finish, consisting of prime coat and thermosetting topcoat.

2. Casing seals on periphery of rotor and on duct divider and purge section.

3. Support vertical rotors on grease permanently lubricated bearings. Support horizontal rotors on tapered roller bearing.

C. Rotor: Polymer segmented wheel strengthened with radial spokes impregnated with non-migrating, water-selective, molecular-sieve desiccant coating.

1. Maximum Solid Size for Media to Pass: 800 micrometer.

D. Drive: Fractional horsepower motor and gear reducer 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 Division 23 Section "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.

E. Disposable Panel Filters:

1. Factory-fabricated, dry, extended-surface type.

2. Thickness: 4 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.

2.2 CAPACITIES AND CHARACTERISTICS

A. See Air Handling Unit Schedules for specific criteria.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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- 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.

3.2 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 Division 23 Section "Air Duct Accessories."
- B. Install floor-mounted units within Modular Central Station Air Handling Units matching base rails and housekeeping concrete base.
- C. Equipment Mounting: Integral with Custom Indoor Central-Station Air-Handling Unit.
 - 1. See Section 23 73 14 for Indoor Central-Station Mounting Requirements. Total Energy Wheel shall comply with that section's mounting requirements.
- D. Install units with clearances for service and maintenance.
- E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 CONNECTIONS

- A. Connect piping to units mounted on vibration isolators with flexible connectors.
- B. Comply with requirements for ductwork specified in Division 23 Section "Metal Ducts."
- C. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
 - 1. Install electrical devices furnished with units but not factory mounted.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

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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. 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.

C. Air-to-air energy recovery equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 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.

3.6 COMMISSIONING

- A. Refer to Commissioning Specifications, Division 01, for related commissioning requirements.
- B. Contractor shall provide all necessary support to the commissioning team to implement commissioning plan as outlined in Division 01.

END OF SECTION 237200

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SECTION 23 73 14 - OUTDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units with the following components and accessories:
 - 1. Direct-expansion cooling.
 - 2. Heat-pump refrigeration components.
 - 3. Hot-gas reheat.
 - 4. Gas furnace.
 - 5. Integral, space temperature controls.
- B. Related Sections include the following:
 - 1. Section 237333.16 "Indoor, Indirect, Gas-Fired Heating and Ventilating Units" for outdoor units providing 100 percent tempered outdoor air with heat exchangers.
 - 2. Section 237433 "Dedicated Outdoor-Air Units" for outdoor equipment air conditioning 100 percent outdoor air to replace air exhausted from a building.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. ECM: Electrically commutated motor.
- C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- D. Outdoor-Air Refrigerant-Coil Fan: The outdoor-air refrigerant-coil fan in AHUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
- E. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- F. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating

operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

- G. VVT: Variable-air volume and temperature.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design AHU supports to comply with wind performance requirements, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each AHU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
- C. Delegated-Design Submittal: For AHU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 2. Wind-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: 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. Structural members to which AHUs will be attached.
- B. Manufacturer Wind Loading Qualification Certification: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Seismic Qualification Certification: Submit certification that AHUs, accessories, and components will withstand seismic forces defined in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Field quality-control test reports.
- E. Warranty: Special warranty specified in this Section.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For AHUs to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fan Belts: One set for each belt-driven fan.
 2. Filters: One set of filters for each unit.

1.9 QUALITY ASSURANCE

- A. ARI Compliance:
 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for AHUs.
 2. Comply with ARI 270 for testing and rating sound performance for AHUs.
- B. ASHRAE Compliance:
 1. Comply with ASHRAE 15 for refrigeration system safety.
 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
 3. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

- D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- E. UL Compliance: Comply with UL 1995.
- F. 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.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of AHUs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Gas Furnace Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion.
 - 3. Warranty Period for Solid-State Ignition Modules: Manufacturer's standard, but not less than three years from date of Substantial Completion.
 - 4. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AAON, Inc.
 - 2. Daikin Applied
 - 3. McQuay International.
 - 4. Trane; American Standard Companies, Inc.
 - 5. YORK International Corporation.

2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 1. Exterior Casing Thickness: 0.0626 inch thick.

C. Inner Casing Fabrication Requirements:

1. Inside Casing: Galvanized steel, 0.034 inch thick.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

1. Materials: ASTM C 1071, Type I.
2. Thickness: 1 inch.
3. Liner materials shall have air-stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
4. Liner Adhesive: Comply with ASTM C 916, Type I.

E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.

1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
2. Drain Connections: Threaded nipple.
3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.3 FANS

- A. Direct-Driven Supply-Air Fans: Double width, airfoil, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.
- C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.
- D. Relief-Air Fan: Airfoil, shaft mounted on permanently lubricated motor.
- E. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.4 AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

A. General Requirements for Air-to-Air Energy Recovery Equipment

1. Provide Total Energy Wheel in accordance with Specification Section 23 72 00.
2. Wiring of Wheel shall be provided to the SSPP.
3. Energy Wheel Bypass:

- a. Bypass damper shall be provided to allow bypassing of wheel when outside air conditions are favorable from a temperature/humidity condition.

2.5 COILS

A. Supply-Air Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Coil Split: Interlaced.
4. Baked phenolic coating.
5. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

B. Hot-Gas Reheat Refrigerant Coil:

1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
2. Polymer strip shall prevent all copper coil from contacting steel coil frame or condensate pan.
3. Baked phenolic coating.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Four.

B. Compressor: Fixed speed, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve with a replaceable magnetic coil.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.7 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
 - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
 - 1. Fuel: Natural gas.
 - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Venting: Gravity vented.
- E. Safety Controls:
 - 1. Gas Control Valve: Modulating.
 - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

2.8 DAMPERS

- A. Outdoor-Air and Exhaust-Air Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet..
 - 1. Damper Motor: Modulating with adjustable minimum position.

2.9 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with control-circuit transformer with built-in overcurrent protection.

2.10 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Coil guards of painted, galvanized-steel wire.
- D. Hail guards of galvanized steel, painted to match casing.
- E. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of AHUs.
- B. Examine roughing-in for AHUs to verify actual locations of piping and duct connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install AHUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations.
 - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Unit Support: Install unit level on structure. Coordinate wall penetrations and flashing with wall construction. Secure AHUs to structural support with anchor bolts.

3.3 CONNECTIONS

- A. Install piping adjacent to AHUs to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Section 221123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- B. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Connect supply ducts to AHUs with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

3.4 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. Report results in writing.
- B. Perform tests and inspections and prepare test reports.

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. Report results in writing.

C. Tests and Inspections:

1. After installing AHUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system.
 - b. Do not operate below recommended low-ambient temperature.
 - c. Complete startup sheets and attach copy with Contractor's startup report.
18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.

20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.
 - a. Measure gas pressure on manifold.
 - b. Inspect operation of power vents.
 - c. Measure combustion-air temperature at inlet to combustion chamber.
 - d. Measure flue-gas temperature at furnace discharge.
 - e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Return-air volume.
 - c. Relief-air volume.
 - d. Outdoor-air intake volume.
27. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
 - a. High-temperature limit on gas-fired heat exchanger.
 - b. Low-temperature safety operation.
 - c. Filter high-pressure differential alarm.
 - d. Economizer to minimum outdoor-air changeover.
 - e. Relief-air fan operation.
 - f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 ADJUSTING

- A. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 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.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

3.9 COMMISSIONING

- A. Refer to Commissioning Specifications for related commissioning requirements.
- B. Contractor shall provide all necessary support to the commissioning team to implement commissioning plan.

END OF SECTION 23 73 14

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SECTION 238219 - FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fan coil units and accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of fan coil unit indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which fan coil units will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:

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- a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
- 6. Perimeter moldings.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
 - 1. Operation and Maintenance Data shall also include the following:
 - a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 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. Fan Coil Unit Filters: Furnish 1 spare filter for each filter installed.
 - 2. Fan Belts: Furnish 1 spare fan belt for each unit installed.

1.7 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

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1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED FAN COIL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Corporation; a UTC company.
 2. Daikin Applied
 3. ENVIRO-TEC; by Johnson Controls, Inc.
 4. McQuay International; a member of Daikin Group.
 5. Trane Inc.
 6. YORK; by Johnson Controls, Inc.
 7. Mitsubishi.
- B. Fan Coil Unit Configurations:
1. Number of Cooling Coils: One with two-pipe system.
- C. Coil Section Insulation: 1-inch-thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Coil Section Insulation: Insulate coil section according to Section 230700 "HVAC Insulation."
1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

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- E. Main and Auxiliary Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel. Floor-mounting units shall have leveling screws.
- G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
 - 1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis.
 - 2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
 - 3. Mixing Plenum: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
- H. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
 - 1. MERV Rating: 8 when tested according to ASHRAE 52.2.
- I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- J. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
- K. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- L. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- M. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
 - 1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
- N. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
 - 1. Two-way, modulating control valve for chilled-water coil.

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2. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.
 - a. Length: 24 inches.
 - b. Minimum Diameter: Equal to fan coil unit connection size.
 3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem.
 4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.
 5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.
 6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
 7. Wrought-Copper Unions: ASME B16.22.
- O. Control devices and operational sequence are specified in Section 230900 "Instrumentation and Control for HVAC".
- P. Basic Unit Controls:
1. Control voltage transformer.
 2. Wall-mounting thermostat with the following features.
 - a. Heat-cool-off switch.
 - b. Fan on-auto switch.
 - c. Fan-speed switch.
 - d. Automatic changeover.
 - e. Adjustable deadband.
 - f. Exposed set point.
 - g. Exposed indication.
 - h. Degree F indication.
 3. Wall-mounting humidistat.
 - a. Exposed set point.
 - b. Exposed indication.
 4. Unoccupied-period-override push button.
 5. Data entry and access port.
 - a. Input data includes room temperature, and humidity set points and occupied and unoccupied periods.
 - b. Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

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Q. Building Automation System (BAS) Interface Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet interface for central BAS workstation for the following functions:
 - a. Adjust set points.
 - b. Fan coil unit start, stop, and operating status.
 - c. Data inquiry, including supply- and room-air temperature and humidity.
 - d. Occupied and unoccupied schedules.

R. Electrical Connection: Factory wire motors and controls for a single electrical connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548.13 "Vibration Controls for HVAC Piping and Equipment."
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
- E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
 1. Install piping adjacent to machine to allow service and maintenance.
 2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.

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3. Connect condensate drain to indirect waste.

- a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

- B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 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 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 electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

3.6 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. 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.

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3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

SECTION 260000 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 GENERAL

- A. Basic Requirements: The Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. General Provisions: Provide all labor, materials, equipment, and incidentals required to make ready for use complete electrical systems as specified herein and shown on the drawings.
- C. Provide and Install: The word "provide" where used on the Drawings or in the Specifications shall mean "furnish, install, mount, connect, test, complete, and make ready for operation". The word "install" where used on the Drawings or in the Specifications shall mean "mount, connect, test, complete, and make ready for operation". Perform work required by, and in accordance with, the Contract Documents.
- D. Installation: Provide and place in satisfactory condition, ready for proper operation, raceways, wires, cables, and other material needed for all complete electrical systems required by the Contract Documents. Additional raceways and wiring shall be provided to complete the installation of the specific equipment provided. Include auxiliaries and accessories for complete and properly operating systems. Provide electrical systems and accessories to comply with the NEC, state and local codes and ordinances. It is the intent of these Specifications that the electrical systems be suitable in every way for the use intended. Material and work which is incidental to the work of this Contract shall be provided at no additional cost to the Contract.

1.2 SCOPE OF WORK

- A. General: Provide labor, materials, permits, inspections and re-inspection fees, tools, equipment, transportation, insurance, temporary protection, temporary power and lighting, supervision and incidental items essential for proper installation and operation of the Electrical systems indicated in the Contract Documents. Provide materials not specifically mentioned or indicated but which are usually provided or are essential for proper installation and operation of the Electrical systems indicated in the contract documents.
- B. Notices: Give notices, file Plans, pay fees, and obtain permits and approvals from authorities having jurisdiction. Include all fees in the Bid Price.

1.3 INTERPRETATION OF DRAWINGS

- A. General: The Drawings are diagrammatic and are not intended to show exact locations of Raceway runs, outlet boxes, junction boxes, pull boxes, etc. The locations of equipment, appliances, fixtures, Raceways, outlets, boxes and similar devices shown on the Drawings are approximate only. Exact locations shall be determined and coordinated in the field. The right is reserved to change, without additional cost, the location of any outlet within the same room or general area before it is permanently installed. Obtain all information relevant to the placing of electrical work and in case of interference with other work, proceed as directed by the Architect.

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- B. Discrepancies: Notify the Architect of any discrepancies found during construction of the project. The Architect will provide written instructions as to how to proceed with that portion of work. If a conflict exists between the Contract Documents and an applicable code or standard, the most stringent requirement shall apply.
- C. Wiring: Each three-phase circuit shall be run in a separate Raceway unless otherwise shown on the Drawings. Unless otherwise accepted by the Architect, Raceway shall not be installed exposed. Where circuits are shown as "home-runs" all necessary fittings, supports, and boxes shall be provided for a complete raceway installation.
- D. Layout: Circuit layouts are not intended to show the number of fittings, or other installation details. Connections to equipment shall be made as required, and in accordance with the accepted shop and manufacturer's setting drawings.
- E. Coordination: Coordinate final equipment locations with drawings or other disciplines. Layout before installation so that all trades may install equipment in available space. Provide coordination as required for installation in a neat and workmanlike manner.

1.4 EQUIPMENT SIZE AND HANDLING

- A. Coordination: Investigate each space in the structure through which equipment must pass to reach its final location. If necessary, ship the equipment in sections of specific sizes to permit the passing through the necessary areas within the structure.
- B. Handling: Equipment shall be kept upright at all times. When equipment has to be tilted for ease of passage through restricted areas during transportation, the manufacturer shall be required to brace the equipment suitably, to insure that the tilting does not impair the functional integrity of the equipment.

1.5 RECORD DRAWINGS

- A. Production: The Contractor shall provide two (2) sets of black or blue line on white drawings to maintain and submit record "As-Built Documents". Label each sheet of the Record Document set with "Project Record Documents" with company name of the installing contractor in stamped or printed letters. One set shall be maintained at the site and at all times be accurate, clear, and complete. These drawings shall be available at all times to the Architect's field representatives.
- B. Recording: Record information concurrent with construction progress. Make entries within 24 hours upon receipt of information. The "As-Built" drawings shall accurately reflect installed electrical work specified or shown on the Contract Documents.
- C. Completion: At the completion of the Work, transfer changes with a colored pencil onto the second set and submit to the Architect. The "As-Built" drawings shall be made available to the Architect to make the substantial completion punch list.
- D. Final: Upon Contractor's completion of the Engineer's final punch list, transfer all "As-Built" conditions and all requirements by the Engineer to a reproducible set of drawings and CAD files. Submit drawings and CAD disks for review and acceptance. The Contractor shall provide updated disks which include final As-Built conditions.

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1.6 CODES, FEES, AND STANDARDS

- A. Application: The codes, standards and practices listed herein generally apply to the entire project and specification sections. Other codes, standards or practices that are more specific will be referenced within a particular specification.
- B. Requirements: All materials and types of construction covered in the specifications will be required to meet or exceed applicable standards of manufacturer, testing, performance, and installation according to the requirements of UL, ANSI, NEMA, IEEE, and NEC referenced documents where indicated and the manufacturer's recommended practices. Requirements indicated on the contract documents that exceed but are not contrary to governing codes shall be followed.
- C. Compliance and Certification: The installation shall comply with the governing state and local codes or ordinances. The completed electrical installation shall be inspected and certified by applicable agencies that it is in compliance with codes.
- D. Applicability: The codes and standards and practices listed herein, and their respective dates are furnished as the minimum latest requirements.

1. State of Florida

- E. Utility Company: Comply with latest utility company regulations, Florida Power & Light (FPL).

- F. Building Code: Florida Building Code (2017), 6th Edition.

- G. Standards: American Society of Mechanical Engineers

1. ASME-A17.1 (2010) Elevator Code, plus Interpretations to Date.

- H. Labels: Materials and equipment shall be new and free of defects, and shall be U.L. listed, bear the U.L. label or be labeled or listed with an approved, nationally recognized Electrical Testing Agency. Where no labeling or listing service is available or desired for certain types of equipment, test data shall be submitted to validate that equipment meets or exceeds available standards.

- I. NFPA: National Fire Protection Association (NFPA) Standards

NFPA-1	Uniform Fire Code™
NFPA-13	Standard for the Installation of Sprinkler Systems
NFPA-70	National Electrical Code (2014)
NFPA-72	National Fire Alarm Code
NFPA-90A	Standard for the Installation of Air Conditioning And Ventilating Systems
NFPA-101	Life Safety Code
NFPA 110	Emergency and Standby Power Systems
NFPA-780	Installation of Lightning Protection Systems

1.7 SUPERVISION OF THE WORK

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- A. Supervision: Provide one field superintendent who has had a minimum of four (4) years previous successful experience on projects of comparable sizes, type and complexity. The Superintendent shall be present at all times when work is being performed. At least one member of the Electrical Contracting Firm shall hold a State Master Certificate of Competency.

1.8 COORDINATION

- A. General: Compare drawings and specifications with those of other trades and report any discrepancies between them to the Architect. Obtain from the Architect written instructions to make the necessary changes in any of the affected work. Work shall be installed in cooperation with other Trades installing interrelated work. Before installation, Trades shall make proper provisions to avoid interferences in a manner approved by the Architect.
- B. Provide all required coordination and supervision where work connects to or is affected by work of others, and comply with all requirements affecting this Division. Work required under other divisions, specifications or drawings to be performed by this Division shall be coordinated with the Contractor and such work performed at no additional cost to Owner including but not limited to electrical work required for:
 - 1. Door hardware
 - 2. Roll-up doors
 - 3. Roll-up grilles
 - 4. Signage
 - 5. Sliding or automatic doors
 - 6. Mechanical, Plumbing, Fire Protection Divisions of the Specifications
 - 7. Kitchen equipment shop drawings.
 - 8. Laundry equipment shop drawings.
 - 9. Low voltage drawings.
 - 10. Landscape Architect drawings
 - 11. Interior design drawings
 - 12. Millwork design drawings and shop drawings
 - 13. Owner provided and installed equipment
- C. Obtain set of Contract Documents from Owner's Authorized Representative or Contractor for all areas of work noted above and include all electrical work in bid whether included in Division 26 Contract Documents or not.
- D. Secure approved shop drawings from all required disciplines and verify final electrical characteristics before roughing power feeds to any equipment. When electrical data on approved shop drawings differs from that shown or called for in Construction Documents, make adjustments to the wiring, disconnects, and branch circuit protection to match that required for the equipment installed.
- E. Damage from interference caused by inadequate coordination shall be corrected at no additional cost to the Owner.
- F. Adjustments: Locations of raceway and equipment shall be adjusted to accommodate the work with interferences anticipated and encountered. Determine the exact routing and location of systems prior to fabrication or installation.

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- G. Priorities: Lines which pitch shall have the right of way over those which do not pitch. For example, plumbing drains shall normally have the right of way. Lines whose elevations cannot be changed shall have the right of way over lines whose elevations can be changed.
- H. Modifications: Offsets and changes of direction in raceway systems shall be made to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. Provide elbows, boxes, etc., as required to allow offsets and changes to suit job conditions.
- I. Replacement: Work shall be installed in a way to permit removal (without damage to other parts) of other system components provided under this Contract requiring periodic replacement or maintenance. Raceway shall be arranged in a manner to clear the openings of swinging overhead access doors as well as ceiling tiles.
- J. Layout: The Contract Drawings are diagrammatic only intending to show general runs and locations of raceway and equipment, and not necessarily showing required offsets, details and accessories and equipment to be connected. Work shall be accurately laid out with other Trades to avoid conflicts and to obtain a neat and workmanlike installation, which will afford maximum accessibility for operation, maintenance and headroom.
- K. Contract Conflicts: Where discrepancies exist in the Scope of Work as to what Trade provides items such as starters, disconnects, flow switches, etc. such conflicts shall be coordinated between the divisions involved. It is the intent of the Contract Documents that all work shall be provided complete as one bid price.
- L. Drawing Conflicts: Where drawing details, plans or specification requirements are in conflict and where sizes of the same item run are shown to be different within the contract documents, the most stringent requirement shall be included in the Contract. Systems and equipment called for in the specification or as shown on the drawings shall be provided as if it was required by both the drawings and specifications. Prior to ordering or installation of any portion of work, which appears to be in conflict, such work shall be brought to Architect's attention for direction as to what is to be provided.
- M. It is the responsibility of this Contractor to coordinate the exact required location of floor outlets, floor ducts, floor stub-ups, etc. with Owner's Authorized Representative and Designer (and receive their approval) prior to rough-in. Locations indicated in Contract Documents are only approximate locations.
- N. The Contract Documents describe specific sizes of switches, breakers, fuses, Raceways, conductors, motor starters and other items of wiring equipment. These sizes are based on specific items of power consuming equipment (heaters, lights, motors for fans, compressors, pumps, etc.). Coordinate the requirements of each load with each load's respective circuitry shown and with each load's requirements as noted on its nameplate data and manufacturer's published electrical criteria. Adjust circuit breaker, fuse, Raceway, and conductor sizes to meet the actual requirements of the equipment being provided and installed and change from single point to multiple points of connection (or vice versa) to meet equipment requirements. Changes shall be made at no additional cost to the Owner.
- O. Working Clearances: Minimum working clearances about electrical equipment and mechanical equipment requiring electrical connections shall be as referenced in the applicable edition NEC Article 110, and shall include equipment installed in ceiling spaces.

PART 2 - PRODUCTS

BASIC ELECTRICAL REQUIREMENTS

Dewberry Architects, Inc. 50101397

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2.1 MATERIALS

- A. Specified Method: Where several brand names, make or manufacturers are listed as acceptable each shall be regarded as equally acceptable, based on the design selection but each must meet all specification requirements. Where a manufacturer's model number is listed, this model shall set the standard of quality and performance required. Where no brand name is specified, the source and quality shall be subject to Engineer's review and acceptance. Where manufacturers are listed, one of the listed manufacturers shall be submitted for acceptance. No substitutions are permitted unless submitted prior to bid and approved by Architect/Engineer prior to bid. Reference Division 1 specifications for bid substitution process.
- B. Certification: When a product is specified to be in accordance with a trade association or government standard requested by the Engineer, Contractor shall provide a certificate that the product complies with the referenced standard. Upon request of Engineer, Contractor shall submit supporting test data to substantiate compliance.
- C. Basis of Bid: Each bidder represents that his bid is based upon the manufacturer's materials, and equipment described in the Contract Documents.
- D. Space Requirements: Equipment or optional equipment shall conform to established space requirements within the project. Equipment which does not meet space requirements, shall be replaced at no additional expense to the Contract. Modifications of related systems shall be made at no additional expense to the Contract. Submit modifications to the Architect/Engineer for acceptance.

2.2 SHOP DRAWINGS

- A. General: Shop drawings shall be submitted for every item listed within the Submittals section each individual specification section. One copy shall be submitted to the engineer prior to ordering equipment. Refer to Basis of approval paragraph.
- B. Responsibility: It is the Contractors responsibility to provide material in accordance with the plans and specifications. Material not provided in accordance with the plans and specifications shall be removed and replaced at the Contractors expense.
- C. Official Record: The shop drawing submittal shall become the official record of the materials to be installed. If materials are installed which do not correspond to the record submittal they shall be removed from the project without any additional cost or delays in construction completion.
- D. Information: The shop drawing record submittal shall include the following information to the extent applicable to the particular item;
 - 1. Manufacturer's name and product designation or catalog number.
 - 2. Standards or specifications of ANSI, ASTM, ICEA, IEEE, ISA, NEMA, NFPA, OSHA, UL, or other organizations, including the type, size, or other designation.
 - 3. Dimensioned plan, sections, and elevations showing means for mounting, raceway connections, and grounding, and showing layout of components.
 - 4. Materials and finish specifications, including paints.
 - 5. List of components including manufacturer's names and catalog numbers.

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6. Internal wiring diagram indicating connections to components and the terminals for external connections.
 7. Manufacturer's instructions and recommendations for installation, operation, and maintenance.
 8. Manufacturer's recommended list of spare parts.
 9. Provide 1/2" = 1'-0" enlarged electrical room layout drawings for all electrical rooms and in chases where electrical equipment is indicated. All equipment shall be indicated at actual size of equipment being provided, coordinated with feeder and branch circuit conduits entering space or room. All dimensions and required working clearances shall be shown.
- E. Preparation: Prior to submittal, shop drawings shall be checked for accuracy and contract requirements. Shop drawings shall bear the date checked and shall be accompanied by a statement that the shop drawings have been examined for conformity to Specifications and Drawings. This statement shall also list discrepancies with the Specifications and Drawings. Shop drawings not checked and noted shall be returned to Contractor not reviewed.
- F. Basis of Review: Approval is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Contractor is responsible for quantities, dimensions, fabrication processes, and construction techniques.
- G. Responsibility: The responsibility that dimensions are confirmed and correlated with proper coordination of other trades shall be included as part of the Contract Documents. The responsibility and the necessity of providing materials and workmanship required by the Specifications and Drawings which may not be indicated on the shop drawings shall be included as part of the Contract Documents. The Contractor is responsible for any delays in job progress occurring directly or indirectly from late submissions or re-submissions of shop drawings, product data, or samples.
- H. Ordering Equipment: No material shall be ordered or shop work started until the Engineer has officially received the shop drawings record submittal and has formally released the Contractor for submittal requirements.
- I. Brochure Requirements: Submit Technical Information Brochures at the start of construction or no later than 30 days after Award of the Contract. Each brochure shall consist of an adequately sized, hardcover, 3-ring binder for 8-1/2" X 11" sheets. Provide correct designation on outside cover and on end of brochure. When one binder is not enough to adequately catalog all data, an additional binder shall be submitted.
- J. Brochure Contents: First sheet in the brochure shall be a photocopy of the Electrical Index pages in these specifications. Second sheet shall be a list of Project Addresses for this project. Third sheet shall list Project Information. Provide reinforced separation sheets tabbed with the appropriate specification reference number and typed index for each section in the Electrical Schedule. Technical Information consisting of marked catalog sheets or shop drawings shall be inserted in the brochure in proper order on all items specified and shown on drawings. At the end of the brochure, provide and insert a copy of the specifications for this Division and all addenda applicable to this Division.
- K. Contractor's Review: Review the brochures before submitting to the Engineer. No request for payment shall be considered until the brochure has been reviewed, stamped and submitted for review.
- L. Technical Data: Submit technical data verifying that the item submitted complies with the requirements of the specifications. Technical data shall include manufacturer's name and model

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number, dimensions, weights, electrical characteristics, and clearances required. Indicate optional equipment and changes from the standard item as called for in the specifications. Provide drawings, or diagrams, dimensioned and in correct scale, covering equipment, showing arrangement of components and overall coordination.

- M. Same Manufacturer: In general, relays, contactors, starters, motor control centers, switchboards, panelboards, dry type transformers, disconnect switches, circuit breakers, manual motor starter switches, etc., shall be supplied and manufactured by the same manufacturer. This requirement shall apply to same type of electrical components specified in other Divisions.

2.3 EQUIPMENT, MATERIALS, AND SUPPORTS

- A. General: Each item of equipment or material shall be manufactured by a company regularly engaged in the manufacture of the type and size of equipment, shall be suitable for the environment in which it is to be installed, shall be approved for its purpose, environment, and application, and shall bear the UL label.
- B. Installation Requirements: Each item of equipment or material shall be installed in accordance with instructions and recommendations of the manufacturer, however, the methods shall not be less stringent than specified herein.
- C. Required Accessories: Provide all devices and materials, such as expansion bolts, foundation bolts, screws, channels, angles, and other attaching means, required to fasten enclosures, raceways, and other electrical equipment and materials to be mounted on structures which are existing or new.
- D. Protection: Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by the elements. Equipment shall be stored in dry permanent shelters. If apparatus has been damaged, such damage shall be repaired at no additional cost or time extension to the Contract. If apparatus has been subject to possible injury, it shall be thoroughly cleaned, dried out and put through tests as directed by the Manufacturer and Engineer, or shall be replaced, if directed by the Engineer, at no additional cost to the Contract.

2.4 IDENTIFICATION OF EQUIPMENT

- A. General: Electrical items shall be identified as specified in the Contract Documents. Such identification shall be in addition to the manufacturer's nameplates and shall serve to identify the item's function and the equipment or system, which it serves or controls. Refer to Identification Section of the specifications for additional information.

2.5 CONCRETE PADS

- A. General: Provide reinforced concrete pads for floor mounted electrical equipment. Unless otherwise noted, pads shall be nominal four (4) inches high and shall exceed dimensions of equipment being set on them, including future sections, by six (6) inches on all sides, except when equipment is flush against a wall, then the side or sides against the wall shall be flush with the equipment. Chamfer top edges 1/2". Trowel surfaces smooth. Refer to Structural specifications and details.
- B. Generator Pad: Generator concrete pad shall be provided, based on submitted manufacturer's requirements, and equipment weights, including base fuel tank and fuel. Refer to Structural

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specifications and notes as well. Provide concrete pad shop drawings, signed & sealed by Florida Structural P.E., for review based on submitted manufacturer.

- C. Utility Transformer Pad: Provide concrete pad, per latest FPL requirements and standards.

2.6 SURFACE MOUNTED EQUIPMENT

- A. General: Surface mounted fixtures, outlets, cabinets, panels, etc. shall have a factory-applied finish or shall be painted as accepted by Engineer. Raceways and fittings, where allowed to be installed surface mounted, shall be painted to match the finish on which it was installed. Paint shall be in accordance with other applicable sections of these specifications.

2.7 CUTTING AND PATCHING

- A. Core Drilling: The Contractor shall be responsible for core drilling as required for work under this section, but in no case shall the Contractor cut into or weld onto any structural element of the project without the written approval of the Architect.
- B. Cutting and Patching: Cutting, rough patching and finish patching shall be provided as specified in the contract documents. Cutting and patching shall be performed in a neat and workmanlike manner. Upon completion, the patched area shall match adjacent surfaces.
- C. Openings and Sleeves: Locate openings required for work performed under this section. Provide sleeves, guards or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: Provide roofer with pitch pans, fittings, etc., required for electrical items which penetrate the roof. Roof penetrations are to be waterproofed in such a manner that roofing guarantees are fully in force. Roof penetrations shall be coordinated with other Trades to ensure that roof warranty is not invalidated.

2.8 SLEEVES AND FORMS FOR OPENINGS

- A. Sleeves: Provide sleeves for Raceways penetrating floors, walls, partitions, etc. Locate necessary slots for electrical work and form before concrete is poured. Watertight sleeves shall be line seal type WS. Fire rated partition sleeves shall be mild steel. Sleeves shall be Schedule 40 PVC or galvanized rigid steel unless specifically noted otherwise. Size shall be one standard diameter larger than pipe being installed or of a larger diameter to below 1/4" minimum clearance.
- B. Forms: Provide boxed out forms for Raceway penetrations only where allowed by the Architect. Fill opening after Raceway installation, with equivalent material.

2.9 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. General: Thoroughly instruct the Owner's Representative, to the complete satisfaction of the Architect and Engineer, in the proper operation of all systems and equipment provided. The Contractor shall make all arrangements, via the Architect, as to whom the instructions are to be given in the operation of the systems and the period of time in which they are to be given. The Architect shall be completely satisfied that the Owner's Representative has been thoroughly and completely instructed in the proper operation of all systems and equipment before final payment is made. If the Architect determines that complete and thorough instructions have not been given by the Contractor

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to the Owner's Representative, then the Contractor shall be directed by the Architect to provide whatever instructions are necessary until the intent of this paragraph of the Specification has been complied with.

- B. Submittals: Submit to the Architect for approval five (5) typed sets, bound neatly in loose-leaf binders, of instructions for the installation, operation, care and maintenance of equipment and systems, including instructions for the ordering and stocking of spare parts for equipment installed under this contract. The lists shall include part number and suggested suppliers. Each set shall also include an itemized list of component parts that should be kept on hand and where such parts can be purchased.
- C. Information Requirements: Information shall indicate possible problems with equipment and suggested corrective action. The manuals shall be indexed for each type of equipment. Each section shall be clearly divided from the other sections. A sub index for each section shall also be provided.
- D. Instructions: The instructions shall contain information deemed necessary by the Architect and include but not limited to the following:
 - 1. Introduction:
 - a. Explanation of Manual and its use.
 - b. Summary description of the Electrical Systems.
 - c. Purpose of systems.
 - 2. System:
 - a. Detailed description of all systems.
 - b. Illustrations, schematics, block diagrams, catalog cuts and other exhibits.
 - 3. Operations:
 - a. Complete detailed, step by step, sequential description of all phases of operation for all portions of the systems, including start up, shutdown and balancing. Include posted instruction charts.
 - 4. Maintenance:
 - a. Parts list and part numbers.
 - b. Maintenance and replacement charts and the Manufacturer's recommendations for preventive maintenance.
 - c. Trouble shooting charts for systems and components.
 - d. Instructions for testing each type of part.
 - e. Recommended list of on-hand spare parts.
 - f. Complete calibration instructions for all parts and entire systems.
 - g. General and miscellaneous maintenance notes.
 - 5. Manufacturer's Literature:
 - a. Complete listing for all parts.

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- b. Names, addresses and telephone numbers.
- c. Care and operation.
- d. All pertinent brochures, illustrations, drawings, cuts, bulletins, technical data, certified performance charts and other literature with the model actually furnished to be clearly and conspicuously identified.
- e. Internal wiring diagrams and Engineering data sheets for all items and/or equipment furnished under each Contract.
- f. Guarantee and warranty data.

2.10 TEMPORARY LIGHT AND POWER

- A. Capacity: Provide capacity from new temporary service. Make arrangements with the Owner for temporary service and pay all related expenses. Temporary light and power shall be provided constantly during the project dependent upon Owner's safety requirements.
- B. Lighting: Temporary light shall be based on one 200 watt lamp covering each 1,000 square foot of floor area in the building. Each room 100 square foot and over shall have a minimum of one 100-watt lamp with guards. Provide power for motors up to 3/4 horsepower only. Provisions are to be made for electric welders, if required.
- C. Outlets: Provide outlets located at convenient points so that extension cords of not over fifty (50) feet will reach work requiring artificial light or power.
- D. Other Connections: Contractors of other trades shall furnish their own cords and sockets, as may be required for their work and shall also pay for cost of temporary wiring of construction offices and shanties used by them.
- E. New Fixtures: Permanently installed lighting fixtures may be used for temporary lighting at the Contractor's option with the provision that cool white lamps for fluorescent, clear lamps for incandescent and marked temporary for other types shall be installed. At job completion, lamps shall be replaced with permanent lamps specified.
- F. Wiring: Temporary electrical work shall be furnished and installed in conformity with the National Electrical Code and in accordance with the requirements of the local ordinances and shall be maintained in a workmanlike manner throughout their entire construction period and shall be removed after installation of the permanent electrical systems. Extension cords shall be GFCI protected or shall be fed from GFCI circuit breakers.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. General: The installation of materials and equipment shall be performed in a neat, workmanlike and timely manner by an adequate number of craftsmen knowledgeable of the requirements of the Contract Documents. They shall be skilled in the methods and craftsmanship needed to produce a quality level of workmanship. Personnel who install materials and equipment shall be qualified by training and experience to perform their assigned tasks.
- B. Acceptable Workmanship: Acceptable workmanship is characterized by first-quality appearance and function, conforming to applicable standards of building system construction, and exhibiting a high

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degree of quality and proficiency which is judged by the Architect as equivalent or better than that ordinarily produced by qualified industry tradesmen.

- C. Performance: Personnel shall not be used in the performance of the installation of material and equipment who, in the opinion of the Architect, are deemed to be careless or unqualified to perform the assigned tasks. Material and equipment installations not in compliance with the Contract Documents, or installed with substandard workmanship and not acceptable to the Architect, shall be removed and reinstalled by qualified craftsmen, at no change in the contract price.

3.2 PROTECTION AND CLEAN UP

- A. Protection and Restoration: Suitably protect equipment provided under this Division during construction. Restore damaged surfaces and items to "like new" condition before a request for substantial completion inspection.
- B. Handling: Materials shall be properly protected and Raceway openings shall be temporarily closed by the Contractor to prevent obstruction and damage. Post notice prohibiting the use of systems provided under this Contract, prior to completion of work and acceptance of systems by the Owner's representative. The Contractor shall take precautions to protect his materials from damage and theft.
- C. Safeguards: The Contractor shall furnish, place and maintain proper safety guards for the prevention of accidents that might be caused by the workmanship, materials, equipment or systems provided under this contract.
- D. Cleanup: Keep the job site free from debris and rubbish. Remove debris and rubbish from the site and leave premises in clean condition on a daily basis.

3.3 SYSTEMS GUARANTEE

- A. General: Provide a one-year guarantee. This guarantee shall be by the Contractor to the Owner for any defective workmanship or material, which has been provided under this Contract at no cost to the Owner for a period of one year from the date of substantial completion of the System. The guarantee shall include lamps, for ninety days after date of Substantial Completion of the System. Explain the provisions of guarantee to the Owner at the "Demonstration of Completed System".

3.4 FINAL OBSERVATION

- A. General: Work shall be completed, and forms and other information shall be submitted for acceptance one week prior to the request for final observation of the installation.

3.5 SPECIAL CONSIDERATIONS

- A. Comply with special requirements imposed at site by Owner. This may include badging of employees, prohibition of smoking, special working hours, or special working conditions.

END OF SECTION 260000

SECTION 260013 - POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study. Power system study shall include protective device coordination study, fault current study, and arc flash study. All shall be performed by the distribution equipment manufacturer or an independent firm currently engaged in high- and low-voltage power system evaluation. All studies shall be performed using approved software. An electronic copy of the final study shall be submitted in the format used to perform the study. Power system study shall be based specifically on selected manufacturer's equipment and components.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. 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. Coordination-Study Report, signed and sealed, by an electrical Professional Engineer, registered in the State of Florida.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For coordination-study specialist.
- B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

1.5 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 not acceptable.

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- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer. Submitted report shall be signed and sealed by the Professional Engineer licensed in the State of Florida.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
- B. Computer Software Developers: Subject to compliance with requirements, provide products by one of the following:

Basis-of-Design Product:

- 1. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 242 and IEEE 399.
- B. 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.
- C. 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. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

PART 3 - EXECUTION

3.1 GENERAL

- A. A coordination study shall be performed to support the selection of instrument transformer ratios, protective relay characteristics and settings, fuse ratings, low voltage circuit breaker ratings, characteristics, and settings.

3.2 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.

3.3 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other electrical 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. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. 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.

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- 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 interrupting rating in amperes rms symmetrical.

3.4 FAULT-CURRENT STUDY

- A. The fault current study shall include both new equipment and existing equipment, where applicable, being connected to the new power distribution system.
- B. The maximum available short circuit current shall be calculated in amperes RMS symmetrical at circuit breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-base bolted short circuit at each of the electrical system components, including, but not limited to:
 - 1. Branch circuit panelboards
 - 2. Disconnect Switches
 - 3. Distribution Panelboards
 - 4. Medium-Voltage equipment
 - 5. Switchgear and switchboard bus
 - 6. Transfer switches
 - 7. Variable Frequency Drives
- C. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- D. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- E. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 and IEEE 242.
 - 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.

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- c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. Low-Voltage Fuses: IEEE C37.46.
- F. Study Report:
- 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- G. Equipment Evaluation Report:
- 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
 - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.5 ARC FLASH PROTECTION STUDY

- A. The Arc Flash Hazard Analysis shall be performed in compliance with IEEE Standard 1584, Guide for Performing Arc Flash Hazard Calculations. Using an approved computer software program, Arc Flash Incident Energy (AFIE) levels and flash protection boundary distances shall be calculated. Safe working distances shall be based upon the calculated arc flash boundary, considering an incident energy of 1.2 cal/cm². The study shall identify recommendations for reducing AFIE levels and enhancing worker safety. In addition, the study shall include the correct settings to avoid nuisance tripping for any arc flash reduction maintenance switch(es).
- B. The study shall include both new equipment and existing equipment, where applicable, being connected to the new power distribution system. The study will be performed using an approved computer software program.
- C. The arc flash hazard study shall include all significant locations in the electrical distribution system when work could be performed on energized parts. Locations shall include, but not be limited to, the following:
 - 1. Controller equipment such as Variable Frequency Drives
 - 2. Disconnect switches
 - 3. Enclosed circuit breakers
 - 4. Feeders
 - 5. Lighting and appliance panelboards
 - 6. Motor control centers
 - 7. Panelboards

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8. Switchboards
 9. Switchgear
 10. Transfer Switches
- D. The fault current calculations and clearing times of the phase overcurrent devices shall be retrieved from the fault current and coordination study model. Ground overcurrent relays shall not be taken into consideration when determining the clearing time when performing incident energy calculations.
- E. The incident energy calculations shall consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
1. Fault contribution from induction motors shall not be considered beyond 3-5 cycles.
 2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typical decay from 10 per unit to 3 per unit after 10 cycles).
- F. For each equipment location with a main overcurrent protective device, calculations for incident energy and flash protection boundary shall include both the line and bus side of the main device.
- G. When performing incident energy calculations on the line side of a main device (as required above), the line side and bus side contributions shall be included in the fault calculation.
- H. Arc flash calculations shall be based on actual overcurrent device clearing time. Maximum clearing time will be capped at two (2) seconds based on IEEE 1584.
- I. Arc Flash Study Report: The study report shall include pertinent data, procedures, assumptions, results and recommendations for arc flash hazard reduction.
- J. Arc Flash Evaluation Summary: Provide an arc flash evaluation summary listing the following:
1. Bus name.
 2. Upstream protective device name, type and settings.
 3. Bus line-to-line-voltage.
 4. Protective device bolted fault current.
 5. Arcing fault current.
 6. Protective device trip/delay time.
 7. Breaker opening time.
 8. Solidly grounded column.
 9. Equipment type.
 10. Gap.
 11. Arc flash boundary.
 12. Working distance.
 13. Incident energy.
 14. Required protective fire-rated clothing type and class.

K. Arc Flash Hazard Label:

1. Provide a 3.5 inch x 5 inch thermal transfer-type label of high adhesion polyester for each equipment location analyzed. All labels shall be based on recommended overcurrent device settings and shall be provided after the results of the study have been approved.
2. Each label shall include the following information, at a minimum:
 - a. Equipment designation.
 - b. Nominal voltage.
 - c. Flash hazard protection boundary.
 - d. Hazard risk category.
 - e. Limited approach boundary.
 - f. Restricted boundary.
 - g. Prohibited boundary.
 - h. Date of issue
3. The arc flash hazard labels shall be applied to the equipment at the end of construction, prior to substantial completion.

3.6 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 141 recommendations for fault currents and time intervals.
- C. 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.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.

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- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves 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.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 - 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 - 2. Coordination Curves: Prepared to 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:
 - a. Device tag.
 - b. Voltage and current ratio for curves.
 - c. Three-phase and single-phase damage points for each transformer.
 - d. No damage, melting, and clearing curves for fuses.
 - e. Cable damage curves.
 - f. Transformer inrush points.
 - g. Maximum fault-current cutoff point.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 260013

SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Electrical equipment coordination and installation.
- 2. Common electrical installation requirements.

1.3 COORDINATION

- A. Coordinate arrangement, mounting, and support of electrical equipment:

- 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
- 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
- 3. To allow right of way for piping and conduit installed at required slope.
- 4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

- C. Coordinate installation of cable trays above ceilings with other trades, including mechanical ductwork, piping, structure, light fixtures.

- D. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

- E. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

- F. Coordinate installation of electrical equipment, including switchboards, panelboards, transformers, etc., with other trades, including mechanical ductwork, piping, structure, light

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fixtures, other wall mounted equipment or floor mounted equipment, prior to installation to verify proper NEC working clearances, and dedicated space requirements per NEC where required.

PART 2 - PRODUCTS

2.1 GROUT

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

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

- A. Comply with NECA 1.
- B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.
- D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.
- E. Right of Way: Give to piping systems installed at a required slope.

END OF SECTION 260500

SECTION 260519 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work specified of this section.

1.2 WIRES AND CABLES

- A. Description: Provide a complete and continuous system of conductors as specified herein. All conductors shall be in accordance with the latest edition of the NEC.

1.3 QUALITY ASSURANCE

- A. Qualifications: Manufacturers shall be regularly engaged in the manufacture of wire systems and fittings of types and sizes required, and whose products have been in satisfactory use in similar service for not less than 5 years in the USA.
- B. Compliance: Materials shall comply with the following codes and standards, current edition as adopted by the Authority Having Jurisdiction, as they apply to the different wire types specified herein.

- 1. UL:

- a. 44 – Thermoset-Insulated Wire and Cables
- b. 83 – Thermoplastic-Insulated Wires and Cables
- c. 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors
- d. 486C – Splicing Wire Connections
- e. 493 – Thermoplastic-Insulated Underground Feeder and Branch Circuit Cables
- f. 514 – Standard for Fittings for Cable and Conduit
- g. 854 – Service Entrance Cables
- h. 1581 – Standard for Reference Standard for Electrical Wires, Cables, and Flexible Cords

- 2. NFPA-70: (2011) National Electrical Code.

- a. Metal Clad Cable

- 3. Insulated Cable Engineers Association (ICEA).

- D. Provide required separation between cable and other work.
- E. Provide cable routing to avoid interference with other work.

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1.4 SUBMITTALS

- A. General: Submit product data on all different types of conductors specified, UL listing, including splicing tape, and terminating/splicing lugs or connectors and cable sleeves.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Material: All conductors shall be copper unless noted otherwise in these specifications.
- B. Size and Insulation: Utilize 600V THHN/THWN insulation for branch circuits #10 and #12, and THHN/THWN-2 for #8 and larger, and THHN/THWN-2 or XHHW-2 insulation for feeders, unless otherwise noted. Conductors #10 AWG and smaller shall be solid (except for control circuits), #8 AWG and larger shall be stranded. All wire shall be sized as shown on the drawings. If no size is shown, wire shall be #12 AWG, except that branch homeruns" over 100 ft. in length shall be minimum #10 AWG for 120/208V circuits, and homeruns over 200' in length shall be minimum #10 AWG for 277/480V circuits. Refer to voltage drop tables on contract drawings. Wire in vicinity of heat-producing equipment shall be type XHHW insulation. All wiring shall be manufactured in the USA and of 98 percent conductivity. Wiring for light fixture "whips", i.e connection from branch circuit wiring to individual light fixture installations, shall be permitted to be #14AWG.
- C. Taps and Splices: All copper taps and splices in #8 AWG or smaller wire shall be fastened together by means of "wirenut" connectors (Ideal or accepted substitution). All taps and splices in wire larger than #8 AWG shall be made with compression type connectors and taped to provide insulation equal to wire. All taps and splices in manholes or in ground pull box shall be made with compression type connectors and covered with Raychem heavy wall cable sleeves (type CTE or WCS) with type "S" sealant coating. Provide sleeve kits as per manufacturer's installation instructions. Keep all splices to a minimum.
- D. Color Coding, General: All power feeders, grounding conductors and branch circuits #6 AWG and smaller shall be installed with color-coded wire with the same color used for a system throughout the building. Conductors above #6 AWG shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape in all junction boxes and panels in accordance with NEC 310-12. Tape shall cover the conductor insulation within the box or panel in such a manner so as to allow standard markings to be readily observed. Unless otherwise accepted, color-code shall be as indicated in specification section 260553 – Electrical Identification. Switch legs shall be a different color than phase or neutral conductors.
- E. Aluminum Conductors:
 - 1. Aluminum conductors shall be compact stranded aluminum allow with XHHW-2 insulation, Alcan Stabiloy AA-8030 Series, 600 volt. UL listed and labeled.
 - 2. Refer to Paragraph 2.1.F – Field Quality Control, for termination of aluminum conductors.

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2.2 MANUFACTURERS

- A. General: Branch circuit and feeder conductors shall be as manufactured by one of the following: General Cable Co., Pirelli, Rome Cable Corporation, Southwire, or American Insulated Wire Corporation, Alcan.

2.3 METAL CLAD (MC) CABLE

- A. Construction: MC Cable shall have galvanized steel armor that has been UL listed as a return grounding path. Conductors shall be 600V NEMA WC70, Type MC, Type THHN/THWN and XHHW. A green insulated grounding conductor shall be included in all MC Cables. Where circuiting on drawings calls for dedicated neutrals MC Cables, if used for these circuits, shall have dedicated neutral conductors.
- B. MC Cable shall be color-coded for cable type (standard, oversized neutral, ground), conductor configuration, and circuit voltage.

PART 3 - EXECUTION

3.1 GENERAL

- A. General:
 - 1. All wiring shall be installed in raceways (power, low voltage and control wiring), unless otherwise indicated or specified under other Sections of this specification.
 - 2. Connections: Conductors #10 and #12 AWG shall be connected with pre-insulated spring connectors encased in a steel shell and rated at not less than 105 degrees C. A minimum of 3/8-inch skirt shall cover the bare wires. The connector shall meet with UL approval for fixture and pressure work, and shall be "Scotch Lok" Type Y, R and B electrical spring connectors as manufactured by the 3M Company or approved equal.
 - 3. Connector Manufacturers: Lugs and wire connectors shall be one of the following: Burndy Corporation, Thomas & Betts, Co., Appleton or ILSCO.
 - 4. Equipment Installations: Neatly form, train and tie the cables in panelboards, cabinets, wireways, switches and equipment assemblies.
 - 5. Install products in accordance with manufacturer's instructions.
 - 6. Conductor sizes indicate on circuit homeruns or in schedules shall be installed over the entire length of the circuit unless noted otherwise on the drawings or specifications.
 - 7. Before installing raceways and pulling wire to any mechanical equipment, verify electrical characteristics with final shop drawing submittal on equipment to assure proper quantity and rating of conductors (as for multiple speed motors, different motor starter arrangements, etc.).
 - 8. Coordinate all wire sizes with lug sizes on equipment, devices, etc. Provide and install lugs as required to match wire size.
 - 9. Where conductors have been oversized (due to voltage drop, etc.), provide lugs as required to match conductors, or provide splice box, and splice to reduce conductor size to match lug size.
 - 10. Where MC cable is used, install in accordance with the National Electrical Code, and other sections of this specification.

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11. Perform field inspection and testing under provisions of the General Requirements of the Contract Documents.
12. Inspect wire for physical damage and proper connection.
13. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
14. Verify continuity of each branch circuit conductor.

B. Examination:

1. Verify that interior of building has been protected from weather.
2. Verify that mechanical work likely to damage wire has been completed.

C. Preparation:

1. Completely and thoroughly swab raceway prior to installing conductors.

D. Wiring Methods:

1. Use only building wire, Type THHN/THWN for #10 and #12, and THHN/THWN-2 for #8 and larger insulation, in raceway or MC cable, unless otherwise noted.
2. Wiring in vicinity of heat producing equipment: use only XHHW insulation, in raceway.
3. Conductors installed within fluorescent fixture channels shall be Type THHN or XHHW, rated 90 degrees C dry. Conductors for all other light fixtures shall have temperature ratings as required to meet the UL listing of the fixture; however, in no case shall the temperature rating be less than 90 degrees C.
4. Pre-manufactured cable systems for power distribution are not allowed.

E. Interface With Other Products:

1. Identify wire and cable under provisions of Specification Section 26 05 53 – Identification For Electrical Systems, and this Section.
2. Identify each conductor with its circuit number or other designation indicated on contract drawings.
3. Identify neutrals with its associated circuit number(s).

F. Vertical Risers:

1. Provide vertical cable riser supports. These shall be located in accessible pullboxes of adequate size per NEC requirements. Provide for adequate structural connection of cable supports to pullboxes, which will transfer cable weight to building.

G. Pulling:

1. No wire shall be pulled until the conduit system is complete from pull point to pull point and major equipment terminating conduits have been fixed in position.
2. Mechanical pulling devices shall not be used on conductors #8 and smaller. Pulling means which might cause damage to the raceway shall not be used.

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3. Use only powdered soapstone or other pulling lubricant acceptable to the Architect/Engineer. Compound or lubricant shall not cause the conductor or insulation to deteriorate.
4. All conductors to be installed in a common raceway shall be pulled together. The manufacturer's recommended pulling tension shall not be exceeded.
5. Bending radius of insulated wire or cable shall not be less than the minimum recommended by the manufacturer.
6. Where communications type conductors are installed, special requirements shall apply as outlined under that specific system detailed specifications.

H. Control and Signal Circuits:

1. Free-wire cabling is permissible under the following conditions:
 - a. All cabling will be supported by J-hooks.
 - b. All cabling entering a wall shall be sleeved by conduit (not FMC) to the junction box where the device is to be terminated.
 - c. Bending radius of the cable shall not be less than the minimum recommended by the manufacturer.
 - d. Only red cable, rated for use in fire alarm systems, shall be used for fire alarm systems.
 - e. Install additional supports as necessary to prevent cable sagging.
 - f. Zig-zagging cables through building elements as method of support is not acceptable.
 - g. All rated walls and partition walls shall be sleeved for cable through penetrations.
 - h. Cable or outer sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to the Owner in its entirety, the cable shall not be spliced or the jacket taped to be repaired.
 - i. Cables shall be securely fastened with UL listed devices intended for such use.

I. Color Coding:

1. All power feeders and branch circuits #6 and smaller shall be wired with color-coded wire with the same color used for a system throughout the building. Power feeders larger than #6 shall either be fully color-coded or shall have black insulation and be similarly color-coded with tape or paint in all junction boxes and panels. Tape or paint shall completely cover the full length of conductor insulation within the box or panel.
2. Unless otherwise accepted or required by Architect/Engineer, color code shall be as follows:
 - a. Neutrals to be white for 120/208V system, natural gray for 277/480V systems.
 - b. Ground wire green, bare; isolated ground wire green with yellow stripes.
 - c. Phase Conductors 120/208V: Phase A – Black, Phase B – Red, Phase C – Blue.
 - d. Phase Conductors 277/480V: Phase A – Brown, Phase B – Orange, Phase C – Yellow.
3. All switch legs, other voltage system wiring, control and interlock wiring shall be color coded other than those above.

J. Taps, Splices, Connectors, Terminations:

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1. Clean conductor surfaces before installing lugs and connectors.
2. Make splices, taps and terminations to carry full ampacity of conductors with no perceptible temperature rise.
3. Power and lighting conductors shall be continuous and unspliced where located within conduit. Splices shall occur within troughs, wireways, outlet boxes or equipment enclosures where sufficient additional room is provided for splices. No splices shall be made in in-ground pullboxes without written permission of Architect/Engineer.
4. Splices in lighting and power outlet boxes, wireways and troughs shall be kept to a minimum. Pull conductors through to equipment, terminal cabinets and devices.
5. No splices shall be made in junction boxes and outlet boxes for conductors #8 and larger without written permission of Architect/Engineer.
6. No splices shall be made in communications outlet boxes, pullboxes or wireways (i.e., fire alarm, data, telephone, intercom, sound system, access control system, CCTV, BMS etc.) without written acceptance of Architect/Engineer. Pull cables through to equipment cabinets, terminal cabinets, racks and devices.
7. Allow adequate conductor lengths in all junction boxes, pullboxes and terminal cabinets. All termination of conductors in which conductor is in tension will be rejected and shall be replaced with conductors of adequate length, at no cost to the Owner. This requirement shall include the providing by the Contractor of sleeve type vertical cable supports in vertical raceway installations provided in pullboxes at proper vertical spacings.

K. A calibrated torque wrench shall be used for all bolt tightening.

L. Interior Locations:

1. All (non-electronic systems) copper taps and splices #8 and smaller shall be fastened together by means of "spring type" connectors. All taps and splices in wire larger than #8 shall be made with compression type connectors and taped to provide insulation equal to wire.

M. Exterior Locations:

1. Make splices, taps and terminations above grade in splice and termination cabinets. Do not splice any cable in ground or below finished grade.
2. All taps and splices shall be made with compression type connectors and covered with Raychem heavy wall cable sleeves (Type CRSM-CT, WCSM or MCK) with Type "S" sealant coating with sleeve kits per manufacturer's installation instructions or be terminated/connected to terminal strips in above grade terminal boxes suitable for use.
3. Provide and install above grade termination cabinets sized to meet acceptable codes and standards, where required for splicing.

3.2 ALUMINUM CONDUCTORS

- A. Aluminum conductors shall be used only for panelboard, service entrance switchboard, and distribution panel feeders, #1 AWG and larger.
- B. Connections: Conductors from the load side of all disconnect switches to connect moving, vibrating, and heat-producing equipment (including indoor dry-type transformers), shall be copper. Proper UL

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accepted lugs must be provided in the disconnect switch for size and type of conductor used. Aluminum conductors shall not be connected to motors.

C. Terminations, Splices and Taps:

1. Where aluminum conductors, No. 1 AWG and larger are terminated, spliced or tapped, the connectors shall be color-coded, tool applied compression type made of aluminum with wire barrels factory prefilled with oxide-inhibiting compound.
2. Connectors shall pass UL Standard, bear markings AL7CU (75 degree C) or AL97C (90 degree C) for application, and have a UL label.
3. Set-screw type connectors are not acceptable.
4. Installation shall be as follows:
 - a. Installing tools and dies, of hexagonal or circumferential type the connector manufacturer shall be used for installation. Tooling shall be with color-coded or disconnect coding system for inspection purposes. Where UL listing is applicable for connectors, the manufacturer's recommended toolings shall be used. Connectors shall be cleaned with a wire brush immediately before connecting.
 - b. Terminal lugs with bolting pads shall be tin plated for low contact resistance.
 - c. The connectors shall meet the performance requirement Underwriters Laboratories Test of UL, except that heating or current cycling tests shall be for a minimum of 500 cycles.
 - d. Belleville-type compression washers shall be used with all bolted connections properly tightened with a torque wrench.
 - e. Taps and/or splices made of dissimilar metals shall be made with accepted connectors of a type where they never come in direct contact with each other.

3.3 METAL CABLE (MC) USE AND INSTALLATION

- A. General: MC cable may be used in Area A administration spaces, above ceiling for lighting circuits within a room or area, and in walls for receptacle circuits.
- B. MC cables, where permitted, shall be used only in interior dry locations, and concealed in walls and above ceilings.
- C. MC cables installed in stud walls shall begin from circuit collector boxes in the ceiling directly above first device or equipment served.
- D. MC cables shall not be installed where subject to mechanical injury or exposure to heat.
- E. MC Cable may be utilized for 30A or less, lighting or receptacle branch circuit wiring only, where not restricted by NEC.
- F. MC cable is acceptable for homeruns under the following conditions:
 1. The homerun cable shall be continuous from origination to area served.
 2. The required neutrals shall be in the same raceway.
 3. The required grounding conductor shall be in the same raceway.

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4. The homerun cable shall terminate in a minimum 4-11/16 inch square circuit collector box.
 5. Cables shall not be bundled.
 6. Cables shall maintain a minimum 1/2" separation from each other.
 7. Homerun cables shall be labeled at maximum 30' intervals with the panel and circuit designation, and if it passes through a wall, the label shall be provided on both sides within 2' of the wall.
 8. Cables shall be run parallel and perpendicular to the lines of the building and shall be neatly supported by the structure or trapeze system of Unistrut and all-thread.
 9. Manufacturer's recommended bending radius shall not be exceeded.
 10. If multiple MC cables are routed down a wall, the cables shall be independently supported from the wall with their own support system.
 11. MC cable homeruns to branch panelboards shall be transition from MC cable to conduit and conductors through a wireway above the branch panelboard in electrical room. MC cables shall not be run directly to branch panelboards.
- G. MC cable shall not be used for any equipment feeders or for any emergency or legally required branch circuit or feeders, or for fire alarm power or low voltage circuits.
- H. Connectors for MC Cables shall be manufactured by the MC Cable manufacturer, and shall have insulated throat.
- I. Connectors and supporting components shall be UL listed for such use.
- J. MC cables shall be cut with UL listed tools intended for such use. Ream smooth and free of sharp and abrasive areas. Install bushing between conductors and outer jacket. The use of side cutters, snips, or dikes to cut cables is not acceptable.
- K. For branch circuit lighting and power circuits only, maximum #8 gauge copper is permitted.
- L. Maintain minimum 1/2" separation between each cable and support per NEC. Cables shall not be bundled.
- M. Support cables directly from building structure. Support within 12" every box, cabinet, etc., and secure at intervals not to exceed 5 feet.
- N. Attachment of cables to ceiling system or support wires, regardless if support wire is a dedicated wire, is prohibited. Only a vertical cable drop down to a recessed lay-in luminaire can be supported to the fixture support wire with approved fasteners. Vertical cable drop attachment may be by means of Ty-Rap cable tie, if approved by the Local Authority Having Jurisdiction and UL plenum rated within plenum air environments.
- O. Attachment of cables to, on or from mechanical (HVAC) equipment, supports, etc., is not permitted.
- P. Install additional supports as necessary to omit cable sagging.
- Q. Zig-zagging cables through building elements as a method of support is not acceptable.
- R. Cable with outer metal sheath damaged by construction elements and/or improper installation shall be replaced at no additional cost to the Owner.

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- S. Cables shall be securely fastened with UL listed devices intended for such use.
- T. MC cable is allowed for installation as a switch leg under the following conditions: No other wiring is permitted in the cable except the power, switch leg and the grounding conductor.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NETA MTS.
 - a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
 - b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- 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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

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- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

- B. Bare Copper Conductors:

- 1. Stranded Conductors: ASTM B 8.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.
- C. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Ground Rods: Connections shall be exothermic weld, Cadweld or equal. Ground test well shall be provided at each location, minimum 18" deep, appropriate traffic rated cover, flush with finished grade/paving.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel, sectional type; 3/4 inch diameter by 10 feet in length.

2.4 GROUND BAR

- A. Telecommunications: Provide CPI #13622-10 and 13622-012, or equal, as a minimum size, dependent on the amount of items to be bonded to ground in each room. Coordinate with UCF CS&T prior to ordering. Provide two-hole compression type connectors.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Telecommunications: Refer to tables in contract drawings, Systems Riser Diagram.
- C. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum, unless noted otherwise.

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1. Bury at least 24 inches below grade.
- D. Grounding Bus: Install in electrical and Security Electronics, Communications rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
 3. Busbars shall be cleaned prior to fastening the conductors to the busbars, and an anti-oxidant
- E. Conductor Terminations and Connections:
1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.
1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location, unless noted otherwise on the contract drawings (refer to Tables in Systems Riser Diagram).
 2. The following items shall be bonded to the telephone terminal backboards, MDF Room main ground bar and IDF ground bars: building entrance protectors for outside plant (OSP) copper telephone cabling facilities, OSP copper cables, equipment racks, ladder racks, cable trays, metallic conduits for outside plant/ riser/ structured cabling, metallic raised computer floor components where applicable, and network electronic equipment cases. Coordinate grounding with UCF CS&T.
 3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- E. Electrical Rooms: Terminate grounding conductor on a minimum 1/4-by-4-by-12-inch grounding bus.

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- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 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 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.
- C. 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.
- D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.
- E. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

3.4 LABELING

- A. Comply with requirements in Division 26 Section "Electrical Identification" Article for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.5 FIELD QUALITY CONTROL

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- 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. 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. 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.
 - 4. 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.
- E. Prepare test and inspection reports.
- F. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment: 2.5 ohms.
 - 2. Panelboards Serving Electronic Equipment: 2.5 ohms.
 - 3. Main Service: 5 ohms maximum.
- G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.

1.5 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. 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 single-bolt conduit clamps using spring friction action for retention in support channel.
- D. 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.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

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- C. 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.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To New Concrete: Bolt to concrete inserts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 4. 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.

3.3 CONCRETE BASES

- A. For free standing electrical equipment (transfer switches, switchboards, panelboards, transformers), other than exterior generator and utility transformer pad, provide concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit and 6" high, and so anchors will be a minimum of 10 bolt diameters from edge of the base. Refer to Structural specifications and notes.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 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 minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 9 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 2 Section "Underground Ducts and Utility Structures" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. LFMC: Liquidtight flexible metal conduit.
- D. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

- A. 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.
- B. Manufacturer: Rigid Metallic Conduit, Electrical Metallic Tubing, Flexible Steel Conduit, Liquid-Tight Flexible Conduit, and PVC Conduit, Electrical Boxes, Handholes, Pullboxes, etc., shall be manufactured within the United States, and each shall be as manufactured by one manufacturer.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Rigid Metal Conduit (RMC): ANSI C80.1.

1. Conduit ends shall have precision cut hi-torque threads. One end of the conduit shall have a coupling and the other shall be covered with a color-coded plastic thread protector
2. Conduit shall be manufactured in 10 foot lengths.
3. Fittings shall be cut groove steel. Cast fittings are not acceptable.
4. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.
5. Locknuts: Rigid steel box connections shall be made with double locknuts and bushings. Turn down on threads to solidly connect raceway to box or enclosure.
6. Bushings: Grounded insulated bushings shall be used on all rigid steel conduits terminating in panels, wire gutters, or cabinets. Bushing shall be impact resistant plastic molded in an irregular shape at the top to provide smooth insulating surface at top and inner edge. Material in these bushings must not melt or support flame.

B. Electric Metallic Tubing (EMT): ANSI C80.3.

1. Provide steel compression type fittings. Steel fittings shall be fitted with non-removable insulated throats, and male threaded ends provided with a locknut.
2. Provide locknuts for securing conduit to enclosures with sharp edges for digging into metal, and ridged outside circumference for proper fastening.

C. Flexible Metallic Conduit (FMC):

1. Zinc-coated steel or aluminum. A continuous length, spirally wound steel strip, zinc-coated, each convolution interlocked with following convolution into a helix form.
2. Product shall meet Federal Specification WW-C-566 and UL 1242.
3. Straight terminal connectors shall be one piece body, female end with clamp and deep slotted machine screw for securing conduit.
4. 45 and 90 degree terminal angle connectors shall be 2 piece body, with removable upper section, female end with clamp and deep slotted machine screw for securing conduit.

D. Liquidtight Flexible Metal Conduit (LFMC):

1. Plastic jacketed (PVC) liquid-tight flexible steel conduit with copper bonding conductor, and steel material galvanized inside and outside.
2. Fittings: Provide cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings with insulated throat.

E. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

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2. Expansion Fittings: To match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.2 MALLEABLE IRON EXPANSION FITTINGS

- A. Type: Conduit expansion fittings shall be malleable iron (hot dipped galvanized inside and outside).
- B. Fittings: These fittings shall have a 4 inch expansion chamber to allow approximately 2 inch movement parallel to conduit run in either direction from normal.
- C. Internal Bonding: Fittings shall have factory-installed packing and internal tinned copper braid packing to serve as a bonding jumper.
- D. External Bonding: Unless the fitting used is listed by Underwriters Laboratories for use "without external bonding jumpers", an external copper bonding jumper shall be installed with each metal expansion fitting. One end of the fitting shall be clamped on each conduit entering fitting.

2.3 NON-METALLIC CONDUIT

- A. Rigid Non-metallic Conduit (RNC): NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated. Schedule 40, 90 degrees C. UL rated, PVC conduit shall be composed of High Impact PVC (polyvinyl chloride C-2000 Compound), and shall conform to industry standards, and be UL listed in accordance with Article 352 of National Electrical Code for underground and exposed use. Materials must have tensile strength of 55 PSI, at 70 degrees F., flexural strength of 11,000 psi, compression strength of 8600 psi. Manufacturer shall have five years extruding PVC experience
- B. Fittings for RNC: NEMA TC 3; match to conduit type and material.

2.4 OUTLET BOXES

- A. General: Outlet boxes shall be of such form and dimensions as to be adapted to the specific use and location, type of device or fixtures to be used, and number and size of conductors and arrangement, size and number of conduits connecting thereto.
- B. Boxes shall be manufactured in the USA.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A, recessed in interior metal stud walls: Provide standard galvanized one-piece steel outlet boxes at all concealed outlets for electric lights, switches, convenience receptacles, telephone outlets, etc. where mounted in metal stud walls. Acceptable manufacturers shall be T&B, Steel City, Raco, or approved equal.

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1. Low Voltage Device Box Dimensions: Minimum 4 inches square by 2-1/8 inches deep, and unless otherwise noted on plan drawings. Provide deeper boxes as required based on conduit sizes (1-1/2", 2", etc.).
 2. Electrical Device Box Dimensions: Minimum 1-1/2" deep, number of gangs required per device layout, unless otherwise noted on plan drawings.
 3. Gangable boxes are prohibited.
 4. Welded boxes are prohibited.
- D. Recessed in Interior or Exterior Masonry Walls, or Interior Surface Boxes: Comply with NEMA FB 1. Outlet boxes and conduit bodies shall be the heavy cast aluminum or iron with external raised hubs - Appleton, Crouse Hinds or Steel City or accepted substitution. Trim rings shall also be of one piece construction.

2.5 FLOOR BOXES

- A. General: Provide enamel coated cast metal boxes for slab on grade applications, and steel boxes for slab above grade applications. Outlets in slab on grade shall conform to Federal Specifications No. WC-526b, Type 1, with threaded conduit hubs
- B. Construction: All assemblies shall be designed and installed to maintain grounding continuity, fireproofing and watertight integrity. Connections to boxes in slabs on grade shall be made tight or sealed to prevent entrance of moisture.
- C. Accessories: Box trim, service fittings and flanges, receptacle brackets, communications brackets, and other accessories shall be as required to provide a complete installation.
- D. Special Consideration: Flush caps removed to provide service fittings shall be turned over to the Owner.
- E. This floor box shall have been examined and tested by Underwriters Laboratories Inc. to Standard UL514A and/or UL514C and Canadian Standard C22.2, No. 18-92 and bear the U.S. and Canadian UL Listing Mark. This floor box shall also conform to the standards set in the National Electrical Code, Section 300-21. This floor box shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
- F. Basis of design: The recessed floor box shall be Wiremold Evolution Series manufactured by The Legrand Company. Floor boxes of other manufacturers may be considered, if equal in functionality and quality, by written approval of the specifying engineer and shall meet all the performance standards specified herein. Refer to power plans and electrical legend for specific information and requirements.

2.6 METAL WIREWAYS AND AUXILIARY GUTTERS

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- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 for interior applications, manufacturer's standard enamel finish. Type 4X Stainless Steel for exterior applications, unless otherwise indicated, and sized according to NFPA 70.
- B. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. 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.
- D. Wireway Covers: Vertical mounting hinged type, horizontal mounting screw-cover type with. Flanged-and-gasketed type for exterior, unless otherwise indicated. Stainless steel hinges, and screws.

2.7 ENCLOSURES, AND CABINETS

- A. Approved Manufacturers: Hoffman, or approved equal.
- B. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- C. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- D. Cabinets:
 - 1. NEMA 250, Type 1 for interior, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel, NEMA Type 4X stainless steel for exterior.
 - 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.

2.8 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with SCTE 77.
 - 1. Color of Frame and Cover: Gray.
 - 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, heavy traffic rating.
 - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - 5. Cover Legend: Molded lettering, "ELECTRIC" for power circuits, "COMM" for low voltage (security, data, etc.).

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6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
 7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Fiberglass Handholes and Boxes with Polymer-Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester-resin enclosure joined to polymer-concrete top ring or frame.
1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Armorcast Products Company.
 - b. Carson Industries LLC.
 - c. Christy Concrete Products.
 - d. Synertech Moulded Products, Inc.; a division of Oldcastle Precast.
 - e. Quazite

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Raceways: Apply raceway products as specified below unless otherwise indicated:
1. Exterior:
 - a. Exposed not permitted except for under roof structures where conduit is required to be GRC e.g., loading docks, canopies, etc., except in fenced-in secured areas (utility yard, lift station yard).
 - b. Underground: Schedule 40 PVC.
 - c. Connection to Vibrating Equipment including transformers and hydraulic, pneumatic, electric solenoid, motor driven equipment: liquid tight flexible metal conduit.
 2. Interior:
 - a. Secure Electronic Equipment Rooms, Mechanical Rooms, Electrical Rooms, Sprinkler Riser Rooms, Chases, etc.: Exposed conduit permitted using EMT, IMC, GRC, where allowed by NEC.
 - b. Secure Inmate-Accessible Spaces (corridors, multi-purpose rooms, housing/dayroom areas, clinic, booking, indoor recreation, etc.): Exposed conduit not permitted from finished floor to 10 feet above finished floor. Exposed conduit above 10 feet is permitted using IMC or GRC.
 - c. Maintenance/Laundry/Kitchen (where accessible to inmates): Exposed conduit is permitted. GRC required from finished floor to 10 feet above finished floor. Above 10 feet, exposed conduit is permitted using RMC, IMC or EMT.
 - d. Exposed: Unless specifically permitted above, exposed conduit is not permitted.
 - e. Concealed above gypsum wall board ceilings offices, classrooms, exam rooms, storage, etc.: GRC, IMC or EMT.

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- f. Connection to Vibrating or Mechanical Equipment including transformers and hydraulic, pneumatic, electric solenoid, motor driven equipment: liquid tight flexible metal conduit.
 - g. Damp or wet locations: GRC with water-tight connectors.
 - h. Below on-grade concrete slab: Schedule 40 PVC.
 - i. Unfilled CMU masonry: GRC, IMC, EMT.
 - j. Cast-in-Place Concrete walls, slab on grade, topping slab, suspended slab, tunnel form: GRC, IMC, EMT, SCH 40 PVC, SCH 80 PVC.
 - k. Pre-Cast Concrete pre-cast panels, tilt-up, concrete modules, pre-cast elements: GRC, IMC, EMT, Sch 40 PVC, Sch 80 PVC, ENT.
 - l. Embedded in structural footing for lightning protection downloads: ENT or RNC required.
- B. Minimum Exterior Raceway Size: 1-inch trade size, inside diameter.
- C. Minimum Interior Raceway Size: 3/4-inch trade size, inside diameter, for power circuits and fire alarm.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
 - 2. Primary, Secondary power, Telecommunications conduits: Utilize rigid galvanized steel long sweep elbows for horizontal turns and where turning up into equipment.

3.2 PVC RACEWAYS

- A. Restricted Location: PVC raceways shall be used only where listed above. PVC shall be used for lightning protection down conductors and grounding electrode raceways, concealed in exterior walls or columns. No PVC shall be allowed anywhere except underground or in slab, with the exception that PVC conduit may be used in non-fire rated poured block walls and poured in place columns.
- B. Floor Penetrations Exposed: Where PVC penetrates a floor in an exposed location from underground or in slab, a black mastic coated steel conduit elbow shall be used. This includes stub ups from the exterior into floor mounted electrical equipment.
- C. Floor Penetrations in Block: PVC may also be used for penetrations of floor into concrete block or hollow walls up to first outlet box provided outlet box is at a maximum height of 48 inches above finished floor.
- D. Ground Conductor Installation: All individual bare copper ground conductors (i.e. service, transformer, or lightning protection grounds) shall be installed in PVC raceway.
- E. Joints: PVC joints shall be solvent welded. Threads shall not be permitted on PVC raceway and fittings, except for rigid steel to PVC couplings. Installation of PVC raceway shall be in accordance with manufacturer's recommendations.
- F. Restrict Support: PVC raceway shall not be used to support fixture or equipment.

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- G. Bends: Field bends shall be made with an approved hotbox. Heating with flame and hand held dryers are prohibited.

3.3 FLEXIBLE CONNECTIONS

- A. Vibrating Equipment Connection: All connections to motors or other vibrating equipment or at other locations where required shall be made with not less than 12 inches of flexible liquid-tight steel conduit, using special type of connectors with strain relief fittings at both terminations of conduit, Kellems Type 074-09 Series or accepted substitution. Connections for transformers can be made with flexible metal conduit.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight raceway runs above ground which are more than one hundred feet long.

3.4 ELECTRICAL METALLIC TUBING

- A. Location: Install Electrical Metallic Tubing (thin wall) inside buildings, above the ground floor where not subject to mechanical injury.
- B. Handling: All cut ends shall be reamed to remove rough edges.

3.5 GENERAL INSTALLATION

- A. Support: All raceways shall be run in a neat and workmanlike manner and shall be properly supported and in accordance with the latest edition of the NEC. Supporting conduit and boxes with wire is not acceptable. Exposed raceways where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls, and with lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight foot section. Support within one foot of changes in direction. All required hangers, supports and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed) or beam-clamps for mounting to building structure or special brackets.
- B. Hanger Installation: Where 2 or more raceways 1 inch or larger run parallel trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts and galvanized "L" angle iron, or Unistrut cross members. These raceways shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a raceway run and at each elbow. J-bolts, or approved clamps, shall be installed on each third

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intermediate trapeze hanger to fasten each raceway. See Division 26 Section "Hangers and Supports for Electrical Systems."

- C. Routing: Raceways shall be run parallel to building walls wherever possible, exposed or concealed as specified, and shall be grouped in workmanlike fashion. Crisscrossing of conduits shall be minimized.
- D. Location: All raceways except those from surface-mounted switches, outlet boxes or panels shall be run concealed from view. Surface mounted devices and equipment shall be specifically noted on the contract drawings. It is the intent that all raceways shall be run concealed unless specifically noted.
- E. Protection: All raceway runs, whether terminated in boxes or not, shall be capped during the course of construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is complete.
- F. Coordination: All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- G. Masonry Installation: All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- H. Arrangement: All raceways shall be run connecting outlet to circuits generally as shown on the drawings. Provide circuit connection arrangement shown. Actual final arrangement shall be in accordance with the record drawings section as specified herein.
- I. Grounding: All branch circuit and feeder raceways shall have a copper system ground conductor within the conduit throughout the entire length of the circuit. All conduit shall be electrically continuous to establish redundant grounding.
 - 1. Branch circuit raceways shall have an insulated equipment grounding conductor installed within the conduit raceway system.
 - 2. Grounding conductor shall be included in total conduit fill determining conduit sizes, even though not shown on drawings.
- J. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.
- K. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- L. Complete raceway installation before starting conductor installation.
- M. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- N. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which a maximum of two 90-degree bends are allowed.

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- O. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- P. Raceways 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.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- R. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- S. Empty Raceways: Install pull wires in all empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- T. Roof Installation: Raceway installations on roofs shall be kept to a bare minimum. Raceway shall be supported above roof at least 6 inches using approved raceway supporting devices. Supports shall be fastened to roof using roofing adhesive as specified in other sections of this specification.
- U. Firewall Installation: Provide pullboxes, junction boxes, fire barrier at fire rated walls etc., as required by NEC Article 300 where required with UL listed fire seal to maintain fire rating of wall, floor, etc.
- V. Dissimilar Metals: Avoid the use of dissimilar metals to reduce the possibility of electrolysis. Where dissimilar metals are in contact, coat all surfaces with corrosion inhibiting compound before assembling.
- W. Identification: Provide appropriate identification as required by codes and as indicated on the drawings and in accordance with the methods specified herein.
- X. Anchors: Raceways shall be anchored down to prevent floating while pouring in concrete.
- Y. Sealoff Fittings: Provide a closed cell silicone foam sealant rated to provide a rating equal to the wall, ceiling, or floor assembly rating. Provide seals for the exterior of conduit penetrations consisting of a cast-in-place sleeve with a compressible rubber gasket between the conduit and the sleeve. Provide seals for the interior of the conduit penetrations consisting of gland type sealing bushing or closed cell silicone foam. Provide duct seal inside an appropriate seal-off fitting to seal the interior of the conduit system from water seepage or hazardous gases. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, 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 raceway sealing fittings at the following points:

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1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- Z. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semi-recessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- 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.
- BB. Set metal floor boxes level and flush with finished floor surface.
- CC. Coordinate core-drilling of slab with appropriate trades prior to installation of poke-thrus.
- DD. 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.
- EE. 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 surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- FF. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- GG. Locate boxes so that cover or plate will not span different building finishes.
- HH. 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,
- II. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- JJ. Floor Boxes:
1. Adjustment: Where floor or fill depth is 3 inches or more, adjustable boxes with maximum vertical and angular adjustment for after concrete pour shall be used. After pour is complete, boxes shall be set and readjusted to provide a smooth surface conforming to the elevation and slope of the surrounding finished floor. The box shall contain four locations to accommodate leveling for pre-concrete pour adjustment and shall provide four leveling screws for the pre-pour adjustment.
 2. Installation procedures and practices shall be in strict accordance with applicable codes and standards. Prior to and during installation, refer to system layout drawing containing elements of the systems. Installer shall comply with manufacturer's printed installation instructions.

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3. Electrical Security: The boxes shall be electrically continuous and connected to electrical outlets, boxes, and cabinets, in accordance with manufacturer's installation instructions.
4. Installation drawings shall be furnished showing the appropriate power layouts where the raised floor box and flexible wiring system is to be used. The installation must be represented on the layout drawing in the form of a legend. The legend shall contain a catalog number and a description describing the components use. Installer shall comply with detailed manufacturer's installation instruction sheets that accompany the raised floor box.

3.6 INSTALLATION OF UNDERGROUND CONDUIT (OTHER THAN SECONDARY POWER (GENERATOR & NORMAL SERVICE SECONDARY FEEDERS))

- A. General: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300-5 of the NEC except that the minimum cover for any raceway or duct bank shall be two feet, unless otherwise indicated.
- B. Stubs: Spare raceway stubs shall be capped and accurately dimensioned on as-built drawings, with sizes and quantities noted.
- C. Separation: All raceways run underground, or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose, or shall be strapped to Kindorf channel supported by raceway driven into ground or tied to steel.
- D. Coating: Rigid metallic conduit installed underground shall be coated with waterproofing black mastic before installation, and all joints shall be recoated after installation.

3.7 INSTALLATION OF UNDERGROUND CONDUIT – SECONDARY POWER (GENERATOR & NORMAL SERVICE SECONDARY FEEDERS) DUCTBANKS

- A. Description: Underground duct lines where shown shall be of individual conduits encased in concrete where not installed under building structural slab. The conduit shall be of plastic, unless indicated or specified otherwise. The conduit used shall not be smaller than 4 inches inside diameter, unless otherwise noted. The concrete encasement surrounding the duct bank shall be reinforced as shown and rectangular in cross-section, having a minimum concrete thickness of three inches from the edge of the concrete to the structural tie wires. Conduit shall be separated by a minimum concrete thickness of 3 inches.
- B. General: The concrete work shall conform to Section on "Concrete". The top of the concrete envelope shall be not less than 24 inches below grade for the ductbanks. Concrete shall be installed in a continuous pour to eliminate joints in the duct run. Duct lines shall have a continuous slope downward toward manholes and away from buildings with a pitch of not less than 3 inches in 100 feet. Changes in direction of runs exceeding a total of 10 degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of 25 feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.

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- C. Conduit Separators: Separators shall be of pre-cast concrete, high impact polystyrene, steel or any combination of these. The joints of the conduits shall be staggered by rows so as to provide a duct line having the maximum strength.
- D. During construction partially complete duct lines shall be protected from the entrance of debris, such as mud, sand and dirt by means of suitable conduit plugs. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand or gravel; conduit plug shall then be immediately installed.
- E. Conduit, General: Plastic conduit, fittings and joints shall not have been stored in the sun or weather, in any excessively heated space, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be U.L. listed and conform to NEMA Standard TC6-1972.
- F. Trench: Trenches for duct banks shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided if necessary to keep trench dry.
- G. Excavation: Backfilling shall be in layers not more than 8 inches deep, and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4 inch sieve. The succeeding layers shall be excavated material having stones no larger than would pass through a 4-inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left.
- H. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in connection with site work.
- I. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.
- J. Counterpoise: Two #4 AWG bare stranded copper counterpoise shall be run above all duct banks and shall be run building and be grounded at building service ground.
- K. Warning Tape: All underground ductbanks shall have non-detectable warning tape that conforms to the following specifications installed that identifies the specific systems buried below. Warning tape shall meet OSHA regulation 1926-956(C)(I). Tape shall be 6" wide with black lettering imprinted on a color-coded background that conforms to APWA color code specifications. Tape shall be installed between 18" and 30" above the top of the pipe and a minimum of 6" below grade.

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- L. Tracer Wire: All non-metallic pipes installed underground (except pipe containing electric wires and traceable communication lines) and all piping installed 6 feet below grade shall have a tracer wire installed along the length of the pipe. The tracer wire shall be taped to the pipe and not allowed to "float freely" within the backfill. The tracer wire shall be continuous without splicing from access point to access point along the length of the pipe. The tracer wire shall be accessible at all structures (manholes, pull boxes) along the length of the pipe. The tracer wire shall have an access point at the beginning and ending points of the pipe run with no distance between access points to exceed 400 feet within the pipe run. The tracer wire shall have a color coded jacket as follows:

Normal Electrical Distribution: Blue

Emergency Electrical Distribution: Red

The tracer wire for piping less than 12 inches in diameter shall be #12 AWG where less than 6 feet below grade, and #10AWG where 6 feet or more below grade, and shall be HS-CCS high-strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. HS-CCS conductor must be 21% conductivity for locating purposes, break load 380# minimum. HDPE insulation shall be RoHS compliant and utility virgin grade material. Insulation copper shall meet the APWA color code standard for identification of buried utilities. Tracer wire shall be *Copperhead™* HS-CCS HDPE 30 mil insulation or pre-approved equal and made in the USA. Any disturbance of this tape shall require replacement after work is completed.

3.8 INSTALLATION OF 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 sieve to No. 4 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 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 the enclosure.
- E. 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.

3.9 EXPANSION FITTINGS:

- A. 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 conduit that is located where

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environmental temperature change may exceed 100 deg F (55 deg C) and that has straight-run length that exceeds 100 feet (30 m).

- B. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations.
 - 1. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - 2. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - 3. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
- C. 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 0.000078 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.
- D. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
- E. 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.

3.10 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to maintain integrity of original fire-resistance rating of assembly. Provide firestopping sleeve, manufactured by Hilti, minimum 4" equivalent capacity, for low voltage penetrations of fire-rated floor and wall assemblies to maintain integrity of fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.11 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

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SECTION 260543 - PRIMARY DUCTBANK SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Contractual Conditions and Division 01 Specification sections apply to this section.

1.2 SUMMARY

- A. This section includes the requirements for provision and installation of primary ductbank for the Utility Company system.

1.3 DESCRIPTION

- A. Provide and install all equipment, labor, material, accessories and mounting hardware for a complete and operating ductbank system including, but not limited to:
 - 1. Plastic conduit.
 - 2. Metal conduit.
 - 3. Rigid Metal.
 - 4. Duct.
- B. System to include PVC conduit with black mastic coated rigid galvanized sweeping elbows for all changes in direction.
- C. Provide and install ductbank systems for all primary feeders.

1.4 SUBMITTALS

- A. Shop Drawings: Provide for conduit and accessories
- B. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation.

1.5 PROJECT AS-BUILT DOCUMENTS

- A. Record actual locations of exact routing of ductbank, dimension from known landmarks.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified with minimum three years experience.

1.7 REFERENCES AND REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. and testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.
- B. Conform to the requirements of the following:

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1. AASHTO - Standard Specification for Highway Bridges.
2. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
3. ANSI/ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.
4. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.
5. ANSI/IEEE C2 - National Electrical Safety Code.
6. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
7. ANSI/NFPA 70 - National Electrical Code.
8. ASTM A48 - Gray Iron Castings.
9. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.
10. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
11. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
12. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
13. NEMA TC 8 - Extra-Strength PVC Plastic Utilities Duct for Underground Installation.
14. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
15. NEMA TC 10 - PVC and ABS Plastic Communications Duct and Fittings for Underground Installation.
16. NEMA TC 14 - Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings.

1.8 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of ductbank prior to excavation for rough-in.
- C. Ductbank routing is shown in approximate locations unless dimensions are indicated. Route as required to complete duct system. Coordinate exact routing requirements with FPL, prior to installation.

PART 2- PRODUCTS

2.1 CONDUIT

- A. Comply with Division 26 Section Raceways and Boxes for Electrical Systems.

2.2 ACCESSORIES

- A. Underground Warning Tape: 4 inch wide plastic tape, detectable type, colored yellow with suitable warning legend describing buried electrical lines.
- B. Provide pullboxes in accordance with Florida Power & Light (FPL) current standards.

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PART 3- EXECUTION

3.1 EXAMINATION

- A. Verify that excavation, base material installation, and compaction is completed.

3.2 PREPARATION

- A. Prepare excavation in accordance with Florida Power & Light (FPL) current standards.

3.3 DUCTBANK INSTALLATION

- A. Install duct in accordance with Florida Power & Light (FPL) current standards instructions.
- B. Provide long radius rigid galvanized steel conduit for all bends and stub ups into equipment.
- C. Install duct to locate top of duct bank at depths as indicated on drawings.
- D. Install ducts with minimum slope of 4 inches per 100 feet. Slope away from building entrances.
- E. Cut duct square using saw or pipe cutter; de-burr cut ends.
- F. Insert duct to shoulder of fittings; fasten securely.
- G. Join nonmetallic duct using adhesive as recommended by manufacturer.
- H. Wipe nonmetallic duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- I. Install no more than equivalent of three 90-degree bends between pull points.
- J. Provide suitable fittings to accommodate expansion and deflection where required.
- K. Use suitable separators and chairs installed not greater than 4 feet on centers.
- L. Band ducts together before placing concrete.
- M. Securely anchor duct to prevent movement during concrete placement.
- N. Provide suitable pull string in each empty duct except sleeves and nipples.
- O. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- P. Backfill trenches under provisions of Division 02.
- Q. Interface installation of underground warning tape with backfilling. Install tape 6 inches below finished surface.
- R. All excavation for underground feeders shall be performed in accordance with all State of Florida standards and regulations for trench safety.

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- S. Maintain a minimum of 7.5 inches center-to-center spacing between all raceways.
- T. Fill medium shall be compacted to eliminate air pockets and to assure uniform heat dissipation. All trenches shall be free of cans, bottles, scrap lumber, trash and obstructions prior to back filling.

3.4 COORDINATION

- A. Coordinate ductbank routing locations with all existing and new underground utilities and building structures. Modify location/routing shown on drawings as required to facilitate installation. Coordinate exact routing requirements with FPL prior to installation.

3.5 CONDUIT

- A. Install plastic conduit in concrete envelope with rigid steel sweeping elbows with largest possible factory radius for all changes in direction.
- B. Minimum bend in conduits 2" and larger shall be equal to or greater than then ten (10) times the internal diameter of the conduit, unless otherwise noted on the plan drawings. Provide larger radius as necessary to achieve acceptable pulling tension or as required by cable installers.

END OF SECTION 260543

SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 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. See Section 28311 for details of fire alarm conduit and conductor identification.

1.2 SUMMARY

- A. Extent: Electrical identification work as required by the Contract Documents or other specifications.
- B. Types: Electrical identification work specified in the Contract Documents include the following;
 - 1. Electrical power, control and communication conductors.
 - 2. Operational instructions and warnings.
 - 3. Danger signs.
 - 4. Conduits, boxes, etc.
 - 5. Distribution Equipment.
 - 6. Cabinets.
 - 7. Equipment/system identification signs and tags.

1.3 SUBMITTALS

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.

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- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Provide all products in this section in English.
- C. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one single type is specified for an application, selection shall be at the installer's option, however, provide a single selection for each application.
- D. Voltage Marking: Except as otherwise indicated, provide lettering which indicates voltage of the conductor(s) in conduit. Provide 4 inch minimum length with 7/8 inch minimum lettering for 2 inch and smaller conduit. Provide 8 inch minimum length with 1-1/4 inch minimum lettering for larger than 2 inch conduit. Provide one marker for each 20' section of conduit. Color shall match system printing requirements.
- E. Painted Band: Provide painted bands in color to match plastic markers or tape on all conduit. Provide colors as specified herein.
- F. Cable/Conductor Identification Bands: Provide manufacturer's standard vinyl cloth self-adhesive cable/conductor markers of the wrap-around type; either pre-numbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

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- G. Color Coding: Color code all power and lighting cable. Use wire colored by integral pigmentation, making the wire 100 percent colored. Where not practicable or available (in larger conductor sizes), color code the wire by using colored plastic tape, painting the ends accessible at junction or pull boxes, or other method acceptable to the Engineer. Use the following chart as applicable:

	120/208
CONDUCTOR	VOLTS
Phase A	Black
Phase B	Red
Phase C	Blue
Neutral	White
Equip.Ground	Green

	277/480
CONDUCTOR	VOLTS
Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Gray
Equip.Ground	Green

- H. Snap-Around, Color-Coding Bands for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- I. In areas where pre-manufactured red conduit is not installed for fire alarm system, fire alarm conduit shall be identified by red bands painted at 10-foot increments. Marking may be accomplished by applying red tape at the same interval or painting each conduit fitting and box cover. Refer to Specification Section 283111 Digital Addressable Fire Alarm System for raceway requirements.
- J. All junction box covers shall be identified as to which system it is connected to and include the panelboard and circuit numbers,

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

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2.3 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
 - 3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 10 by 14 inches.

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E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.6 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.7 EQUIPMENT IDENTIFICATION LABELS

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in Division 9 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

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- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- H. Painted Identification: Comply with requirements in Division 9 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
 - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded conductors.
 - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Colors for 480/277-V Circuits:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

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- B. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- C. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
 - 1. Limit use of underground-line warning tape to direct-buried cables.
 - 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- D. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
 - 1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 - 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
 - d. Enclosed circuit breakers.
 - e. Enclosed controllers.
 - f. Variable-speed controllers.
 - g. Contactors.
 - h. Disconnect Switches.
 - i. Transfer Switches.
 - j. Line Voltage Light Switch Coverplates: Provide final panel identification and circuit number on light switch coverplate, neatly written in indelible ink on reverse side of coverplate. For rayon or stainless steel coverplates, provide 3/16" laser

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etched lettering indicating final panelboard and circuit number, black lettering on stainless steel or white coverplates.

- k. Receptacle Coverplates: Provide final panel identification and circuit number on light switch coverplate, neatly written in indelible ink on reverse side of coverplate. For rayon or stainless steel coverplates, provide 3/16" laser etched lettering indicating final panelboard and circuit number, black lettering on stainless steel or white coverplates.
- l. Junction Box Covers: Provide final panel identification and circuit number(s) on the front of the junction box cover, neatly written in indelible ink.

END OF SECTION 260553

SECTION 260800 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Related Sections: Refer to Division 01 Section 019113 "General Commissioning Requirements for additional commissioning scope and requirements. All testing and commissioning requirements of that section shall be met.
- C. The Commissioning Team will include representatives of the Owner, Design A/E, General Contractor and Installing Subcontractors, Test and Balance Subcontractor, BAS Subcontractor and Commissioning Authority (CxA).
- D. Scope of Electrical equipment and systems commissioning
 - 1. Lighting and daylighting controls

1.2 CONTRACTOR'S RESPONSIBILITIES

- A. Attend the Commissioning Kick-off meeting and other Commissioning meetings as required.
- B. Attend construction phase coordination meetings.
- C. Attend testing, adjusting, and balancing review and coordination meetings.
- D. Submit completed manufacturer's start-up checklists for the equipment being commissioned.
- E. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period. Provide meters, gauges and instruments for Functional Performance Testing.
- F. Perform all commissioning tests at the direction of the CxA.
- G. Complete tasks required to correct items noted by the CxA in the Deficiency Log.
- H. Participate in systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- I. Provide O&M data including warranties, tables, recommended maintenance schedules, checklists, spare parts lists, wiring and parts diagrams, points of contact for service, for all equipment, systems and controls being commissioned.
- J. Provide training of the Owner's operations and maintenance personnel in accordance with the project's construction documents and commissioning plan.
- K. Provide information requested by the CxA for final commissioning documentation.

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1.3 CxA'S RESPONSIBILITIES

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual Electrical systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Provide a Commissioning Plan.
- C. Provide Functional Performance Checklists.
- D. Direct commissioning testing.
- E. Maintain and distribute the deficiency logs.
- F. Verify that the training of the Owner's personnel is complete and documented.
- G. Provide a Preliminary Commissioning Summary Report.
- H. Provide a Final Commissioning Report.

1.4 PROCESS

- A. Functional Performance Testing will commence after preliminary punch list items are completed by the Contractor. Functional Performance Testing will not be scheduled until the completed manufacturer's start-up checklists are received by the Commissioning Authority.

1.5 SUBMITTALS

- A. Certificate of Readiness indicating the Electrical systems are ready for Commissioning.
- B. Manufacturer's start-up checklists.
- C. Lighting and Daylighting Control System point to point checklists.
- D. Sixty (60) days before any electrical testing is conducted, provide an overall testing plan and schedule for electrical, lighting control and daylighting control systems that lists the equipment, modes to be tested, dates of testing and parties required to conduct the test. Put this information in to the master construction schedule. Keep the plan and schedule updated.

1.6 COMMISSIONING DOCUMENTATION

- A. Provide the following information to the CxA for inclusion in the commissioning documentation (commissioning plan or Systems Manual):
 - 1. Approved submittals with designer review comments of submittals resolved, operation and maintenance manuals, and assistance in drafting the systems manuals, and other documents and reports requested by the Commissioning Authority in searchable pdf format

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2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase on as built markup of the design documents (plans and specifications)
3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for Electrical systems, assemblies, equipment, and components to be verified and tested.
4. Schedule indicating when Electrical systems, subsystems, equipment, and associated controls will be ready for functional testing. The date for permanent connection of power is required.
5. Corrective action documents.
6. Any additional information requested by the CxA.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 GENERAL

- A. The Contractor shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Commissioning Team members shall sign-off on appropriate sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and CxA.
- B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by the Contractor.
- C. Contractor shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the work.

3.2 TESTING PREPARATION

- A. Certify in writing the Electrical systems, subsystems, and equipment and controls have been installed, calibrated, started and are operating per the Contract Documents. Ensure the PFCs are completed and submitted by factory authorized start up tech and submitted to the Contractor.
- B. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- C. Inspect and verify the position of each device and interlock identified in the sequences, control schematics and or on checklists.
- D. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- E. Testing Instrumentation: Install measuring instruments and logging devices to record test data if directed by the CxA in the Commissioning Plan.

3.3 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning tests at the direction of the CxA.
- B. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- C. The Contractor shall execute the detailed testing plans, procedures, and checklists (FPTs) prepared by the CxA for systems, subsystems, and equipment being commissioned.
- D. Tests will be performed using design conditions whenever possible.
- E. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered to achieve simulated conditions.
- G. If tests cannot be completed because of a deficiency outside the scope of the system, the CxA will document the deficiency and report it to the Owner. After deficiencies are resolved, the Contractor will reschedule the tests.
- H. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 INSTRUMENTATION

- A. Instrumentation for Functional Performance Testing and data recording will be provided by the individual trade Subcontractors. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of IEEE Standards.
- B. Application of instruments and accuracy of measurements shall be in accordance with IEEE Standards.

3.5 INSTALLATION VERIFICATION

- A. Before system start-up begins, the Contractor shall conduct a final installation verification audit. The Contractor shall be responsible for completion of work including change orders and punch list items to the Owner's satisfaction.
- B. If work is found to be incomplete, incorrect, or non-functional, the Contractor shall correct the deficiency before system start-up work proceeds.

3.6 FUNCTIONAL PERFORMANCE TESTING

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- A. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements, design intent, and Owner requirements.
- B. Functional Performance Testing begins after all manufacturer's start-up forms have been completed, submitted, and reviewed by the CxA, and after Test and Balance has been completed.
- C. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.
 - 1. Field testing plans and testing requirements are specified in Division 26 Sections and construction documents.
 - 2. Lighting and Daylighting Controls: Provide technicians, instrumentation, tools, and equipment to test performance of lighting control systems and daylighting control devices/systems.

3.7 NON-CONFORMANCE

- A. The CxA will record the results of the Functional Performance Tests. All deficiencies, non-conformance issues, or test failures will be noted and reported to the Contractor in a deficiency list or in a punch-list format.
- B. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
- C. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owners Representative.
- D. Re-testing:
 - 1. If a Functional Performance Test fails, corrections shall be made to the deficient equipment or systems by the Contractor. The systems will be re-tested until they pass the Tests.
 - 2. The time/cost for the CxA to perform any re-testing required because of improper set up of the systems by the Contractor or failed functional or performance tests will be back-charged to the Contractor (who may choose to recover costs from the party responsible for executing faulty equipment start-up/checkout and associated checklists). This includes instances where a specific item was overlooked in the equipment start-up and checkout procedures, reported to have been successfully completed, but determined during Functional Performance testing to be faulty.
 - 3. Any required re-testing by any Contractor or vendor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.8 OWNER STAFF TRAINING

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- A. The Commissioning Authority will coordinate training with the Owner and Contractor. The Owner will provide direction on the level of training and training requirements as well as the personnel requiring training. The Contractor will coordinate the scheduling of training.
- B. The Contractor and associated manufacturer's representatives shall provide required training to operational staff. The Contractor training sessions shall provide a detailed analogy of systems operation and maintenance.
- C. Training shall be recorded by the Contractor and documentation shall be provided to the Commissioning Authority.

END OF SECTION 260800

SECTION 26 09 43 - NETWORK LIGHTING CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes manually operated, digital lighting controls with integration into the Buildings Automation Control System via gateway or interface, lighting control relays, and control module, and is comprised of the following components:
 - 1. System Software Interfaces:
 - a. Management Interface
 - b. Historical Database and Analytics Interface
 - c. Visualization Interface
 - d. Personal Control Applications
 - e. Smartphone Programming Interface for wired devices
 - 2. System Backbone and Integration Equipment:
 - a. System Controller
 - b. OpenADR Interface
 - 3. Wired Networked Devices:
 - a. Wall Stations
 - b. Graphic Wall Stations
 - c. Digital Key Switches
 - d. Auxiliary Input/Output Devices
 - e. Occupancy and Photocell Sensors
 - f. Wall Switch Sensors
 - g. Embedded Sensors
 - h. Power Packs and Secondary Packs
 - i. Networked Luminaires
 - j. Relay and Dimming Panel
 - k. Bluetooth® Low Energy Programming Device
 - l. Communication Bridge

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- B. The networked lighting control system shall meet all of the characteristics and performance requirements specified herein.
- C. The contractor shall provide, install and verify proper operation of all equipment necessary for proper operation of the system as specified herein and as shown on applicable drawings.

1.3 DEFINITIONS

- A. BACnet: A networking communication protocol that complies with ASHRAE 135.
- B. BAS: Building automation system.
- C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling and power-limited circuits.
- D. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.
- E. PC: Personal computer; sometimes plural as "PCs."
- F. Power Line Carrier: Use of radio-frequency energy to transmit information over transmission lines whose primary purpose is the transmission of power.
- G. RS-485: A serial network protocol, similar to RS-232, complying with TIA/EIA-485-A.

1.4 SUBMITTALS

- A. Product Data: For control modules, power distribution components, relay panels, manual switches and plates, and conductors and cables.
- B. Shop Drawings: In addition to requirements indicated on contract drawings, Sheets E801 and E802, submit detail assemblies of standard components, custom assembled for specific application on this Project.
 - 1. Outline Drawings: Indicate dimensions, weights, arrangement of components, and clearance and access requirements.
 - 2. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
- C. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

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1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.

D. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

E. Field quality-control test reports.

F. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

G. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control module and power distribution components through one source from a single manufacturer.

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 47 CFR, Subparts A and B, for Class A digital devices.

D. Comply with protocol described in IEC 60929, Annex E, for DALI lighting control devices, wiring, and computer hardware and software.

E. Comply with NFPA 70.

F. Installation and Startup Qualifications:

1. System startup shall be performed by qualified personnel approved or certified by the manufacturer.

G. Service and Support Requirements:

1. Phone Support: Toll free technical support shall be available.
2. Remote Support: Toll free technical support shall be available.

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3. Onsite Support: The bidder shall offer onsite support, after Certificate of Occupancy, that is billable at whole day rates.
4. Service Contract: The bidder shall offer a Service Contract that packages phone, remote, and onsite support calls for the project. Response times for each type of support call shall be indicated in the terms of the service contract included in the bid package.

1.6 COORDINATION

- A. Coordinate lighting control components to form an integrated interconnection of compatible components.
 1. Match components and interconnections for optimum performance of lighting control functions.
 2. Coordinate lighting controls with HVAC controls. Design display graphics showing building areas controlled; include the status of lighting controls in each area.
 3. Coordinate lighting controls with that in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship or from transient voltage surges within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Failure of software input/output to execute switching or dimming commands.
 - b. Failure of modular relays to operate under manual or software commands.
 - c. Damage of electronic components due to transient voltage surges.
 2. Warranty Period: The manufacturer shall provide a minimum five-year warranty on all hardware devices supplied and installed. Warranty coverage shall begin on the date of substantial completion. The hardware warranty shall cover repair or replacement of any defective productions within the warranty period.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Electrically Operated Relays, power packs, occupancy sensors, daylight sensors of each type: Equal to 5 percent of amount installed for each type indicated, but no fewer than 5 of each type.

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1.9 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years. Refer to Paragraph 1.5 above.
- 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 revise licenses for use of the software.
 - 1. Provide 30-day notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment, if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Acuity Controls nLight.
 - 2. Approved Alternate: Douglas Lighting Controls.

2.2 SYSTEM COMPLIANCE

- A. System Components shall comply with UL 916 and UL 924 standards where applicable.
- B. System components shall comply with CFR Title 47, Part 15 standards where applicable.
- C. All equipment shall be installed and connected in compliance with NFPA 70.

2.3 SYSTEM REQUIREMENTS

- A. System Architecture:
 - 1. System shall have an architecture that is based upon three main concepts: (1) networkable intelligent lighting control devices, (2) standalone lighting control zones using distributed intelligence, (3) optional system backbone for remote, time based and global operation between control zones.
 - 2. Intelligent lighting control devices shall have individually addressable network communication capability and consist of one or more basic lighting control components: occupancy sensor, photocell sensor, relay, dimming output, contact closure input, analog 0-10V input, and manual wall station capable of indicating switching, dimming, and/or scene control. Combining one or more of these components into a single device enclosure shall be permissible so as to minimize overall device count of system.

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3. System must be capable of interfacing directly with networked luminaires such that either low voltage network cabling or wireless RF communication is used to interconnect networked luminaires with control components such as sensors, switches and system backbone (see Control Zone Characteristics sections for each type of network connection, wired or wireless).
4. Lighting control zones consisting of one or more networked luminaires and intelligent lighting control devices and shall be capable of providing automatic control from sensors (occupancy and/or photocell) and manual control from local wall stations without requiring connection to a higher-level system backbone; this capability is referred to as “distributed intelligence.”
 - a. Lighting control zones (wired and wireless) of at least 128 devices per zone shall be supported.
5. Networked luminaires and intelligent lighting control devices shall support individual (unique) configuration of device settings and properties, with such configuration residing within the networked luminaires and intelligent control devices.
6. Networked luminaires and intelligent lighting control devices shall have distributed intelligence programming stored in non-volatile memory, such that following any loss of power the lighting control zones shall operate according to their defined default settings and sequence of operations.
7. Lighting control zones shall be capable of being networked with a higher-level system backbone to provide time based control, remote control from inputs and/or systems external to the control zone, and remote configuration and monitoring through a software interface.
8. The system may include one or more system controllers that provide time-based control and global system control across multiple control zones and backbone network segments. The system controller also provides a means of connecting the lighting control system to a system software interface and building management systems via BACnet/IP or BACnet MS/TP protocol.
9. The system may include “communication bridge” devices that route communication from lighting control zones (wired or wireless) to and from the system controller, for purposes of decreasing system wiring requirements.
10. All system devices shall support remote firmware update, such that physical access to each device is not necessary, for purposes of upgrading functionality at a later date.

B. Wired Networked Control Zone Characteristics:

1. Connections to devices within a wired networked lighting control zone and to backbone components shall be with a single type of low voltage network cable, which shall be compliant with CAT5e specifications or higher. To prevent wiring errors and provide cost savings, the use of mixed types of low voltage network cables shall not be permitted.
2. Devices in an area shall be connected via a “daisy-chain” topology; requiring all individual networked devices to be connected back to a central component in a “hub-and-spoke” topology shall not be permitted, so as to reduce the total amount of network cable required for each control zone.
3. System shall provide the option of having pre-terminated plenum rated low voltage network cabling supplied with hardware so as to reduce the opportunity for improper wiring and communication errors during system installation.

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4. Following proper installation and provision of power, all networked devices connected together with low voltage network cable shall automatically form a functional lighting control zone without requiring any type of programming, regardless of the programming mechanism (e.g., software application, handheld remote, pushbutton). The “out of box” default sequence of operation is intended to provide typical sequence of operation so as to minimize the system startup and programming requirements and to also have functional lighting control operation prior to system startup and programming.
5. Once software is installed, system shall be able to automatically discover all connected devices without requiring any provisioning of system or zone addresses.
6. All networked devices shall have the ability to detect improper communication wiring and blink its LED in a specific cadence as to alert installation/startup personnel.
7. Networked control devices intended for control of egress and/or emergency light sources shall not require the use of additional, externally mounted UL924 shunting and/or 0-10V disconnect devices, so as to provide a compliant sequence of operation while reducing the overall installation and wiring costs of the system. The following types of wired networked control devices shall be provided for egress and/or emergency light fixtures:
 - a. Low-Voltage power sensing: These devices shall automatically provide 100% light level upon detection of loss of power sensed via the low voltage network cable connection.

C. System Integration Capabilities:

1. The system shall interface with third party security system to support two-way communication using the industry standard BACnet/IP or BACnet MS/TP protocols. The following system integration capabilities shall be available via BACnet/IP and BACnet MS/TP protocols:
 - a. The system shall support control of individual devices, including, but not limited to, control of relay and dimming output.
 - b. The system shall support reading of individual device status information. The available status will depend on the individual device type and capabilities, which may include but not be limited to, relay state, dimming output, power measurement, occupancy sensor status, and photocell sensor states or readings. All system devices shall be available for polling for devices status.
 - c. The system shall support activation of pre-defined system Global Profiles (*see Supported Sequence of Operations for further definition of Global Profile capabilities*).
2. The system shall support activation of Profiles (local or global) and Preset Scenes from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485. (See Supported Sequence of Operations for further definition of Profile and Scene Preset capabilities.)
3. The system shall support activation of demand response levels from Demand Response Automation Servers (DRAS) via the OpenADR 2.0a protocol.

D. Supported Sequence of Operations:

1. Characteristics and performance requirements herein shall be supported by the networked lighting control system.

2. Control Zones:
 - a. Networked luminaires and intelligent lighting control devices installed in an area (also referred to as a group of devices) shall be capable of transmitting and tracking occupancy sensor, photocell sensor, and manual switch information within at least 48 unique control zones to support different and reconfigurable sequences of operation within the area. These shall also be referred to as local control zones.
 - b. Networked luminaires and intelligent lighting control devices located in different areas shall be able to transmit and track information within at least 128 system-wide control zones to support required sequences of operation that may span across multiple areas. Occupancy and photocell commands shall be available across a single controller, and switch commands shall be available across single or multiple controllers. These shall also be referred to as global control zones.
3. Wall station Capabilities:
 - a. Wall stations shall be provided to support the following capabilities:
 - 1) On/Off of a local control zone and global control zone simultaneously, as required.
 - 2) Continuous dimming control of light level of a local control zone and global control zone simultaneously, as required.
 - 3) Preset Scenes that can activate a specific combination of light levels across multiple local and global channels, as required.
 - 4) Profile Scenes that can modify the sequence of operation for the devices in the area (group) in response to a button press. This capability is defined as supporting “Local Profiles” and is used to dynamically optimize the occupant experience and lighting energy usage. Wall stations shall be able to manually start and stop Local Profiles, or the local profile shall be capable of ending after a specific duration of time between 5 minutes and 12 hours. Parameters that shall be configurable and assigned to a Local Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.
 - b. 3-way / multi-way control: multiple wall stations shall be capable of controlling the same local and global control zones, so as to support “multi-way” switching, dimming, preset scene, and profile scene control.
4. Occupancy Sensing Capabilities:
 - a. Local and global control: Occupancy sensors shall be configurable to control a local and global zone simultaneously, as required.
 - b. Multi-sensor control: multiple occupancy sensors shall be capable of controlling the same local and global control zones. This capability combines occupancy sensing coverage from multiple sensors without consuming multiple control zones.
 - c. System shall support the following types of occupancy sensing sequence of operations:

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- 1) On/Off Occupancy Sensing
 - 2) Partial-On Occupancy Sensing
 - 3) Partial-Off Occupancy Sensing
 - 4) Vacancy Sensing (Manual-On / Automatic-Off)
- d. On/Off, Partial-On, and Partial-Off Occupancy Sensing modes shall function according to the following sequence of operation:
- 1) Occupancy sensors shall automatically turn lights on to a designated level when occupancy is detected. To support fine tuning of Partial-On sequences the designated occupied light level shall support at least 100 dimming levels.
 - 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
 - 3) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
 - 4) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
- e. Vacancy Sensing mode (also referred to as Manual-On / Automatic-Off) shall function according to the following sequence of operation:
- 1) The use of a wall station is required turn lights on. The system shall be capable of programming the zone to turn on to either to a designated light level or the previous user light level. Initially occupying the space without using a wall station shall not result in lights turning on.
 - 2) Occupancy sensors shall automatically turn lights off or to a dimmed state (Partial-Off) when vacancy occurs or if sufficient daylight is detected. To support fine tuning of Partial-Off sequences the designated unoccupied dim level shall support at least 100 dimming levels. To provide additional energy savings and an enhanced occupant experience, the system shall also be capable of dimming the lights when vacant and then turning the lights off completely after an additional amount of time.
 - 3) To minimize occupant impact in case the area or zone is still physically occupied following dimming or shutoff of the lights due to detection of vacancy, the system shall support an "automatic grace period" immediately following detection of vacancy, during which time any detected occupancy shall result in the lights reverting to the previous level. After the grace period has expired, the use of a wall station is required to turn lights on.

- 4) Photocell readings, if enabled in the Occupancy Sensing control zone, shall be capable of automatically adjusting the light level during occupied or unoccupied conditions as necessary to further reduce energy usage. Additional requirements and details for photocell sensing capabilities are indicated under Photocell Sensing Capabilities.
 - 5) At any time, the use of a wall station shall change the dimming level or turn lights off as selected by the occupant. The lights shall optionally remain in this manually-specified light level until the zone becomes vacant; upon vacancy the normal sequence of operation, as defined above, shall proceed.
 - f. To accommodate different types of environments, occupancy time delays before dimming or shutting off lights shall be specifiable for control zones between 15 seconds to 2 hours.
5. Photocell Sensing Capabilities (Automatic Daylight Sensing):
 - a. Photocell sensing devices shall be configurable to control a local and global zone simultaneously, as required.
 - b. The system shall support the following types of photocell-based control:
 - 1) On/Off: The control zone is automatically turned off if the photocell reading exceeds the defined setpoint and automatically turned on if the photocell reading is below the defined setpoint. An adjustable time delay or adaptive setpoint behavior may be used to prevent the system from exhibiting nuisance on/off switching, as well as a dead band to prevent on/off cycling.
 - 2) Continuous Dimming: The control zone automatically adjusts its dimming output in response to photocell readings, such that a minimum light level consisting of both electric light and daylight sources is maintained at the task. The photocell response shall be configurable to adjust the photocell setpoint and dimming rates.
6. Schedule and Global Profile Capabilities:
 - a. The system shall be capable of automatically modifying the sequence of operation for selected devices in response to any of the following: a time-of-day schedule, contact closure input state, manually triggered wall station input, RS-232/RS-485 command, and BACnet input command. This capability is defined as supporting "Global Profiles" and is used to dynamically optimize the occupant experience and lighting energy usage.
 - b. Global profiles may be scheduled with the following capabilities:
 - 1) Global Profiles shall be stored within and executed from the system controller (via internal timeclock) such that a dedicated software host or server is not required to be online to support automatic scheduling and/or operation of Global Profiles.
 - 2) Global Profile time of day schedules shall be capable of being given the following recurrence settings: daily, specific days of week, every "n" number of days, weekly, monthly, and yearly. Lighting control profile schedules shall support

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definition of start date, end date, end after “n” recurrences, or never ending. Daylight savings time adjustments shall be capable of being performed automatically, if desired.

- 3) Global Profile Holiday Schedules should follow recurrent settings for specific US holiday dates regardless if they always occur on a specific date or are determined by the day/week of the month.
- 4) Global Profiles shall be capable of being scheduled to run according to timed off-sets relative to sunrise or sunset. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- 5) System shall support blink warning and timed extension capabilities. At the end of a scheduled period, the system shall be capable of providing a visible “blink warning” 5 minutes prior to the end of the schedule. Wall stations may be programmed to provide timed overrides that turn the lights on for an additional period of time. Timed override duration shall be programmable for each individual device, zone of devices, or customized group of devices, ranging from 5 minutes to 12 hours.
- 6) Software management interface shall be capable of displaying a graphic calendar view of profile schedules for each control zone.

c. System Global Profiles shall have the following additional capabilities:

- 1) Global Profiles shall be capable of being manually activated directly from the system controller, specially programmed input devices, scene capable wall stations, and the software management interface.
- 2) Global Profiles shall be selectable to apply to a single device, zone of devices, or customized group of devices.
- 3) Parameters that shall be configurable and assigned to a Global Profile shall include, but not be limited to, fixture light level, occupancy time delay, response to occupancy sensors (including enabling/disabling response), response to daylight sensors (including enabling/disabling response), and enabling/disabling of wall stations.

d. A backup of Local and Global Profiles shall be stored on the software’s host server such that the Profile backup can be applied to a replacement system controller or wall station.

7. System shall support automated demand response capabilities with automatic reduction of light level to at least three levels of demand response.

E. Security System Interface: Provide hardware and software to enable the facility security system to monitor, control, display, and record data for use in processing reports for specific zones indicates in contract drawings, Sheets E-801 and E-802.

1. Hardwired Points:

- a. Monitoring: On-off status, for all facility interior and exterior lighting via main Eclipse lighting control panel.
- b. Control: On-off operation, for all facility interior and exterior lighting via main Eclipse lighting control panel.

2. ASHRAE 135 (BACnet) communication interface with the security system shall enable the security system operator to remotely monitor lighting from a guard operator workstation for specific zones indicates on Sheets E-801 and E-802.
3. The system shall support activation of Profiles (local or global) and Preset Scenes from third party systems by receiving dry contact closure output signals or digital commands via RS-232/RS-485. Refer to contract drawings, Sheets E-801 and E-802 for additional information.

2.4 SYSTEM SOFTWARE INTERFACES

A. Management Interface:

1. System shall provide a web-based management interface that provides remote system control, live status monitoring, and configuration capabilities of lighting control settings and schedules.
2. Management interface must be compatible with industry-standard web browser clients, including, but not limited to, Microsoft Internet Explorer®, Apple Safari®, Google Chrome®, Mozilla Firefox®.
3. Management interface shall require all users to login with a User Name and Password, and shall support creation of at least 100 unique user accounts.
4. Management interface shall support at least three permission levels for users: read-only, read & change settings, and full administrative system access.
5. Management interface shall be capable of restricting access for user accounts to specific devices within the system.
6. All system devices shall be capable of being given user-defined names.
7. The following device identification information shall be displayed in the Management interface: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
8. Management interface shall be able to read the live status of a networked luminaire or intelligent control device and shall be capable of displaying luminaire on/off status, dim level, power measurement, device temperature, PIR occupancy sensor status, microphonic occupancy sensor status, remaining occupancy time delay, photocell reading, and active Scenes or Profiles.
9. Management interface shall be able to read the current active settings of a networked luminaire or intelligent control device and shall be capable of displaying dimming trim levels, occupancy sensor and photocell enable/disable, occupancy sensor time delay and light level settings, occupancy sensor response (normal or vacancy), and photocell setpoints and transition time delays.
10. Management interface shall be able to change the current active settings and default settings for an individual networked luminaire or intelligent control device.
11. Management interface shall be capable of applying settings changes for a zone of devices or a group of selected devices using a single “save” action that does not require the user to save settings changes for each individual device.
12. A printable network inventory report shall be available via the management interface.
13. A printable report detailing all system profiles shall be available via the management interface.
14. All sensitive information stored by the software shall be encrypted.

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15. All system software updates must be available for automatic download and installation via the internet.

B. Historical Database and Analytics Interface:

1. System shall provide a historical database that stores device operational history and calculates energy usage for all networked luminaires and intelligent control devices.
2. System shall be capable of reporting lighting system events and performance data back to the historical database for display and analysis.
3. Historical database shall be capable of recording historical data for up to 20,000 networked devices for a period of at least 1 calendar year.
4. An "Energy Scorecard" shall be displayed that shows calculated energy savings in dollars, kWh, or CO2.
5. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photocells, manual switching, etc.).
6. Energy savings data shall be calculated for the system as a whole or for individual zones.
7. A time scaled graph showing all relay transitions shall be presented.
8. A time scaled graph showing a zones occupancy time delay shall be presented
9. A time scaled graph showing the total light level shall be presented.
10. User shall be able to customize the baseline run-time hours for a space.
11. User shall be able to customize up to four time-of-day billing rates and schedules.
12. Historical data shall be exportable from the Historical Database via a "CSV" type of file format.

C. Visualization and Programming Interfaces:

1. System shall provide a web-based visualization interface that displays graphical floorplan.
2. Graphical floorplan shall offer the following types of system visualization:
 - a. Full Device Option - A master graphic of the entire building, by floor, showing each control device installed in the project with zones outlined. This shall include, but not be limited to, the following:
 - 1) Controls embedded light fixtures
 - 2) Controls devices not embedded in light fixtures
 - 3) Daylight Sensors
 - 4) Occupancy Sensors
 - 5) Wall Switches and Dimmers
 - 6) Scene Controllers
 - 7) Networked Relays
 - 8) Bridges
 - 9) System Controllers
 - 10) Panels
 - 11) Zone outlines
 - b. Zone Only Option - A master graphic of the entire building, by floor, showing only control zones outlined.

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- c. Allow for pan and zoom commands so smaller areas can be displayed on a larger scale simply by panning and zooming each floor's master graphic.
- d. A mouse click on any control device shall display the following information (as applicable):
 - 1) The device catalog number.
 - 2) The device name and custom label.
 - 3) Device diagnostic information.
 - 4) Information about the device status or current configuration is available with an additional mouse click.

D. Personal Control Applications:

- 1. Software interface shall support personal control software applications that provide user-specific control of individual luminaires/control devices, control zones, global scene presets, and scene selector virtual button presses.
- 2. The system administrator shall be capable of defining personal control permissions for each user account.
- 3. Software interface shall provide a Microsoft Windows® operating system taskbar application for personal lighting control.
- 4. Software interface shall provide an Apple iOS ® operating system application (supported by mobile phones and mobile tablet devices) for personal lighting control.

E. Smartphone Programming Interface for Wired Devices:

- 1. Application interface shall be provided for both Apple iOS® and Android operating systems that allows configuration of lighting control settings.
- 2. The application shall support the configuration and control of wired networked control devices via a Bluetooth® Low Energy (BLE) Programming Device.
 - a. Application shall support a security pin-code to access the zone of lighting control devices.
 - b. The application shall provide indication of signal strength where multiple Bluetooth Low Energy Programming Devices are available for configuration.
 - c. The application shall indicate the number of wired networked control devices connected to the local daisy-chain zone.
 - d. The application shall provide on/off/dimming control of all control groups.
 - e. The application shall provide the ability to identify all individual luminaires and control devices.
- 3. Programming capabilities through the application shall include, but not be limited to, the following:
 - a. Switch/occupancy/photosensor group configuration
 - b. Manual/automatic on modes
 - c. Turn-on dim level
 - d. Occupancy sensor time delays

- e. Dual technology occupancy sensors sensitivity
- f. Photosensor calibration adjustment and auto-setpoint
- g. Trim level settings
- h. Preset scene creation and copy for scene capable devices.
- i. Application of a custom device label.

2.5 SYSTEM BACKBONE AND SYSTEM INTEGRATION EQUIPMENT

A. System Controller:

- 1. Product Series: nECY
- 2. System Controller shall be multi-tasking, real-time digital control processor consisting of modular hardware with plug-in enclosed processors, communication controllers, and power supplies.
- 3. System Controller shall have 32-bit microprocessor operating at a minimum of 1 GHz.
- 4. System Controller shall have minimum of 512MB memory, with a minimum of 4GB non-volatile flash, to support its own operating system and databases.
- 5. System Controller shall perform the following functions:
 - a. Time-based control of downstream wired and wireless network devices.
 - b. Facilitation of global network switch communication between different system controllers.
 - c. Linking into an Ethernet network.
 - d. Integration with Building Management Systems (BMS) and Heating, Ventilation and Air Conditioning (HVAC) equipment.
 - e. Connection to various software interfaces, including management interface, historical database and analytics interface, visualization interface, and personal control applications.
- 6. System Controller shall have an integral web server to support configuration, diagnostics and hosting of software interfaces.
- 7. Device shall have option for a graphical touch screen to support configuration and diagnostics.
- 8. Device shall have three RJ-45 networked lighting control ports for connection to any of the following:
 - a. The graphical touch screen
 - b. Wired communication bridges
 - c. Direct connection to networked wired luminaires and intelligent lighting control devices (up to 128 total devices per port)
- 9. Device shall be capable of communicating with wireless network bridges and software interfaces via LAN connection.
- 10. Device shall automatically detect all networked devices connected to it, including those connected to wired and wireless communication bridges.
- 11. Device shall have a standard and astronomical internal time clock.

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12. Device shall have 2 switched RJ-45 10/100 BaseT Ethernet ports for local area network (LAN) connection.
 - a. Ethernet connection shall support daisy chain wiring to other lighting control system LAN devices, such as other system controllers and wireless networked communication bridges.
 - b. Ethernet connection shall support IPv4 and shall be capable of using a dedicated static or DHCP assigned IP address.
13. Device shall have 2 x USB 2.0 Expansion ports for 802.11 Wi-Fi Adapter enabling wireless connectivity including:
 - a. Hot Spot
 - b. Access Point
 - c. Client
14. Each System Controller shall be capable of managing and operating at least 750 networked devices (wired or wireless).
 - a. Multiple System Controllers may be networked together via LAN connection to scale the system up to 20,000 networked devices.
15. System Controller shall support BACnet/IP and BACnet MS/TP protocols to directly interface with BMS and HVAC equipment without the need for additional protocol translation gateways.
 - a. BACnet MS/TP shall support 9600 to 115200 baud rate.
 - b. System Controller shall be BACnet Testing Laboratory (BTL listed) using Device Profile BACnet Building Controller (B-BC) with outlined enhanced features.
16. System controller shall contain a “FIPS 140-2 Level 1 Inside” cryptographic module.
17. System controller shall be available within a NEMA 1 enclosure with Class 1 and Class 2 separation.
 - a. Enclosure shall support power input power of 120-277VAC, or optional 347VAC.

B. OpenADR Interface:

1. Product Series: nADR
2. System shall provide an interface to OpenADR protocol Demand Response Automation Servers (DRAS) typically provided by local electrical utility.
3. OpenADR interface shall meet all the requirements of Open ADR 2.0a Virtual End Nodes (VEN), including:
 - a. Programmable with the account information of the end-user’s electrical utility DRAS account credentials.

4. OpenADR interface shall support the activation of demand response levels defined in the utility demand response program

2.6 WIRED NETWORKED DEVICES

A. Wired Networked Wall Switches, Dimmers, Scene Controllers:

1. Product Series: nPODM, nPODM xS, nPODM xL
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
5. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
6. Devices with mechanical push-buttons shall be made available with custom button labeling.
7. Wall switches & dimmers shall support the following device options:
 - a. Number of control zones: 1, 2 or 4
 - b. Control Types Supported:
 - 1) On/Off
 - 2) On/Off/Dimming
 - 3) On/Off/Dimming/Correlated Color Temperature Control for specific luminaire types
 - c. Colors: White.
8. Scene controllers shall support the following device options:
 - a. Number of scenes: 1, 2 or 4
 - b. Control Types Supported:
 - 1) On/Off
 - 2) On/Off/Dimming
 - 3) Preset Level Scene Type
 - 4) On/Off/Dimming/Preset Level for Correlated Color Temperature
 - 5) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.
 - 6) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

- c. Colors: White.

B. Wired Networked Graphic Wall Stations:

1. Product Series: nPOD-GFX
2. Device shall surface mount to single-gang switch box.
3. Device shall have a 3.5" full color touch screen.
4. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
5. Device shall have a micro-USB style connector for local computer connectivity.
6. Communication shall be over standard low voltage network cabling with RJ-45 connectors.
7. Device shall enable user supplied screen saver image to be uploaded within one of the following formats: jpg, png, gif, bmp, tif.
8. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
9. Graphic wall stations shall support the following device options:
 - a. Number of control zones: Up to 16
 - b. Number of scenes: Up to 16
 - c. Profile type scene duration: User configurable from 5 minutes to 12 hours
 - d. Colors: White.

C. Wired Networked Digital Key Switches:

1. Product Series: nPOD KEY, nPOD KEY MNTN
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. All switches shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
5. Devices shall have LED user feedback to provide indication of on/off status of the programmed lights or scene, as well as indication of device power.
6. Digital key switches shall support the following device options:
 - a. Control Types Supported:
 - 1) On/Off
 - 2) On/Off/Dimming
 - 3) Preset Level Scene Type
 - 4) Reprogramming of other devices within daisy-chained zone so as to implement user selected lighting scene. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

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- 5) Selecting a lighting profile to be run by the system's upstream controller so as to implement a selected lighting profile across multiple zones. This shall support manual start/stop from the scene controller, or optionally programmed to automatically end after a user selectable duration between 5 minutes and 12 hours.

b. Colors: White.

D. Wired Networked Auxiliary Input / Output (I/O) Devices:

1. Product Series: nIO-1S, nIO-RLX, nIO-MLO-5STEPA, nIO-MLO-AB, nIO-NLI, nIO-X, nIO-D, nIO-EZ-PH, nIO-EZD
2. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. Auxiliary Input/Output Devices shall be specified as an input or output device with the following options:
 - a. Contact closure or Pull High input:
 - 1) Input shall be programmable to support maintained or momentary inputs that can activate local or global scenes and profiles, activate lights at a preconfigured level, ramp light level up or down, or toggle lights on/off.
 - b. 0-10V analog input:
 - 1) Input shall be programmable to function as a daylight sensor.
 - c. RS-232/RS-485 digital input:
 - 1) Input supports activation of up to 4 local or global scenes and profiles, and on/off/dimming control of up to 16 local control zones.
 - d. 0-10V dimming control output, capable of sinking up to 20mA of current:
 - 1) Output shall be programmable to support all standard sequence of operations supported by system.
 - e. Digital control output via EldoLED LEDcode communication:
 - 1) Output shall be programmable to support light intensity control, as well as optional correlated color temperature (CCT) control, of the connected luminaire.

E. Wired Networked Occupancy and Photosensors:

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1. Product Series: nCM, nCMB, nRM, nWV, nHW
2. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
3. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies shall not be accepted.
4. For applications where a second method of sensing is necessary to adequately detect maintained occupancy (such as in rooms with obstructions), a sensor with an additional “dual” technology shall be used.
5. Dual technology sensors shall have one of its two technologies not require motion to detect occupancy. Acceptable dual technology includes PIR/Microphonics (also known as Passive Dual Technology or PDT) which both looks for occupant motion and listens for sounds indicating occupants. Sensors where both technologies detect motion (PIR/Ultrasonic) shall not be acceptable.
6. All sensing technologies shall be acoustically passive, meaning they do not transmit sounds waves of any frequency (for example in the Ultrasonic range), as these technologies have the potential for interference with other electronic devices within the space (such as electronic white board readers). Acceptable detection technologies include Passive Infrared (PIR), and/or Microphonics technology. Ultrasonic or Microwave based sensing technologies shall not be accepted.
7. System shall have ceiling, fixture, recessed & corner mounted sensors available, with multiple lens options available customized for specific applications.
8. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
9. All sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
10. Sensor programming parameter shall be available and configurable remotely from the software and locally via the device push-button.
11. Ceiling mount occupancy sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
12. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
13. Sensors shall have optional features for photosensor/daylight override, automatic dimming control, and low temperature/high humidity operation.
14. Photosensor shall provide for an on/off set-point, and a dead band to prevent the artificial light from cycling. Delay shall be incorporated into the photocell to prevent rapid response to passing clouds.
15. Photosensor and dimming sensor’s set-point and dead band shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
16. Dead band setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
17. A dual zone option shall be available for On/Off Photocell, Automatic Dimming Control Photocell, or Combination units. The secondary daylight zone shall be capable of being controlled as an “offset” from the primary zone.

F. Wired Networked Wall Switch Sensors:

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1. Product Series: nWSX
2. Devices shall recess into single-gang switch box and fit a standard GFI opening.
3. Communication and low voltage power shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors.
4. All wall switch sensors shall have the ability to detect when it is not receiving valid communication and blink its LED in a pattern to visually indicate a potential wiring issue.
5. Devices with mechanical push-buttons shall provide tactile user feedback.
6. Wall switches sensors shall support the following device options:
 - a. User Input Control Types Supported: On/Off or On/Off/Dimming
 - b. Occupancy Sensing Technology: PIR only or Dual Tech acoustic
 - c. Daylight Sensing Option: Inhibit Photosensor
 - d. Colors: White.

G. Wired Networked Embedded Sensors:

1. Product Series: nES
2. Network system shall have embedded sensors consisting of occupancy sensors and/or dimming photocells that can be embedded into luminaire such that only the lens shows on luminaire face.
3. Occupancy sensor detection pattern shall be suitable for 7.5' to 20' mounting heights.
4. Embedded sensors shall support the following device options:
 - a. Occupancy Sensing technology: PIR only or Dual Tech acoustic
 - b. Daylight Sensing Option: Occupancy only, Daylight only, or combination Occupancy/Daylight sensor

H. Wired Networked Power Packs and Secondary Packs:

1. Product Series: nPP16, nPP16-ER, nPP20-PL, nSP16, nSP5-PCD, nSP5-2P-LVR, nSHADE, nAR40, nEPS 60, nPS-80
2. Power Packs shall incorporate one optional Class 1 relay, optional 0-10 VDC dimming output, and contribute low voltage Class 2 power to the rest of the system.
3. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC) and carry a plenum rating.
4. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power.
5. Power Supplies shall provide system power only, but are not required to switch line voltage circuit.
6. Auxiliary Relay Packs shall switch low voltage circuits only, capable of switching 1 amp at 40 VAC/VDC (resistive only).
7. Communication shall be delivered to each device via standard low voltage network cabling with RJ-45 connectors. Secondary packs shall receive low voltage power via standard low voltage network cable.

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8. Power Pack programming parameters shall be available and configurable remotely from the software and locally via the device push-button.
9. Power Pack shall securely mount through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast/driver channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
10. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
11. Power/Secondary Packs shall be available with the following options:
 - a. Power Pack capable of full 16-Amp switching of all normal power lighting load types, with optional 0-10V dimming output capable of up to 100mA of sink current.
 - b. Secondary Pack with UL924 listing for switching of full 16-Amp Emergency Power circuits, with optional 0-10V dimming output capable of up to 100mA of sink current.
 - c. Power and Secondary Packs capable of full 20-Amp switching of general purpose receptacle (plug-load) control.
 - d. Secondary Pack capable of full 16-Amp switching of all normal power lighting load types.
 - e. Secondary Pack capable of 5-Amps switching and dimming 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
 - f. Secondary Pack capable of 5-Amps switching and dimming of 120/277 VAC magnetic low voltage transformers.
 - g. Secondary Pack capable of 4-Amps switching and dimming of 120 VAC electronic low voltage transformers.
 - h. Secondary Pack capable of louver/damper motor control for skylights.
 - i. Secondary Pack capable of providing a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
 - j. Secondary Pack capable of switching 1 amp at 40 VAC/VDC (resistive only) with the intent to provide relay signal to auxiliary system (e.g. BMS).
 - k. Power Supply capable of providing auxiliary bus power (no switched or dimmed load).

I. Wired Networked Relay and Dimming Panel:

1. Product Series: ARP INTENCXX NLT (XX = maximum number of relays per panel)
2. Relay and dimming panel shall be available with 8 to 48 individual relays per panel, with an equal number of individual 0-10V dimming outputs.
3. Optional Field Configurable Relays (FCR) used shall have the following required properties:

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- a. Configurable in the field to operate with single-, double-, or triple-pole relay groupings.
 - b. Configurable in the field to operate with normally closed or normally open behavior.
 - c. Provides visual status of current state and manual override control of each relay.
 - d. Listed for the following minimum ratings:
 - 1) 40A @ 120-480VAC Ballast
 - 2) 16A @ 120-277VAC Electronic
 - 3) 20A @ 120-277VAC Tungsten
 - 4) 20A @ 48VDC Resistive
 - 5) 2HP @ 120VAC
 - 6) 3HP @ 240-277VAC
 - 7) 65kA SCCR @ 480VAC
4. 0-10 dimming outputs shall support a minimum of 100mA sink current per output.
5. Relay and dimming outputs shall be individually programmable to support all standard sequence of operations as defined in this specification.
6. Panel shall be UL924 listed for control of emergency lighting circuits.
7. Panel shall power itself from an integrated 120-277 VAC or optional 347VAC supply.
8. Panel shall provide a configurable low-voltage sensor input with the following properties:
 - a. Configurable to support any of the following input types:
 - 1) Indoor Photocell
 - 2) Outdoor Photocell
 - 3) Occupancy Sensor
 - 4) Contact Closure
 - b. Low voltage sensor input shall provide +24VDC power for the sensor so that additional auxiliary power supplies are not required.
 - c. Sensor input supports all standard sequence of operations as defined in this specification.
9. Panel shall provide a contact closure input that acts as a panel override to activate the normally configured state of all relays (i.e., normally open or normally closed) in the panel. This input is intended to provide an interface to alarm systems, fire panels, security system, or BMS system to override the panel.
10. Panel shall supply current limited low voltage power to other networked devices connected via low voltage network cable.
11. Panel shall be available with NEMA 1 rated enclosure with the following properties:
 - a. Surface-mounted or flush-mounted enclosure back box
 - b. Screw-fastened cover or hinged cover with keyed lock
12. Panel shall be rated from 0-50C.

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13. Wired Networked Bluetooth® Low Energy Programming Device:

- a. Product Series: nIO BT
 - b. Device shall be plenum rated and be inline wired, screw mountable.
 - c. Communication and low voltage power shall be delivered to device via standard low voltage network cabling with RJ-45 connectors.
 - d. Bluetooth Low Energy connection shall allow connection from smartphone application for programming device settings within the local daisy-chain zone (see list of available settings in section 2.4-System Software Interfaces, Sub-section E).
- 1) Device shall provide visual indication of remote Bluetooth connection via LED integrated into device enclosure such that it is visible from all angles while the zone is being programmed.

J. Wired Networked Communication Bridge:

1. Product Series: nBRG
2. Device shall surface mount to a standard 4" x 4" square junction box.
3. Device shall have 8 RJ-45 ports for connection to lighting control zones (up to 127 devices per port), additional network bridges, and System Controller.
4. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to System Controller.
5. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply, or powered via low voltage network connections from powered lighting control devices (e.g. power packs).
6. Wired Bridge shall be capable of redistributing power from its local supply and connected lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

2.7 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, Category 5e for horizontal copper cable and with Division 27 Section "Communications Horizontal Cabling."

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring in raceways. Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables" Minimum conduit size shall be 3/4 inch.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to conductor manufacturer's written instructions.
- D. Install field-mounting transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in terminal cabinets, equipment enclosures, and in junction, pull, and outlet boxes.
- G. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and assist in field testing. Report results in writing. Refer to contract drawings, Sheets E-801 and E-802, for additional information and requirements.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Test for circuit continuity.
 - 2. Verify that the control module features are operational.
 - 3. Check operation of local override controls.
 - 4. Test system diagnostics by simulating improper operation of several components selected by Architect.
- C. Refer to Sheets E-801 and E-802 for additional information and requirements.

3.3 SOFTWARE INSTALLATION

- A. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current licenses for software.

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3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors and to assist Owner's personnel in making program changes to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting controls and software training for PC-based control systems. Refer to contract drawings, Sheets E-801 and E-802, for additional information.

END OF SECTION 26 09 43

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 150 kVA.

1.3 SUBMITTALS

- A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
- B. Source quality-control test reports.
- C. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- C. 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.
- D. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

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1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Square-D; a brand of Schneider Electric.
 - 2. Alternate Manufacturers: G.E., Siemens, Eaton.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Cores: Grain-oriented, non-aging silicon steel.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
 - 2. Coil Material: Aluminum.
- D. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- E. Cores: One leg per phase.
- F. Enclosure: Totally enclosed, except for ventilation openings, NEMA 250, Type 2.
 - 1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.
- G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

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- H. Insulation Class: Minimum 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. 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.
- J. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
 - 4. Provide double neutral lugs on secondary.

2.3 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 2.5 ohms at location of transformer.

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- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Provide primary and secondary disconnect switches to comply with NEC.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.5 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service and distribution switchboards rated 600 V and less.
 - 2. Disconnecting and overcurrent protective devices.
 - 3. Instrumentation.
 - 4. Accessory components and features.
 - 5. Identification.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of switchboard, overcurrent protective device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For each switchboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
 - 5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include schematic and wiring diagrams for power, signal, and control wiring.
- C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

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1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.
- B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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.
- E. Comply with NEMA PB 2.
- F. Comply with NFPA 70.
- G. Comply with UL 891.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.
- B. Handle and prepare switchboards for installation according to NECA 400, NEMA PB 2.1.

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1.8 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.9 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

SWITCHBOARDS

Dewberry Architects, Inc. 50101397

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1. Basis of Design: Square-D; a brand of Schneider Electric.
 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. Front-Connected, Front-Accessible only:
1. Main Devices: Fixed, individually mounted.
 2. Branch Devices: Panel mounted.
 3. Sections front and rear aligned.
- C. Nominal System Voltage: 480Y/277 V.
- D. Main-Bus Continuous: As indicated on drawings.
- E. Indoor Enclosures: Steel, NEMA 250, Type 1.
- F. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.
- G. Barriers: Between adjacent switchboard sections.
- H. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.
- I. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks. Include potential transformers having primary and secondary fuses with disconnecting means and secondary wiring terminated on terminal blocks.
- J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- K. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.
- L. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- M. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.
 2. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
 3. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

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4. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 5. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
- N. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.
- O. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation.

2.2 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response (main breaker only). Adjustable from 20% to 60% of sensor rating, but in no case greater than 1200A. Sending of ground fault at the main bonding jumper or ground strap is prohibited.
 - e. Main breaker shall have a serviceable charging motor installed.
 2. Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
 - f. Communication Capability: Din-rail-mounted communication module with functions and features compatible with power monitoring and control system specified in Division 26 Section "Electrical Power Monitoring and Control."
 - g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

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- i. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
- j. Bolt-on type.

2.3 INSTRUMENTATION

A. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

- 1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from five to 60 minutes.
 - j. Contact devices to operate remote impulse-totalizing demand meter.
- 2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.
- 3. Meter shall be capable of communicating with building's energy management system via a BACnet communication port.
- 4. Appropriate multiplier tag.

B. Impulse-Totalizing Demand Meter:

- 1. Comply with ANSI C12.1.
- 2. Suitable for use with switchboard watt-hour meter, including two-circuit totalizing relay.
- 3. Cyclometer.
- 4. Four-dial, totalizing kilowatt-hour register.
- 5. Positive chart drive mechanism.
- 6. Capillary pen holding a minimum of one month's ink supply.
- 7. Roll chart with minimum 31-day capacity; appropriate multiplier tag.
- 8. Capable of indicating and recording five-minute integrated demand of totalized system.

2.4 CONTROL POWER

A. Control Circuits: 120-V ac, supplied from remote branch circuit.

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- B. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- C. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.

2.6 IDENTIFICATION

- A. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components complete with lettered designations.
- B. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.
- B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.
- C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1.
- B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."

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1. 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.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 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 switchboards.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install filler plates in unused spaces of panel-mounted sections.
- F. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
1. Set field-adjustable switches and circuit-breaker trip ranges.
- G. Install spare-fuse cabinet.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 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.

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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. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
4. Per NEC 230.95 (C), the ground fault protection system for the main switchboard MSB shall be performance tested when first installed on site. The test shall be conducted in accordance with instructions that shall be provided with the equipment. A written record of this test shall be made and shall be available to the authority having jurisdiction.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection report, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

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3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories, and to use and reprogram microprocessor-based trip, monitoring, and communication units.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes. All locations of 20A/1P breakers and multi-pole breakers and their ratings shall match same locations and ratings as indicated contract drawing panel schedules.
- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- C. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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- 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
 - 1. Ambient temperatures within limits specified.
 - 2. Altitude not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

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1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS (BRANCH AND DISTRIBUTION)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Basis of Design: Square-D; a brand of Schneider Electric.
2. Alternate Manufacturers: G.E., Eaton, Siemens.

- B. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.
a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
2. Hinged Front Cover for branch panelboards: Entire front trim hinged to box and with standard door within hinged trim cover.
3. Finishes:
a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Galvanized steel.
4. Directory Card for Branch Panelboards: Inside panelboard door, mounted in transparent card holder.

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5. Distribution Panels: Engraved Phenolic Labels per Section 26 05 53 Electrical Identification for each distribution breaker.
- C. Incoming Mains Location: Top and bottom.
- D. Phase, Neutral, and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 3. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Main and Neutral Lugs: Compression type.
 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 5. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices (all "Spaces"): Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard and Distribution Panel Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rating is prohibited.

2.2 DISTRIBUTION PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Basis of Design: Square-D; a brand of Schneider Electric.
 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Mains: Main lug only or main circuit breaker, as indicated on contract drawing panel schedules.
- D. Circuit Breakers: Bolt-on type circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Square-D; a brand of Schneider Electric.
 - 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Main lug only or main circuit breaker, as indicated on contract drawing panel schedules.
- D. Circuit Breakers: Bolt-on type circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike. The entire front trim of panelboards must be hinged to the box and with a standard door within the hinged trim cover. Trims must cover all live parts and must have no exposed hardware. Door is to be flush when closed, even where lockable breakers are installed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: Square-D; a brand of Schneider Electric.
 - 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 50A-100A, unless noted otherwise below and on contract drawing panel schedules.
 - 2. 150A and larger (except 100A and larger for life safety branch): electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Based on results of Power Systems Coordination Study of selected manufacturer, LI type breaker will be acceptable in lieu of LSI, only upon approval of Engineer through shop drawing review of Coordination Study. If not accepted and approved by Engineer, provide LSI type breakers, of the specific type to allow coordination.

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3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

- a. Standard frame sizes, trip ratings, and number of poles.
- b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
- c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.

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- G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- H. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Electrical Identification."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

3.4 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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

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3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.
 - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 - 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to this section.

1.2 DESCRIPTION

- A. General: Provide factory fabricated wiring devices in type, color and electrical rating for the service indicated to provide convenient access to the electrical system for portable and permanent connections, and control of fixed outlets.
- B. Ratings: Voltage and ampere rating of switches and receptacles shall be marked on the device, and shall conform to Voltage and Ampacity of system to which applied.
- C. Hardware: Devices consist of all the necessary hardware to complete an installation and provide a margin of safety by inaccessibility of live electrical components.

1.3 RECEPTACLES AND SWITCHES QUALITY ASSURANCE

- A. Manufacturers: Manufacturers shall be companies regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical installation work similar to that required for the project.
- C. Compliance: Comply with the latest edition of the following standards;
 - 1. NEMA WD1, WD3 and WD5
 - 2. UL 5, 20 and 231
 - 3. ANSI/IEEE Standard C62.41-1980 (Formerly IEEE 587)
 - a. Test withstand voltage surges of up to 6000 volts and current surges of up to 200 amperes without damage.
- D. Warranty: Provide a minimum one-year warranty from time of final acceptance.

1.4 SUBMITTALS

- A. Wiring Devices: Submit manufacturer's product data on all wiring devices listed on the drawings including;
 - 1. Colors

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2. Dimensions
 3. U.L. Label
 4. Finish
 5. Voltage
 6. Wiring diagrams
 7. Application information
- B. Coverplates and Identification: Submit type of identification used for coverplates to comply with the Identification Section as specified herein. Screws to match coverplate color.

1.5 SEQUENCING AND SCHEDULING

- A. Coordination: Coordinate with other work including wires/cables, electrical boxes and fittings, and raceways, to properly interface installation of all wiring devices.

PART 2 - PRODUCTS

2.1 STRAIGHT BLADE RECEPTACLES

- A. General: All receptacles shall be minimum 20 ampere, 120 volts, grounding type, duplex, except where noted otherwise on the plan drawings.
- B. Convenience Receptacles: Provide commercial specification grade single or duplex receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 120 volts, with metal plaster ears, side wiring, NEMA configuration 5-20R unless otherwise indicated.
- C. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A, grounding type, in all rooms or spaces in Clinic. Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD.
- D. Ground Fault Circuit Interrupter: Provide commercial specification grade, duplex, ground fault circuit interrupter receptacles, grounding type, UL rated Class A, Group 1, 20 ampere ratings, 125 volts, 60 Hz; with solid state ground fault sensing and signaling; with 5 milliampere ground fault trip level; equipped with 20 ampere receptacle configuration, NEMA 5-20R. Device shall contain test and reset pushbuttons, with a visual display of the tripped position. All exterior receptacles (weatherproof) shall be duplex GFI type. Interrupter shall resist tripping from the effects of radio frequency (RF) signals from 10 to 450 MHz.
- E. Security Receptacles: Security coverplate, same devices as above as shown on plans, except provide one-piece heavy coverplate, 11-gauge minimum galvanized steel, Allen head hardened security screws, single, double or triple gang as required, white polyester powder coat. Kenall "Mighty Mac" series, or equal.
- F. Color (Normal): For back of house (mechanical, electrical, storage, janitor's closets, etc.), cell/dayroom/inmate corridors and spaces, devices connected to the normal system shall be grey in color. For Area A administration offices, corridors, conference rooms, etc., devices connected to the normal system shall be white in color, unless otherwise noted.

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- G. Color (Emergency): Devices connected to “optional” standby circuit, shall be red in color.
- H. Device Type: Unless otherwise noted, in all public areas, provide all receptacles as the duplex modular type. Provide standard devices in non-public areas such as storage rooms, janitor's closet, penthouses & mechanical spaces, and electrical rooms.
- I. Construction: Heavy duty nylon face and wraparound mounting strap, locked into and on the body, utilizing heavy-gauge brass ground contacts riveted to strap. Include automatic self-grounding spring to assure ground continuity between mounting strap and metal wall box. T-slot one piece copper alloy contact wipes which interface with plug blades inserted at 3 points. Line terminals shall be screw terminals and accept #14 to #10 AWG copper conductors.
- J. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell

2.2 SWITCHES

- A. Line Voltage Toggle Switches: Provide commercial specification grade, fast-make positive-break, flush single-pole three and four way as indicated; silent operation toggle switches, 20 ampere, 120 volt AC or 277 volt AC as required, with mounting yoke insulated from mechanism, equipped with plaster ears, and side-wired screw terminals. Switch colors will match receptacle device colors in same areas as specified above.
- B. Thermal Switch: Provide fractional horsepower switch with melting alloy type overload relay, with number of poles to coordinate with the equipment being controlled. Surface or flush mounted cover, as required, equipped with padlocking device and pilot light. Provide overload relay heaters for each pole of the switch, sized per the manufacturer's instruction, and adjust heater size to permit normal operation of the motor.
- C. Manufacturer: Manufacturer shall be Pass & Seymour, Leviton or Hubbell.

2.3 WIRING DEVICE ACCESSORIES

- A. Faceplates: Except for inmate areas tagged with “S” adjacent to device, faceplates for interior outlets in shall have Type 302 stainless steel, 0.032 inch thick, non-magnetic, satin finish. Cover plates shall be colored to match devices elsewhere in specification, screws to match coverplate color. Security faceplates, tagged as “S” adjacent to device, shall be provided in all inmate accessible areas, regardless of whether the “S” is indicated adjacent to device or not, for devices less than 7' AFF, one-piece heavy coverplate, 11-gauge minimum galvanized steel, Allen head hardened security screws, single, double or triple gang as required, white polyester powder coat. Kenall “Mighty Mac” series, or equal.
- B. Multigang: Provide all necessary hardware and frames to properly mount various devices in combinations.
- C. Weatherproof Device Covers: For all receptacles installed outdoors and/or in wet locations, provide a weatherproof enclosure in full compliance with NEC Article 406.8B. Enclosure shall be weatherproof, whether or not the attachment plug cap is inserted. Covers to be heavy duty diecast metal, “in-use”.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

- A. General: Provide wiring devices, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Associations "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Completion: Delay installation of devices until wiring and wall finish is completed.
- C. Support: Devices shall be securely supported to box, not supported to device plate. Device shall trim out flush with front of plate. Do not support the device by loosening device mounting screws and attaching the coverplate for leveling.
- D. Adjustment: Provide receptacles and switches only in electrical boxes which are clean, free from excess building materials, debris, etc. Adjust devices to plumb when tightened, and in position to receive faceplate. Devices shall not be leveled by using the mounting screws, outlet boxes shall be flush to wall finish prevent leveling problems. Tighten devices and provide securely, so that there shall be no movement during usage.
- E. Position: Position ground pin at the top of the device in vertical application, unless otherwise noted.
- F. Wiring: Provide screw terminal connections using a single conductor only. Do not "back-stab" devices. Provide single whips for all multiple conductor connections within each box.

3.2 APPLICATION OF COVER PLATES

- A. Mounting: Provide coverplates in true vertical or horizontal alignment as applicable. Plates shall be properly secured by means of screws which have heads with finish matching the plate. Secure plates so as to maintain a snug fit against wall surfaces with no gaps.
- B. Replacement: Replace all coverplates which are warped, cracked, chipped, or whose color does not match the balance of the installation. Replace screws whose threads do not allow the drawing up tight of the coverplate to the device.

3.3 CLEANING

- A. Soiled Devices: Clean devices soiled prior to acceptance inspection, to remove all debris and foreign materials, such as paint, varnish, drywall compound, etc.
- B. Solutions: Do not use liquid cleaning solutions, etc. on the face of the devices without written direction from the Engineer/Architect.

3.4 TESTING

- A. Ground testing: Provide ground testing procedures as specified herein. Prior to energizing circuitry, test wiring devices for electrical continuity, and for short circuits.

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- B. Polarity: Subsequent to energization, test wiring devices for proper polarity, and to demonstrate operations as required in this and other sections of this Specification.
- C. Recording: Record all tests as required in other sections of this specification.

END OF SECTION 262726

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Nonfusible switches.
 - 2. Molded-case circuit breakers (MCCBs).
 - 3. Enclosures.

1.3 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Include evidence of NRTL listing for series rating of installed devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

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2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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.
- D. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 SAFETY SWITCHES

- A. Manufacturers: Subject to compliance with requirements:
 1. Basis of Design: Square-D; a brand of Schneider Electric.
 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. General: All disconnect switches shall be heavy-duty type, unless specifically noted otherwise. Switches shall be fusible or non-fusible and sized as noted on the drawings.

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- C. Switches shall be 240 volt rated on systems up to and including 120/240V and 600V rated on higher voltage systems. All switches serving motor loads or 600V rated shall be horsepower rated.
- D. Provide NEMA 1 enclosure, unless otherwise noted. All switches mounted outdoors shall be NEMA Type 3R or as noted NEMA Type 4X, stainless steel.
- E. Provide lugs on disconnect switch as required to accept conductors called for on drawings.
- F. Provide switches with an externally operated handle; quick make quick break mechanism; the handle shall be interlocked with the switch cover by means of a defeatable interlock device. The switch shall be lockable in the "off" position with a padlock.
- G. Switches shall have arc suppressors and pin hinges. Switch blades shall be readily visible in the OFF position. Switch blades and jaws shall be plated copper. Provide with line side terminal shields.

2.2 FUSES

- A. General: All fuses shall be of the same manufacture to retain selectability as designed. No fuse shall be installed until equipment is ready to be energized and after tightening of all electrical connections, inspection of all ground and grounding conductors and a megger test of adequate insulation to ground of all circuits.
- B. Current Limiting: All fuses shall be current-limiting with 200,000 amperes interrupting capacity.
- C. 600 Amps and Below: Fuses rated 600 amperes or less, installed ahead of circuit breakers or circuit breaker panels, shall be UL Class K-1. Fuses rated 600 amperes or less for all general power circuits shall be dual-element, UL Class K-5 time-delay type. They shall be self protecting from extraneous heat.
- D. Motor Circuits: Fuses installed in individual motor circuits shall be dual element time-delay type, UL Class K-5. Use fuse reducers when fuse clip spacing is larger than the fuse dimension.
- E. Rejection Fuses: Fuses called for to be rejection type are to have rejection fuse holders.
- F. Spare Fuses: Ten percent or minimum of three, whichever is greater, of each size and type of fuse, including control power or control transformer fuses, shall be placed in a spare fuse cabinet, wall mounted near the electric service.
- G. Spare Fuse Cabinet: Cabinet shall be sized as required to store all fuses neatly. Cabinet shall contain shelves and/or slots as required to separate types of fuses. Cabinet door shall be hinged with latch and be located in the Emergency Electrical Room.
- H. Identification Label: A fuse identification label, showing type and size, shall be placed inside the door of each fused switch. Labeling for rejection type fused switches shall read "Warning- Use Only Current Limiting Fuses Class __ , Type __ , MFR __ ," engraved in red laminated plastic.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following:
 - 1. Basis of Design: Square-D; a brand of Schneider Electric.
 - 2. Alternate Manufacturers: G.E., Eaton, Siemens.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers (other than ATS-LS and ATS-OP breakers): Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. ATS-LS and ATS-OP breakers: Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault alarm.
 - 2. Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
 - c. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - d. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - e. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - f. Bolt-on type.
- E. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

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1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4X.
3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Division 26 Section "Electrical Identification."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 262816

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SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes the following enclosed controllers rated 600 V and less:
 - 1. Full-voltage manual.
 - 2. Full-voltage magnetic.
 - 3. Reduced-voltage magnetic.

1.3 DEFINITIONS

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

1.4 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and installed components.
 - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
 - 3. Manufacturer's written instructions for setting field-adjustable overload relays.

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4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- 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 NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square-D; a brand of Schneider Electric.
 - b. Alternate Manufacturers: G.E., Eaton, Siemens.
 - 2. Configuration: Nonreversing.
 - 3. Surface mounting.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square-D; a brand of Schneider Electric.
 - 2. Configuration: Nonreversing.
 - 3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
 - 4. Surface mounting.
- D. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square-D; a brand of Schneider Electric.
 - b. Alternate Manufacturers: G.E., Eaton, Siemens.
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

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- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
- c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
- d. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2.2 REDUCED-VOLTAGE MAGNETIC CONTROLLERS

- A. General Requirements for Reduced-Voltage Magnetic Controllers: Comply with NEMA ICS 2, general purpose, Class A; closed-transition; adjustable time delay on transition. Motor loads 15 hp and greater shall be provided with solid state reduced voltage starters.
- B. Combination Reduced-Voltage Magnetic Controller: Factory-assembled combination of reduced-voltage magnetic controller, OCPD, and disconnecting means.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Basis of Design: Square-D; a brand of Schneider Electric.
 - b. Alternate Manufacturers: G.E., Eaton, Siemens.
 - 2. MCP Disconnecting Means:
 - a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents, instantaneous-only circuit breaker with front-mounted, field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.
 - c. Auxiliary contacts "a" and "b" arranged to activate with MCP handle.
 - d. Current-limiting module to increase controller short-circuit current (withstand) rating to 100 kA.

2.3 ENCLOSURES

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
 - 1. Dry and Clean Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4X, stainless steel.
 - 3. Wash-Down Areas: Type 4X, stainless steel.

2.4 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

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1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.
 - a. Push Buttons: Shrouded types; momentary as indicated.
 - b. Pilot Lights: LED types; colors as indicated.
- B. N.C. N.O. auxiliary contact(s).
- C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in each fusible-switch enclosed controller.
- D. Install fuses in control circuits if not factory installed.
- E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- F. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

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1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers and remote devices and facility's central control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 ADJUSTING

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers at 50 percent.
- E. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

3.6 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

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- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 262913

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SECTION 263213 - EXTERIOR ENGINE GENERATOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work specified of this section.

1.2 DESCRIPTION

- A. General: Provide as part of the base bid an exterior diesel engine generator set. Reference Section 263213.16 for alternate bid price. This section describes materials, installation and testing of a UL2200 listed exterior located engine generator set, with dual main breakers, thermal heat pump and auxiliary support system, to be used for in the event of a utility failure. Generators shall be "standby power rated".

1.3 GENERAL PROVISIONS

- A. Intent: It is the intent of these specifications to secure, for the purchaser, a diesel engine driven generator set of the latest commercial type and design as specified herein. All material and equipment shall be new and undamaged.
- B. Service: The engine-generator supplier shall maintain a local parts and 168 hour/week service facility located within a 100 mile radius of jobsite. The generator set supplier must have no less than 60 percent of all engine replacement parts in his stock within the State at all times. Certified proof of this requirement shall be available from the dealer, and a personal inspection of the dealer's facilities shall be made by the consulting engineer or his appointed representative to substantiate claims made by the generator set supplier. The supplier shall provide all installation and test supervision necessary for final acceptance and testing. The generator set supplier shall provide all equipment except underground fuel storage tanks and fuel piping. All power feeders and service entrance conductors and conduit. All generator control alarm and interlock wiring including conduit shall be completely provided by the Contractor. The Contractor shall be responsible for the generator set supplier and related requirements.
- C. Provide any required air construction permits issued by the local or State of Florida Environmental Protection Agency prior to ordering generator equipment greater than 200 kW. General information (size, fuel type, location, and manufacturer cut sheets) must be provided to Owner at least six (6) months prior to the anticipated order date. Verify that all required environmental forms are approved and in place prior to ordering generator. Generator and associated equipment shall be ordered only after final shop drawing approval, and only after receiving air construction permit from EPA agency by Owner.

1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings in accordance with Section 260100 of this specification.

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- B. Submission: Show applicable ratings, sizes, materials, manufacturers and part numbers, and overall dimensions and weights, for the following equipment;
1. Itemized bill of material
 2. Manufacturer and model of engine
 3. Manufacturer and model of generator
 4. Control panel
 5. Battery charger
 6. Batteries
 7. Governor
 8. Exhaust silencer
 9. Main line circuit breakers
 10. Sub-Base Fuel tank and isolators
 11. Remote annunciator panel
 12. Voltage regulator
 13. Jacket water heaters
 14. Fuel, lube oil and turbo charger intake air filters
 15. System schematic diagram showing wiring interconnections with sizes and quantities.
 16. Modification fact sheet giving fuel, coolant, lubricating oil, and exhaust and ventilation requirements.
 17. Torsional vibration analysis for engine and generator.
 18. NFPA 110 Factory Test Report.
 19. A start-up inspection report signed by the engine manufacturer's authorized field service representative.
 20. Provide an information copy of the standard engine inspection and maintenance service contract. The contract shall be for the complete system including all auxiliary support systems.
 21. Engine emissions
 22. Complete generator and fuel tank assembly drawing showing completed installation and all dimensions.
 23. Sound attenuated, weatherproof housing with location of batteries
 24. Remote Shunt Trip Push Buttons
 25. The name and location of parts and service facility which shall service equipment.
 26. Parts and service as required in this section for engine and generator. Submit preventive maintenance program.
 27. Manufacturer's Warranty
 28. Bore, stroke, piston, speed and number of cylinders.
 29. Engine displacement.
 30. Temperature rise by resistance of both rotor and stator, maximum KVA and KW rating, generator efficiency, type of excitation, generator regulator and regular accessories.
 31. Shop drawings on exhaust muffler and exhaust piping showing all parts, dimensions, and required mounting accessories.
 32. Submit ½"x1'-0" layout showing generator, generator enclosure, sub-base fuel tank, access stair/handrail/platform details, manufacturer's recommended clearances, locations of power connections, critical silencer, exhaust louvers, etc.
 33. Dimensions, installation, and connection requirements for generator units.
 34. Ventilation and combustion air requirements for generator.

1.5 MANUFACTURER'S SERVICES

- A. Manufacturer's Services: Provide authorized equipment manufacturer's services at the jobsite. Install equipment, check the modifications, supervise start-up, and supervise testing and adjustment of the

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equipment. Provide a minimum of two man-days to instruct the Owner's personnel in the operation and maintenance manuals prior to this instruction.

1.6 WARRANTY

- A. Duration: Provide a 5 year comprehensive warranty covering all replacement parts and two (2) year warranty on labor for items provided in this section. Warranty period shall commence at time of Owner acceptance of generator(s).
- B. For a period of one (1) year from the date of final acceptance of the building, the installing Contractor shall be responsible for all NFPA 110 quarterly required inspections, maintenance and testing of the emergency generator. Coordination and scheduling of the system inspections and tests shall be done through the Owner. Records of such activities must be maintained for the duration of the first year, at which time copies must be turned over to the Owner.

PART 2 - MATERIALS

2.1 MANUFACTURERS

- A. General: The units shall be the product of a firm regularly engaged in the manufacture of engine sets and shall meet the requirements of these specifications. It must be a standard model in regular production at the manufacturer's place of business. Engine, generator, and all accessories and control panels shall be serviced by the same supplier so that there shall be one source and one responsibility.
- B. Manufacturers:
 - 1. Basis of Design: Kohler.
 - 2. Acceptable alternate manufacturers shall be Cummins, Caterpillar or Generac. No other manufacturers shall be permitted.
- C. Qualifications: The engine-generator manufacturer shall be an authorized full service dealer.

2.2 RATING

- A. General: The rating of the standby engine-generator shall be as listed below and based on operation when equipped with all operating accessories, including air cleaners, fans, lubricating oil pumps, fuel injection pump, and jacket water pump. The specified standby KW shall be rated for continuous electrical service during interruption of the normal utility source. The engine generator shall have the following ratings;
 - 1. Standby Rating: As indicated on drawings
 - 2. Engine Speed: 1,800 RPM (maximum)
 - 3. Voltage: 277/480 volts, 3 phase, 4 wire
 - 4. Frequency: 60 hertz
 - 5. Power Factor: .8
 - 6. Altitude: 500 feet above sea level, without de-rating standby rating
 - 7. Ambient temperature: 110 degrees F. maximum, 25 degrees F. minimum.

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2.3 ENGINE

A. General: Provide an engine with the following features;

1. Full compression ignition diesel
2. Four-stroke cycle
3. Water cooled
4. Replaceable valve seat inserts
5. Capable of the rated output when operating on a commercially available No. 2 diesel oil (ASTM D 396).
6. Capable of extended no load operation without loss of lubricating oil.
 - a. 166 HP (horsepower) at 1800 rpm, at rated KW.

B. Accessories: Provide the engine with the following accessories;

1. Fuel, lube oil, and intake air filters
2. Intake air silencer, high frequency type
3. Lube oil cooler
4. Flexible fuel lines
5. Gear-driven water pump
6. Coolant and oil drain valves
7. Fuel priming pump
8. Crankcase fumes disposal system
9. Engine control wiring - multi-strand plastic insulated cable enclosed in nylon flexible slotted conduit terminated in bulkhead fittings
10. Weatherproof engine generator set enclosure

2.4 GENERATOR STARTING

- A. Starting Motor: A DC electric starting system with positive engagement drive shall be provided. The motor voltage shall be as recommended by the engine manufacturer.
- B. Automatic Control: Fully automatic generator set start stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, overspeed, overcrank, and two auxiliary contacts for activating accessory items. Controls shall include a 30 second single cranking cycle limit with lockout.
- C. Batteries: A nickel-cadmium storage battery to be used in conjunction with the electric starting system and generator control switchgear shall be provided for the engine. The batteries shall have sufficient capacity to provide for one minute total cranking time without recharging and shall be 12 hour rated. The battery shall be rated by the battery manufacturer in accordance with requirements set forth by the engine manufacturer. Provide a battery rack of fiberglass construction with bottom insert to insulate the batteries and prevent corrosion and necessary cables, clamps and replaceable connectors. Batteries shall be mounted in the building where shown and required. Wiring shall be sized as required by manufacturer for distance involved.

1. Batteries shall be located within the weatherproof housing.

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- D. Battery Charger: Current limiting battery charger shall be provided to automatically recharge batteries. Charger shall float at 1.4 volts per cell and equalize at 1.6 volts per cell. It shall include overload protection silicon diode full wave rectifiers, voltage surge suppressor, DC ammeter, DC voltmeter, and fused AC input. AC input voltage shall be 120 volts, single phase. Amperage output shall be no less than 20 amperes and size based on load of gear and recharge of battery in 24 hours. Charger shall be Lamarche model A46 or approved equal. Charger shall have auxiliary contacts to close on low voltage and N.O. AC input for connection to respective generator control cubicle in generator switchboard. Charger shall be capable of fully charging batteries during running conditions and shall be coordinated with generator provided.

1. Battery charger shall be located within the weatherproof housing and shall be suitable for exterior applications.

2.5 GOVERNING SYSTEM

- A. Governor: Provide a Woodward 2301 or Barber Coleman equal, electronic adjustable isochronous governor with electronic speed sensing.
- B. Speed: Governor shall provide adjustable speed setting from 58 to 62 hertz and maintain the frequency within plus or minus 0.25 percent from no load to full load. Upon load change of not more than 25 percent of rated load, the governor shall re-establish stable operation in not less than one and one-half seconds. Stable operation is defined as operation at a frequency within plus or minus 0.25 percent of rated frequency.
- C. Tolerance: The maximum change of frequency during the one and one-half second load change surging period shall not exceed 0.5 Hz.
- D. Load Change: After any sudden load change of not more than 25 percent of rated load, the governor shall reestablish stable operating conditions in not less than 1-1/2 seconds. Stable operation is defined as operated at a frequency that is constant within plus or minus 0.25 percent of rated frequency.
- E. Maximum Change: The maximum change of frequency during the one-half second surging period shall not exceed 0.5 Hz.
- F. Location: Governor Module shall be mounted inside generator control panel.
- G. Actuator: The engine shall be equipped with a compatible actuator and the necessary magnetic pick-up to drive the governor.
- H. Cable: All connections between the engine governor, engine and switchgear auxiliary switching points shall be made with shielded cable.
- I. Cable Separation: Governor Cable shall not be run in the same conduit with AC control of primary voltages.

2.6 ENGINE GENERATOR ACCESSORIES

- A. Accessories: Cylinder Liners, Pistons, and Valves: Cylinder liners, pistons, and valves shall be as follows:

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1. The engine shall be provided with removable wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
2. Pistons shall be aluminum alloy with cast iron top ring banks and chrome-faced rings.
3. Valve train shall employ replaceable valve seat inserts, alloy steel valves and cast iron guides.

B. Lubrication: Lubrication shall be as follows:

1. A gear-type lubricating oil pump shall supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
2. Pistons shall be spray cooled.
3. Effective full flow lubricating oil filters shall be provided and so located that lubricating oil is continuously filtered except during periods when oil is by-passed to protect vital parts such as when filters are clogged.
4. Replacement resin impregnated cellulose type filter elements shall be accessible and easily removable. Filter system shall be equipped with a spring-loaded bypass valve as an insurance against stoppage of lubricating oil circulation in event the filters become clogged.
5. A suitable water-cooled, engine-mounted lubricating oil cooler shall be provided. The diesel oil sump drain shall be brought to the outside of the set for ease of changing oil.

C. Air Cleaners: One or more engine-mounted dry type air cleaners of sufficient capacity to protect working parts of the engine from dust and grit shall be provided.

D. Jacket Water Heater: Jacket water heater shall be as follows:

1. Provide a unit-mounted thermal circulation-type water heater incorporating a self-contained thermostatic switch, controlled by the exit coolant temperature from the heater to maintain engine jacket coolant to 90 degree F.
2. The heater shall be single phase, 60 Hz, 208 volts, single phase. Heater shall be Chromalox, or Kim-Hotstart, or approved equal. Provide breaker and circuit size as required for heater.
3. Provide hand valves in the heater hoses to facilitate changing heating elements without draining the entire cooling system.
4. Heater shall automatically disengage upon activation of the generator.

E. Duty Cycle: The engine shall be capable of operation at light loads for extended periods of time and shall provide for pre-combustion of fuel or a similar means for the prevention of carbonization.

2.7 FUEL SYSTEM

- A. Description: Fuel System Injection pumps and injection valves shall not require adjustment in service. The engine shall have an individual mechanical injection valve for each cylinder, any one of which may be removed and replaced from parts stock.
- B. Fuel injection pump shall be positive action, constant-stroke pumps, actuated by a cam driven by gears from the engine crankshaft. Fuel lines between injection pump and valves shall be heavy seamless tubing, and, to eliminate irregularity of fuel injections, shall be of the same length for all cylinders.
- C. Fuel system shall be equipped with replaceable fuel filter elements which may be easily removed without breaking any fuel line connections or disturbing the fuel pumps or any other part of the

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engine. Fuel filter shall include fuel pressure gauge, bypass valve (normally closed), manual shutoff valve.

- D. All fuel filters shall be conveniently located in one accessible housing, ahead of injection pump so that fuel shall have been thoroughly filtered before it reaches the pump. No screens or filters requiring cleaning or replacement shall be used in injection pump or injection valve assemblies.
- E. Engine shall be equipped with a built-in gear-type engine-driven fuel transfer pump, capable of lifting fuel against a head of 12 feet, for supplying fuel through the filters to the injection pump at constant pressure.
- F. Provide a water separator on the engine just ahead of the fuel filters constructed of heat-resistant glass, with aluminum-perforated baffle for viewing amount of water contained.
- G. Provide a fuel supply shut-off solenoid.
- H. Provide a low level alarm set at 8 hours fuel load consumption for sub-base fuel tank.

2.8 EXHAUST SYSTEM

- A. Description: Exhaust system shall consist of a critical silencer, Maxim M51, Donaldson TCU Series or approved equal, flexible exhaust fitting, exhaust piping, insulation, and mounting hardware.
- B. Silencer: Provide a critical type silencer constructed of mild steel, mounted on the interior of the generator enclosure. Exhaust noise shall not exceed 75 dBA at 25 feet. Provide brackets, companion flanges, gaskets, and fasteners.
- C. Fittings: Provide Type 316 stainless steel bellows-type flexible exhaust fitting at least 18 inches long.
- D. Discharge: Provide horizontal discharge tailpipe. Undercut at 45 degrees and cover with 80 percent expanded metal bird screen.
- E. Provide exhaust system consisting of adapters, elbows, lined bellows, piping, supports, drain tees, and support assemblies. The system shall be a custom-fitted fabrication.
- F. Pitch: Pitch horizontal runs of exhaust pipe away from the engine. Provide condensate traps with petcocks or valves at low spots in the exhaust system.
- G. Size: Inlet and outlet size shall be as recommended by manufacturer.

2.9 ACOUSTICAL TREATMENT

- A. General: The engine block and heads shall be provided with factory applied acoustical dampening. The amount and location of treatment shall be the normal available from the engine manufacturer. The exhaust manifolds, turbochargers and silencers shall be wrapped with HITCO A.I.M. flexible layered fiberglass blankets or accepted substitution supplied by engine manufacturer installed by the Contractor.

2.10 STRUCTURAL STEEL BASE

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- A. Base: Isolate the structural steel base from the engine with 6 quad spring-type isolators with neoprene-jacketed pre-compressed molded fiberglass noise isolation pads, steel load plate, built-in leveling bolt, welded steel or cast housing, and high deflection steel springs.
- B. Isolators: Isolators shall be Peabody Noise Control, Inc.; Kinetics brand, Type SM; Norfund or Dynamics Corporation

2.11 COOLING SYSTEM - ENGINE MOUNTED RADIATOR

- A. Radiator: Provide an engine-mounted radiator with blower-type fan sized to maintain rated full load continuously at the specified maximum ambient temperature. Fan rpm shall not exceed 819 rpm.
- B. Coolant Switch: Equip the radiator with a 1 inch wide duct adapter flange and low coolant level switch with 1 N.O. and 1 N.C. contact.
- C. Airflow: Airflow restriction from the radiator shall not exceed 0.50 inch water.
- D. Fluid: Fill the engine cooling system with a solution of 30 percent by volume ethylene glycol with rust inhibitor.

2.12 REMOTE ANNUNCIATOR/START/STOP

- A. General: Provide a remote annunciator to be located in on the first floor Area A Main Control Room, to annunciate generator alarms and pre-alarms as specified herein.
- B. Mounting: Remote annunciator shall be surface mounted.
- C. Alarms: Remote annunciator shall mimic all alarms required at the generator control panel. Annunciation shall have individual and distinct alarms for each generator annunciator panel.
- D. Audible Annunciation: The remote annunciator shall have audible alarm annunciation, with a "silence" button. When an alarm is silenced, any new alarm shall automatically reinitiate the audible alarm.
- E. Power: Power for remote annunciator shall be provided from generator battery.

2.13 GENERATOR CONTROL PANEL (LOCATED ON THE EMERGENCY GENERATOR)

- A. Engine Instrument Panel and Safety Switches.
 - 1. Engine Instrument Panel: Provide a generator-mounted instrument panel with gauges for items in the following table.
 - 2. Safety Switches: Provide devices for indication and control of the items in the following table requiring pre-alarm and shutdown.

Indicator Function (at Battery Voltage)	CV	S	RA

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Indicator Function (at Battery Voltage)	CV	S	RA
(a) Overcrank	X	X	X
(b) Low Water Temp. <70°F (21°C)	X		X
(c) High Engine Temp Prealarm	X		X
(d) High Engine Temperature	X	X	X
(e) Low Lube Oil Pressure Prealarm	X		X
(f) Low Lube Oil Pressure	X	X	X
(g) Overspeed	X	X	X
(h) Low Fuel Main Tank (@ 8 hrs. fuel remaining)	X		X
(i) EPS Supplying Load	X		X
(j) Control or Test Switch Not in Auto. Position	X		X
(k) Battery Charger Malfunctioning	X		X
(l) Low Voltage in Battery	X		
(m) Lamp Test	X		
(o) Audible Alarm Silencing Switch			X
(s) Remote Emergency Stop		X	X
(u) Ground Fault Alarm	X		X
KEY: CV Control panel-mtd. visual indication RA Remote Audible S Shutdown of EPS X Required			

B. General: Generator control panel shall include the following equipment;

1. Voltmeter, 1 percent accuracy with 3 phase fuse protection digital type to read true rms.
2. Ammeter, 1 percent accuracy, digital type to read true rms.
3. Frequency meter, 1 percent digital type.
4. Running time meter.
5. Instrument transformers.
6. Automatic starting controls, cycle crank.
7. Voltage level adjustment rheostat, minus 25 to plus 10 percent.
8. Dry contacts for remote alarms wired to terminal strips.
9. Fault indicator lights with press to test feature for low oil pressure, high coolant temperature, low coolant level, overspeed, and overcrank.

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10. Visual alarm indicators for impending shutdown from oil pressure and high coolant temperature.
11. Visual alarm indicators for low fuel level and low coolant temperature.
12. Three-position function switch marked "manual", "off/reset", and "auto".
13. Emergency engine stop pushbutton.
14. Panel illumination lights and switch.

- C. Components: Pilot lights and pushbuttons shall be standard duty type.
- D. Devices: Provide relays and timing devices with clear polycarbonate dust covers. Devices shall be plug-in type with hold down spring retainers. Output contacts shall be rated 10 amperes at 24 volt dc.
- E. Controls: Provide engraved or etched nameplates to show position of switches and function of pilot lights, pushbuttons, and meters.
- F. Provide fully automatic set start-stop controls in the generator control panel. Controls shall operate as follows:
1. With switch in automatic position, the opening of a set of external contacts (open to start) or switch in manual position, the engine shall automatically crank.
 2. An adjustable cranking limiter shall allow from 2 to 5 cycles of 30 seconds continuous cranking. If the engine fails to start, starting circuit shall be locked out and the overcrank light illuminated.
 3. The engine will shut down when operating in the automatic mode and the remote engine run contact open.
 4. Initiation of any safety shutdown shall immediately stop the engine and light the appropriate light.
 5. Upon correction of the fault, the shutoff system shall be made operable by moving the function switch to off/reset and then back to the "auto" position.

2.14 ENGINE MOUNTED GENERATOR MAIN BREAKERS

- A. Provide multiple main line circuit breakers sized in accordance with the NEC with surge suppressors. Circuit breakers shall be solid state, electronic type with adjustable settings for long-time pick-up and delay, short-time pick-up and delay, instantaneous, and ground fault (LSIG).
- B. Install each main line circuit breaker on the generator in a separate, dedicated NEMA 1 enclosure to function as a load circuit interrupting and protection device. Locate within the generator weatherproof enclosure.
- C. Circuit breaker shall be trip free of the handle.
- D. The handle position, or a luminescent flag, shall indicate "off", "on", or "tripped" breaker positions.
- E. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short-circuit protection. Breaker shall also include a 24 volt D.C. shunt trip for remote trip.
- F. Insulated neutral terminals and a ground terminal shall be provided and marked.
- G. The circuit breaker shall meet standards established by UL, NEMA, and NEC.

H. Do not use generator exciter field circuit breakers.

I. Design Selection: Square "D" type PG.

2.15 WEATHERPROOF ENCLOSURE (NON WALK-IN)

A. General: Vandal-resistant, sound-attenuating to 72dBA max noise level @ 23', weatherproof aluminum housing, wind resistant up to 181 mph and included missile impact rating for Large Missile Level E and FBC tested to TAS201-94, TAS202-94 and TAS203-94 standards. multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure. The roof of the enclosure shall meet or exceed the minimum gauge requirements specified but, in addition, shall be strengthened in such a manner as to support the largest commercially available critical exhaust silencer recommended by the engine manufacturer for this application.

B. Alternate Enclosure: Provide alternate price for hurricane-rated, impact resistant enclosure.

C. Enclosure shall be sound attenuated. The published combined engine and exhaust source sound level shall be reduced by 25 dBA at a distance of 23 feet in any direction from the enclosure, measured in a free field environment.

D. Metal Treatment: All sheet metal used in the construction of the enclosure shall be electrostatically applied zinc coated.

E. Doors: All doors on the enclosure shall be located in areas as to allow ease of maintenance on the generator set and allow access to and visibility of instruments, controls, engine gauges, etc. The doors shall be fitted with bolt-on, stainless steel hinges. Each door shall be fitted with flush-mounted, adjustable, same key-lock latches.

F. Louvers: All louvers shall be designed to prevent the entrance of rainwater, but shall have sufficient free area to allow for 120% of the total engine-generator cooling air requirements used in this application.

G. Bolts: All components of the enclosure shall be assembled utilizing stainless steel bolts, nuts and lock washers. In addition, watertight neoprene flat washers shall be used on all roof bolts.

H. Exhaust Connection: Provide mounting brackets for the critical exhaust silencer specified. Provide a 90 degree elbow and rain cap to prevent the entrance of rainwater shall also be supplied. Further, a stainless steel, seamless, flexible exhaust tube and all necessary bolts, flanges, and gaskets to mate with the engine and the critical exhaust silencer shall be provided. The length of the flexible tubing shall be such that additional solid metal nipples or sections shall not be required to be provided as spacers between engine exhaust or the exhaust silencer. Provide exhaust hood on top of generator enclosure exhausting in a horizontal direction.

I. Rain Skirt: Provide "rain skirt" and collar to prevent the entrance of rain and allow for expansion and vibration of the exhaust piping without chafing or stress to the exhaust system.

J. Rust Inhibitor: Prime paint with a minimum of two coats rust inhibitor primer. The final finish painting shall be a minimum of two coats, color to be selected by architect.

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- K. Provide premanufactured metal platform/handrail/stairs for access to generator down to finished grade from generator doors.

2.16 FUEL PIPING AND STORAGE TANKS

- A. Tank: Above ground skid mounted fuel storage shall be provided under this section. All fuel oil piping, remote fuel level gauges, and all necessary valves and fittings shall be provided and installed complete as required. The tank shall be a double wall, above-ground sub-base mounted with a minimum capacity to provide 72 hours of continuous operation at 100% rated load. The Contractor shall be responsible for a complete fuel system installation. Where the tank capacity exceeds 549 gallons, the fuel tank shall be registered with the Florida Department of Environmental Protection through Owner. The Owner shall submit a storage tank registration as soon as it has information on the equipment, which is to be provided by the Contractor. The Contractor shall coordinate the registration of the fuel tank with Owner prior to filling the tank.
- B. Coordination: It shall be the responsibility, however, of the generator set supplier to coordinate all materials and work of other trades so that the total installation is complete and fully operational and meets all engine manufacturer's requirements. Any materials or installation required for proper interfacing of all trades shall be provided and installed by the generator set supplier.
- C. Fuel Filter: Fuel system shall be equipped with replaceable fuel filter elements which may be easily removed without breaking any fuel line connections or disturbing the fuel pump or any other parts of the engine.

2.17 TORSIONAL VIBRATION ANALYSIS

- A. General: Submit a torsional vibration analysis of the engine-generator combination, showing it free of harmful torsional vibration stresses within plus or minus 10 percent of its normal operating speed range, the natural frequency, critical speeds, relative amplitudes of angular displacement, and approximate nodal locations of the complete elastic system of the engine and driven equipment.

2.18 REMOTE EMERGENCY STOP STATION

- A. General: Provide generator stop pushbutton at remote location (Main Control Room) as indicated on drawings. Pushbutton shall be "push to stop" and "pull to reset". Pull to reset shall not automatically restart generator.
- B. Mounting: Pushbutton shall be installed in flush mounted backbox, 48" centerline above finished floor or grade. Pushbutton shall be provided with a "break glass" or similar type of enclosure to prevent accidental actuation of pushbutton. Device shall be UL listed for wet locations.
- C. Identification: Provide phenolic nameplate, to read "Generator Emergency Shutdown; Push to Stop; Pull to Reset Station".

PART 3 - EXECUTION

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3.1 GENERAL

A. Miscellaneous Requirements: Provide the following:

1. Equipment nameplate.
2. Operating manual.
3. Parts list.
4. Special tools (as required).
5. Lubricants.
6. As-built shop drawings.
7. Services of a Manufacturer's Representative, minimum ten (10) days.

3.2 PREVENTIVE MAINTENANCE PROGRAM REQUIREMENT

- A. General: The manufacturer of the Power Generation System equipment shall develop a computerized preventative maintenance program. Specific recommendations for actual equipment application shall be made for a computerized program based on operating hours and/or elapsed time. The preventative maintenance recommendations shall be submitted with the shop drawings.

3.3 SYSTEM SERVICE CONTRACT

- A. General: The supplier of the power system shall provide a copy of and make available to the Owner his standard service contract which, at the Owner's option, may be accepted or refused. This contract shall accompany any documents, drawings, catalog cuts, specification sheet, wiring or outline drawings, etc. submitted for acceptance to the designing engineer.

3.4 REMOTE ANNUNCIATION

- A. General: All necessary underground conduit, wiring, and relays provided by the generator system supplier, for remote annunciation for each generator of all required alarm and/or control functions.

3.5 FACTORY TESTING

- A. General: Perform factory tests prior to shipment. Include the following;

1. Demonstrate proper operation of all safety devices.
2. Conduct load tests utilizing combination resistive and reactive load banks at generator rated power factor as follows:

Load	Hours
half	1
three quarter	1
full	4

3. At the end of two hours at full load, the engine-generator shall be block loaded from no load to full load for a total of two times, and the voltage dip shall be recorded by a strip chart recorder.
4. Record current, voltage, frequency, water temperature, lube oil pressure, and lube oil temperature every 15 minutes.
5. Submit test reports to the Engineer for review.

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3.6 FUEL

- A. General: Division 26 contractor shall be responsible for filling the main tank and day tank with No. 2 fuel oil meeting ASTM D 396. After field testing is complete, refill the tank. Substantial completion shall require all tanks filled to capacity.

3.7 PAINTING AND COATING

- A. Finish: Coat enclosure and structural steel base per specified in other sections. Color of finish coats shall be color to be selected by Architect.

3.8 STARTUP

- A. Initial: On completion of the installation, the initial startup shall be performed by a factory-trained service representative of the engine supplier, who shall thoroughly inspect, operate, test and adjust the equipment.
- B. Provisions: The inspection shall include the soundness of all parts, completeness of all details, and proper operation of all components with special emphasis on safety devices, correctness of settings, proper alignments, and correct phase rotation to match other sources.
- C. Tests: Field tests shall include the following;
 - 1. Simulate power failure by tripping the main breaker and demonstrate complete manual and automatic start, load, unload, and stop sequence of the engine-generator.
 - 2. Conduct a two-hour run with generator operating, utilizing maximum available load. If available load is less than 100% of the generator's rating, then furnish and add loads to obtain 100% generator loading. Load banks shall be resistive load type.
 - 3. Conduct a block loading test in accordance with NFPA-110.

3.9 SCHEDULED OIL SAMPLING

- A. Sampling Analysis: In order to minimize engine failure, the supplier of the equipment shall provide a quarterly (every three months) oil sampling analysis (for each engine) for a period of two years from date of acceptance.
- B. Method: This scheduled oil sampling shall be of the atomic absorption spectrophotometry method accurate to within "1 ppm for the following elements: lead, iron, chromium, copper, aluminum, and silicon.
- C. Test Requirements: In addition, test the sample for the presence of water, fuel, dilution, and antifreeze.
- D. Equipment: Provide equipment needed to take oil samples in a kit at the time of acceptance. Include a sample gun kit, bottles, mailers, and written instructions.
- E. Notification: Provide immediate notification (within two hours of analysis) by telephone or email to the Owner when analysis results show any critical reading. If readings are normal, provide a report by mail showing that the equipment is operating within established requirements.

- F. Owner Availability: This scheduled oil sampling program to be available to the Owner at the supplier's normal rate, after the mandatory 2 years and shall be continued thereafter at the Owner's option.

3.10 ENGINE GENERATOR TEST PROCEDURE

- A. General Overview: The test shall be performed in accordance with the latest edition of the NFPA-110, and as modified herein. Two basic load tests shall be performed after the EPSS is completely installed. The first test shall utilize the maximum available building load and the second test shall utilize a full capacity load bank. Tests shall be witnessed by the State Fire Marshal or his designated representative and shall be present to witness the on-site acceptance and load bank testing. Provide minimum one month's notice to Owner prior to date of testing.
- B. Procedure: Provide an outline of the entire test procedure to be followed. The outline shall include the following:
1. Breaker and relay positions (open or closed) prior to loss of power.
 2. Method of initiating power loss.
 3. Locations of observation points during the tests to properly record all necessary data and observe operating conditions. A plan showing these locations may be necessary for a complicated or "spread-out" type system. The time required to restore each type of priority load shall be recorded and any changes in breaker relay position must be noted.
 4. Procedure to perform the cycle crank test for each engine.
 5. Procedure to test all safety alarms, pre-alarms, shutdown requirements and annunciation including a diagram showing where safety monitoring devices are located and how each will be activated.
 6. Other procedures necessary for a complete test.
- C. Test Requirements: The following are requirements for testing;
1. With prime mover in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure to the building or facility. Test load shall be the maximum load that is served by the EPSS.
 - a. Observe and record the time delay on start for the generator.
 - b. Observe and record the cranking time until the prime mover starts and runs.
 - c. Observe and record the time required to reach operating speed.
 - d. Record voltage and frequency overshoot for the generator. Utilize appropriately sensitive meters.
 - e. Observe and record time required to achieve steady-state condition with all switches transferred to the emergency position. Verify that each transfer switch has properly transferred.
 - f. Record voltage, frequency, and amperes for the generator. Record the data at first load acceptance and every 15 minutes thereafter until the completion of the two-hour test period.
 - g. Record prime mover oil pressure, water temperature where applicable, and battery charge rate at 5 minute intervals for the first 15 minutes, and at 15 minute intervals thereafter.
 - h. Continue load test for two hours observing and recording load changes and the resultant effect on voltage and frequency.

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- i. Verify that all loads have transferred and are operating as follows:
 - Look for motor starters that are locked out and do not automatically restart.
 - Check to see that elevators are re-energized within 60 seconds.
 - Verify that duct dampers associated with emergency AHU's and exhaust fans are open.
 - Verify that no exhaust gases are entering building.
 - Verify that all essential system loads are still energized and status of all circuit breakers.
 - j. Return normal power to the building or facility, record the time delay on retransfer to normal for each switch (minimum setting: 30 minutes), and the time delay on prime mover cool down period and shutdown (minimum setting: 5 min.).
2. After completion of the above test, the prime mover shall be allowed to cool for 5 minutes, after which the following full load test shall be performed:
- a. Full Load Test: A load shall be applied for a two-hour, full load test. The building load can serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate KVA rating (at unity power factor) of the EPS, less applicable derating site conditions.
 - b. The full load test shall be initiated immediately after the cooling time allowed above by any method that will start the prime mover and, immediately upon reaching rated rpm, pick up 100 percent of nameplate KW rating on one step, less applicable derating factors for site conditions. Record instantaneous and sustained voltage dips for all load applications and compare to manufacturer's criteria. Record prime mover data same as in item 1.h. above.
 - c. At the end of the two-hour period, reconnect normal power. Record final breaker and relay positions.
 - d. Disconnect load bank and reconnect building loads.
 - e. Allow generator to run through its cool down cycle and shutoff. Record cool down cycle time.
 - f. Tabulate all data and submit a complete testing report to the Engineer. Report is to include all results compared to expected or published maximums, minimums or normal operation.
3. Cycle Crank Test: Utilize any method recommended by the manufacturer to prevent the prime mover from running. Put the control switch into "run" to cause the prime mover to crank. Observe the complete crank/test cycle as follows:
- a. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration. Upon starting and running of the prime mover, further cranking shall cease. Two means of cranking termination shall be utilized so that one will act as backup to the other to prevent inadvertent starter engagement. Fifteen KW and smaller otto cycle and all diesel prime movers shall be permitted to use continuous cranking methods. Cranking limiter time shall be 75 seconds for cycle crank and 45 seconds for continuous crank.

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4. Test all safeties specified in NFPA 110, Section 3-5.5 and 3-5.6 as recommended by the manufacturer and as required to verify proper operation.
5. The following shall be made available to the Engineer at the time of the acceptance test:
 - a. Results of the prototype test required by NFPA 110, Section 3-2.1
 - b. Certified analysis required in NFPA 110, Section 3-5.10.2 (Torsional Vibration Compatibility Test).
 - c. Results of complete generator damage and decrement curves.
 - d. A manufacturer's certification of a rated-load test at rated power factor with the ambient, altitude, and fuel grade recorded.
 - e. Generator parameters, expected circulating currents and harmonic generation analysis, including recommended derating.
6. Provide the following independent acceptance test for engine generators in accordance with International Electrical Testing Association specification:
 - a. Insulation - resistance tests on generator winding with respect to ground in accordance with ANSI/IEEE Standard 43. Determine polarization index.
 - b. Test protective relay devices in accordance with applicable sections of NETA ATS.
 - c. Perform phase rotation test to determine compatibility with load requirements.
 - d. Where unusual vibration or noise occurs, perform vibration base-line test. Plot amplitude versus frequency for each main bearing cap.
 - e. Test values shall be as follows:
 - 1) Insulation-resistance test shall be at voltage listed in Table 10.2 of NETA ATS-1991.
 - 2) Polarization index values shall be in accordance with IEEE Standard 43.
 - 3) Vibration levels shall not exceed manufacturer's published recommendations.

END OF SECTION 263213

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SECTION 263213.16 – GASEOUS ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 GENERAL

- A. Provide ALTERNATE price for natural gas generator set, in lieu of diesel generator set per Specification Section 263213. Price shall include the cost of natural gas charges for natural gas utilized during required testing up to and including acceptance of Substantial Completion.

1.3 SUMMARY

- A. Section includes packaged engine generators for non-emergency use with the following features:
 - 1. Natural gas engine.
 - 2. Gaseous fuel system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Outdoor generator-set enclosure.
 - 7. Vibration isolation devices.
 - 8. Finishes.
- B. Related Requirements:
 - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.
 - 4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
 - 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 - 6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95 deg F, 80 deg F, 70 deg F, and 50 deg F. Provide drawings showing requirements and limitations for location of air intake and exhausts.

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7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
8. Include emergency transfer switch and associated CAM lock connectors. .

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified.
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. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and testing agency.
- B. Source Quality-Control Reports: Including, but not limited to, the following:
 1. Certified summary of prototype-unit test report.
 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
 4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 5. Report of sound generation.
 6. Report of exhaust emissions showing compliance with applicable regulations.
- C. Field quality-control reports.
- D. Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators 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. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

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- b. Operating instructions laminated and mounted adjacent to generator location.
- c. Training plan.

1.7 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: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 years from date of Substantial Completion.
 - 2. A one year service contract shall be provided with installation and a proposal shall be provided to the College for an extension.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Basis of Design: **Kohler Power Systems.**
 - 2. Alternate acceptable manufacturers: Cummins Power Generation, Caterpillar, Generac.
- B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance:
 - 1. Comply with NFPA 37.

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2. Comply with NFPA 70.
- B. UL Compliance: Comply with UL 2200. Type 10.
- C. Engine Exhaust Emissions: EPA Certified for natural Gas.
- D. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- E. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 5 to 104 deg F.
 2. Relative Humidity: Zero to 95 percent.
 3. Altitude: Sea level to 1000 feet.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.
- C. Power Rating: Standby
- D. Power Factor: 0.8, lagging.
- E. Frequency: 60 Hz
- F. Governor: Adjustable isochronous, with speed sensing.
- G. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.
- H. Capacities and Characteristics:
 1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

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I. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: 10 seconds.

2.4 GASEOUS ENGINE

- A. Fuel: Natural gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: 208V 1-phase electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.
- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

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3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
1. Minimum sound attenuation of 25 dB at 500 Hz.
 2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.
- G. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 24-V electric, with negative ground.
1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: 60 seconds.
 4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
 5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
 7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35 A minimum continuous rating.

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9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 GASEOUS FUEL SYSTEM

A. Natural Gas:

1. Carburetor.
2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
4. Fuel Filters: One for each fuel type.
5. Manual Fuel Shutoff Valves: One for each fuel type.
6. Flexible Fuel Connectors: Minimum one for each fuel connection.
7. Gas flow adjusting valve.
8. Fuel change gas pressure switch.

2.6 CONTROL AND MONITORING:

- A. Control Panel: Kohler DEC6000, with on-board paralleling controls provided at each generator set with an MCP3000 Master control Panel to be located in Master Control Room, Area A.
- B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

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- C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- D. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.
- E. Comply with UL 508A.
- F. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.
- G. Control and Monitoring Panel: Retain one or both of first two subparagraphs below. First subparagraph is for an integrated digital controller; second is for an analog controller.
 - 1. Digital controller with integrated LCD to be provided with on-board paralleling capability, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 - 2. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
 - a. Cranking control equipment.
 - b. Run-Off-Auto switch.
 - c. Control switch not in automatic position alarm.
 - d. Overcrank alarm.
 - e. Overcrank shutdown device.
 - f. Low water temperature alarm.
 - g. High engine temperature prealarm.
 - h. High engine temperature.
 - i. High engine temperature shutdown device.
 - j. Overspeed alarm.
 - k. Overspeed shutdown device.
 - l. Low fuel main tank.
 - m. Coolant low-level alarm.
 - n. Coolant low-level shutdown device.
 - o. Coolant high-temperature prealarm.
 - p. Coolant high-temperature alarm.
 - q. Coolant low-temperature alarm.
 - r. Coolant high-temperature shutdown device.
 - s. EPS supplying load indicator.
 - t. Battery high-voltage alarm.
 - u. Low cranking voltage alarm.
 - v. Battery-charger malfunction alarm.
 - w. Battery low-voltage alarm.
 - x. Lamp test.
 - y. Contacts for local and remote common alarm.

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- z. Low-starting air pressure alarm.
- aa. Low-starting hydraulic pressure alarm.
- bb. Remote manual stop shutdown device.
- cc. Air shutdown damper alarm when used.
- dd. Air shutdown damper shutdown device when used.
- ee. Hours of operation.
- ff. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
- gg. Generator overcurrent protective device not closed alarm.

H. Connection to Datalink:

- 1. Provide connections for datalink transmission of indications to remote data terminals via Ethernet.
- I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
- J. Remote Alarm Annunciator with ATS Controls: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
- 1. Overcrank alarm.
 - 2. Coolant low-temperature alarm.
 - 3. High engine temperature prealarm.
 - 4. High engine temperature alarm.
 - 5. Low lube oil pressure alarm.
 - 6. Overspeed alarm.
 - 7. Low fuel main tank alarm.
 - 8. Low coolant level alarm.
 - 9. Low cranking voltage alarm.
 - 10. Contacts for local and remote common alarm.
 - 11. Audible-alarm silencing switch.
 - 12. Air shutdown damper when used.
 - 13. Run-Off-Auto switch.
 - 14. Control switch not in automatic position alarm.
 - 15. Fuel tank derangement alarm.
 - 16. Fuel tank high-level shutdown of fuel supply alarm.
 - 17. Lamp test.
 - 18. Low cranking voltage alarm.
 - 19. Generator overcurrent protective device not closed.
 - 20. ATS monitoring for up to four (4) ATS's with ATS position & source indicators and built in test features.
- K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

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- L. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip LSI type; 100 percent rated; complying with UL 489. Breakers to be electrically operated to feed EDP lug pad for parallel operation.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
 - 4. Mounting: Adjacent to or integrated with control and monitoring panel.
- B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:
 - 1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.
 - 2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
 - 3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
 - 4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- E. Enclosure: Drip-proof.
- F. Instrument Transformers: Mounted within generator enclosure.

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- G. Voltage Regulator: Solid-state type, separate from exciter.
 - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. Maintain voltage within 15 percent on one step, full load.
 - 3. Provide anti-hunt provision to stabilize voltage.
 - 4. Maintain frequency within 5 percent and stabilize at rated frequency within 2 seconds.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating to 72dBA max noise level @ 23', weatherproof aluminum housing, wind resistant up to 181 mph and included missile impact rating for Large Missile Level E and FBC tested to TAS201-94, TAS202-94 and TAS203-94 standards. multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
- B. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.
- C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 181 mph.
- D. Hinged Doors: With padlocking provisions.
- E. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- F. Muffler Location: Within enclosure.
- G. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
 - 3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

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2.10 VIBRATION ISOLATION DEVICES – Integral per Kohler standard

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Test generator, exciter, and voltage regulator as a unit.
 - 3. Full load run.
 - 4. Maximum power.
 - 5. Voltage regulation.
 - 6. Transient and steady-state governing.
 - 7. Single-step load pickup.
 - 8. Safety shutdown.
 - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation.
- C. Equipment Mounting:
 - 1. Install packaged engine generators on cast-in-place concrete equipment bases.

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- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.
- F. Gaseous Fuel Piping:
 - 1. Natural gas piping, valves, and specialties for gas piping are specified in Section 231123 "Facility Natural-Gas Piping."
- G. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Gaseous Fuel Connections:
 - 1. Connect fuel piping to engines with a gate valve and union and flexible connector.
 - 2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
 - 3. Vent gas pressure regulators outside building a minimum of 60 inches from building openings.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- E. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.4 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.5 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.

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B. Perform tests and inspections with the assistance of a factory-authorized service representative.

C. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection
 - 1) Compare equipment nameplate data with drawings and specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify the unit is clean.
 - b. Electrical and Mechanical Tests
 - 1) Perform insulation-resistance tests in accordance with IEEE 43.
 - a) Machines larger than 200 hp. Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
 - 2) Test protective relay devices.
 - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
 - 5) Perform vibration test for each main bearing cap.
 - 6) Verify correct functioning of the governor and regulator.
2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

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5. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 6. Exhaust Emissions Test: Comply with applicable government test criteria.
 7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.
- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- F. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- G. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- I. Remove and replace malfunctioning units and retest as specified above.
- J. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- K. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

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3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213

SECTION 263600 - AUTOMATIC TRANSFER SWITCH (UP TO 600V)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. General: Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 DESCRIPTION

- A. General: Provide automatic transfer switches of the size, number of poles, amperage, voltage and withstand ratings as shown on the contract drawings and as specified herein.
- B. Description: Using a NEMA 1 enclosure, the switches shall automatically transfer the load to the generator during normal power outages. The switches shall be fully rated, electrically operated, mechanically held unit with both electrical and mechanical interlocks to prevent simultaneous energizing of both sides.

1.3 QUALITY ASSURANCE

- A. Manufacturer Requirements: Firms regularly engaged in manufacture of automatic transfer switches, of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Manufacturers: Subject to compliance with the requirements of this specification, provide an automatic transfer switch manufactured by the following:
 - 1. Basis of Design: ASCO 7000 Series.
 - 2. Approved Manufacturers/Equals: Zenith, Russelectric.
- C. Standards: Comply With The Following Standards:
 - 1. UL-1008.
 - 2. As a precondition for acceptance, transfer switch, complete with timers relays and accessories shall be listed by Underwriters Laboratories, Inc. in their Electrical Construction Materials Catalog, and accepted for use on emergency systems.
 - 3. When conducting temperature rise tests to Paragraph 99 of UL-1008 the manufacturer shall include post-endurance temperature rise tests to verify the ability of the transfer switch to carry full rated current after completing the overload and endurance tests.
 - 4. Produce UL 1008 closing and withstand ratings for 3 cycles at the ATS's rated voltage certified test reports from an independent testing laboratory to verify the identical samples have been subject to three phase short circuit current at voltage indicated on drawings, for a minimum of 3 cycles duration, without contact damage or contact welding and without the use of current limiting fuse protection. ATS shall be provided with required withstand rating regardless of upstream overcurrent device. Oscillograph

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traces are to be supplied to verify that the test parameters have been met. The above shall be met with any overcurrent device upstream.

1.4 SUBMITTALS

- A. Shop Drawings: Provide all equipment cabinet dimensions and wiring diagrams as required.
- B. Product Data: Provide all applicable options, accessories, and interrupting or withstanding current ratings. Provide all electrical characteristics and data as required to show compliance with these specifications.
- C. Testing: Provide test results from UL 1008 as listed above. Provide actual nameplate data to be provided inside switch enclosure for review.

1.5 PRODUCT HANDLING

- A. Equipment Storage: The Contractor shall store items provided under these specifications until time of installation. Such storage shall meet the requirements of the system supplier and be accepted by the Engineer. The stored equipment shall not be delivered to the site until it is to be installed.
- B. Protection: Use all means necessary to protect the materials of this section before, during and after installation and to protect the installed work and materials from the activities of all other trades.
- C. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the acceptance of the Engineer and at no cost to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Type: Provide 4 pole automatic transfer switches as shown on plans, with full load current and voltage rating as shown, 60 Hz normal and emergency.
- B. Load Types: The transfer switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure that is constructed in accordance with Underwriters Laboratories, Inc., Standard UL-1008. It shall be mechanically held voltage sensing relays, one-second time delay, test switch, engine starting contacts, adjustable time delay on re-transfer, five minute unloaded running time-delay after re-transfer, spare auxiliary contacts, exercising timer, and time delay for transfer to emergency.
- C. Accessories: All relays, timers, control wiring and accessories to be front accessible.
- D. Housing: All transfer switches shall be floor-standing enclosures (where indicated on drawings), with front accessibility for units mounted adjacent to walls (refer to documents for specific unit).

2.2 COMPONENTS

- A. Features: Provide the following transfer switch features:
1. The transfer switch shall be double throw, actuated by a single electrical operator momentarily energized; and mechanically connected to the transfer mechanism by a simple over center type linkage with a total transfer time not to exceed 1/6 of a second.
 2. The mechanism shall be a high speed actuator, capable of transferring successfully in either direction with 70 percent of rated voltage applied to the switch terminals.
 3. Circuit breaker switches are not acceptable.
 4. Mechanical interlocking of transfer switches to prevent unintended interconnection of the normal and alternate sources of power.
 5. A means of safe manual operation of the transfer switch.
- B. Main Contacts: The normal and emergency contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be fully rated, arc quenching, mechanically locked in both the normal and emergency positions without the use of hooks, latches, magnet, or springs and shall be renewable silver-tungsten alloy protected by arcing contacts, with magnetic blowouts on each pole. Contacts shall be able to withstand high fault current levels without contact damage or separation. Parallel main contacts are not acceptable.
- C. Exercise Timer: Include an exerciser with the transfer switches for exercising the generator in loaded or unloaded condition, up to every 168 hours for a period adjustable from a minimum of 20 minute intervals to 24 hours.
- D. Phase Rotation Fault: Automatic transfer switch shall have capability to detect a phase rotation fault in the connected power source and transfer to the alternate power source.
- E. Delayed Transition: Provide off-time (center-off or neutral position) capability with controls for transfer and retransfer of motor and inductive loads so that inrush currents do not exceed normal starting currents. Transfer switch ATS-OP shall be delayed transition.
- F. Neutral Contacts: Include fourth pole neutral contacts with same rating as power poles.
- G. Engine Start Delay: Time delay to override momentary normal source power outages to delay engine start signal and transfer switch operation. Adjustable 0.5 to 3 seconds, factory set at 3 seconds.
- H. Load Test Switch: Load test switch to simulate normal power failure. (Maintained type). Provide dry contacts on Test switch to interface with Powerlogics I/O Card
- I. Contact Failure Indicators: Contact to open on failure of normal and emergency sources to interface with BAS system.
- J. Pilot lights: Green push to test pilot light on the cabinet door to indicate the main switch in normal position. Red push to test pilot light on the cabinet door to indicate the main switch in emergency position.
1. "Normal Source Available" - Green Pilot Light

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2. "Emergency Source Available" - Red Pilot Light

- K. Auxiliary Contacts: Provide an auxiliary contact closed in normal position. Provide an auxiliary contact closed in emergency position. Include bypass position contacts (open/closed, test, automatic, isolate)
- L. Additional Contacts: Two sets of relay contacts shall be provided to open and close upon loss of the normal power supply.
- M. Load Shed Relay: Provide load shed relay with interface to generator control panel auxiliary contacts for ATS-OP.
- N. Display: Provide LCD display to indicate system status, and voltage. Display shall also be used for programming of time delays.

2.3 BYPASS AND ISOLATION SWITCHING

- A. General: All automatic transfer switches shall be provided with bypass isolation switching feature.
- B. Isolation and Bypass Switch: Make before make bypass of the load to either the normal or the emergency power source and complete isolation of the automatic transfer switch. Provide automatic transfer and bypass-isolation switches as a product of one manufacturer and be completely factory interconnected and tested as a unit.
- C. Operation: The bypass-isolation switch shall permit proper operations by one person through the movement of two handles at a common dead front panel.
- D. Ratings: The electrical ratings of the bypass-isolation switch shall equal or exceed those of the associated automatic transfer switch.
- E. Bussing: All interconnection between transfer and bypass switches are by silver plated copper bus bar.
- F. Indication: Provide a visual position indicator showing switch position, and availability of normal and emergency sources.

2.4 OPERATION

- A. Low Voltage: Provide engine starting contacts in transfer switches to start engine generators if any ungrounded phase of the normal source drops below 70 percent of rated voltage, after a non-adjustable time delay period of 1 to 3 seconds, to allow for momentary dips.
 - 1. Generator start signals shall be "open to start", to provide additional troubleshooting capabilities in the event of a start circuit failure.
- B. Transfer: The transfer switch shall transfer to emergency as soon as the generator source voltage and frequency have reached 90 percent of rated values.
- C. Stabilization; After restoration of normal power on all phases to 90 to 95 percent of rated voltage, adjustable time delay period of 2 to 25 minutes shall delay transfer to normal power

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until it has had time to stabilize. If the emergency power source shall fail during the time delay period, the time delay shall be by-passed, and the switch shall return immediately to the normal source.

- D. Generator No-Load Operation: Whenever the switch has retransferred to normal, the engine-generator shall be allowed to operate at no load for a fixed period of time (5 minutes) to allow it to cool before shut-down.
- E. Test Switch: The transfer switch shall include a test switch to simulate normal power failure with actual load transfer.

PART 3 - EXECUTION

3.1 INSTALLATION CONDITIONS

- A. Inspection: Prior to performing the work required by this section, carefully inspect the installed materials and equipment of all other trades and verify that the project has progressed to a point where this inspection may properly begin.
- B. Verification: Verify that all equipment provided under this section of the specification may be installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.
- C. Discrepancies: If any discrepancies are found, immediately notify the Engineer. Do not proceed with the installation in areas of discrepancy until all such discrepancies have been fully resolved.
- D. Pads: Provide 4 inch concrete housekeeping pad for all floor mounted transfer switches, unless specifically indicated otherwise by manufacturer's recommendations.

3.2 CONNECTIONS

- A. Tightening Connectors: 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 486B.

3.3 WARRANTY

- A. Duration: Provide a 5 year comprehensive warranty for all parts and labor for each transfer switch.
- B. Submittal: Provide warranty information as part of shop drawing submittal and Operations and Maintenance manuals.

END OF SECTION 263600

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SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes lightning protection for structures. General: Provide a complete lightning protection system as indicated on the drawings and as specified herein, and that fully complies with NFPA 780. The lightning protection system shall be installed by a firm presently engaged in installations of UL Master Labeled certified lightning protection systems. The system as completed shall comply with the latest edition of UL96A, Installation Requirements for Lightning Protection Systems, and NFPA-780 "Standard for the Installation of Lightning Protection Systems." All components required for a UL Master Label certification plate shall be provided whether or not such materials are specifically addressed by the contract drawings or described herein.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system at 1/16" = 1'-0" scaled drawings, indicating all components and connections to the system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- C. Qualification Data: All installers shall be experienced with installing UL master labeled certified systems or of equivalent qualification, as accepted in writing by the engineer of record. A UL certified installer shall be on the project site at all times during installation of the systems and shall supervise all of the installation. Include data on listing or certification by UL.
- D. Certification, signed by Contractor, that roof adhesive and thru-roof components are approved by manufacturer of roofing material.
- E. Field quality-control reports.
- F. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.

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- G. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:

1. Ground rods.
2. Ground loop conductor.
3. Test wells.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL, trained and approved for installation of units required for this Project.
- B. System Certificate:
1. UL Master Label.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.5 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

1.6 COUNTERPOISE/GROUND LOOP CONDUCTOR

- A. The structure shall be provided with a below-grade continuous counterpoise conductor, equal in size to the largest conductor in the building lightning protection system, or sized as indicated on the drawing. This conductor shall be installed at a minimum depth of two feet below finished grade and a minimum of two feet from the exterior foundation wall of the building. The counterpoise conductor shall be copper and extend continuously around the entire perimeter of the building. All joints and connections shall be exothermically welded
- B. Counterpoise: As a minimum, the counterpoise conductor shall be connected to each of the following system components utilizing appropriate exothermic welds:
1. Each down conductor.
 2. All counterpoise conductors on power and communications ducts which enter the building.
 3. The building electrical service ground.
 4. All metallic water and gas services entering the building (ahead of meter).

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5. All metallic fence posts, safety railings, etc., or any other metallic item within ten feet of the project building.
6. Exterior generator enclosure.
7. Exterior chiller enclosure.
8. Exterior lift station fencing, control panel channel supports.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum unless otherwise indicated. Provide blunt tip type where installed other than perimeter of roof on parapet.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. East Coast Lightning Equipment Inc.
 - b. ERICO International Corporation.
 - c. Harger.
 - d. Heary Bros. Lightning Protection Co. Inc.
 - e. Thompson Lightning Protection, Inc.
 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.
- C. Main and Bonding Conductors on Roof: Aluminum.
- D. Bi-Metallic Connector: Brass, for transition between aluminum and copper conductors.
- E. Down Conductors: Copper.
- F. Ground Loop Conductor: Copper, same size and type as the main conductor except tinned.
- G. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10' sectioned lengths, minimum 20' in length.
- H. Connections: All connections shall be exothermic weld.
- I. Test Wells: Provide ground test wells for all locations of buried ground rods.

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PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. Conductors within normal view of exterior locations at grade within 200 feet of building.
 - 2. Down conductors and any conductors located on the interior of the building down to grade shall be concealed from view in 1" PVC conduit through exterior columns or walls down to buried ground rods.
- D. Cable Connections: Use exothermic-welded connections in underground portions of the system.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- G. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of area indicated.
 - 1. Bury ground ring not less than 24 inches from building foundation, and a minimum of 18" below grade.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.
- I. Keep conductors clear of fire protection piping.
- J. Down conductors shall not be routed in same cavity as fire protection piping. The down conductor shall be installed an adequate distance away as to not require bonding of the down conductor to any fire protection piping.

3.2 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

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- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.3 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.

END OF SECTION 264113

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SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes field-mounted SPD for low-voltage (120 to 600 V) power distribution and control equipment.
- B. Related Sections:
 - 1. Division 26 Section "Wiring Devices" for devices with integral SPD.

1.3 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. SPD: Surge Suppression Device, both singular and plural.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating weights, electrical characteristics, furnished specialties, and accessories.
- B. Operation and Maintenance Data: For SPD devices to include in emergency, operation, and maintenance manuals.
- C. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

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- C. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.
- D. Comply with NEMA LS 1.
- E. Comply with UL 1283 and UL 1449.
- F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

- A. Service Conditions: Rate SPD devices for continuous operation under the following conditions unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Temperature: 30 to 120 deg F.
 - 3. Humidity: 0 to 85 percent, noncondensing.
 - 4. Altitude: Less than 20,000 feet above sea level.

1.7 COORDINATION

- A. Coordinate location of field-mounted SPD devices to allow adequate clearances for maintenance.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- B. Special Warranty for Cord-Connected, Plug-in Surge Suppressors: Manufacturer's standard form in which manufacturer agrees to repair or replace electronic equipment connected to circuits protected by surge suppressors.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

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2.1 PANELBOARD SUPPRESSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Advanced Protection Technologies Inc. (APT).
 - 2. LEA International.
 - 3. Liebert Corporation; a division of Emerson Network Power.
- B. Surge Protection Devices:
 - 1. Comply with UL 1449.
 - 2. Modular design (with field-replaceable modules).
 - 3. Short-circuit current rating complying with UL 1449, and matching or exceeding the panelboard short-circuit rating and redundant suppression circuits; with individually fused metal-oxide varistors.
 - 4. LED indicator lights for power and protection status.
 - 5. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
- C. Peak Single-Impulse Surge Current Rating: 150 kA per mode/320 kA per phase.
- D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2:
 - 1. Line to Neutral: 70,000 A.
 - 2. Line to Ground: 70,000 A.
 - 3. Neutral to Ground: 50,000 A.
- E. Protection modes and UL 1449 SVR for grounded wye circuits with 480Y/277 V, 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:
 - 1. Line to Neutral: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
 - 2. Line to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.
 - 3. Neutral to Ground: 800 V for 480Y/277 V, 400 V for 208Y/120 V.

2.2 ENCLOSURES

- A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

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3.1 INSTALLATION

- A. Install SPD devices at service entrance on load side, with ground lead bonded to service entrance ground.
- B. Install SPD devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
 - 1. Provide multiple, circuit breaker as scheduled as a dedicated disconnecting means for SPD unless otherwise indicated.

3.2 STARTUP SERVICE

- A. Do not energize or connect panelboards, control terminals, and data terminals to their sources until SPD devices are installed and connected.
- B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to maintain SPD devices.

END OF SECTION 264313

SECTION 265119 - INTERIOR LED LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes the following types of LED luminaires:

1. Cylinder.
2. Downlight.
3. Highbay, linear.
4. Highbay, nonlinear.
5. Linear industrial.
6. Lowbay.
7. Parking garage.
8. Recessed, linear.
9. Strip light.
10. Surface mount, linear.
11. Surface mount, nonlinear.
12. Suspended, linear.
13. Suspended, nonlinear.

- B. Related Requirements:

1. Section 260943 "Network Lighting Controls" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.

- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project, IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

- B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

- C. Sustainable Design Submittals:

1. Provide L70 lamp life and CRI for each fixture type.

- D. Qualification Data: For testing laboratory providing photometric data for luminaires.

- E. Product Certificates: For each type of luminaire.

- F. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

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1.6 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. LED Drivers: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 deg F.
 - 1. Relative Humidity: Zero to 95 percent.

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- B. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE 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. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.
- D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- F. California Title 24 compliant.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A 36/A 36M for carbon structural steel.
 - 2. ASTM A 568/A 568M for sheet steel.
- C. Stainless Steel:
 - 1. 1. Manufacturer's standard grade.
 - 2. 2. Manufacturer's standard type, ASTM A 240/240 M.
- D. Galvanized Steel: ASTM A 653/A 653M.
- E. Aluminum: ASTM B 209.

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2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: minimum 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.

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D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaires:

1. Attached using through bolts and backing plates on either side of structural wall.
2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaires:

1. Ceiling Mount:
 - a. Minimum two 5/32-inch-diameter aircraft cable supports adjustable to 10 feet or as required for specific fixture based on mounting height indicated above finished floor.
 - b. Pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 10 feet in length or as required for specific fixture based on mounting height indicated above finished floor.
 - c. Hook mount.
2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

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- I. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power or standby generator and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943 "Network Lighting Controls" and requirements of Sheet E602.

3.7 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to a minimum of two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

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SECTION 265600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Exterior luminaires with lamps and ballasts.
 - 2. Poles and accessories.

- B. Related Sections:

- 1. Division 26 Section "Interior LED Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. HID: High-intensity discharge.
- D. LER: Luminaire efficacy rating.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.
- F. Pole: Luminaire support structure, including tower used for large area illumination.
- G. Standard: Same definition as "Pole" above.

1.4 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

- A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.
- B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.
- C. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

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1. Basic wind speed for calculating wind load for poles 50 feet high or less is 120 mph.
 - a. Wind Importance Factor: 1.0.
 - b. Minimum Design Life: 25 years.
 - c. Velocity Conversion Factors: 1.0.

1.5 SUBMITTALS

- A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 2. Details of attaching luminaires and accessories.
 3. Details of installation and construction.
 4. Luminaire materials.
 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. 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.
 6. Ballasts, including energy-efficiency data.
 7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
 8. Materials, dimensions, and finishes of poles.
 9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
 10. Anchor bolts for poles.
 11. Manufactured pole foundations.
- B. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a structural professional engineer registered in the State of Florida.
- C. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
- D. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

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- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- 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.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Handle wood poles so they will not be damaged. Do not use pointed tools that can indent pole surface more than 1/4 inch deep. Do not apply tools to section of pole to be installed below ground line.
- D. Retain factory-applied pole wrappings on fiberglass and laminated wood poles until right before pole installation. Handle poles with web fabric straps.
- E. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products 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 specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
 - 4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

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1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. LED drivers: Provide one additional LED driver for every type of fixture.
 - 2. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
 - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
 - 2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
 - 3. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.

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- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Structural Characteristics: Comply with AASHTO LTS-4-M.
 - 1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
 - 2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.
- B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

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- C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.
 - 1. Materials: 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.
 - 3. Anchor-Bolt Template: Plywood or steel.
- D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.
- E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."
- F. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, 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.
- G. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.4 PRE-STRESSED CONCRETE POLES

- A. Poles: Manufactured of cast concrete.
 - 1. Shape: Square, tapered.
 - 2. Mounting Provisions: Embedded.
 - 3. Finishing: Capped at top and plugged at bottom. Seat each steel reinforcing strand with epoxy adhesive.
 - 4. Grounding: Continuous copper ground wire cast into pole. Terminate at top of pole and attach to 24-inch (610-mm) air terminal mounted on light fixture housing.
- B. Cure with wet steam and age for a minimum of 15 days before installation.
- C. Fabricate poles with a hard, nonporous surface that is resistant to water, frost, and road and soil chemicals and that has a maximum water-absorption rate of 3 percent.
- D. Cast aluminum nameplate into pole wall at approximately 5 feet (1.5 m) above ground line, listing name of manufacturer, Project identifier, overall height, and approximate weight.
- E. Pole Brackets: Comply with ANSI C136.13.
- F. Finish Color: Provided by color material complying with ASTM C 979, uniformly impregnated throughout the pole concrete. Color material shall provide a uniform, stable, permanent gray color and be as follows:
 - 1. Inert, and carbon free.

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2. Unaffected by environmental conditions and contaminants including, but not limited to, UV solar radiation, salts, and alkalis.

G. Finish Texture: Standard form

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
- C. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

3.2 POLE INSTALLATION

- A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.
- B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:
 1. Fire Hydrants and Storm Drainage Piping: 60 inches.
 2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.
 3. Trees: 15 feet from tree trunk.
- A. Embedded Poles with Tamped Earth Backfill: Set poles to depth below finished grade indicated on Drawings, but not less than one-sixth of pole height.
 1. Dig holes large enough to permit use of tampers in the full depth of hole.
 2. Backfill in 6-inch (150-mm) layers and thoroughly tamp each layer so compaction of backfill is equal to or greater than that of undisturbed earth.
 3. Cure concrete a minimum of 72 hours before performing work on pole.
- B. Poles and Pole Foundations Set in Concrete Paved Areas: Install poles with minimum of 6-inch- (150-mm-) wide, unpaved gap between the pole or pole foundation and the edge of adjacent concrete slab. Fill unpaved ring with pea gravel to a level 1 inch (25 mm) below top of concrete slab.
- C. Raise and set poles using web fabric slings (not chain or cable).

3.3 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

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- B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.4 GROUNDING

- A. Ground nonmetallic poles and support structures according to Division 26 Section "Grounding and Bonding."
 - 1. Install grounding electrode for each pole.
 - 2. Install grounding conductor and conductor protector.
 - 3. Ground metallic components of pole accessories and foundations.

END OF SECTION 265600

SECTION 270500 – COMMON WORK RESULTS FOR TECHNOLOGY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all labor, equipment, supplies, and materials to support owner provided Telecom, and Security systems in accordance with the Contract Documents. Structured Cabling systems include, but are not limited to:
 - 1. Telecommunications Grounding Network
- B. The work includes the following as well as work not listed below but described elsewhere as it applies to all Structure Cabling systems:
 - 1. Raceway and cable trays
 - 2. Telecommunications Grounding Network
 - 3. Fire Stopping
 - 4. Documentation and submissions

1.2 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.

1.3 SUMMARY

- A. Scope Includes:
 - 1. This section describes responsibilities of the Division 27 Contractor relative to the provisions required for future Security Electronics, Data Network scope. The actual equipment and installation for equipment not shown on drawings will be performed by the owner and/or owner's contractor.
 - 2. Work specific to the Division 27 scope is described in the Division 27 specifications and on the Technology drawing sheets. The technologies that are specified by this document include conduit and back box infrastructure for the support of telecom and security systems. Telecommunications Grounding Network.
 - 3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a complete NEC code compliant installation.

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4. Drawings are diagrammatic and indicate general arrangement of system and equipment, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement.
5. Refer to dimensioned architectural drawings for exact, locations of building elements.
6. The owner, user reserves the right to make any reasonable change in location of devices and equipment prior to rough installation without involving additional expense. All changes from the drawings as are necessary to make the work of the Contractor conform to the building as constructed shall be included and installed without extra cost.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Refer to Section 016000 – Product Requirements
- B. Products that have been in manufacture for at least one year, unless otherwise specified by performance requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. National Electrical Code requirements are applicable to all work.
- B. Coordinate location of equipment with other trades to minimize interferences.
- C. Holes shall not affect structural sections such as ribs or beams.
- D. Holes shall be laid out in advance. The Architect shall be advised prior to drilling through structural sections for determination of proper layout.
- E. Any holes created in walls, floors, or ceilings by the Contractor are to be sealed with a fire rated caulking according to all national, state, and local codes.
- F. Hangers and other supports shall support only equipment and materials. Provide not less than a safety factor of 5, which shall conform to any specific requirements in the Construction Documents.
- G. Provide and Install a complete raceway system for the electronic security systems including back boxes, conduit, conduit fittings, metallic wire way systems with pull strings and cable trays.

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- H. Provide and Install a complete raceway system for future structured cabling systems including back boxes, conduit, conduit fittings, and metallic wire way systems with pull strings.
- I. Note that new structured cabling systems are NIC (not in contract). Only rough-in and demolition of existing copper and fiber communications cable is within this contract.
- J. Electrical Contractor shall provide and install grounding bus bars and grounding conductor back to main electrical grounding bus bar. All Earthing and Bonding conductors within Telecommunications/Security Electronics rooms are provided by and installed by the owner/ and or owner's contractor.

END OF SECTION 270500

SECTION 270526 – GROUNDING AND BONDING FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

A. General

1. Provide a complete Telecommunications Grounding and Bonding system as indicated in Project Documents.
2. Provide all necessary materials and labor for the Backbone Cabling system and the Telecommunications Grounding and Bonding system in all Telecommunication Entrance Facilities, Telecommunications Rooms and Telecommunications Equipment Rooms as indicated in Project Documents.

B. Telecommunications Grounding and Bonding System

1. Provide Telecommunications Grounding Busbar (TGB), Telecommunications Bonding Backbones (TBB), Grounding Equalizer (GE), and Bonding Conductor for Telecommunications as indicated in Project Documents.
2. It shall be the responsibility of this contractor to ensure that the telecommunication grounding system for this facility is continuous, complete, and meets or exceeds all applicable codes and standards.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 01
- C. Provide materials listed by UL or ETL.

2.2 TELECOMMUNICATIONS GROUNDING BUSBAR

A. Specifications

1. Pre-drilled solid copper 3/8" diameter holes, spaced 5.75" apart.
2. Hole patterns accommodate two-hole lugs
3. Bolt hole sizing and spacing: NEMA standard
4. Minimum thickness: 0.25"
5. Minimum dimensions: 4" H x 12" W minimum. Sized to accommodate all indicated and required connections
6. Mounting: 300 series stainless steel insulated

7. Follow BICSI and ANSI/EIA/TIA-607 standards. standoff brackets

B. Acceptable Manufacturers

1. Chatsworth
2. Hubbell
3. Panduit
4. Square D
5. Storm Cooper Components

2.3 BONDING CONDUCTOR FOR TELECOMMUNICATIONS

A. Specifications

1. Gage: #6 AWG through 3/0 based on length,
see drawings for sizing requirements
2. Insulation: Green PVC 600V insulated

B. Acceptable Manufacturers

1. General Cable
2. Belden Cable
3. Alpha Cable

2.4 TWO HOLE COMPRESSION LUGS

A. Specifications

1. UL listed for use up to 35 KV
2. Temperature rated 90 degrees Celsius
3. CSA certified to 600V
4. Meets J-STD-607-A
5. Electroplated tinned copper
6. Two hole minimum

B. Acceptable Manufacturer

1. Chatsworth
2. Hubbell
3. Panduit
4. Square D
5. Storm Cooper Components

2.5 TWO HOLE GROUND TERMINAL BLOCK

A. Specifications

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1. ¾" H x 1 ½" W
2. 5/8" Hole Spacing
3. #14 AWG to 2/0

B. Acceptable Manufacturers

1. Chatsworth
2. Hubbell
3. Panduit
4. Square D
5. Storm Cooper Components

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ground all equipment as per manufacturer's recommendations, IEEE 1100, NEC and TIA/EIA guidelines.
- B. Provide equipment grounding conductor from equipment grounding lugs to ground bar. Size conductor based on length; see drawings for sizing requirements.
- C. Provide green insulated grounding conductors from ground bar to the following-
 1. Telecom Equipment Racks and Cabinets
 2. Building Steel
 3. Local electrical panel
 4. Conduits and conduit sleeves
 5. Cable tray
- D. Provide a green insulated grounding conductor from each end of the metallic sheath on the telephone backbone cable to the ground bar.
- E. Remove paint and or finish on all equipment racks, cable trays, etc., exposing bare metal at all locations where grounding conductor is terminated.

3.2 LABELING

- A. Use TMGB for the Telecommunications Main Grounding Busbar.
- B. Use TGB for the Telecommunications Grounding Busbar.
- C. Provide an identifier for each Telecommunications Grounding Busbar that incorporates the identifier of the Telecommunications Space the busbar serves.
- D. Label both ends of all grounding conductors with both bus bars connected.

3.3 TESTING

- A. Certify system is complete and functional.
- B. Test all cabling and connections. Perform final functional tests in presence of the Architect.
- C. Complete certified testing report.

END OF SECTION 270526

SECTION 270536 – CABLE TRAY FOR TELECOMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Ladder cable trays.
 - 2. Wire cable trays.
 - 3. Cabling Supports.

PART 2 - PRODUCTS

2.1 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.
- B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.
- C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
 - 1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
 - 2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
 - 3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.2 LADDER CABLE TRAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. B-line, an Eaton business For use in telecommunications closets.
 - 2. Chatsworth.
 - 3. Hoffman.

B. Description:

1. Configuration: Two I-beam side rails with transverse rungs welded to side rails.
2. Rung Spacing: 12 inches (300 mm) o.c.
3. Radius-Fitting Rung Spacing: 9 inches (225 mm) at center of tray's width.
4. Minimum Cable-Bearing Surface for Rungs: 7/8-inch (22-mm) width with radius edges.
5. No portion of the rungs shall protrude below the bottom plane of side rails.
6. 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.
7. Minimum Usable Load Depth: 4 inches (100 mm).
8. Straight Section Lengths: 10 feet (3 m) 12 feet (3.6 m) 20 feet (6 m) 24 feet (7.4 m) except where shorter lengths are required to facilitate tray assembly.
9. Width: 18 inches (450 mm) unless otherwise indicated on Drawings.
10. Fitting Minimum Radius: 12 inches (300 mm).
11. Class Designation: Comply with NEMA VE 1, Class 12B.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.
14. Splice Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

2.3 WIRE CABLE TRAYS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. B-line, an Eaton business.
2. Chatsworth.
3. Hoffman.

B. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:
 - a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
 - b. Wire Depth: 4-inch (100-mm) usable loading depth by 12 inches (300 mm) or 8 inches (450 mm) wide.
5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.4 MATERIALS AND FINISHES

A. Aluminum (ladder type):

1. Materials: Alloy 6063-T6 according to ANSI H 35.1/H 35.1M for extruded components and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H 35.1/H 35.1M for fabricated parts.
2. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

B. Stainless Steel

1. Materials: Low-carbon, passivated, stainless steel, Type 304L or Type 316L, ASTM F 593 and ASTM F 594.
2. Hardware for Stainless-Steel Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

- A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.
- B. Barrier Strips: Same materials and finishes as for cable tray.
- C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

- A. Lettering: 1-1/2-inch- (40-mm-) 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 260553 "Identification for Electrical Systems."

2.7 CABLE SUPPORTS

- A. UL Listed for support of Category 6 4-pair UTP cables and Category 5e 25 Pair UTP cables.
- B. 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.

2.8 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

- A. Install cable trays according to NEMA FG 1.
- 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 and install seismic restraints.
- G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 260548.16 "Seismic Controls for Electrical Systems."
- H. 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.
- I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.
- J. Support bus assembly to prevent twisting from eccentric loading.
- K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.
- L. Locate and install supports according to NEMA FG 1. Do not install more than one cable tray splice between supports.
- M. Support wire cable trays with trapeze hangers.
- N. Support trapeze hangers for wire trays with 3/8-inch- (10-mm-) diameter rods.
- O. 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.

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- P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.
- Q. Make changes in direction and elevation using manufacturer's recommended fittings.
- R. Make cable tray connections using manufacturer's recommended fittings.
- S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Fire stopping."
- T. Install capped metal sleeves for future cables through fire stop-sealed cable tray penetrations of fire and smoke barriers.
- U. Install cable trays with enough workspace to permit access for installing cables.
- V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.
- W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.
- X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.
- Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

- A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."
- B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.
- D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.
- E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 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 72 inches (1800 mm).
- E. Tie MI cables down every 36 inches (900 mm) where required to provide a 2-hour fire rating and every 72 inches (1800 mm) elsewhere.
- F. In existing construction, remove inactive or dead cables from cable trays.

3.4 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 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 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 the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
 - 4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
 - 5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
 - 6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
 - 7. Check for improperly sized or installed bonding jumpers.
 - 8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.

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9. 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.

- B. Prepare test and inspection reports.

3.6 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.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all labor, equipment, supplies and materials for the complete installation of a fully functional replacement Security Control System in accordance with the Contract Documents and the RFP. Security Systems include but are not limited to:
1. Section 260529 – Hangers and Supports for Electrical Systems
 2. Section 260533 – Raceways and boxes for Electrical Systems
 3. Section 280510 – Maintenance Service, and Warranty for Electronic Security
 4. Section 280511 – Backbone System Cabling for Electronic Security
 5. Section 280512 – Horizontal Cabling for Electronic Security
 6. Section 280513 – Conductors and Cables for Electronic Security
 7. Section 280526 – Grounding and Bonding for Electronic Security
 8. Section 280530 – Tamper Proof Fasteners
 9. Section 281116 – Cabinets and Enclosures for Electronic Security
 10. Section 281300 – Access Control System for Electronic Security
 11. Section 282313 – Video Surveillance System for Electronic Security
 12. Section 284619 – PLC Hardware for Electronic Security
 13. Section 284620 – PLC Software for Electronic Security
 14. Section 285000 – Miscellaneous Systems for Electronic Security
 15. Section 285123 – Integrated Intercom/Paging System for Electronic
- B. The work includes the following, as well as work not listed below but described elsewhere as it applies to Security Systems:
1. All electrical work associated with the installation of the Security Control System.
 2. New head-end equipment installation and termination
 3. Installation of field devices
 4. Installation of device cabling
 5. Programming
 6. Start up, testing, de-bugging and commissioning
 7. Documentation and training
 8. Maintenance and service
- C. Interpretation of Contract Documents
1. This section of the specifications describes general provisions applicable to all Division 28 Security Systems.
 2. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

3. Mention in these specifications or indications and/or reasonable implications whereby articles, materials, operation or methods related to execution of the work are noted, specified, drawn or described, thereby requires execution of each such item of work and provision of all labor, materials, equipment and accessories required for execution thereof.
4. No exclusions from, or limitations in the language used in the specifications shall be interpreted as meaning that the accessories necessary to complete any required system or item of equipment are to be omitted.
5. The use of words in the singular shall not be considered as limiting where other indications denote that more than one item is referred to.
6. This is a new project. The overarching goal of this project is to install the door control, intercom, video surveillance, access control, and other systems and integrate them into a single integrated platform allowing multi-tier takeover scenarios, and a common graphical user interface in all control locations. Furnish and install all materials for complete and functioning systems, resulting upon completion, in functioning systems in compliance with the performance requirements specified. The omission of express reference to any parts necessary for, or reasonably incidental to a complete installation shall not be construed as a release from furnishing such parts. This reference shall apply to all systems and sub-systems specified herein or otherwise included in these contract documents.
7. Drawings are diagrammatic and indicate general arrangement of system and equipment, except when specifically dimensioned or detailed. They are to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not exact detail or arrangement. The division 28 contractor is responsible for final verification of field device counts.
8. Field verification of measurements take priority over dimensioned drawings.
9. Dimensions indicated anywhere, are limiting dimensions.
10. The Owner reserves the right to make any reasonable change in location of devices and equipment prior to rough installation without involving additional expense. All changes from the drawings as are necessary to make the work of the SEC conform to the building as constructed shall be included and installed without extra cost.

1.2 SCOPE AND RESPONSIBILITY

- A. Provide full time on site field representation for Division 28 Security Control Systems series scope for work for the duration of installation and prior to turn over. This requirement shall commence upon the start of work inside the secure area of the facility.
- B. Include detailed scheduling information for Security Electronics systems installation and testing in the construction schedule. Provide detailed GHANT chart construction schedule showing all tasks referenced in the project phasing plans. Include:
 1. Engineering
 2. Shop Drawing Preparation
 3. Software Programming
 4. Shop Fabrication
 5. Equipment Installation
 6. Electrical Work
 7. Testing, Commissioning, and training.

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8. This schedule must be submitted fourteen (14) calendar days after receipt of contract. The duration of this schedule must also comply with the completion dates of the construction schedule contained in the contract documents.
9. Work with the owner and engineer to schedule/conduct periodic coordination meetings (either weekly or bi-weekly) between trades to make everyone aware of critical areas of construction. Distribute the meeting minutes and attendance to the Owner Representative, the Engineer, and other trades in a timely fashion.
10. Provide coordination of the Security Electronics System installation.
11. Provide coordination as required to complete the inspection described in paragraph 3.1 INSPECTION.
12. When on-site inspect routing for conduit raceway system including back boxes, junction boxes, and mortar boxes for all Security Systems. Notify the Engineer of any discrepancies immediately.
 - a. Furnish and install all equipment racks and cabinets.
 - b. Furnish and install all required surge protection field devices.
 - c. Provide all required circuit protection internal to the head end equipment racks.
 - d. Where work is required, all security electronics systems cabling shall be installed in conduit from the field device to the secured equipment rooms.
 - e. Furnish and install all devices, equipment, and appurtenances resulting in complete, functional, and fully operational systems as specified herein, indicated on the drawings and listed below:
 - 1) Section 280510 – Maintenance Service, and Warranty for Electronic Security
 - 2) Section 280511 – Backbone System Cabling for Electronic Security
 - 3) Section 280512 – Horizontal Cabling for Electronic Security
 - 4) Section 280513 – Conductors and Cables for Electronic Security
 - 5) Section 280526 – Grounding and Bonding for Electronic Security
 - 6) Section 280530 – Tamper Proof Fasteners
 - 7) Section 281116 – Cabinets and Enclosures for Electronic Security
 - 8) Section 281300 – Access Control System for Electronic Security
 - 9) Section 282313 – Video Surveillance System for Electronic Security
 - 10) Section 284619 – PLC Hardware for Electronic Security
 - 11) Section 284620 – PLC Software for Electronic Security
 - 12) Section 285000 – Miscellaneous Systems for Electronic Security
 - 13) Section 285123 – Integrated Intercom/Paging System for Electronic
 - f. Furnish and install the Security equipment.
Furnish and install all miscellaneous systems equipment and materials as required for a complete and fully functional security system as specified and/or indicated on the drawings.
 - g. Prior to fabrication, coordinate exact location and installation of security electronic devices.
 - h. Provide coordination to complete the inspection described in Paragraph 3.1 INSPECTION.
 - i. Provide complete system test, operational certification and Owner training as called for in the contract documents.
 - j. Provide complete factory certified training to the Owner.
 - k. Coordinate the work of this Section with the Engineer and that of other Sections to ensure that the entire work of this Project will be carried out in an orderly, complete and coordinate fashion.

1.3 RELATED DOCUMENTS

A. General

1. Drawings, specifications and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section. The SEC and all subcontractors are responsible for locating information pertaining to required items of work specified or indicated elsewhere in the Contract Documents.

B. Related Work Specified Elsewhere

1. Division 00 - BIDDING REQUIREMENTS
2. Division 01 - GENERAL REQUIREMENTS

C. Reference Specifications, Materials, and/or Codes

1. Submit all items necessary to obtain all required permits to the appropriate Regulatory Agencies, obtain all required permits and pay all required fees.
2. All work shall conform to the National Electrical Code (NEC) and to applicable National Fire Protection Association (NFPA) codes.
3. All work shall conform to all Federal, State and local ordinances.
4. Where applicable, all fixtures, equipment and materials shall be as approved or listed by the following:
 - a. Factory Mutual Laboratories (FM).
 - b. Underwriters Laboratories, Inc. (UL).
 - c. National Electrical Manufacturers Association (NEMA).
5. References to the National Electrical Code and National Fire Protection Association (NFPA) are a minimum installation requirement standard. Design drawings and specification sections shall govern in those instances where requirements are greater than those specified in the NEC and NFPA.
6. 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 Standard will be accepted provided equipment and material are 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, ICEA or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings. NOTE: It is not required that the final installed system be UL listed as a single product.
7. All work shall meet or exceed the standards and procedures of the following:
 - a. National Fire Protection Association (NFPA): NFPA 70, NFPA 72, NFPA 90A
 - b. National Electrical Code (NEC)
 - c. American National Standards Institute (ANSI)
 - d. National Electrical Manufacturers Association (NEMA)
 - e. American Society of Testing Materials (ASTM)

- f. Institute of Electronic & Electrical Engineers (IEEE)
 - g. Underwriters Laboratory (UL)
 - h. Americans With Disabilities Act (ADA)
 - i. American Corrections Association (ACA)
8. Include all items of labor and material required to comply with such standards and codes. Where quantity, sizes or other requirements indicated on the drawings or herein specified are in excess of the standard or code requirements, the specifications or drawings, respectively, shall govern.

1.4 QUALITY ASSURANCE

A. General

- 1. Furnish and install only new equipment and materials required (less than 1 year from manufacture), unused without blemish or defect.
- 2. Each major component of equipment shall have the manufacturer's name, address, model number and rating on a plate securely affixed in a conspicuous place. The nameplate of a distributing agent is not permitted. NEMA Code Ratings, UL label, or other data which is die-stamped into the surface of the equipment shall be stamped in a location easily visible. Performance as delineated in schedules and in the specifications shall be interpreted as minimum performance. In many cases, equipment is oversized to allow for pickup loads which cannot be delineated under the minimum performance.
- 3. All equipment of the same type shall be the product of one manufacturer.
- 4. The original factory condition of manufactured equipment shall not be modified without the written approval of the Architect /Engineer.
- 5. Provide only **Non-Proprietary** software. All software logic shall be developed in the Wonderware or Omron InduSoft environment and not developed in third party software or provided in a compiled DLL, EXE file format or other encrypted file format/extension. Any software approach that is found to be provided with proprietary approach shall be removed and the SEC shall replace it with non-proprietary software as specified at no additional cost to the owner. The basis of whether the software is considered proprietary or non-proprietary will be as determined by an audit conducted by the manufacturer of the development tools. All costs to remove and rewrite the software shall be the SEC's responsibility.

B. Qualifications

- 1. Bids will be evaluated based on the following criteria:
 - a. Security electronics subcontractor is licensed by the State of Florida.
 - b. All bidders must be in full compliance with the rules and regulations set forth by the State.
 - c. The SEC shall have been in existence for a minimum of 5 years.
 - d. The Electronic Security System integrator shall have completed a minimum of 5 projects similar in scope to this project. The company's Project manager/coordinator assigned to this project must have been involved in at least 4 of the 5 company projects.

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- e. The SEC shall specialize in the installation of security control systems in correctional facilities of equal scope, quality, type, and complexity to that required herein.
- f. The SEC shall be trained and certified on the programming, configuration, and setup of all microprocessor based electronics including but not limited to Programmable Logic Controllers (PLC), and Graphical User Interface (GUI).
- g. The principal members and key personnel to be assigned to the project shall each have a minimum of 5 years' experience in completing projects of equal scope, quality, type, and complexity to that required herein.
- h. On-site installing personnel will have successfully completed all training requirements set forth by the primary security electronics product manufacturers. A copy of the training certificates shall be available upon request.

C. Qualification Proposal Requirements to be submitted with bids

- 1. SECs seeking to be approved are responsible for providing documented proof that all qualifications have been met. Burden of proof is on the proposer. Delivery of the following documentation is required with the SECs bid. Qualification proposal shall include the following-
 - a. A history of the Contractor that reflects the length of time they have performed services similar to those required for this project.
 - b. Contractor Qualification Statement AIA-305A.
 - c. Audited financial statement for the previous year.
 - d. Name, address, and telephone number of organization's current Bonding company and level of bonding capacity.
 - e. Resumes of the principal members and key personnel of the organization indicating years of experience in successfully completing projects of equal scope, quality, type and complexity to that required herein. Include resume(s) of personnel in the employ of the organization responsible for the engineering, fabrication, and installation of comparable systems. Include a delineation of each individual's responsibilities on this project. Resumes must include information about the individual's security experience and systems integration capabilities.
 - f. Provide integrators UL508A custom control panel manufacturing certificates.
 - g. Provide proof of compliance with PLC/GUI manufacturer's integrator certification program; IE: Omron IWS Certified System Integrator Certificate.
 - h. List all completed projects, on which work has been performed, that have been operational for at least 1 year. Include for each facility the following:
 - 1) Name and location of project.
 - 2) Date of occupancy.
 - 3) Name, address, and telephone number of Owner/User.
 - 4) Name, address, and telephone number of Architect
 - 5) Name, address, and telephone number of General Contractor.
 - 6) Name, address, and telephone number of organization's Bonding Company for the individual project.
 - 7) A description of the systems involved, the construction dates, and the contract amount for the equipment and services for which the Contractor had responsibility.

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- i. List all projects, within the last 5 years, in which the organization has been involved in litigation with a City, County, State or Federal government agency. Include summary of final decisions and status of pending litigation.
- j. Provide line list of all manufactures represented (established dealer) and period of time represented.
- k. A technical proposal that indicates an understanding of the scope, quality, and technical aspects of the work and shall include the following:
 - 1) A technical description of the SECs approach to implementing each of the major systems included in the work. Interfaces with other contractor's work, if any, must be specifically addressed.
 - 2) A list of major systems components, including the equipment manufacturer's product numbers, to be used on this project. Detailed technical specifications and catalog cut sheets must accompany any proposed substitutions for the specified equipment in accordance with Division 01 requirements.
- l. The qualification proposal will be evaluated by the Owner and engineer. The SEC will be selected based on the most qualified responsive bid.
- m. List of Pre-Qualified bidders are as follows:
 - 1) Accurate Control Inc. – Ripon, WI.
 - 2) Stanley Security Solutions – Noblesville, IN
 - 3) South West Communications – Decatur, AL
 - 4) Cornerstone Detention – Madison, AL

1.5 SUBMITTALS

- A. Refer to Section 013300 – Submittal Procedures
- B. Duplicate copies of the bidding documents are not acceptable and will be rejected.
- C. Product Submittal
 - 1. Submittal must consist of a complete package, bound in a three ring binder, including, Product Data for each Section of the Division 28 Security Systems series specifications, and Shop Drawings as applicable. PARTIAL OR INCOMPLETE SUBMITTALS ARE NOT ACCEPTABLE. The Submittal shall include the following:
 - 2. A Title Page complete with the following required information:
 - a. Project name.
 - b. Date.
 - c. Name and address of the Architect Engineer.
 - d. Name and address of the General Contractor - Advisor
 - e. Name and address of the Electrical Trade Contractor
 - f. Name and address of any Subcontractors.
 - 3. An Index Page complete with the following required information:
 - a. Name of the Supplier.

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- b. Name of the Manufacturer.
 - c. Title, section and paragraph of the Specification Sections. (Example section 281116, paragraph 2.4)
 - d. Products in order as specified in PART 2 of the related specification.
4. Each Specification section shall be separated, collated in order, and complete with the following information:
- a. Title sheet.
 - b. Descriptive purpose of the system, stating how each product is to function.
5. Each Data Sheet shall have the specific reference to the Specification it is to be used for, noting the section and paragraph.
6. Product Data showing multiple products, models, or options shall be clearly marked identifying the specific product, model, and options which are submitted for review. Unmarked submittals or facsimile copies shall not be acceptable.
7. Submit product data for all equipment showing:
- a. Original Data Sheets Only. Fax copies are not acceptable.
 - b. Product performance, mechanical and electrical specifications.
 - c. Manufacturer's installation instructions.
 - d. Certification from the submitted manufacturers that the SEC's designated personnel are trained on the installation of the system. Include installer's name, experience and responsibility.
 - e. Product test compliance certificates if required.

D. Shop Drawings

1. Submittals consisting of reproduced copies of the original bidding documents will be rejected. The SEC is required to develop a complete set of drawings specific to the final configuration of the system based on the manufacture and models of all components included. Shop drawings are to include all changes noted in addenda, as well as any changes included in architects special instructions or change orders issued prior to the submittal of the shop drawings.
2. Shop drawings shall be submitted with product data.
3. All drawings shall be created using an industry recognized computer aided design program. Recognized programs include AutoDesk Revit, or Auto Cad. All drawings are to be made using the latest software release available.
4. Submit shop drawings for all equipment showing:
- a. Location and layout of all field equipment on floor plans.
 - b. Large scale (minimum 1/4"=1') floor plan and elevation view drawings of all security electronics rooms and control rooms depicting all racks, consoles, cabinets, equipment, outlets, etc.
 - c. Size and spacing of all anchors, wall penetrations, joinery construction, etc., required for complete system installation.
 - d. Sizes, shapes, thickness and finishes of all materials and equipment surfaces.
 - e. Electrical riser diagrams identifying all signal, power and ground circuitry.
 - f. Block diagram(s) depicting system integration details.

- g. Scaled elevations of all security equipment racks showing equipment mounting locations (front and rear if any equipment is rear-mounted).
- h. Wall elevations showing mounting of cabinets and enclosures, conduit routing, etc.
- i. Wire management details for the installation of cable harnesses inside racks, equipment cabinets, consoles, control panels and other areas of exposed cable.
- j. Wiring diagrams for all equipment and devices (active and passive).
 - 1) Wiring diagrams are required to show point-to-point connection of all terminations for all devices.
 - 2) Indicate wire type used for connection.
 - 3) Indicated type of termination to be made. (i.e. terminal strip, euro block, XLR, etc.)
 - 4) Indicate wire tag number.
- k. Scaled layout of all custom integrated control system graphic user interface panels.
- l. Installation detail of all surface or flush mounted devices including but not limited to speakers, cameras, intercom, card readers, etc. Detail to show all required mounting and suspension hardware, as well as connection made to structure. Provide front, side, and top views.
- m. Installation detail of all suspended devices including but not limited to speaker systems, cameras, etc. Detail to show all required mounting and suspension hardware, as well as connection made to structure. Provide front, side, and top views.
- n. Functional and operational written reports of all security systems.

E. Samples

- 1. Provide samples as requested for review and approval of substitutions or as specified in Division 28 Security Systems specification.
- 2. Submit for each type of tamper-proof fastener. Indicate materials, finish, head design, strength, corrosion resistance, and installation/removal methods.
- 3. Submit four (4) samples of each type of tamper proof fastener proposed for use

F. Test Plan and Documentation

- 1. Submit a complete testing plan for all systems for approval with the shop Drawing/Product Data submittal.
- 2. Plan submitted must include shop and field-testing of each and every field device and control function.
- 3. Plan submitted must include examples of testing documentation. Shop testing documentation must be submitted for approval prior to control system shipment to job site. Field-testing documentation must be submitted when requesting final Demonstration/Inspection (described below).
- 4. Detailed testing agenda and testing documentation forms for all systems. Detailed agenda outlining the "hands-on" training sessions to be provided to the User. The operation, programming/debugging, troubleshooting, repair and maintenance of all systems shall be covered.

G. Training Plan and Documentation

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1. Submit a complete training plan for all systems for approval.
2. As a minimum, the plan submitted must include individualized training paths for the following personnel on all aspects of the Security Electronics system.
 - a. Administrators
 - b. Supervisors
 - c. Operators
 - d. Maintenance Personnel
3. As a minimum, the plan submitted must include the following:
 - a. Proposed classes or sessions.
 - b. Recommended attendees for each class or session.
 - c. Proposed class or session objectives.
 - d. Proposed class or session agenda and duration.
 - e. Proposed supporting materials for each class or session.
 - f. Proposed testing procedure for evaluation purposes.
 - g. Proposed documentation of testing and evaluation.
4. Do not commence training until the Engineer has approved the plan.
5. Plan submittal must include names of technical instructors. SEC must provide technician responsible for project as instructor. SEC instructor shall submit evidence of factory training on system provided.

H. Operating and Maintenance Data

1. Provide a bound and illustrated control console operator's manual. One copy shall be provided for each control station.
2. The operator's manual shall be written in laymen's language and printed so as to become a permanent reference document for the operators, describing all control panel icon operations, graphic symbol definitions, and all indicating functions and a complete explanation of all software.
3. Provide a bound and illustrated service manual. Three copies of the manual shall be provided.
4. The service manual shall be written in laymen's language and printed so as to become a permanent reference document for maintenance personnel, describing how to run internal self-diagnostic software programs, troubleshoot head-end hardware and field devices with a complete scenario simulation of all possible system malfunctions and the appropriate corrective measures.
5. Provide four (4) copies of each operating and maintenance manual for each Division 28 Security Systems. Manuals shall be bound in "D-ring" binders with a detailed table of contents.
6. The O & M manuals shall be cross-referenced to the Record Documents and contain the following information for all systems:
 - a. Product catalog cut sheets and specifications of all equipment.
 - b. "Hands-on" operational description of all equipment and performance features in each system using clear and understandable terminology.
 - c. Detailed programming instructions for all systems and all software programs.
 - d. Printed copy of all equipment settings.

- e. Copy of all software programs required. Copy shall include most recent version of manufacturer's software, and all final programming settings. Software shall be stored on CD/DVD and USB thumb drive. Provide one CD/DVD copy for each O&M Manual, and one USB thumb drive that is to be left in the rear of the equipment rack.
- f. Troubleshooting procedures to diagnose malfunctions in each system.
- g. Repair procedures for all equipment.
- h. Preventative maintenance procedures for all equipment.
- i. Table listing the model numbers for all equipment in each system including the names and phone numbers of the manufacturer and their representative directly responsible for this project.

I. Record Documents

- 1. Submit four (4) black line prints, and electronic copy of the "As-built" condition of all systems including:
 - a. A set of updated shop drawings showing all Contract changes.
 - b. A set of updated product data showing all Contract changes.
 - c. "Hands-on" operational description of all equipment and performance features in each system using clear and understandable terminology.
 - d. Floor plan showing conduit raceway routing including all equipment rack, cabinet and pull box locations, and conduit sizes.
 - e. Complete point-to-point wiring diagrams showing ALL equipment, devices, wire and cable (Signal, power and ground). This document shall also include all terminal block designations, abbreviations and color-coding.
 - f. Provide report showing results of all tests required and outlined in individual Division 28 series specifications.
 - g. Four (4) copies of approved training session DVD.
 - h. Transmittal letter listing delivery and acceptance of complete spare parts inventory.
 - i. Copy of warranty statement
 - j. Procedures for addressing warranty/repair issues.

1.6 ADDITIONAL CONSTRUCTION ADMINISTRATION SERVICES BY THE ENGINEER

- A. The SEC shall be obligated to reimburse the Owner/User for reasonable costs for the following additional professional services for which the Owner will be required to compensate the Engineer. Reimbursement shall be on an hourly basis at the Engineers standard rates, plus reasonable reimbursable expenses billed at a rate of 1.1 times the actual cost to the Engineer. A deductive change order to the Trade Contract sum will be processed periodically for the cost of such services incurred by the Owner.
 - 1. More than two reviews of the same submittal.
 - 2. Responding to multiple "Requests for Information" (RFI) for which the answer is readily obtainable in the Contract Documents.
 - 3. Preparation and follow up review of more than one "Punch List" for the same items of work.

4. Construction administration services that extend more than 60 days past the initial date of Substantial Completion. These services include, but are not limited to, all work associated with the following: attending pay/progress meetings, on-site observation, and processing the Application and Certification for Payment.
 - a. The Engineer will endeavor to notify the Owner and the SEC prior to performing any work that will result in the aforementioned additional services; and to review any proposed modifications to the contract. Contract modification shall not be contingent, however, upon issuance of any such notice or prior review.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. All products shall be new (less than one year from manufacture and unused and without blemish or defect).

2.2 SUBSTITUTIONS

- A. Submit substitutions in accordance with Section 013300 – Submittals and Substitutions. No other method of substitution is acceptable.
- B. Deviations from specifications
 1. Any deviations from the specifications must be approved 10 calendar days prior to the bid date. This includes changes to the scope of work, equipment substitutions, and changes to the general provision.
 2. Changes to the scope of work in the bid proposal are not acceptable. Any proposed change is to be submitted to the Engineer for review. Any approved changes will be listed by addendum prior to the bid opening.
 3. Any proposed equipment substitution must be submitted 14 calendar days prior to the bid date. Accompany the request, the contractor must provide manufactures product specifications for the exact model to be substituted. This literature must clearly state all specifications called for in the bidding documents, as well as performance characteristics not specified but inherent to the product listed in the specifications. Any items approved for substitution will be listed by addendum prior to the bid opening. Substitutions after the award of bid will only be allowed in case of discontinued equipment, or if an item of equal or better quality is available and will not affect the contract cost of the system.
 4. Changes to the general provisions are not acceptable. Any proposed change is to be submitted to the Engineer for review. Any approved changes will be only listed by addendum prior to the bid opening.
 5. When a specified item is found to be discontinued or obsolete by the manufacturer, the SEC is required to substitute the manufacturer recommended equivalent for that product. If an equivalent is not available, the contractor is instructed to notify the Engineer in writing prior to bid time.
 6. Where specific products are sole source specified, no substitutions will be allowed.

2.3 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 are available.
- B. Equipment Assemblies and Components
 - 1. All components of an assembled unit need not be products of the same manufacturer; however, all components must be acceptable to the Architect Engineer and the Owner.
 - 2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.
 - 3. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.
 - 4. Components shall be compatible with each other and with the total assembly for the intended service.
 - 5. Constituent parts which are similar shall be the product of a single manufacturer.
 - 6. Moving parts of any element of equipment of the unit normally requiring lubrication shall have means provided for such lubrication, and shall be adequately lubricated at the factory prior to delivery.
 - a. All factory wiring shall be identified on or provided with the equipment being furnished and on all wiring diagrams and included with O & M manuals.
 - b. When factory testing is specified:
 - 7. The Engineer shall have the option of witnessing factory tests. The SEC shall notify the Engineer a minimum of 15 working days prior to the manufacturer making the factory tests.
 - 8. Four copies of certified test reports containing all test data shall be furnished to the Engineer prior to final inspection and not more than 90 days after completion of tests.
 - 9. When equipment fails to meet factory test and re-inspection is required, the Trade Contractor shall be liable for all additional expenses.

2.4 EQUIPMENT IDENTIFICATION

- A. In addition to the requirements of the National Electrical Code, install an identification sign that clearly indicates information required for use and maintenance of items such as cabinets, control devices and other significant equipment.
- B. Nameplates shall be laminated black phenolic resin with a white core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.
- C. All inputs and outputs are to be clearly labeled. Inputs to include the source location and signal type. Outputs should indicate location signal is sent to.
- D. All custom input plates labeling shall be engraved and paint filled or laser etched with a contrasting color as shown on the specification.
- E. Any and all user serviceable devices shall be clearly labeled

PART 3 EXECUTION

3.1 INSPECTION

- A. Before installing electronic equipment, carefully inspect the installed Work of all other Trades. Verify that all such Work is complete to the point where the installation of electronic equipment may properly commence. Verify that the security/telecommunications closets are free of airborne contaminants prior to the installation of electronic equipment.
- B. Verify that all equipment is installed in accordance with all pertinent codes and regulations, the original design, and the referenced standards.
- C. In the event of discrepancy, immediately notify the Engineer.
- D. Do not proceed with installation in areas of discrepancy until such discrepancies have been fully resolved.
- E. Return to original (preconstruction) condition any work disturbed during system installation.

3.2 INSTALLATION

- A. Install all equipment in strict accordance with the manufacturer's recommendations, reviewed shop drawings and ANSI/EIA/TIA standards.
- B. Do not attach electrical materials to roof decking, removable or knockout panels, or temporary walls and partitions, unless indicated otherwise.
- C. Secure equipment with fasteners suitable for the use, materials and loads encountered. If requested, submit evidence proving suitability.
- D. National Electrical Code requirements are applicable to all work.
- E. Working spaces shall be not less than specified in the National Electrical Code for all voltages specified.
- F. Where the Engineer determines that the SEC 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. "Conveniently accessible" 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.
- G. All programming of control panels and recording/storage devices shall be performed in the SECs shop prior to delivery to the job site. All equipment is to be fully tested.
- H. To the extent possible all equipment racks are to be fully assembled and wired in the SECs shop prior to delivery to the job site. Where existing cabinets are to be used, new panel inserts are to be fully assembled and ready from installation in the existing cabinets. All electronics are to be fully tested.

3.3 WORK PERFORMANCE

- A. Coordinate location of equipment with other trades to minimize interferences.
- B. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills shall not be allowed, except where permitted by the Engineer and the Owner as required by limited working space.
- C. Holes shall be located so as not to affect structural sections such as ribs or beams.
- D. Holes shall be laid out in advance. The Architect/Engineer shall be advised prior to drilling through structural sections for determination of proper layout.
- E. Any holes created in walls, floors, or ceilings by the SEC are to be fire-stopped according to all national, state, and local codes.
- F. Hangers and other supports shall support only equipment and materials. Provide not less than a safety factor of 5, which shall conform to any specific requirements in the Construction Documents.
- G. The SEC is responsible for repairing and or replacing any damage caused by their workforce at no additional cost to the Owner.

3.4 PROTECTION AND CLEANING OF SYSTEMS AND EQUIPMENT

- A. Protect all materials and equipment from damage during storage at the Site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, moisture, cold and rain.
- B. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on all sides with securely fastened protective rigid or flexible waterproof coverings.
- C. Piping shall be protected by storing it on elevated supports and capping the ends with suitable closure material to prevent dirt accumulation in the piping.
- D. During construction, cap the top of all conduits and raceway installed vertically.
- E. During installation, protect equipment against entry of foreign matter on the inside, and vacuum clean both inside and outside before testing and operating.
- F. Damaged equipment, as determined by the Engineer, shall be replaced.
- G. Painted surfaces shall be protected with removable heavy craft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection.

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- H. Repaint damaged “FINISH” paint on equipment and materials with painting equipment and finished with same quality of paint and workmanship as used by the original manufacturer so repaired areas are not obvious.
- I. Conduit back boxes, floor boxes, and poke thru’s shall be vacuumed clean prior to the installation of cable.

3.5 IDENTIFICATION

- A. Nameplates shall be laminated black phenolic resin with a white core and engraved lettering, a minimum of 1/4-inch high. Nameplates that are furnished by manufacturer, as a standard catalog item, or where other methods of identification are herein specified, are exceptions.
- B. Uppercase letters of uniform height; centered on device, cover plate, or enclosure; engraved letters filled with a contrasting color; and all characters made clearly and distinctly.
- C. Use abbreviations defined in the contract documents whenever possible. Use plan designations for labeling unless indicated otherwise.

3.6 LABELING

- A. All cables shall be properly identified using a high quality thermal transfer-labeling device such as the Kroy K4100 or equal.
- B. Cable
 - 1. Provide typewritten labels on both ends of all security electronics system cabling. Locate label within 6” of cable termination. Cover label with clear heat shrink tubing.
 - 2. Label designation to consist of letter indicating type of cable (i.e. V for video, C Control, M for Master Station etc.) and a number. Numerical designations shall be sequential.
 - a. Power Outlets
 - 3. Power outlet labels are to be mechanically generated.
 - 4. All power outlets designated for security equipment shall be labeled “SECURITY ELECTRONICS EQUIPMENT ONLY”. On top.
 - 5. Provide a second label on the bottom of the outlet cover plate indicating service panel number and circuit breaker number.
 - 6. Text lettering to be 1/8” high.
- C. Rack Mounted Electronic Components
 - 1. Electronic component labels are to be mechanically generated.
 - 2. All inputs are to be labeled identifying source location of signal.
 - 3. All outputs are to be labeled identifying signal destination.
 - 4. Provide ¼” diameter indicator dot showing level setting for all rotary knobs, sliders, and pushbutton switches.

5. Power switches shall be clearly labeled indicating switch is to be left in the on position at all times.

3.7 CABLE TERMINATIONS AND DRESS

- A. Installation of signal, video, communication, and control conductors shall adhere to the following:
 1. Cables shall be installed in Panduit wire duct (or approved equal) in all cabinets, racks and/or at control panels and consoles for all wire and cable management.
 2. Cables shall be secured to equipment cabinet backboards, console members or to other system components using Panduit wire duct (or approved equal). SEC shall furnish and install cable support posts, cable clamps or wraps, if required, to facilitate system installation where plastic wire duct use is not possible.
 3. All cables and/or conductors shall be terminated with approved cable termination connectors compatible with the specific termination.
 4. Label all cables on both ends and on all termination points.

3.8 CLEANING

- A. Refer to Section 017400 – Cleaning
- B. Daily during construction and prior to User acceptance of the building, remove from the premises and dispose of all packing material and debris caused by work performed under Division 28 Security Systems.
- C. Remove all dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.
- D. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and the like and leave the premises clean, neat and orderly.
- E. All bright metal or plated work shall be thoroughly polished. All pasted labels, dirt and stains shall be removed from the devices.

3.9 COMPLETION

- A. Results Expected
 1. All equipment and materials shall be in place, all controls shall be set and calibrated, all programming shall be installed and debugged, and all systems shall be demonstrated to be operationally complete.
 2. All testing, start-up and cleaning work shall be complete.
 3. All documented testing results are submitted and approved by the Architect Engineer. THE SEC AT NO ADDITIONAL COST SHALL REPLACE ANY COMPONENT OF THE SYSTEM THAT FAILS TO MEET THE PERFORMANCE AS SPECIFIED.
 4. All O & M Manuals and Record Documents are reviewed and accepted.

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5. Substantial Completion inspection is performed and granted. The Substantial Completion inspection punch list is completed by SEC.
6. All facility training shall be complete and the DVD of the training session is accepted.
7. All warranties are received.
8. Transmittal letter listing delivery and receipt of complete spare parts inventory.
9. Special test equipment is received.
10. A copy of all program files associated with the system shall be turned over to the owner.

3.10 DEMONSTRATION/INSPECTION

- A. Upon completion of approved testing procedure and submittal of testing documentation as described above, the SEC shall notify the Engineer, who will visit the project for a demonstration of the systems and an inspection of the completed work in conformance with the Construction Documents. It is mandatory for a representative from the SEC directly responsible for the project to be present during demonstration and inspection periods.
- B. Items which do not comply with the Contract Documents, or which function incorrectly, will be listed and the list will be submitted by the Engineer to the Contractor.
- C. After all corrections have been made, the SEC shall notify the Architect Engineer who will recheck the system for compliance of all items listed. **IF THE ENGINEER OR OWNER IS REQUIRED TO AGAIN RETURN TO THE SITE FOR FURTHER INSPECTIONS, THE SEC SHALL REIMBURSE ALL LABOR AND TRAVEL EXPENSES.**

3.11 TRAINING

- A. Provide training after all final tests and adjustments have been completed. Instruct the User's personnel according to the approved Training Plan specified above in "Training Plan and Documentation." Training shall cover all aspects of systems operation, maintenance and programming, and shall be provided by the responsible SEC technical representatives.
- B. Provide written operating instructions specific to the basic operation of the system. Basic instructions should cover all operational aspects of the system required for basic operation including system powering, signal patching and routing, and level control. These instructions are to be laminated and located with the main system power control.
- C. Schedule training sessions to meet the needs of facility personnel as determined by the Owner. Provide training during first, second and third shifts.
- D. Record all training sessions. Submit an edited DVD copy to the Engineer for review and approval. Present all materials used in the training session on the video. Any DVD found to be inferior in recording or material content shall be reproduced at no cost until an acceptable tape is submitted.
- E. Provide a minimum of 40 hours of training. All training is to be completed during the time frame established during scheduling with the Owner. Training may not necessarily be in continuous periods. Training will need to take place for staff on 1st, 2nd, and 3rd shifts during

those times. This training is to also include a higher level of training for two (2) Owner employees on programming of the PLC's.

F. Refer to individual sections for system specific training requirements.

G. Shake Down Period:

1. The SEC shall provide 3 days of system shakedown, which shall include providing a fully trained employee of the SEC who shall provide additional training, system repairs and alterations prior to, during and after the transfer of inmates into the facility. The system shall be fully operational and certified prior to the shakedown period beginning.
2. This person shall be on-site during the 1st shift and be available or on-call during 2nd and 3rd shift.

3.12 MAINTENANCE MATERIALS

- A. All special tools for proper operation and maintenance of the equipment provided under this Specification shall be delivered in conformance with Section 280510.
- B. Provide spare materials as indicated in Contract Documents and as required for proper maintenance of the Security Systems.

3.13 WARRANTY, WARRANTY SERVICE AND MAINTENANCE

- A. Refer to Section 280510 – Maintenance Service and Warranty for Electronic Security

END OF SECTION 280500

SECTION 280510 - MAINTENANCE, SERVICE, AND WARRANTY FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish and install all equipment, materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Scheduled Maintenance
 - 2. Non-Scheduled Maintenance
 - 3. Documentation of Maintenance
 - 4. Spare Parts Inventory
 - 5. Future Staff Training
 - 6. Third Party Service Contracts
- B. It is the intent of this Section to define maintenance services to support all systems included in the 280500 series specifications.
- C. The SEC shall provide maintenance and service as part of the Contract during the (2) year guarantee period. The guarantee period shall begin with Owner acceptance of the systems as “complete as specified” not at Substantial completion.
- D. Six months prior to the end of the (2) year guarantee period, the SEC shall provide a proposal for a two (2) year continued maintenance contract for the complete Security Electronics System. If accepted, the maintenance contract shall take effect at the completion of the initial two (2) year guarantee period.

1.2 PRODUCTS

- A. All products used in parts replacement shall meet the specifications for the original equipment. The Architect Engineer must approve any substitutions.

1.3 SPARE PARTS – (Each item listed below is to have two (1) sets required for spares.

- A. One GUI including touch screen monitor, CPU, Keyboard and mouse.
- B. One case of paper and four replacement cartridges for printer specified.
- C. 10 spares of each type of relay used on this project.
- D. 25 fuses of each type used

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- E. One spare PLC CPU
- F. One spare PLC Module of each type used
- G. One spare PLC power supply
- H. One spare linear power supply of each type used
- I. One spare intercom master station
- J. One intercom sub-station
- K. Two (2) spare cameras of each type used
- L. One spare proximity card reader of each type used.
- M. One spare duress alarm and panic alarm

1.4 SOFTWARE SERVICE

- A. Update software to latest version at project completion.
 - 1. Install and program software upgrades that become available within two (2) years from date of substantial completion.
 - 2. Upgrading software shall include the operating system.
 - 3. Upgrade shall include new or revised licenses for use of software.
- B. 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 EXECUTION

2.1 WARRANTY AND WARRANTY SERVICE

- A. Warranty
 - 1. The Division 28 series security systems shall be fully guaranteed for a period of two (2) years beginning on the date of Owner acceptance.
 - 2. The guarantee shall include the entire Division 28 series scope of work including all equipment, devices, materials, cable/wire, software and installation as it applies to security electronics.
 - 3. Work shall be guaranteed to be free from defects. Any defective materials or workmanship, as well as damage to the Work of all other Trades resulting from same, shall be replaced or repaired as directed by the Owner for a period of two (2) years from the date of Owner final acceptance. The SEC shall provide written warranties for all systems and all buildings to the Owner.
 - 4. The guarantee shall exclude acts of God, vandalism, physical abuse or operator misuse.

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5. Acceptance by a manufacturer of an order for equipment for this contract signifies acceptance of this warranty. During the warranty period there shall be no charge to the Owner for equipment, material, software, etc. for guarantee work.
6. During the warranty period, there shall be no charges to the Owner for service calls (mileage, labor, travel, expenses, etc.) for warranty work.

B. Warranty Service

1. The SEC shall provide warranty service as part of this Contract during the warranty period.
2. Warranty service agreement must be submitted separately and must contain the name, phone number of the service provider capable of meeting the response times as defined by the Engineer.
3. This service shall consist of the following:
 - a. 24-hour staffed phone number.
 - b. Technician's factory trained by the manufacturers of the system's components.
 - c. Authorized representation of the manufacturer via an agreement of factory support.
 - d. Five years experience (minimum) servicing systems of the type included in this project.
 - e. Capability of making additions or changes to the software systems used in this project.
 - f. Capability of servicing the individual system components and the total security electronics system.
 - g. Equipment and knowledge to test all specified equipment and devices.
 - h. Current system documentation including but not limited to the following:
 - 1) Wiring diagrams.
 - 2) Operation and maintenance manuals.
 - 3) Software programs.
 - 4) Other documentation as required to provide assistance to the Owner in the operation and maintenance of the systems.
 - 5) All documents shall be made available to Owner.
 - 6) Upon termination of maintenance agreement all system documents shall be furnished to Owner for maintenance continuity.
4. The Owner and/or Engineer shall notify the SEC in writing, outlining operational malfunctions or defects in the Division 28 series Security Electronics system. This report shall be emailed to the service provider, which will establish the date and time or problem notification.
5. Upon successful completion of warranty service, the responsible technician shall return a copy of the original service request to the facility with a detailed description of the problem found, and corrective action taken including a list of equipment/parts/software repaired or replaced. The technician shall also sign the on-site service log at the facility.
6. The SEC shall maintain a repair parts inventory sufficient to maintain the response times specified. All parts used from the Owner's spare parts inventory for warranty service shall be replaced at no cost to the Owner.

2.2 OWNER INSPECTIONS

- A. Inspections by the Owner shall consist of "go, no-go" type inspections to determine the operational state of a system. It is not intended that the Owner perform adjustments or modifications for system restoration.
- B. The Owner as a result of daily inspections and/or operational use of the systems will initiate non-scheduled maintenance. Categories of maintenance support and the response time for system restoration are defined in NON-SCHEDULED MAINTENANCE below.

2.3 SCHEDULED MAINTENANCE

- A. The SEC shall provide scheduled maintenance as described below.
- B. Quarterly Scheduled Maintenance
 - 1. Security Control System
 - a. Touch Screens and CPUs (inspect and clean).
 - b. Programmable logic controllers.
 - c. Test all duress/panic pushbuttons.
 - d. Relay cabinets.
 - e. Electro-mechanical detention hardware (Note: The Trade Contractor shall verify proper security control system operations only).
 - f. Inspect and clean all system filters.
 - g. Auxiliary devices such as indication lights, push buttons, door position switches.
 - 2. Intercom, Paging and Communication Systems
 - a. Verify proper operation of master stations.
 - b. Verify operation of sub-stations
 - c. Verify proper adjustment of all remote intercom amps.
 - d. Verify proper adjustment and operation of all paging amplifiers.
 - 3. Video Surveillance System System
 - a. Verify proper video signal at each monitor.
 - b. Verify proper auto-iris operation, video and sync. signal at each camera.
 - c. Check video clarity of each camera.
 - d. Perform focus adjustments, etc. as required.
 - e. [Test/adjust using CAMERA MASTER meter (provided to Owner in Section 1)].
 - 4. Access Control System
 - a. Test all Guard Tour proximity card readers.
 - b. Access Control system panels
 - c. Door lock power supplies

5. Uninterruptible Power Systems (UPS)
 - a. Verify proper voltage and current levels
 - b. Exercise UPS function by system power blackout and emergency generator test.
6. Grounding and Surge Protection
 - a. Check status of all devices.
 - b. Perform ground measurements.

2.4 NON-SCHEDULED MAINTENANCE

- A. The SEC shall provide non-scheduled or "on-call" maintenance services in accordance with the following Service Response Categories.

1. Critical: Items which compromise the security of the facility or have an adverse effect on the operations of the facility. Items in this category shall be returned to service within 8 actual hours after receipt of a service call by the SEC. Service shall be available on a 7-day, 24-hour basis.
2. Sensitive: Items which adversely impact the operations of the facility but are not considered "critical" as defined above. Items in this category shall be returned to service within 24 actual hours after receipt of a service call by the SEC.
3. Normal: Items which require maintenance support but are not "critical" or "sensitive" as defined above. These are typically items which staff personnel identify and accept that maintenance shall be performed by SEC during the standard quarterly inspection.

- B. System/Response Category Table

PRODUCT/SYSTEM		CATEGORY
1.	Touch Screen/PLC/Security Control	
a.	All components	Critical
2.	Video Surveillance System	
a.	All components	Critical
3.	Access Control System	
a.	All components	Critical
4.	Intercom System	
a.	Master Station	Critical
b.	Single remote station	Sensitive
c.	Paging	Critical

- 5. Uninterruptible Power Systems (UPS)
 - a. All components Critical
- 6. Surge Suppression
 - a. All components Sensitive

2.5 DOCUMENTATION OF MAINTENANCE

- A. It shall be the responsibility of the SEC to maintain all documents and modify drawings, schedules, and other documents as required to effect documentation which reflects the current system or wiring configuration.
- B. Create and maintain a maintenance log that details maintenance services provided, system modifications, and software upgrades. One copy of log is to remain at the facility.
- C. Upon termination of the service contract, the SEC shall return all system documents to the Owner.

2.6 SPARE PARTS INVENTORY

- A. An inventory of spare parts consisting of at least the quantity of items herein must be provided and maintained by the SEC to support the maintenance response requirements defined in this document.
- B. The spare parts inventory may be comprised of SEC furnished and/or maintained parts.
- C. The SEC shall maintain a spare parts inventory in excess of the amount indicated in Contract Documents, as he deems necessary to support the maintenance and service requirements of this section.
- D. During the maintenance and service period, the Contractor shall maintain a log of all component failures and parts replaced.
- E. Six months prior to the expiration of the maintenance and service period, the SEC shall submit the replaced parts log to the Owner. The Owner shall use the replaced parts log to evaluate the on-site spare parts inventory required for future maintenance by the Owner/User.

2.7 FUTURE STAFF TRAINING

- A. It shall be the responsibility of the SEC to train the Owner on new system features or software which may be provided to enhance the system's capability.

2.8 THIRD PARTY SERVICE CONTRACTS

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- A. The SEC shall provide a third-party service contract for all equipment supplied that is more efficiently serviced by the third-party company.
- B. The service contract shall provide service response times as described above.
- C. All third-party service requests shall be acknowledged through the SEC to verify appropriate service procedures have been followed as outlined in the service manual.

END OF SECTION 280510

SECTION 280511 - BACKBONE SYSTEM CABLING FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SYSTEM DESCRIPTION

- A. General

- 1. Provide Fiber Optic Backbone Cabling for the security electronics system Ethernet LAN.
 - 2. Provide Fiber Optic Backbone system cabling, fiber optic termination enclosures, patch cables, terminations and testing for the Fiber Optic Backbone Cabling system as indicated in Project Documents.

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.

2.2 FIBER OPTIC BACKBONE CABLE

- A. Specifications

- 1. Single mode
 - a) Core Diameter: 8.3 um nominal
 - b) Cladding Diameter: 125 +/- 1 um
 - c) Core/Clad Concentricity Error: < .5 um
 - d) Coating fiber diameter: 245 +/- 10 um
 - e) Cladding Non-circularity: <1%
 - f) Coating/Cladding Concentricity Error: <12 um
 - g) Colored Fiber Diameter: 254 um
 - h) Effective Group Index of Ref. @1310 nm: 1.466

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- i) Effective Group Index of Ref. @1550 nm: 1.467
- j) Point Discontinuities: .1 dB
- k) Max. Fiber Loss @1310: .7 dB/km
- l) Max. Fiber Loss @1550: .7 dB/km

B. Acceptable Manufacturer

- 1. Building
 - a) AMP/Netconnect
 - b) Commscope/Uniprise
 - c) Panduit/General Cable
 - d) Hubbell
 - e) Belden/CDT

2.2 FIBER OPTIC PATCH PANEL

A. Specifications

- 1. 14 ga. CRS construction
- 2. 19 rack mount, 4 RMS (7" high)
- 3. Modular construction
- 4. Provide fiber management bend limiting clips
- 5. Provide strain relief brackets
- 6. Provide adapter panels to support the fiber optic strand count shown on the plans.

B. Acceptable Manufacturers

- 1. AMP/Netconnect
- 2. Commscope/Systimax
- 3. Panduit/General Cable
- 4. Hubbell
- 5. Belden/CDT

2.3 FIBER OPTIC WALL INTERCONNECT

A. Specifications

- 1. 14 ga. CRS construction
- 2. Modular construction
- 3. Provide fiber management bend limiting clips
- 4. Provide strain relief brackets
- 5. Provide adapter panels to support the fiber optic strand count shown on the plans.

B. Acceptable Manufacturers

- 1. Commscope/Systimax
- 2. Panduit/General Cable

3. Hubbell/Mohawk
4. Belden/CDT

2.4 FIBER OPTIC PATCH PANEL ADAPTOR PLATE

A. Specifications

1. SC duplex multi mode adaptors
2. Provide adaptor panels to support the fiber optic strand count shown on the plans.
3. Ferrell color based on cross-connect field identification color code, TDMM 12th edition, chapter 7.

B. Acceptable Manufacturers

1. Commscope/Uniprise/Systimax
2. Panduit/General Cable
3. Hubbell/Mohawk
4. Belden/CDT

2.5 FIBER OPTIC CONNECTORS

A. Specifications

1. Duplex LC type connector
2. High impact plastic body
3. Zerconia/Ceramic ferrule
4. .3dB typical insertion loss
5. –30dB/-40dB reflectance, Multimode respectively
6. 32° – 131° F operating temperature
7. 12 pound tensile strength
8. Ferrell color based on cross-connect field identification color code, TDMM 13th edition, chapter 7.

B. Acceptable Manufacturers

1. AMP/Netconnect
2. Commscope/Uniprise/Systimax
3. Panduit/General Cable
4. Hubbell/Mohawk
5. Belden/CDT
6. Leviton

2.6 FIBER OPTIC PATCH CABLES

A. Specifications

1. Duplex LC connectors
2. Ferrell color based on cross-connect field identification color code, TDMM 13th edition, chapter 7.
3. Length as required for installation.
4. Patch cables are to be turned over to the Owner for use in installation of active equipment outside the scope of the project.
5. Furnish quantity of patch cables as required for installation plus 10% spare.

B. Acceptable Manufacturers

1. AMP/Netconnect
2. Commscope/Uniprise/Systimax
3. Panduit/General Cable
4. Hubbell/Mohawk
5. Belden/CDT
6. Leviton

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. Install all fiber cabling in accordance with applicable standards and codes.
2. Maintain fire rating of all penetrations through rated walls during construction.
3. Coordinate fire stopping of all cable runs through floor sleeves with field conditions
4. Install all fiber cabling and secure utilizing wire management brackets and hook and loop type (VelcroTM) straps. No plastic cable ties shall be used to secure any cabling.

B. Backbone Cabling

1. Install cabling as per manufacturer's instructions.
2. Do not exceed specified pulling tensions.
3. Do not exceed specified bend radius.
4. Provide a 3 meter maintenance loop of fiber cable
5. All fiber optic cable shall be installed in plenum inner duct.

C. Fiber Optic Termination Enclosures

1. Install all cabling and secure utilizing wire management system.
2. Secure fiber jacket in a minimum of two locations.
3. Install minimum one meter of unjacketed fiber strands coiled on the enclosure routing guides.

4. Terminate and connect all fibers in fiber termination enclosure:
 - a. Populate the multimode fibers on the ports beginning with
5. Use only hook and loop (Velcro™) type straps to secure and dress fiber cables.

3.2 LABELING

A. General

1. Provide labeling based on ANSI/TIA/EIA-606A administration concepts for all conduits, fiber, patch panels, jacks, bus bars, racks, etc.
2. Provide machine generated typewritten labels, hand labeling is not acceptable

B. Equipment Room Terminating Hardware

1. Provide an identifier for each Patch Panel that incorporates the Cabinet identifier. (e.g. TR2A-RR3-PP1 is the first patch panel in the third relay rack in the first intermediate telecommunications room on the second floor)
2. Provide an identifier for each Patch Panel port that incorporates the Patch Panel identifier. (e.g. TR2A-RR3-PP1-09 is the ninth port on the first patch panel in the third relay rack in the first intermediate telecommunications room on the second floor)

C. Backbone Cable

1. Provide both of the cable's Patch Panel Port identifiers on both ends of all backbone cables.
2. Insure that label is intact after termination of cable.

3.3 TESTING

A. General

1. Certify system is complete and functional.
2. Test all cabling and connections. Perform final functional tests in presence of the Architect Engineer.
3. Complete certified testing report.

B. Fiber Cable Testing

1. All fiber testing shall be performed on all fibers in the completed end to end system.
2. Every fiber shall be tested in both directions with a light source tester.
3. There shall be no splices unless clearly defined in construction documents.
4. Maximum allowable attenuation for 50 micron fiber shall be 3.0 dB per km at 850nm and 1.0 dB per km at 1300 nm.
5. All testing shall follow TIA/EIA-TSB-140 (or later revisions of this document) standards.

END OF SECTION 280511

SECTION 280512 - HORIZONTAL CABLING SYSTEM FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SYSTEM DESCRIPTION

A. General

1. Provide a complete Horizontal Cabling system that supports voice, and data as indicated in Project Documents relative to the electronic security system(s).
2. Provide, equipment room rack mounted termination equipment, equipment room patch cables, work area outlets, work area equipment cables, terminations, labeling and testing for the Horizontal Cabling system as indicated in Project Documents.
3. Provide Fire stopping Materials for Horizontal Cabling as indicated in Project Documents, provide all labor and materials to maintain Fire stopping at all penetrations at all times during construction and to insure adequate Fire stopping at all penetrations at completion.
4. Provide all necessary materials and labor for the horizontal cabling system in all equipment rooms and closets as indicated in project documents.

B. Horizontal Cabling Subsystems

1. Provide a complete UTP horizontal cabling system as indicated in project documents relative to the electronic security system(s).
2. Provide UTP horizontal system cables, equipment room rack mounted UTP termination equipment, equipment room UTP patch cables, work area UTP jacks and faceplates, work area equipment cables, UTP terminations, labeling and testing for the UTP Horizontal Cabling system as indicated in Project Documents.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide materials listed by UL or ETL. All cables shall be marked according to current standards.

- B. All cable must be NEC type CMP unless installed in conduit from end to end.

2.2 UTP HORIZONTAL CABLE

A. Specifications

1. ANSI/EIA/TIA Category 6 compliant
2. Quantities and locations as indicated in Project Documents
3. 4 pair, 23 AWG, solid bare annealed copper
4. Flame retardant semi-rigid PVC insulation
5. Longitudinal rip-cord
6. Color based on cross-connect field identification color code, TDMM Latest edition, chapter 7.
7. All cables terminated per T568B.

B. Acceptable manufacturers

1. Panduit
2. Belden
3. Berk-Tek
4. Commscope
5. Superior Essex

2.3 PATCH PANELS

A. Specifications

1. Modular rack mounted
2. Release snap feature on faceplate allowing front access to installed modules.
3. Label version for easy port identification
4. Replacement label/label covers
5. Mount standard EIA 19" rack
6. Jack color to correspond with color of jack at work area outlet location.

B. Acceptable Manufacturers

1. Panduit
2. Belden
3. Berk-Tek
4. Commscope
5. Leviton

2.4 CATEGORY 6 RJ-45 JACKS

A. Specifications

1. Exceeds TIA/EIA-568-B.2 Category 6 and ISO 11801 2nd Edition Class D standards
2. Each jack is 100% tested to ensure NEXT and RL performance and is individually serialized for traceability
3. No punchdown tool required; termination tool ensures conductors are fully terminated by utilizing a smooth forward motion without impact on critical internal components for maximum reliability
4. Can be re-terminated a minimum of twenty times
5. Red termination cap designates Category 6 performance and provides a positive strain relief; helps control cable bend radius and securely retains wires
6. Terminates 4-pair, 22 – 26 AWG, 100 ohm, solid or stranded twisted pair cable
7. Termination cap is color coded for T568A and T568B wiring schemes
8. Accepts 6 and 8-position modular plugs without damage
9. Can be clearly identified with optional labels and icons
10. Colors include blue, white, green, yellow, red, or violet.

B. Acceptable Manufacturers

1. Panduit
2. Belden
3. Berk-Tek
4. Commscope
5. Leviton

2.5 CROSS CONNECT AND PATCH CABLE ASSEMBLIES

A. Specifications

1. ANSI/EIA/TIA Category 6
2. 4 pair RJ45
3. Bootless
4. All patch cables shall be an appropriate length. (this may require custom cable lengths in the telecommunications room)
5. Patch cables shall be constructed with cable of the same manufacturer as installed horizontal cable.

B. Acceptable Manufacturers

1. Panduit
2. Belden
3. Berk-Tek
4. Commscope
5. Leviton

PART 3 EXECUTION

3.1 INSTALLATION

A. General

1. Follow all ANSI/EIA/TIA installation guidelines
2. Follow all cabling solution provider installation guidelines
3. Install all cabling and secure utilizing wire management and hook and loop (Velcro™) Straps. No plastic cable ties shall be used to secure any cabling.

B. Equipment Rooms

1. Install all Horizontal Cable System equipment as indicated in Project Documents
2. Install cable management to support and train cables with spacing as required to meet bend radius and support requirements.

C. Work Area

1. Install all Horizontal Cabling System Work Area equipment and cabling as indicated in Project Documents
2. Do not exceed recommended pulling tensions
3. Route cabling from outlets to patch panel in equipment rooms or closets as indicated on the drawings.
4. Do not exceed 90 meter horizontal length for horizontal cables. Notify the Architect Engineer prior to install if any horizontal runs that have the potential of exceeding 90 meters.
5. Terminate data cabling per T568B wiring method.
 - a. Maintain wire twists to within 0.5 inches of termination.
 - b. Remove no more than 1.0 inches of cable jacket.

3.2 LABELING

A. Equipment Room Cabinet Labeling

1. Provide each cabinet a laminated black phenolic resin label with a white core and engraved lettering, a minimum of 1/4-inch high.

B. Equipment Room Patch Panel Labeling

1. Provide each Patch Panel with a laminated black phenolic resin label with a white core and engraved lettering, a minimum of 1/4-inch high.
2. Provide permanent, computer-generated labels at each Patch Panel port.

C. Horizontal Cable Labeling

1. Provide permanent, computer generated labels on both ends of every Horizontal Cable, Patch Cord and Work Area Equipment Cable.
2. Example of horizontal wiring label: 1A-A001 1A=Equipment Room number, A=the patch panel, and 001= patch panel port.

D. Work Area Outlet Labeling

1. Provide permanent, computer generated labels at the station faceplate

E. General

1. Provide labeling based on ANSI/TIA/EIA-606 administration concepts
2. Provide typewritten labels, hand labeling is not acceptable

F. Telecommunication Spaces and Pathways

1. Use the identifier ER for the Equipment Rooms
2. Provide a unique identifier for each Equipment Room that indicates the floor and an ordinal designation (e.g. ER2A is the first equipment room on the second floor)
3. Provide an identifier for each cabinet in each equipment room that incorporates the ER identifier (e.g. ER2A-RR3 is the third cabinet in the first equipment room on the second floor).
4. Provide an identifier for each cabling pathway

G. Equipment Room Terminating Hardware

1. Provide an identifier for each Patch Panel that incorporates the cabinet identifier (e.g. ER2A-EC3-PP1 is the first patch panel in the third equipment cabinet in the first equipment room on the second floor)
2. Provide an identifier for each Patch Panel port that incorporates the Patch Panel identifier (e.g. ER2A-EC3-PP1-09 is the ninth port on the first patch panel in the third equipment cabinet in the first equipment room on the second floor)

H. Work Area

1. Provide an identifier for each Work Area Activation Point that indicates the room number and an ordinal designation (e.g. 142A is the first activation point in room 142).
2. Provide an identifier for each Work Area Activation Point jack that Work Area Activation Point designation (e.g. 142A-2 is the second jack in the first TO in room 142).

I. Horizontal Cable

1. Provide the cable's Patch Panel Port identifier and Work Area Activation Point Jack identifier on both ends of all Horizontal cables.
2. Insure that label is intact after termination of cable.

3.3 TESTING

A. Copper cable testing

1. Test all Category 6 horizontal cabling using a digital cable analyzer and certify that the system is complete and functional.
2. A level IIe or better test unit is required and must be updated to include the requirements of ANSI/TIA/EIA-568-B.
3. The basic tests required are:
 - a. Wire Map
 - b. Length
 - c. Attenuation
 - d. NEXT (Near and crosstalk)
 - e. Return Loss
 - f. Propagation Delay
 - g. Delay Skew
 - h. PSNEXT (Power sum near-end crosstalk loss)
 - i. PSELFET (Power sum equal level far-end crosstalk loss)

END OF SECTION 28 05 12

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Division 1 Specifications Sections, apply to this Section.

1.2 SYSTEM DESCRIPTION

- A. General:

1. This is a new project.
2. Provide all necessary materials for the cabling system in all equipment rooms and at all field devices as indicated in the project documents.
3. Provide a complete Horizontal Cabling system that supports all devices and systems as indicated in Project Documents relative to the electronic security system(s).
4. Provide equipment room rack mounted termination equipment, equipment room patch cables, work area outlets, work area equipment cables, terminations, labeling and testing for the Horizontal Cabling system as indicated in Project Documents.
5. Provide Telecommunications Grounding and Bonding of all Horizontal Cabling system components as indicated in Project Documents.
6. Provide Fire stopping Materials for Horizontal Cabling as indicated in Project Documents, provide all labor and materials to maintain Fire stopping at all penetrations at all times during construction and to insure adequate Fire stopping at all penetrations at completion.
7. Provide all necessary materials and labor for the horizontal cabling system in all equipment rooms and closets as indicated in project documents.
8. Provide complete system test, Manufacturer's minimum 20-year performance certification and Owner/User training by the personnel responsible for the Structured Cabling System installation.

- B. For new wire and cable, include all termination and cable management as described in section 280500.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide materials listed by UL or ETL.
- B. All cable must be NEC type CMP unless installed in conduit from end to end.

2.2 UTP HORIZONTAL CABLE

- A. Specifications
 - 1. ANSI/EIA/TIA Category 6 compliant
 - 2. Quantities and locations as indicated in Project Documents
 - 3. 4 pair, 23 AWG, solid bare annealed copper
 - 4. Flame retardant semi-rigid PVC insulation
 - 5. Longitudinal rip-cord
 - 6. Color based on cross-connect field identification color code, TDMM 13th edition, chapter 7.
 - 7. All cables terminated per T568B.
 - 8. Security cable color to be yellow.
 - 9. Data cable color to be blue
- B. Acceptable manufacturers
 - 1. Commscope/Systimax
 - 2. Belden
 - 3. Berk-Tek
 - 4. Superior Essex

2.3 CATEGORY 6 RJ-45 JACKS

- A. Specifications
 - 1. Exceeds TIA/EIA-568-B.2 Category 6 and ISO 11801 2nd Edition Class D standards
 - 2. Each jack is 100% tested to ensure NEXT and RL performance and is individually serialized for traceability
 - 3. Utilizes patent-pending enhanced *Giga-TX*TM Technology for jack terminations which optimizes performance by maintaining cable pair geometry and eliminating conductor untwist
 - 4. No punch down tool required; termination tool ensures conductors are fully terminated by utilizing a smooth forward motion without impact on critical internal components for maximum reliability
 - 5. Can be re-terminated a minimum of twenty times
 - 6. Red termination cap designates Category 6 performance and provides a positive strain relief; helps control cable bend radius and securely retains wires
 - 7. Terminates 4-pair, 22 – 26 AWG, 100 ohm, solid or stranded twisted pair cable
 - 8. Termination cap is color coded for T568A and T568B wiring schemes
 - 9. Accepts 6 and 8-position modular plugs without damage
 - 10. Can be clearly identified with optional labels and icons
 - 11. Colors include blue, white, green, yellow, red, or violet.

B. Acceptable Manufacturers

1. Commscope/Systimax
2. Panduit
3. Belden
4. Berk-Tek
5. Leviton

2.4 CATEGORY 6 PATCH PANELS

A. Specifications

1. Modular rack mounted
2. ANSI/EIA/TIA Category 6 RJ-45 connectors
3. Port count as indicated in Project Documents
4. Sweep tested through 250 MHz
5. UL 94VO polycarbonate construction
6. Phosphor bronze 90/10 tin lead IDC contacts
7. UL 1863 compliant
8. IDCs accept 26 through 22 AWG solid copper conductors

B. Acceptable Manufacturers

1. AMP/Netconnect
2. Commscope/Uniprise
3. Panduit/General Cable
4. Hubbell
5. Belden/CDT

2.5 CROSS CONNECT AND PATCH CABLE ASSEMBLIES

A. Specifications

1. ANSI/EIA/TIA Category 6
2. 4 pair RJ45
3. Bootless
4. All patch cables shall be an appropriate length. (this may require custom cable lengths in the telecommunications room)
5. Patch cables shall be constructed with cable of the same manufacturer as installed horizontal cable.

B. Acceptable Manufacturers

1. Commscope
2. Panduit
3. Belden
4. Berk-Tek

5. Leviton

2.6 MULTICONDUCTOR SHIELDED PAIRED CABLING

A. Specifications

1. #18 AWG 19 x 30 stranded tinned copper conductor
2. Overall aluminum polyester tape foil shield 100% coverage
3. 18 AWG drain wire
4. Pair count as appropriate to the application
5. Type CMP jacket (Type CM if installed in conduit)

B. Acceptable Manufacturers

1. Belden
2. West Penn Wire
3. Commscope
4. Mohawk

2.7 MULTICONDUCTOR UNSHIELDED PAIRED CABLING

A. Specifications

1. #18 AWG 19 x 30 stranded tinned copper conductor
2. Pair count as appropriate to the application
3. Type CMP jacket (Type CM if installed in conduit)

B. Acceptable manufacturers

1. Belden
2. West Penn Wire
3. Alpha

2.8 LOW VOLTAGE BUILDING WIRE

A. Specifications:

1. Conform to system manufacturer's requirements regarding size and type.
2. Conforms to UL Article 444 for low smoke and low flame and rated for use in air plenums.
3. Conforms to NEC 300-21, 300-22, and 725-2.
4. Low voltage wire shall be type THHN, THWN, or TFFN as appropriate to the application.
5. All low voltage building wiring shall be installed in conduit.

B. Acceptable Manufacturers

1. Atlas Wire
2. Cerrowire
3. Arthur J. Hurley Company

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Follow all ANSI/EIA/TIA installation guidelines
2. Follow all manufacturer installation guidelines
3. Follow all applicable NFPA and NEC codes

B. Cabling

1. Do not exceed recommended pulling tensions
2. Use only hook and loop type (Velcro™) Straps to secure and dress cabling.

3.2 LABELING

A. Equipment Room Cabinet Labeling:

1. Provide each cabinet with a laminated black phenolic resin label with a white core and engraved lettering, a minimum of 1/4-inch high.

B. Horizontal Cable Labeling:

1. Provide permanent, computer generated labels on both ends of every Horizontal Cable, Patch Cord and Equipment Cable

C. General:

1. Provide labeling based on ANSI/TIA/EIA-606 administration concepts
2. Provide typewritten labels, hand written labeling is not acceptable

3.3 WARRANTY

1. The Structured Cabling System shall have a factory warranty for twenty (20) years beginning on the date of Owner/User acceptance.

END OF SECTION 280513

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SECTION 280526 - GROUNDING BONDING AND POWER CONDITIONING FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Surge Protectors.
 - a. Protection of exterior power circuits
 - b. Protection of exterior data circuits
 - c. Protection of exterior signal circuits
 - d. Protection of power circuits entering equipment racks
 - 2. Ground Circuits
 - a. Ground circuitry for proper dissipation of lightning, voltage spikes, surges, transients and as required for life safety.
 - 3. Back Up Power
 - a. All microprocessor-based equipment shall be powered by an un-interruptible power supply (UPS).

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.

2.2 CARD READER SURGE PROTECTION

A. Specifications

1.	Service Voltage - Power:	12V/24V
2.	MCOV – Power:	18V/38V
3.	Clamping Voltage – Power:	22V/47V
4.	Service Voltage – Data:	<5V
5.	MCOV – Data:	6.8V
6.	Clamping Voltage:	7.2V
7.	Service Voltage:	<5V
8.	MCOV – LED:	8V
9.	Clamping Voltage – LED:	12V
10.	Max Cont Current:	3 Amps Power/Data, 150 MA LED
11.	Max Surge Protection:	2,000 Amps per pair (power)
12.	Protection Modes:	Line-ground
13.	UL497B listed	

B. Acceptable Manufacturer

1. Ditek DTK-4LVLPDR
2. Northern Technologies
3. Edco

2.3 POWER LINE SURGE PROTECTION

A. Specifications

1.	Load Rating:	20 amps at 120 volts
2.	Limiters:	Series surge reactor current limiter. Cascaded auto-tracking dual polarity voltage limiter. Dual pulse inverters.
3.	Clamping Voltage Onset:	172 volts nominal (2 volts above peak line voltage, auto tracking)
4.	Filter:	With 50 ohm load: 3 dB @ 3 kHz; 38 dB @ 100 kHz; 50 dB @ 300 kHz; 50 dB @ 5 MHz; 50 dB @ 30 MHz.
5.	Let-Through Slew Rate:	5000 volt/us disturbance reduced to 28 volts/us within power wave envelope; less than 10 volts/us outside power wave envelope.
6.	Snubber:	Instant reacting snubber for fast-rising surges generated within the building.
7.	Max Applied Surge Pulse Voltage:	6000 volts (1.2 x 50 us pulse)
8.	Max Applied Surge Pulse Joule Rating:	Unlimited, due to current limiting. (8x20 us)
9.	Max Applied Surge Pulse Current:	100,000 amperes (8x20 us)

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10. UL 1449-2 Adjunct Classification Test Results: 1000 surges, 6000 volts, 3000 amps, C1 pulse, measured suppressed voltage
290 volts, no failures.

B. Acceptable Manufacturer

1. SurgeX SX20-NE/RT, Wall Mount applications. SurgeX SX2120, rack mount applications. Provide one power conditioner for each 20-amp circuit feeding security electronics equipment
2. Eaton
3. Surge Guard
4. Approved Equal.

2.4 FLAT PANEL DISPLAY SURGE PROTECTION

A. Specifications

1. Load Rating: 8 amps @120 volts
2. Power Requirements: 10 Watts
3. UL Adjunct Class. Test Results: 1000 surges, 6000 volts, 3000 amps, C1 pulse, measured suppressed voltage
290 volts, no failures.
4. Federal Guidelines: Grade A, Class 1, Mode 1
5. EMI/RFI Filter, Normal Mode: 40 dB@ 100 kHz, 50 dB @ 300 kHz,
6. Max. Applied Surge Pulse Joule Rating: Unlimited, due to current limiting.
7. Maximum Applied Surge Pulse Voltage: 6000 volts (1.2 x 50 us pulse)
8. Overvoltage Shutdown: 145 volts

B. Acceptable Manufacturer

1. SurgeX SA82FlatPak.
2. Eaton
3. Surge Guard
4. Approved Equal

2.5 DATA LINE SURGE PROTECTION

A. Specifications

1. Primary Tech: Bipolar Silicon Avalanche Diode
2. Operating Frequency: DC to 30 MHz
3. Response Time: <5 nanoseconds
4. Protected Lines: Two pairs
5. Peak Pulse Energy Disp: 10 joules each mode
6. Interface: Wire clamp terminals
7. Current Rating: 7 amps max
8. Series Impedance: <.01 ohms

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9. UL497B listed

B. Acceptable Manufacturer

1. Northern Technologies PLP-S series surge protectors.
2. Ditek
3. Edco
4. Approved equal.

2.6 RS-232 SURGE PROTECTION

A. Specifications

1. Max Operating Voltage:	/- 20 V
2. Typ. Leakage current:	5 u amps
3. Max Data Rate:	22 kbps
4. Max Surge Current (10x1000usec):	43 amps
5. Max Clamp Voltage :	35 volts
6. Max Transient Voltage :	6 kV
7. Clamp Response Time:	< 1 nanosecond
8. UL 497B listed	

B. Acceptable Manufacturers:

1. Edco SRS-232 series surge protector
2. Ditek
3. Northern Technologies

2.7 VIDEO AND CAMERA POWER LINE SURGE PROTECTION

A. Specifications

1. Connection Method:	RJ-45, #22 - #14 AWG screw terminal
2. Svc. Voltage – Power:	48V
3. MCOV:	64V
4. Clamp Voltage:	72V
5. Peak Surge Current:	30A/pair
6. Standards Compliance:	EIA/TIA 568A, EIA/TIA 568B
7. Data Rate:	Gigabit Ethernet using all four pairs
8. Max. Continuous Power:	.3 A Video/Data, 5A power
9. Protection Mode:	Line-ground (All)
10. Listing:	UL497B

B. Acceptable Manufacturers

1. Ditek DTK-MRJPOE
2. Edco

3. Northern Technologies

2.8 RACK MOUNT UNINTERRUPTIBLE POWER SUPPLIES

A. Specifications

1. Nominal Input Voltage: 120 VAC +10% to -30%
2. Frequency: 50/60 Hz +/- 5 Hz
3. Capacity: 2.2kW
4. Power Factor: >.97
5. Harmonic Distortion: Less than 5%
6. Battery: Maintenance free sealed lead acid
7. Backup: 7mins full load
8. Life: 8 year design
9. Output Voltage: 120 VAC +/- 3%
10. Frequency: 50/60 Hz +/- .5%
11. Capacity: 1.4 kW
12. THD: 1% typical, 3% max
13. Current (RMS): 16.7 amps
14. Max Peak Current: 50 amps
15. Crest Factor: 3.0
16. Overload Capacity: 150% for 60 seconds
17. Monitoring: RS-232
18. UL 1778 listed, CUL Listed
19. True online double conversion design utilizing Insulated Gate, Bipolar Transistor (IGBT) technology

B. Acceptable Manufacturer

1. Toshiba UPS. Provide UPS for all circuits feeding security electronics headend equipment except those circuits feeding inductive loads.
2. Mitsubishi
3. MGE
4. Powerware

2.9 GROUNDING BUSS BAR

A. Specifications

1. Predrilled solid copper
2. NEMA standard bolt hole spacing
3. 0.25" thick minimum
4. Minimum dimensions: 4" high x 12" wide size to accommodate required connections.
5. Mounting: Minimum 2" insulated standoffs.
6. Cover: Lettered plexiglass as detailed in drawings.

B. Acceptable Manufactures

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1. Panduit
2. Harger
3. Andrew

2.10 GROUNDING CONDUCTORS

A. Specifications

1. Gauge: As indicated on drawings
2. Insulation: Green PVC 600 volt rated

B. Acceptable Manufacturers

1. Harger
2. Tessco
3. Kris-Tech

2.11 TWO HOLE CODE CONDUCTOR

A. Specifications

1. UL listed for use up to 35 KV
2. Temperature rated 90 degrees Celsius
3. CSA certified to 600V
4. Meets J-STD-607-A
5. Painting piercing washers required

B. Acceptable Manufacturer

1. Panduit
2. Harger
3. Andrew

PART 3 EXECUTION

3.1 INSTALLATION

- A. The System shall be installed by qualified personnel in strict compliance with manufacturer's instructions.
- B. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
- C. Equipment shall be firmly secured, plumb and level.
- D. All cable shall be tagged and identified.

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- E. Coordinate all work with other trades.
- F. Ground all equipment as per manufacturer's recommendations, IEEE 1100, NEC, and EIA/TIA guidelines.
- G. Provide equipment grounding conductor from equipment grounding lugs to ground bar. Size conductor based on length; see drawings for sizing requirements.
- H. Provide a green insulated grounding conductor from rack to ground bar.
- I. Grounding of security cables and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- J. The Trade Contractor shall provide power line surge and noise suppressor/filters for all equipment proposed. These devices shall buffer all video, control, and paging systems.

3.2 SYSTEM INITIALIZING AND PROGRAMMING

- A. The power system shall be turned on and adjustment made to meet requirements of the specification and on-site conditions prior to powering any security systems.
- B. Verify the output voltage of each power source outlet is within NEC guidelines for variation in voltage.
- C. All UPS units shall be fully charged prior to powering any security systems.

3.3 GROUNDING

- A. All equipment shall be grounded in accordance with the NEC, these specifications, and the equipment supplier's recommendations. Discrepancies shall be brought to the attention of the Architect Engineer for resolution prior to execution of the work.
- B. Power ground system and security electronics ground system shall remain physically separated throughout the facility and terminated at a single point on ground buss bar in the main electrical equipment room.
- C. Each equipment cabinet shall be bonded and grouped cabinets shall be bonded together and connected at a single point on ground buss bar.

3.4 LABELING

- A. Provide an identifier for each Grounding Bus bar that incorporates the identifier of the space the bus bar serves.
- B. Label both ends of all grounding conductors with both bus bars connected.

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3.5 SURGE PROTECTION

- A. All security metallic data and video lines entering or leaving a building shall be protected with surge protection devices. This specification also applies to field devices mounted on the exterior of the building.
- B. Grounding of protective devices shall be in accordance with the manufacturer's recommendations and/or as described in these specifications and drawings.
- C. All signal line protective devices shall be located at the terminal point nearest the cable interface with the exterior cable plant. Devices shall be mounted to the back panel of the cabinet. Provide separate enclosure for all surge protection devices mounted in equipment cabinets.

3.6 SYSTEM TEST PROCEDURES

- A. The System shall be completely tested to assure that all components are hooked up and in working order. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the 28 series scope of work, promptly notify the Architect Engineer in writing, indicating the cause of the defect and suggested corrective procedures.
- B. Provide written documentation showing all test results.
- C. The System shall be final tested in the presence of the Engineer.

3.7 OWNER INSTRUCTION

- A. Instruct Owner on replacement of all user serviceable components including surge protectors, UPS units, breakers, and fuses.

END OF SECTION 280526

SECTION 280530 – TAMPER-PROOF FASTENERS

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Removable tamper proof metal fasteners.
 - 2. Tools for removal and installation.
- B. Provide security (pinhead) Torx® type fasteners for all devices with exposed hardware. Pinhead Allen, spanner screw, etc. are not acceptable.
- C. Retrofit all exposed hardware of equipment provided with security hardware per these specifications. Products manufactured with exposed spanner or pinhead Allen hardware are required to have the manufacturers hardware removed and replaced with like type and size using the pinhead Torx® drive.

PART 2 PRODUCTS

2.1 DEFINITIONS

- A. Exposed areas: All areas within the building except Control rooms and Equipment Rooms.
- B. Secured areas:
 - 1. Within equipment rooms and within control rooms.
 - 2. Areas above security ceilings, behind access panels, and with-in pipe and duct chases.
- C. Tamper proof fasteners: Engineer approved, corrosion resistant, hardened, high strength, plated or stainless steel metal fasteners of size and type best suited for intended application. Removable types will have head design that requires special tool of controlled availability for installation and removal. Pinhead Allen, spanner screw, etc. are not acceptable.

2.2 MANUFACTURED UNITS

- A. Removable Fasteners
 - 1. Pinned TORX™ head socket fasteners.
 - 2. Spanner head screws: not permitted.

3. Pinned Allen screws: not permitted.

B. Accessories

1. Provide (4) complete sets of manual drive tools required for each type and size of fastener used.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Refer to individual specification sections for additional installation requirements
- B. Coordinate tamper proof fasteners material, finish, size, type, and thread requirements with other specification sections.

END OF SECTION 280530

SECTION 281116 - CABINETS AND ENCLOSURES FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish and install all equipment, materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Cabinets
 - 2. Non-standard manufacturer furnished enclosures and back boxes

PART 2 - PRODUCT

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.

2.2 FREE STANDING ELECTRONIC EQUIPMENT CABINETS

- A. Specifications
 - 1. Provide freestanding equipment cabinets to house 19" rack mountable equipment in the equipment rooms. Each cabinet shall have a rectangular frame with removable top panel, side panels and doors. Installed cabinets shall include thermal, power, and cable management accessories that control airflow through the cabinet and keep signal and power cables separate and organized
 - 2. The cabinet frame shall be rectangular with four corner posts, manufactured from steel with welded frame construction. The sides of the frame shall be punched at the top and bottom with a hole pattern to allow attachment of equipment mounting rails and thermal, cable and power management accessories. The cabinet frame shall support 2000 lbs of equipment.
 - 3. The cabinet shall be 27.6" wide by 36.3" deep by 88.8" high when doors, top panel and side panels are installed. Leveler feet will add approximately 1" to the height of the frame/cabinet.

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4. Each cabinet shall include two pairs of equipment mounting rails. Mounting rails shall bolt to the side of the cabinet frame at the top and bottom of the frame and shall be adjustable in depth to provide front and rear support for equipment. Equipment Mounting Rails shall be spaced horizontally to support 19" wide EIA-310-D compliant rack-mount equipment and shall provide up to 30.3" of rail-to-rail depth for equipment. Mounting rails shall be square-punched according to the EIA-310-D Universal hole pattern with equipment mounting holes on alternating 5/8" – 5/8" – 1/2" vertical hole centers. Square-punched holes shall accept cage nut hardware with various threads. Rack mount spaces or units (RMU) shall be 1-3/4" high and shall be marked and numbered on the mounting rails. Numbering shall start at the bottom of the rail. Mounting rails shall provide 48 RMU for equipment
5. The cabinet shall include a solid top panel with one 3" x 11.5" cable access port located near the center of the frame. The cable access port shall be plastic with a brush seal to allow easy addition and removal of cables while limiting bypass airflow.
6. The cabinet shall include two locking solid side panels with spring loaded latches for easy installation and removal. The cabinet shall be designed to allow baying with or without side panels installed.
7. The cabinet shall include a single front door with a perforated metal panel, hidden tamper-resistant hinges with quick-release hinge pins and a swing handle. The door shall be removable and reversible to open from the right or left. The door shall open to 150° when the cabinet is bayed with other cabinets. The front door shall have a single-point slam latch with a keyed lock.
8. The cabinet shall include a Single rear door with a perforated metal panel, hidden tamper-resistant hinges with quick-release hinge pins and a swing handle. The door shall be removable and reversible to open from the right or left. The door shall open to 150° when the cabinet is bayed with other cabinets. The front door shall have a single-point slam latch with a keyed lock.
9. The cabinet frame, top panel and side panel shall be manufactured from steel. The door frames shall be manufactured from steel and aluminum. Door panels shall be steel. The door handle, side panel latches, rear door hinges and top panel cable access ports shall be plastic. The cabinet frame and front and rear door shall be welded and bolted. Cabinet components shall assemble with hardware.
10. The mounting rails, top panel, side panels and doors shall be electrically bonded to the cabinet frame.
11. The cabinet shall be UL Listed as an Information Technology and Communications Equipment Cabinet, Enclosure and Rack System to standard UL 60950 under category NWIN. UL Listing will be stated in the manufacturer's product literature.
12. The metal components of the cabinet frame, top panel, side panels, and doors shall be painted black with epoxy-polyester hybrid powder coat paint. The mounting rails shall be zinc-plated and silver-colored. Plastic components shall be black.
13. The cabinet shall include (4) leveling feet, (4) clamps for securing the leveling feet to the floor, cage nuts of size and type required to mount all equipment and a means for bonding the cabinet to the Telecommunications Grounding Busbar.

B. Acceptable Manufacturers

1. Atlas Soundolier
2. Middle Atlantic

3. Lowell
4. Approved Other

2.3 MISCELLANEOUS EQUIPMENT RACK PANELS AND VENTS

A. Blank Panels

1. Specifications
 - a. 16 gauge steel.
 - b. Flanged top and bottom.
 - c. Durable textured black powder coat finish.
 - d. Available in 1-6 space sizes.
2. Acceptable Manufacturers
3. Middle Atlantic SB Series
4. Atlas Soundolier
5. Lowell

B. Vent Panels

1. Specifications
 - a. 1/16" diameter hole with 1/8" staggered centers. 23% open area.
 - b. 16 gauge perforated steel.
 - c. Flanged top and bottom.
 - d. Durable black powder coat finish.
 - e. Available in 1-4 space sizes.
2. Acceptable Manufacturers
 - a. Middle Atlantic VTF Series
 - b. Atlas Soundolier
 - c. Lowell

2.4 FREE STANDING EQUIPMENT CABINET COOLING FAN

A. Specifications

1. 115V 10" fan
2. Ball bearing design
3. Fan guard
4. Proportional speed control
5. Free air CFM, 500
6. Thermostatic fan control

B. Acceptable Manufacturer

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1. Middle Atlantic MW-10FT-FC fan and control. Furnish one for each free standing equipment cabinet. Provide vent blockers in accordance with manufacturers recommendations.
2. Lowell
3. Atlas Sound

2.5 POWER DISTRIBUTION UNITS

A. Specifications

1. 120 VAC output nominal
2. Max total current draw 16 Amps
3. NEMA L5-20P single phase locking plug
4. NEMA 5-20R receptacles (quantity of ??)
5. One, 3 meter line cord
6. Vertical rack design

B. Acceptable manufacturers

1. APC AP7530
2. Middle Atlantic
3. Lowell
CPI

2.6 NEMA RATED SECURITY EQUIPMENT ENCLOSURES

A. Specifications

1. All equipment enclosures installed indoors shall be NEMA 12 enclosures.
2. All equipment enclosures installed outside or exposed to weather shall be NEMA 4X enclosures.
3. Provide double door, continuous hinge enclosures
4. Enclosures shall be constructed of 14 gauge rolled steel, minimum.
5. Enclosure doors shall be furnished with key lock-able doors with all Enclosures under Division 28 keyed alike.
6. All enclosures shall be furnished with removable steel back panels for mounting equipment.
7. 60" x 48" and larger enclosures will be equipped with floor standing "feet"
8. Enclosures shall be grounded as specified in Section 28 05 26.
9. All enclosures shall be furnished with black-on-white laminated plastic nameplates identifying each cabinet.
10. Enclosures finish shall be ANSI 61 gray inside and out.
11. Enclosures shall be sized in strict accordance with the NEC. Minimum size is as indicated on the drawings.
12. Enclosure back panels shall be furnished with a grounding lug to be used to connect the cabinet to the signal grounding system specified in section 28 05 26.

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13. Enclosures shall be furnished with cross-ventilated, forced-air cooling to maintain the optimum temperature performance range of the equipment.

B. Acceptable Manufacturers

1. Hoffman.
2. Wiegmann
3. Hammond Manufacturing
4. Saginaw Control and Engineering

2.7 2 POST DATA RACK

A. Specifications

1. Standard 19" Data Rack
2. 45U Capacity
3. Black power coated
4. 1000 pound load capacity
5. 19"W, EIA-310-D compliant
6. Extruded Aluminum

B. Acceptable Manufacturers

1. Chatsworth
2. Middle Atlantic
3. Tripp Lite

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The System shall be installed by qualified personnel in strict compliance with manufacturer's instructions.
- B. All equipment cabinets are to be assembled and tested in the Security Electronics Contractor's facility prior to on-site installation. With the exception of field wiring, all interconnecting cables should be terminated and installed. All power distribution shall be completed.
- C. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
- D. Equipment shall be firmly secured, plumb and level.
- E. Cabinets shall be installed with the minimum NEC clearance of three feet in the front and three feet in the rear of the cabinet.

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- F. All cable shall be tagged and identified.
- G. Provide Panduit IN-Cabinet cable management system. segregate cabling into groups based on signal type and voltage.
- H. All power cables lengths are to be kept to a minimum and plugged into the nearest power outlet. Additional cable length shall be bundled and tied together using nylon cable ties.
- I. Maintain separation between 120VAC power cables and all signal level cables. When necessary, cross 120VAC power cables perpendicular to all other cable types.
- J. Coordinate all work with General Contractor and other trades contractors.
- K. Grounding of audio cables and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- L. All entrance and exit conduit shall utilize grounding bushings to terminate the conduit to the equipment enclosure. Route a green insulated ground conductor to the TMGB/TGB. See drawings for conductor sizing based on length.
- M. Blank panels and vent panels shall be used to fill all unused rack space.
- N. Every equipment rack shall be equipped with a ventilation fan and adequate venting. The fan shall be installed to bring air in from the bottom of the rack, drawing the cool air up and exiting out the top.
- O. Provide security covers for all rack mounted electronic components that do not require user interface.
- P. The Trade Contractor is responsible for 120VAC power distribution within the equipment racks.
- Q. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools etc. and leave the premises clean, neat and orderly.

3.2 SYSTEM TEST PROCEDURES

- A. Verify that all doors open and close without obstruction.
- B. Verify that cabinet fans are capable of circulating cool air throughout the equipment rack.
- C. Verify that all door locks function properly.
- D. Provide written documentation showing all test results.
- E. The system shall be final tested in the presence of the Architect Engineer.

END OF SECTION 28 11 16

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SECTION 281300 – ACCESS CONTROL SYSTEM FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
1. Furnish and install a complete and functional access control system. Provide coordination to ensure that the system furnished includes integration of or interfacing to all devices and systems.
 2. Provide programming that integrates control and monitoring of devices indicated in the project documents.
 3. Access control system will interface with the PLC Security Controls Systems allowing full control and monitoring of the access control system thru the PLC graphical user interface.
 4. Proximity card readers will interface with the access control system. Card data base, door schedules, event schedules, Guard tours, etc. will be maintained on the access control software.
 5. Detention grade proximity card reader will be used as notification points with in the Guard Tour timed events.
 6. Access control panel relay outputs will interface with the PLC security controls systems as inputs. The PLC system will then switch the required lock power to the electrified hardware. Valid card reads will initiate relay closures that in turn initiate the door open sequence.
 7. Access control panel relay feeds PLC input as valid read request to exit.
 8. Electro mechanical locking devices and door position switches will terminate to the security controls system.
 9. All system control locks will fail to a locked state.
- B. Furnish all software and programming labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
1. Programming of Access Control Computer and Controllers. Include programming that implements system management, control, and information storage data bases.
- C. System Configuration
1. The system shall be built with a three-tiered hardware hierarchy.
 - a. At the top tier is the network controller, which shall contain the database engine, web server, application software, and configuration data. It is at this level that System Users, through a browser interface, shall interact with the System, set configurations, monitor activities, run reports, and manage alarms.
 - b. At the second tier is the network node, an intelligent device with native TCP/IP support, which shall make and manage access control decisions.

- c. At the third tier are the application extension blades. Each of these blades shall connect to and manage the card readers and other peripheral devices in the access control system.
2. The network devices will reside on the facility's security control LAN.
3. The system shall perform access control decisions, define access levels, time specifications and threat levels, write system activity into a log file, maintain a personnel enrollment database, receive signals from card readers, energize output relays, and provide on-screen monitoring features.
4. The system shall have configurable threat levels. A change in threat level shall be capable of effecting a change in the behavior of the system. The areas of security system behavior that threat levels can change are portal unlock behavior, alarm event actions, and the function of access levels. A system user shall be able to configure threat levels, define behavioral changes based on the system threat level, and set the current threat level.
5. The system shall allow users to define access controlled regions that enforce either conventional timed anti-passback or heirarchical regional anti-passback. The software shall detect tailgate, occupancy, and passback violations. Users shall be able to specify the type of response to violations for each region. Response types shall include: Ignore, Soft, and Hard. If the response type is "Ignore," the system shall take no action. If the response type is "Soft," the system shall allow access but will log the occurrence in the activity log. If the response type is "Hard," the system will not allow access.
6. Ability to develop events of specific actions to respond to each violation and response type.
7. The system shall provide graphic floor plan capability including graphic display of links to other floorplans, alarms, and system resources such as portals, IP video cameras, inputs, outputs, and temperature monitoring points. The Network Administrator shall be able to graphically configure device icons onto the floor plan images. JPEG and PNG images shall be supported. The device images placed on the floor plan shall provide the following functions in real time:
 - a. Portal icons shall indicate access activity and permit lock control.
 - b. Video camera icons shall permit the display of the camera view.
 - c. Temperature point icons shall display the current temperature and allow the display of temperature graphs of temperature data from the last hour, day, week, or month.
 - d. Links shall provide one-click access to other floor plans.
 - e. Inputs and outputs shall graphically indicate alarm and activation states.
 - f. Alarm icons shall graphically indicate that an alarm is active.
8. The system shall provide for the performance of system administration tasks from any network-connected computer with a browser. These administrative tasks shall include but not be limited to monitoring all system activity including IP video, generating reports, enrolling personnel and credentials, and configuring system devices, and arming alarm panels.
9. The system shall maintain person data relating to access control, system user privileges, photo identification, system activity, and contact information. All person data in the system shall be integrated onto one tabbed page for viewing, editing, and deletion by

system users. This data shall be kept on the network controller and shall not require the use of separate storage devices. All decisions regarding persons in the system shall be made based upon this data. This includes access control decisions, system user privileges, and email or SMS notification of system events.

10. The system shall be Open Database Connectivity (ODBC) compliant. The on-board DBMS shall be PostgreSQL.
11. Provide 25% spare capacity for future expansion.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 01.
- C. Provide materials listed by UL or ETL.

2.2 CONTROLLER

A. Specifications

1. Cardholders: 150,000
2. Access Levels: Unlimited
3. Unique User Roles: 16
4. Simultaneous Users: 25
5. Time Specifications: 512
6. Portal Capacity: 1,792
7. Node Capacity: 128
8. Maximum Inputs / Outputs: 2,000 / 2,000
9. Online Transactions: Up to 160 million records
10. Client Requirements:
 - a. Operating System: Windows 10 (Owner requires latest version)
 - b. Browser: Chrome, Internet Explorer, Firefox and Safari
 - c. Processor: Intel Core i3 or higher
 - d. Memory (RAM): 8GB minimum
 - e. Hard Drive: 100GB minimum
11. Appliance
 - a. Storage Capacity: 128GB
 - b. Storage Configuration: N/A
 - c. Processor: Intel Pentium
 - d. Memory (RAM): 4GB
 - e. Operating System: Ubuntu Linux

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- f. Ethernet Ports: 1
- g. MTBF: 172,199
- h. Chassis: Standard 1U rack mount, rail kit included
- i. AC Input: 100-240 VAC, 50/60 Hz, 6/3A
- j. BTU Maximum: 948 per hour

B. Acceptable Manufacturers

- 1. S2 Security NetBox Enterprise
- 2. Lenel
- 3. Hirsch-Identive
- 4. IDentacard
- 5. Approved Equal

2.3 NETWORK NODE

A. Specifications

- 1. Portals: 2
- 2. Access Levels: 512
- 3. Supervised Inputs: 4
- 4. Relay Outputs: 4; 2 wet / dry selectable
- 5. Temperature Inputs: 1
- 6. Credential Storage: 150,000
- 7. Buffered Transactions: 800,000
- 8. Client Requirements:
 - a. Operating System: Windows 7 32 or 64 bit
 - b. Browser: Chrome, Internet Explorer, Firefox and Safari
 - c. Processor: Intel Core i3 or higher
 - d. Memory (RAM): 4GB
 - e. Hard Drive: 100GB minimum
- 9. General:
 - a. Processor: TI AM3352 ARM
 - b. Memory: 512MB SDRAM
 - c. Operating System: Linux
 - d. Ethernet Ports: 1
 - e. MTBF: 297,000 hrs

B. Acceptable Manufacturer

- 1. S2 Security MicroNode Plus
- 2. Lenel
- 3. Hirsch Identive
- 4. IDentacard
- 5. Approved Equal

2.4 Access Control Blade

A. Specifications:

1. Support up to two readers, four supervised inputs, and four relay outputs.
2. Reader connectors are 7-pin. Reader LED color control and reader beeper control are supported for many reader brands.
3. Readers require twisted, shielded 22 AWG Belden #9536 (6 conductor) or equivalent wiring and may be no more than 500 feet (152 meters) from the Access blade.
4. Supervised input connectors are 2-pin. The system shall support a wide variety of input supervision types including normally-open circuit and normally-closed circuits, and zero, one or two resistor configurations.
5. Inputs require twisted, shielded 22 AWG Belden #9462 or equivalent wiring and may be no more than 2000 feet (610 meters) from the blade.
6. Relay output connectors are 3-pin. Both normally-open circuit and normally-closed circuit output devices are supported. The relay outputs shall support any output devices that operate on the following maximum electrical ratings: 30 Volts DC or AC, 2.5 Amps inductive or 5.0 Amps non-inductive.
7. Outputs require twisted, shielded 22 AWG Belden #9462 or equivalent wiring and may be no more than 2000 feet (610 meters) from the blade.
8. Receive power via the ribbon cable bus directly from the Node Blade. The access blade shall supply up to 400 milliamps of power to one reader or 200 milliamps of power to each of two readers. Readers requiring more power than this shall be equipped with separate external power supplies.

B. Acceptable Manufacturers:

1. S2 Security
2. Lenel
3. Hirsch Identive
4. IDentacard
5. Approved Equal

2.5 WALL MOUNT PROXIMITY READERS

A. Specifications

1. 13.56 MHz.
2. 3.25" iClass Card maximum read range
3. 2" iClass Key/Tag maximum read range
4. Compatible with iClass 2kbits, 16kbits, 32kbits
5. Encrypted algorithm data transmission between card and reader
6. 64-bit authentication key

B. Approved Manufacturer

1. HID iClass readers. Provide model 6120B R40 reader for standard wall mount

- applications. Provide 6100B R10 for mullion mount applications.
- 2. Honeywell
- 3. Assa Abloy
- 4. Approved Equal

2.6 MULLION MOUNT READERS

- A. Specifications
 - 1. Proximity technology
 - 2. Single piece construction
 - 3. Potted electronics 4-16 VDC operation
 - 4. Compact modular design
 - 5. Field programmable
 - 6. No direct contact required
 - 7. Weather and vandal resistance
 - 8. Wiegand compatible
 - 9. Cable distance, 500 feet
 - 10. LED indicator with audible beep.

- B. Acceptable Manufacturer

- 1. HID iClass SE R10 mullion mount reader.
 - 2. Honeywell
 - 3. Assa Abloy
 - 4. Approved equal

2.7 VANDAL RESISTANT PROXIMITY READERS FOR GUARD TOUR

- A. Specifications
 - 1. Power requirements 5 or 12VDC (field selectable)
 - 2. Read Range = 4"
 - 3. ¼" stainless steel faceplate
 - 4. Audio and visual feedback

- B. Approved Manufacturer

- 1. Essex electronics – ROXPROX II series
 - 2. Honeywell
 - 3. Farpoint
 - 4. Approved Equal

2.8 SECURITY NETWORK SWITCH

- A. Specifications

- 1. (48) Ethernet 10/100/1000 ports

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2.	Forwarding Bandwidth:	108 Gbps
3.	Switching Bandwidth:	216 Gbps
4.	Forwarding Rate:	130.9 Mpps
5.	Flash Memory:	128 MB
6.	DRAM:	512 MB
7.	MAC addresses:	Up to 16,000
8.	IGMP groups/Multicast routes:	Up to 1000
9.	Configurable MTU:	9216 Bytes with jumbo frames
10.	1000BaseT ports:	RJ-45 connectors
11.	Input power:	100 – 240 VAC, 50-60 Hz
12.	Indicators:	
13.	Port link integrity	
14.	Port disabled	
15.	Port Activity	
16.	Port speed	
17.	Port full duplex	
18.	System status	
19.	System RPS	
20.	System link status	
21.	System link duplex	
22.	System PoE	
23.	System link speed	
24.	Operating Temp:	23° – 113° deg F
25.	Operating relative humidity:	10 – 85% non-condensing
26.	MTBF:	233,370 hours
27.	Measured Power consumption:	66 watts
28.	Certifications:	UL listed, FCC part 15 Class A
29.	POE:	IEEE 802.3at

B. Acceptable Manufacturers

1. Cisco9200 series PoE+ switch
2. HP
3. Extreme

2.9 PROXIMITY CARDS

A. Specifications

1.	Maximum read range	1.5-2.5"
2.	Dimensions	2.125"x3.375"x0.070" max.
3.	Construction	ABS Shell with PVC cover label
4.	Memory	EEPROM, read/write
5.	Multi-application memory	2k bit with 2 application areas

B. Acceptable Manufacturer

1. HID iClass SE Clam Shell – furnish 500 cards

2. ID Card Group
3. HID Global
4. Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All system programming shall be done at the contractor's facility prior to installation on site.
- B. Qualified personnel shall install the System in strict compliance with manufacturer's instructions.
- C. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
- D. Equipment shall be firmly secured, plumb and level.
- E. All cable runs to the main equipment rack shall be clearly tagged and identified. Refer to labeling section.
- F. Coordinate all work with other trades and Contractors.
- G. Grounding of devices and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- H. Install and configure Security local area network as required for control and communication between system devices. When required, provide necessary coordination, termination, and programming associated with integrating Security local area network with facility network.
- I. Equipment cabinets shall be assembled in the Contractor's shop prior to delivery to the job site.

3.2 SOFTWARE SUPPORT

- A. Refer to Section 284620 for software support and programming requirements.

3.3 SYSTEM INITIALIZING AND PROGRAMMING

- A. All programming shall occur in the Contractor's shop prior to installation on site.
- B. The System shall be turned on and adjustment made to meet requirements of the specification and on-site conditions.
- C. The System shall be programmed to function as specified.
- D. Any special programming shall be documented and a written copy given to the Owner/User.
- E. Coordinate integration of other electronic systems as called for in the contract documents.

3.4 SYSTEM TEST PROCEDURES

- A. The System shall be completely tested to assure that all components are installed and in working order.
- B. The System shall be pre-tested by the security equipment contractor and certified, in writing, to function in accordance with the plans and specification.
- C. The contractor is to verify the system is communicating with all controlled devices.
- D. Testing to be performed in the Contractors shop prior to delivery-
 - 1. Test 120VAC power equipment and hardware internal to all equipment racks. Test all conductors for shorts, opens, and polarity.
 - 2. Fully charge all UPS systems. Test unit by removing power thereby causing the unit to switch to battery reserve.
 - 3. Utilizing a test jig, simulate the operation of every circuit required.
- E. Testing to be performed at the job site prior to powering the system
 - 1. Test all 120VAC power sources for correct polarity and voltage. Test grounding system for continuity. Notify Electrical Contractor of any problems.
 - 2. The System shall be completely tested to assure that all components are hooked up and in working order. Motion detectors are to be aligned allowing for optimal pickup area. Locking devices are to be adjusted so that doors lock and unlock without interference. Correct all causes of such defects. If the cause is outside of the scope of the 281300 series scope of work, promptly notify the Architect in writing, indicating the cause of the defect and suggested corrective procedures.
- F. Additional job site testing
 - 1. After installation of head end electronics, verify proper operation of all field devices including locks, door position switches, card readers, push buttons, and intercom stations.
 - 2. Verify proper integration between control system and
 - a. Door control system
 - b. Video Surveillance system
 - c. Intercom/Paging system
 - d. Elevator controls
 - e. Overhead door controls
 - f. Handicap assist door operators
- G. The System shall be completely tested to assure that all components are hooked up and in working order. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the Division 28 series scope of work, promptly notify the Architect in writing, indicating the cause of the defect and suggested corrective procedures.
- H. The system shall be capable of operating under normal operating conditions.

- I. Provide written documentation showing all test results.
- J. The System shall be final tested in the presence of the Architect. Contractor is to provide all required testing equipment.

3.5 FIELD QUALITY CONTROL

- A. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 TRAINING

- A. Provide the facility personnel with training in the use and maintenance of the entire access control system. Coordinate that training session with the Owner/User. Completed classroom sessions will be documented by the Contractor, certified by the attending Owner/User representative, and approved by the Architect. Instruction shall take place during normal working hours (Monday through Friday, 8:00 a.m. to 5:00 p.m.). Instruction will not begin until all systems are operational as designed.
- B. The training sessions will cover the operation and the maintenance manuals and the control console operators manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain the control system.
- C. Contractor is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not be limited to the following-
 - 1. Review all O+M manuals with Owner/Users representatives present for training.
 - 2. Perform a tour of the entire facility. During the tour the trainer shall point out all control equipment and provide a brief description of its purpose and use. This is to include but not be limited to control panels (graphic and pushbutton), all control system hardware, and devices controlled.
 - 3. Explain functionality and operation of controlled entrances and systems including-
 - a. Overhead doors
 - b. Architectural doors
 - c. Detention doors
 - d. Elevators.
 - e. Handicap assist operators

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- f. Video surveillance
- g. Intercom/Paging

END OF SECTION 281300

SECTION 282313 – VIDEO SURVEILLANCE FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Visual surveillance of the facility via closed circuit television cameras as indicated on the plans.
- B. Video monitoring of all cameras on desktop and wall mount monitors at locations identified on the plans.
- C. Video monitoring of all cameras at work stations as shown on the plans.
- D. Review capabilities for the digitally recorded images via the facility LAN on Owner/User furnished workstations.
- E. Stored image transfer capabilities to allow archival functions and stored image transfer via removable media such as CD/DVD, USB.
- F. System is comprised of POE IP high resolution fixed color cameras. Refer to plans for quantity and location of cameras.
- G. Fixed cameras will utilize Category 6 cable to transport video signal to the recording system.
- H. Remote viewing software is required. Provide and install software for up to (4) remote viewing stations as indicated on the plans.
- I. Video surveillance system will integrate with PLC Control system allowing for automatic camera call up based on alarm activation. When an alarm is activated, the nearest camera will fill the designated call up monitor.
- J. All IP cameras, recording devices, viewing stations, and controllers will reside on the dedicated Security System LAN.
- K. Provide all software and licensing as required.
- L. Camera system to offer masking capability. Typical masking to include toilet/shower areas in detention areas, as well as other areas requested by Owner/User during final system testing.
- M. Camera system interfaces with PLC/GUI touchscreen system.
 - 1. When call in button on an intercom station is pushed, the intercom system initiates call up of the camera nearest the intercom station. Image is then displayed on the video surveillance monitor designated for call up.
 - 2. When a duress pushbutton or door position switch is activated, the access control system initiates call up of the camera nearest the duress or door. Image is then displayed on the video surveillance monitor designated for call up.

N. Requirements for video storage shall be determined by the following factors:

1. 30 days of video retention for all cameras
2. 7 fps
3. 24 hours/day recording
4. 40% motion factor
5. H.264 compression

O. All video must reside on the Storage Area Network.

P. Provide 25% spare capacity for future expansion.

PART 2 - PRODUCTS

2.1 GENERAL

A. Equipment specified is intended as a reference standard for level of quality.

B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 01.

C. Provide materials listed by UL or ETL.

2.2 INDOOR FIXED CAMERA, (3-9 MM, 2 MP), with Recessed Mount

A. Specifications

1. Image Sensor:	1/3" progressive scan RGB CMOS
2. Lens:	3-10 mm
3. Light Sensitivity:	.15 lux F1.3
4. Shutter Time:	1/66500 to 1 s
5. Camera Angle Adjustment:	Pan 180 deg, tilt 100 deg, rotation +/- 90 deg
6. Video Compression:	H.264 baseline profile
7. Resolution:	1920x1080
8. Frame Rate:	25/30 fps
9. Video Streaming:	Multiple, individually configurable streams in H.264 and Motion JPEG
10. Network:	Password protection, IP address filtering, HTTPS encryption, IEEE 802.1Xb network access control, digest authentication, User access log.
11. Audio:	Two-way. AAC LC 8/16 kHz, G.711 PCM 8 kHz, G.726 ADPCM 8 kHz configurable bitrate. External microphone input or line input, line output.

12. Supported Protocols: IPv4/v6, HTTP, HTTPSb, SSL/TLSb, QoS Layer 3 Diffserv, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, SynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
13. Intelligent Video: Video Motion Detection, Active tampering alarm, AXIS Camera Application Platform, enabling installation of additional applications.
14. Event Triggers: Intelligent video, edge storage events, external input
15. Event Actions: File upload, notification, external output activation, video recording to edge storage, pre and post alarm video buffering
16. Casing: IK10 impact resistant aluminum casing with transparent, polycarbonate cover and dehumidifying membrane.
17. Power: PoE IEEE 802.3af/802.3at Type 1 Class 2

B. Acceptable Manufacturers

1. Axis P3375-V Camera , recessed mount option used on indoor applications T94K02L
2. Bosch
3. Sony
4. Hanwha-Techwin

2.3 INDOOR/OUTDOOR 180 DEG CAMERA, (3-10.5 MM, 5 MP)

A. Specifications

1. Image Sensor: 4 x ½.9” progressive scan RBG CMOS
2. Lens: 3.2 mm
3. Light Sensitivity: .157lux F2.0
4. Shutter Time: 1/33500 s to 1 s
5. Camera Angle Adjustment: Pan +/-180 deg, tilt 35, 45, 55 deg, rotation +/- 10 deg
6. Video Compression: H.264 baseline profile
7. Resolution: 4320x1920
8. Frame Rate: 25/30 fps
9. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG
10. Network: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1Xb network access control, digest authentication, User access log.

11. **Supported Protocols:** IPv4/v6, HTTP, HTTPSb, SSL/TLSb, QoS Layer 3 Diffserv, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, SynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
12. **Intelligent Video:** Video Motion Detection, Active tampering alarm, AXIS Camera Application Platform, enabling installation of additional applications. Analytics included
13. **Event Triggers:** Intelligent video, edge storage events, external input
14. **Event Actions:** File upload, notification, external output activation, video recording to edge storage, pre and post alarm video buffering
15. **Casing:** IK10 impact resistant casing with transparent, polycarbonate cover and dehumidifying membrane.
16. **Power:** PoE IEEE 802.3af/802.3at Type 1 Class 3

B. **Acceptable Manufacturer**

1. Axis P3807-PVE
2. Bosch
3. Sony
4. Hanwah-Techwin

2.4 **INDOOR 360 DEG CAMERA, (1.8 MM, 6 MP)**

A. **Specifications**

1. **Image Sensor:** 1/8" progressive scan RGB CMOS
2. **Lens:** 1.6 mm
3. **Light Sensitivity:** .16 lux F2.0
4. **Shutter Time:** 1/100000 s to 2 s
5. **Camera Angle Adjustment:** Rotation 180 deg
6. **Video Compression:** H.264 baseline profile
7. **Resolution:** 2048x2048 to 160x160
8. **Frame Rate:** 25/30 fps
9. **Video Streaming:** Multiple, individually configurable streams in H.264 and Motion JPEG
10. **Network:** Password protection, IP address filtering, HTTPS encryption, IEEE 802.1Xb network access control, digest authentication, User access log.

11. Supported Protocols: IPv4/v6, HTTP, HTTPSb, SSL/TLSb, QoS Layer 3 Diffserv, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, SynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
12. Intelligent Video: Video Motion Detection, Active tampering alarm, AXIS Camera Application Platform, enabling installation of additional applications. Analytics included
13. Event Triggers: Intelligent video, edge storage events, external input
14. Event Actions: File upload, notification, external output activation, video recording to edge storage, pre and post alarm video buffering
15. Casing: IK10 impact resistant polycarbonate casing with transparent, polycarbonate cover and dehumidifying membrane.
16. Power: PoE IEEE 802.3af/802.3at Type 1 Class 3

B. Acceptable Manufacturers

1. Axis M3057-PLVE
2. Bosch
3. Sony
4. Hanwah-Techwin

2.5 OUTDOOR FIXED CAMERA, (4.3 – 8.6 MM, 5 MP)

A. Specifications

1. Image Sensor: 1/8" progressive scan RGB CMOS
2. Lens: 4.3 – 8.6 mm
3. Light Sensitivity: .24 lux F1.5
4. Shutter Time: 1/71500 s to 2 s
5. Camera Angle Adjustment: Pan 360 deg, tilt 80 deg, rotation 175 deg
6. Video Compression: H.264 baseline profile
7. Resolution: 3072x1728
8. Frame Rate: 25/30 fps
9. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG
10. Network: Password protection, IP address filtering, HTTPS encryption, IEEE 802.1Xb network access control, digest

11. Audio: authentication, User access log.
External microphone input or line input, line output.
12. Supported Protocols: IPv4/v6, HTTP, HTTPSb, SSL/TLSb, QoS Layer 3 Diffserv, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, SynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
13. Intelligent Video: Video Motion Detection, Active tampering alarm, AXIS Camera Application Platform, enabling installation of additional applications.
14. Event Triggers: Intelligent video, edge storage events, external input
15. Event Actions: File upload, notification, external output activation, video recording to edge storage, pre and post alarm video buffering
16. Casing: IK10 impact resistant aluminum casing with transparent, polycarbonate cover and dehumidifying membrane.
17. Power: PoE IEEE 802.3af/802.3at Type 1 Class 3

B. Acceptable Manufacturer

1. Axis Q3517-LV
2. Bosch
3. Sony
4. Hanwah – Techwin

2.6 MINIATURE PINHOLE CAMERA

A. Specifications

1. Image Sensor: 1/4" progressive scan RBG CMOS
2. Lens: 3.7 mm
3. Shutter Time: 1/24500 s to 1/6 s
4. Horizontal Field Of View: Horizontal 57 deg.
5. Video Compression: H.264, Motion JPEG
6. Resolution: 1280x720
7. Frame Rate: 25//30 fps
8. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG
Controllable frame rate and

- 9. Network:
 - bandwidth, VBR/CBR H.264
 - Password protection, IP address filtering, HTTPS encryption, IEEE 802.1Xb network access control, digest authentication, User access log.
- 10. Supported Protocols:
 - IPv4/v6, HTTP, HTTPSa , SSL/TLSa , QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMP v1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, SFTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS, SSH

B. Acceptable Manufacturer

- 1. Axis P1214
- 2. Bosch
- 3. Hanwha – Techwin

2.7 32” DESKTOP VIDEO MONITOR

A. Specifications

- 1. Screen Size: 32” class
- 2. 4K compliant
- 3. Aspect Ratio: 16:9
- 4. Native Resolution: UHD (3840x2160)
- 5. Display Type: LED
- 6. Brightness: 350 CD/m2
- 7. Refresh Rate: 60 Hz min
- 8. Response Time: 8 ms
- 9. Viewing Angle: 178 degrees hor/ver
- 10. Dynamic Contrast Ratio: 5,000:1
- 11. Pixel Pitch: .2451 x .2451
- 12. Inputs: Displayport, USB, and (4) HDMI
- 13. 4K compliant

B. Acceptable Manufacturer

- 1. LG display for use with CCTV viewing station.
- 2. Sony
- 3. Panasonic
- 4. Approved equal

2.8 VIDEO MANAGEMENT SYSTEM SERVER

A. Specifications

1.	Operating System:	Microsoft Windows Server 2016
2.	Processor:	Intel i7 – Processors as required
3.	Memory:	(4) 16GB DIMMs
4.	Slots:	2 x PCIe 3.0 slots + 1 slot for internal storage
5.	Network Controller:	2 x 1GbE
6.	Video Outputs:	2 x VGA
7.	Remote Access:	iDRAC8 Express
8.	Form Factor:	Rack server
9.	Power:	2 x 350 W hot plug redundant power supplies

B. Acceptable Manufacturer

1. HP DL 580
2. Dell
3. Approved Equal

2.9 VIDEO MANAGEMENT SYSTEM

A. Specifications

1. Enterprise-Class Client/Server based video management system.
2. Operating System: Windows 10 (Owner requires latest version)
3. The NVMS shall provide the capability to configure and manage alarms and events.
 - a) Individual alarms from a third party system (access control, etc.) can be pre-selected and configured to be monitored.
 - b) Can define alarm events and triggers.
 - c) Can configure resulting video operations.
 - d) Detect if the video or audio signal is lost. And alert the system administrator.
 - e) Support receiving SNMP messages from servers and alert users.
 - f) Alarm and event notifications can be customized and forwarded to:
 - 1) Users logged into the client application
 - 2) Users logged into the mobile application
 - 3) Configured email addresses
 - 4) External entities and third party software, such as central monitoring stations and call centers
 - g) Can escalate alarms from one user or group to another if the alarm is unacknowledged for a preset duration.
 - h) Email notifications can be configured to:

- 1) Notify users and system administrators when an event or system health error occurs
 - 2) Schedule when email notifications are sent
 - 3) Include camera images in email notifications
- i) Support receiving digital input triggers and triggering digital outputs from:
 - 1) An input/output board
 - 2) Supported IP camera or encoder
 - 3) Integrated system
4. The NVMS shall provide the ability to send central monitoring stations heartbeat messages, or regular notification to confirm the system connection and that there are no events of note.
5. The NVMS shall maintain an event log and allow users to use the log events as triggers for specific event actions. Logged events include:
 - a) Server Events
 - b) Device Events
 - c) User Events
 - d) Alarm Events
6. The NVMS shall have the ability to assign actions in response to specific event triggers. Response actions include:
 - a) User Notification Actions
 - b) Monitoring Actions
 - c) Device Actions
 - d) PTZ Actions
 - e) Alarm Actions
7. The NVMS shall support conditional event triggers based on the selected digital input status.
8. The NVMS shall monitor events and alarms based on a user configurable schedule.
9. The NVMS shall provide a maintenance log and audit trail of all system errors and events.
10. The NVMS shall support software level integration with third party applications using the NVMS SDK, The SDK shall provide the following features to the third party software:
 - a) Connection
 - b) Video Streaming
 - c) Video overlays
 - d) PTZ Control
 - e) Audio-Streaming
 - f) Alarm Management
 - g) Event Management
 - h) Bookmark Management
 - i) Digital Output
 - j) Backup/export

11. The NVMS shall provide a process for upgrading versions:
 - a) Upgrades shall be launched from the client interface.
 - b) All connected servers and clients shall receive a distribution of the new version upgrade.
12. The NVMS shall run as a service configured to automatically start when the server or workstation is powered on.
13. The NVMS shall allow users to monitor and administer the system from:
 - a) A single client application for monitoring live and recorded video and audio.
 - b) A single window for administering all system connections.
 - c) A single tab for monitoring overall system health and connected sites in parent-child relationships.
 - d) Any client with access to a local or distributed network.
14. The NVMS shall provide multiple levels of system redundancy.
15. The NVMS shall provide the capability to rename all sites, servers, and video and audio sources.
16. The NVMS shall support the following video and audio recording programs:
 - a) The ability to manually trigger recording.
 - b) Provide a pre-event and post-event recording option.
 - c) Provide a reference frame recording option in the absence of events.
 - d) Create a recording schedule than can be defined individually for each video source.
17. The NVMS shall provide configurable classified object detection for each device with self-learning video analytics capabilities.
 - a) Allow users to connect individual video sources to analytics appliance channels.
 - b) Allow users to configure events based on classified object motion detection.
 - c) Allow configured video analytics events to be used as alarm and rule triggers.
 - d) Allow users to mark classified objects as a true or false detection.
18. The NVMS shall support the following video analytic event types when captured by supported cameras.
 - a) Objects in area.
 - b) Object loitering.
 - c) Object crossing defined line.
 - d) Object appears or enters area.
 - e) Object not present in area.
 - f) Object enter area.
 - g) Object leave area.
 - h) Object stops in area.
 - i) Anticipated direction of travel is violated.

- j) Scene dramatically changes in an unexpected fashion.
19. The NVMS shall authenticate users before granting access to the system.
 20. The NVMS shall provide access rights that can be tailored to each user or groups of users. Access rights include:
 - a) View live images.
 - b) View recorded images.
 - c) Manage saved images.
 - d) Manage maps
 - e) Manage web pages.
 - f) Manage virtual matrix monitors.
 - g) Initiate collaboration sessions.
 - h) Manage user sessions.
 - i) Listen to microphones.
 - j) Setup cameras.
 - k) Setup sites
 - l) Setup servers
 21. The NVMS shall provide the ability to rank access rights based on a user's position within a configured.
 22. The NVMS shall allow the creation of Site families.
 23. The NVMS shall support multiple credentials to gain access to the system including, but not limited to:
 - a) The ability to import members of Active Directory groups as users in the NVMS.
 - b) Using Windows credentials to authenticate users.
 - c) Accept user credentials entered into the NVMS user database.
 22. The NVMS shall provide the ability to schedule archive of recorded video with associated events to a local folder or mapped network drive.
 23. The NVMS shall provide the ability to backup settings and configuration for each server including:
 - a) All site settings such as user/groups, maps and web pages.
 - b) All server settings including device connections.
 - c) Ability to encrypt the backup to maintain security of information.
 24. The NVMS shall be able to restore backed-up settings and configurations to a new or replacement server in a Site.
 25. The NVMS shall provide the ability to enable and configure PTZ control on the RS-485 interface of a video source.
 26. The NVMS shall provide the ability to change the following image quality and image rate parameters for each individual video source.
 27. The NVMS shall provide the ability to change supported video options at the client or video source.
 28. The NVMS shall provide the ability to change the input, output, gain and volume for an audio source.

29. The NVMS shall support the use of uni-directional and bi-directional audio.
30. The NVMS shall provide the ability to link any audio source to any video source.
31. The NVMS shall provide the ability to manage and personalize user access.
32. The NVMS shall support the ability to bias the displayed video to a lower frame rate or lower image resolution if there is sufficient network bandwidth or processing power.
33. The NVMS shall provide the ability to control the client application using the following types of peripherals.
 - a) A USB keyboard and/or mouse.
 - b) A USB joystick.
 - c) A PTZ controller keyboard.
34. The NVMS shall support the ability to share the application window display in a joint session with other users for collaborative investigations.
35. The NVMS shall provide a system tree of video sources, maps, saved views and web pages in the video monitoring tab.
36. The NVMS shall support an unlimited number of monitors used for monitoring video and audio streams connected to a single workstation.
37. The NVMS shall provide a Virtual Matrix application module.
38. The NVMS shall provide the option to display overlays on top of video images.
39. The NVMS shall support alarm management operations through the video monitoring interface.
40. The NVMS shall support the ability to manually trigger digital output.
41. The NVMS shall support the ability to create a map that represents the physical location of cameras and other devices throughout the surveillance system.
42. The NVMS shall support playback of recorded audio and video.
43. The NVMS shall support the following methods for navigating recorded video:
 - a) Timeline shall list all displayed video sources.
 - b) Timeline shall highlight motion and events in the recorded video.
 - c) The NVMS shall support a timeline that can display down to quarter second increments.
 - d) The NVMS shall support a timeline that can synchronize video displayed on multiple tabs to the same point in time.
44. The NVMS shall support recorded video search.
 - a) Time
 - b) Date
 - c) Video Source
 - d) Alarm
 - e) Event type
 - f) Visual search based on pre-defined image area, or image thumbnail.
 - g) Pixel motion or user defined areas.
 - h) Classified object motion detection on supported video analytics sources.
 - i) Bookmarks.
45. The NVMS shall support the ability to export media and provide the following options:

a) Export recorded video in the following formats:

- 1) Native (AVE)
- 2) JPEG
- 3) PNG
- 4) TIFF
- 5) AVI
- 6) Print

b) Export recorded audio in the following formats:

- 1) WAV
- 2) Native (AVE)
- 3) AVI

46. The NVMS shall have the ability of retaining all stored video for 30 calendar days.

B. Acceptable Manufacturer

1. ExacqVision
2. Genetec
3. Avigilon
4. Bosch
5. Approved Equal

2.10 VIDEO MANAGEMENT SYSTEM WORKSTATION

A. Specifications

1. Viewing Streams:	Up to 72
2. Viewing Rate:	Up to 10 MB/s
3. Operating System:	Windows 10
4. Processor:	Intel Xeon Processor E3-1220V3
5. Memory:	8 GB RAM
6. Network Interface:	2 Gigabit Ethernet RJ-45 port (1000Base-T)
7. Video Outputs:	2 active (1 DisplayPort and 1 DVI)
8. Optical Drive:	1 DVD-RW
9. Power Input:	100 to 240 VAC, 50/60 Hz, auto-switching
10. Power Supply:	Single non-redundant
11. Power Consumption:	320 W
12. Supplied Accessories:	USB Keyboard, USB mouse, power cord, 1 DisplayPort to DVI adapter, (1) DVI to VGA adapter

B. Acceptable Manufacturer

1. HP
2. DELL
3. Approved Equal

2.11 VIDEO STORAGE AREA NETWORK

A. Specifications

1.	Storage Controllers:	Dual controllers with 16GB non-volatile memory
		per controller with up to 512GB non-volatile memory in a group of 16 arrays
2.	Drive Types:	24 hot-pluggable 2.5" SSD's
3.	Network Interface:	10GbE connectivity; management network: 1 x 100BASE-TX per controller: interface ports: 2 x 10GBASE-T with RJ-45 or 2 x 10GbE SFP+ for fibre or twin-ax copper cabling
4.	Drive Capacities:	1.6TB SSD
5.	System Capacities:	Up to 38.4TB (up to 614.4TB with 16 arrays)
6.	Host protocol:	Any standards compliant iSCSI initiator
7.	Operating system:	Microsoft Windows Server
8.	RAID:	RAID 6
9.	TCP network support:	IPv4, IPv6 compliant. USGv6 certified
10.	Reliability:	Redundant hot-swappable controllers, hot-swappable disk drives and power supplies
11.	Form Factor:	2U
12.	Power:	dual 700W

B. Acceptable Manufacturer

1. HP MSA 2050. Provide a quantity of digital storage arrays to support the number of cameras shown on the plans, as well as the recording parameters outlined in this section.
2. Dell
3. Axis
4. Approved Equal

2.12 SECURITY NETWORK SWITCH

A. Specifications

1.	(48) Ethernet 10/100/1000 ports	
2.	Forwarding Bandwidth:	108 Gbps
3.	Switching Bandwidth:	216 Gbps
4.	Forwarding Rate:	130. Mpps
5.	Flash Memory:	128 MB
6.	DRAM:	512 MB
7.	MAC addresses:	Up to 16,000
8.	IGMP groups/Multicast routes:	Up to 1000
9.	Configurable MTU:	9216 Bytes with jumbo frames
10.	1000BaseT ports:	RJ-45 connectors
11.	Input power:	100 – 240 VAC, 50-60 Hz
12.	Indicators:	

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- a) Port link integrity
- b) Port disabled
- c) Port Activity
- d) Port speed
- e) Port full duplex
- f) System status
- g) System RPS
- h) System link status
- i) System link duplex
- j) System PoE
- k) System link speed

13. Operating Temp:	23° – 113° deg F
14. Operating relative humidity:	10 – 85% non-condensing
15. MTBF:	233,370 hours
16. Measured Power consumption:	66 watts
17. Certifications:	UL listed, FCC part 15 Class A
18. POE:	IEEE 802.3at

B. Acceptable Manufacturers

- 1. Cisco 9200 series PoE+ switch
- 2. HP
- 3. Extreme

PART 3 - COMPLETION

3.1 INSTALLATION

- A. All system programming shall be done at the contractor's facility prior to installation on site.
- B. Qualified personnel shall install the System in strict compliance with manufacturer's instructions.
- C. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
- D. Equipment shall be firmly secured, plumb and level.
- E. All cable runs to the main equipment rack shall be tagged and identified.
- F. Coordinate all work with other trades and Contractors.
- G. Grounding of cables and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- H. Install and configure Security local area network as required for control and communication

between system devices. When required, provide necessary coordination, termination, and programming associated with integrating Security local area network with facility network.

- I. Equipment cabinets shall be assembled in the Contractor's shop prior to delivery to the job site.
- J. Cameras shall be aimed and focused.
- K. Cameras
 - 1. Cameras shall be securely mounted to structure in compliance with details outlined in the bidding documents as well as requirements of the manufacturer.
 - 2. Cameras shall be aimed to optimize intended viewing area.
 - 3. Cameras shall be focused.
 - 4. Iris shall be adjusted to maximize image quality.
 - 5. Manual zoom shall be adjusted.
 - 6. Clean camera, lens, and housing of dust, debris, and any loose materials.
 - 7. Cable shall be dressed to avoid kinks or excessive bends. Secure cable in back box.
 - 8. Necessary trim plates shall be included to mask back box/openings.
- L. Viewing Workstation/Software
 - 1. Cameras shall be given a unique name corresponding to room/area covered. All naming shall be reviewed and approved by the owner/user prior to final programming.
 - 2. Define viewing/programming permissions with owner/user. Establish all necessary log-ins required for authorized users.
 - 3. Define and program viewing configurations for each viewing workstation including intended camera images, matrix layout, etc.
 - 4. Define and program camera specific characteristics including record frame rate, record on motion parameters, blocking, video analytics, etc.
 - 5. Configure remote viewing on owner furnished mobile devices.
 - 6. Define and program camera blocking preventing viewing of sensitive data by blocking live and recorded cameras based on permission levels.
 - 7. Program camera image call up and increased record frame rate based on alarm activation. Provide necessary programming and integration between video surveillance system and access control or alarm system.
 - 8. Integrate video surveillance LAN with facility LAN for remote viewing.

3.2 SOFTWARE SUPPORT

- A. Refer to Section 284620 for software support and programming requirements.

3.3 SYSTEM OPERATIONAL SUPPORT

- A. As part of the shop drawing submittal, the Contractor is required to submit a written report outlining the project specific functions and operational procedures of the video surveillance system. The report shall be provided to the owner/user for their review and comment. This report will include the following-

1. The Contractor shall present proposed operational procedures for every function specified in Contract Documents or recognized as industry standard or convention for a visual surveillance system. All operational procedure possibilities will be presented to the Owner/User & Architect by the Contractor.
2. The Contractor shall address integration of the components and subsystems making up the system when presenting the proposed operational procedures.
3. As a minimum the report shall contain the following:
 - a) A procedural description of each and every control function.
 - b) A procedural description of all administrative functions available to supervisory and maintenance personnel (e.g. log in storage requirements, record on motion, masking, etc.).
 - c) A preliminary technical description of how each function will be accomplished.
 - d) Schedules of integrated actions (e.g. Record activated by duress alarms, camera call-up, etc.).
4. Contractor shall review report with owner/user and based on received input define the final programming requirements of the system.

3.4 SOFTWARE SUPPORT

- A. Prior to programming of the system, the Contractor shall request, in writing, scheduling of a system programming coordination meeting. This meeting is to take place prior to product procurement, after submittals have been approved. A proposed agenda shall be included with the request.
- B. Using the above mentioned report as a guideline, the purpose of the coordination meeting is to define the project specific functions and operational procedures of the video surveillance system with the Owner/User and Architect.
- C. The Contractor shall present proposed operational procedures for every function specified in Contract Documents or recognized as industry standard or convention. The Contractor will present all operational procedure possibilities to the Owner/User & Architect.
- D. The Contractor shall address integration of the components and subsystems making up the video surveillance system when presenting the proposed operational procedures.
- E. The contractor shall refrain from any programming of the video surveillance system until after the Architect has reviewed and approved the programming report.
- F. The Owner/User and Architect reserve the right to change programming of the video surveillance system after installation and prior to final acceptance.

3.5 FINAL ADJUSTMENTS

- A. Calibrate video surveillance equipment and verify operation before the system is placed on-line. **Provide written calibration values for each camera utilizing an IP camera tester such as the CCDCAM ET-2623T or equivalent.** Before obtaining permission

from the Owner/User to schedule the acceptance test, provide written certification to the Architect that the complete system has been calibrated, tested and is ready to begin the 14 day burn-in period and acceptance testing.

B. Acceptance tests

1. Conduct final acceptance test after a period of not less than 14 consecutive normal working days of trouble free operation, on the complete and operational video surveillance systems to demonstrate that it is functioning in accordance with all requirements of this specification. During this burn-in period, the video surveillance system shall operate continuously for 24 hours per day. Demonstrate the correct operation of all monitored and controlled points as well as the operation and capabilities of all sequences during the acceptance test.
2. Should retesting be deemed necessary by the Architect due to malfunction or inappropriate construction methods, the Contractor shall be fully responsible for additional cost incurred for retesting, including the Architect and Contractor's time.
3. Final system acceptance shall be based upon the completion of the following items:
 - a) Completion of the installation of all hardware items. Complete operation of the system, with no failures during the entire acceptance test period.
 - b) Satisfactory completion of the as-builts, operating, and maintenance manuals.
 - c) Satisfactory completion of all training programs.
 - d) Upon final acceptance, the warranty period shall begin.

3.6 SYSTEM TEST PROCEDURES

- A. The System shall be completely tested to assure that all components are hooked up and in working order. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the Division 28 series scope of work, promptly notify the Architect in writing, indicating the cause of the defect and suggested corrective procedures.
- B. The contractor is to verify the system is communicating with all controlled devices.
- C. Test 120VAC power equipment and hardware internal to all equipment racks. Test all conductors for shorts, opens, and polarity.
- D. Verify operation of battery backup. Test by removing power from system.
- E. Verify all field wiring is free of shorts and opens prior to termination of head end electronics.
- F. Provide written documentation showing all test results.
- G. The System shall be final tested in the presence of the Architect. Contractor is to provide all required testing equipment.

3.7 TRAINING

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- A. Contractor is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not be limited to the following-
 - 1. Review all O+M manuals with Owner/Users representatives present for training.
 - 2. Perform a tour of the entire facility. During the tour the trainer shall point out all surveillance equipment and provide a brief description of its purpose and use. This is to include but not be limited to cameras, monitors, control stations, recording devices, and devices controlled.
 - 3. Typical of viewing stations-
 - a) Demonstrate basic functionality of equipment.
 - b) Demonstrate devices/systems controlled by panel.
 - c) Review camera call up and integration with access control/alarm system
 - d) Review navigation of system.
 - e) Review control functions on keyboard.
 - 4. Typical of recording/storage systems
 - a) Demonstrate basic functionality of equipment
 - b) Demonstrate navigation of system
 - c) Demonstrate archival retrieval
 - d) Demonstrate saving of archival retrieval to disc.

END OF SECTION 282313

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-alarm control unit.
 - 2. Manual fire-alarm boxes.
 - 3. System smoke detectors.
 - 4. Heat detectors.
 - 5. Notification appliances.
 - 6. Magnetic door holders.
 - 7. Remote annunciator.
 - 8. Addressable interface device.
 - 9. Digital alarm communicator transmitter.
 - 10. Firefighter's Smoke Control Panel.

1.3 DEFINITIONS

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

1.4 SYSTEM DESCRIPTION

- A. New non-coded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
- B. The system must be a recent model for which replacement parts and local service are guaranteed to be readily available for a minimum of ten (10) years from the date of installation.
- C. Any materials not specifically mentioned, but required for proper performance and operation must be furnished and installed. Coordination with infrastructure items such as telecommunications must be planned for and itemized as needed.

- D. Installation of any system in no way implies continued maintenance service contracts with the installing Contractor. The installed system shall have replacement parts that are readily obtainable and can be serviced by a third-party, licensed vendor who is Owner-selected by a separate bid process. Such service shall not have an effect on warranties.

1.5 SUBMITTALS

A. General Submittal Requirements:

- 1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
- 2. Complete shop drawing submittals, as listed in Paragraph 1.5.C below, shall be submitted for permit and to the Owner for approval prior to installation.
- 3. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified fire-alarm technician, Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.

B. Product Data: For each type of product indicated.

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work. Shop drawings, battery calculations, voltage drop calculations, wiring diagrams, sequence of operations for all programmed conditions, listings, and complete cut sheets and installation program manuals must be provided for permit and Owner approval prior to installation.

- 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
- 2. Include voltage drop calculations for notification appliance circuits.
- 3. Include battery-size calculations.
- 4. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
- 5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
- 6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- 7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.
- 8. Include sequence of operations for all programmed conditions.
- 9. Include certified listings.
- 10. Include data product sheets for each system component.
- 11. Include installation manuals.
- 12. Include programming manuals.

13. Firefighter's Smoke Control Panel.

D. Qualification Data: For qualified Installer.

1. Installer must be at a minimum a Certified Alarm System Contractor I and a direct sales division of, or the authorized and designated distribution for, the fire alarm system manufacturer.
2. Minimum of five (5) years of manufacturer-certified experience with the installed system.
3. Authorized by manufacturers listed to install their system.
4. Device installation, connections, terminations, final programming, and testing and certification shall be performed by a NICET Level III or higher technician.
5. The installation contractor's personnel shall be FASA certified and have their identification cards with them at all times. Failure will result in removal from the job site until such time as proof of FASA certification is provided.
6. The installed system must have replacement parts which are readily obtainable and can be serviced by a third part licensed vendor which is Owner-selected by separate bid process.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.
3. Provide a digital and printed copy of the site-specific software, including any passwords and/or dongles required for software access.
4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:
 - a. Frequency of testing of installed components.
 - b. Frequency of inspection of installed components.
 - c. Requirements and recommendations related to results of maintenance.
 - d. Manufacturer's user training manuals.
5. Manufacturer's required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete data files and all related access devices/passwords.
3. Print out, in PDF format, of the entire site-specific software, including device address lists, custom control equations, etc.
4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.
- C. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer. Components shall be compatible with, and operate as, an extension of existing system.
- 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.

1.7 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- C. 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.

1.8 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
 - 3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
 - 5. Keys and Tools: One extra set for access to locked and tamper-proofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in the system.

1.9 OWNER TRAINING

- A. A training session must be presented by a fully qualified and trained representative of the equipment manufacturer who is thoroughly knowledgeable of the specific installation for personnel selected by the Owner. Training, consisting of a minimum of two (2) sessions at three (3) hours each must be scheduled with the Owner to accommodate a day and evening shift attendance, and must be video recorded by the Contractor. Training is to cover, at a minimum, how the operator is to perform the basic duties such as resetting, activating, troubleshooting, bypassing and testing. Presentation must include instructional handouts as needed and viewer participation and demonstration.
- B. Provide training session by a qualified installer/trainer. Provide a minimum of three sessions (one per work shift).
- C. A reproducible training presentation shall be provided to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. NOTIFIER; a Honeywell company.
 - 2. Simplex
 - 3. Fire Control Instruments, Inc. (FCI)
- B. Installation of any system in no way implies continued maintenance service contracts by the installing contractor. The system installed must be such that replacement parts are readily available and can be served by a third party licensed vendor. Such service shall not impact any stated warranties.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
 - 4. Duct smoke detectors
 - 5. Verified automatic alarm operation of smoke detectors.
 - 6. Automatic sprinkler system water flow.
 - 7. Heat detectors in elevator shaft and pit
 - 8. Fire-extinguishing system operation.
 - 9. Fire standpipe system.
- B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Recall elevators to primary or alternate recall floors.
10. Activate emergency shutoffs for gas and fuel supplies.
11. Record events in the system memory.
12. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Low-air-pressure switch of a dry-pipe sprinkler system.
3. Elevator shunt-trip supervision.
4. Duct detector operation.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.
9. Low-air-pressure switch operation on a dry-pipe or pre-action sprinkler system.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the event on system printer.

F. Dedicated HVAC control detectors must not sound general alarm unless required by code.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:

1. The fire alarm control panel (FACP) must be in a unified enclosure, microprocessor-based, intelligent loop interfaced, modular in construction, and in a complete new cabinet.
2. Capable of being expanded at any time for up to the predetermined capacity for the known building additions or for a minimum of two (2) additional modules.

3. The system, in its entirety, must be all new from a single manufacturer with a currently Nationally Recognized Testing Laboratory Listing (NRTL) comprehensive of all components for the fire protective signaling purpose for which they are used. Fire alarm panels must be listed at a minimum to the most recent UL 864 edition standards.
4. The FACP must, at a minimum, Include:
 - a. Walk Test.
 - b. Positive Alarm Sequence (PAS).
 - c. Alarm Verification.
 - d. Voice Evacuation.
 - e. Multi-Level Alarm Processing.
 - f. Trouble Reminder.
 - g. Dry Contacts (Zone, Trouble, Alarm and Supervisory).
 - h. Smoke Detector Sensitivity Testing.
 - i. 24VDC non-coded power-limited.
5. Field-programmable, complying with UL 864 and listed and labeled by an NRTL.
 - a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. System must be capable of being programmed on site without requiring the use of any external programming equipment and must accept firmware upgrades via connection with laptop computer, without requirement of replacing microchips, EPROMS, or similar.
 - d. FACP must have the capability to be field-programmed for selective operations customary to the system as required by unique job conditions and must be capable of being programmed by keypad access by the Owner, secured via standard key and code without external computer interface.
6. Addressable initiation devices that communicate device identity and status.
 - a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
 - b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
7. Addressable control circuits for operation of mechanical equipment.
8. Capability of networking with other control panels on single pair of copper wire, Ethernet, or fiber optic cable.
9. EVAC Function: The voice evacuation function must include a microphone, control switches, and zoning as determined by the Owner (typical zone by floor minimum).
 - a. Additional microphone and control modules must be placed at remote annunciators. Local microphone must take priority over all messaging systems. Voice evacuation

message must be appropriate for the facility served and a sample of the factory recorded message shall be provided to the Owner for review and approval.

- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, 2 line(s) of 80 characters, minimum. The display must indicate all system conditions and device locations with descriptions, room number, and relative compass location within the building.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
 - 3. The panel must have a steady “Power On” light and separate “Alarm” (red color) and “Trouble” (amber color) LED indicators.
- C. Circuits:
 - 1. Initiating Device (IDC), Notification Appliance (NAC), and Signaling Line Circuits (SLC): NFPA 72, Class A.
 - a. Notification Appliance Circuits: Style Z.
 - b. T-Tapping or spider-webbing type circuitry is prohibited.
 - c. Single ground fault or open circuit on the SLC must not cause system malfunction, loss of operating power, or ability to report alarm.
 - d. Loss of any one (1) NAC circuit must not cause loss of any other NAC circuit in the system.
 - e. Install no more than 70% of addressable devices on each signaling line circuit.
 - f. Each SLC and NAC must be limited to only seventy-five (75%) of its total capacity during initial installation.
- D. Notification Appliance Circuit: Operation shall sound in a slow whoop.
- E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.
- F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station, Columbia County Sheriff’s Department, for fire alarm monitoring at the Columbia County Sheriff’s Department. Transmission is to proprietary receiving stations. Equipment is to be appropriately listed.

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- H. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
 - 1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.
 - a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.
 - b. Programmable tone and message sequence selection.
 - c. Standard digitally recorded messages for "Evacuation" and "All Clear."
 - d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.
 - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
 - 3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
- A. Printout of Events: The system must have a history buffer capable of storing up to ~~1000~~ 4000 system events. Each of these events will be stored, with time and date stamp. The history buffer must use a non-volatile programmable memory, and must not be lost with system primary and secondary power failure.
- B. The CPU must be capable of being programmed on site without requiring the use of any external programming equipment and must accept firmware upgrades via connection with laptop computer, without requirement of replacement microchips, EPROMS, or similar.
- C. FACP must have the capability to be field programmed for selective operations customary to the system as required by unique job conditions and must be capable of being programmed by keypad access by the Owner, secured via standard key and code without external computer interface. An individual monitored pre-programmed activation and bypass button or single pseudo-point must be provided for each category here: general alarm, HVAC detectors and shutdown, door hold-open devices, or others as determined by the Owner. Code addresses must be supplied to the Owner. The Owner must have programming capability for individual points and manual control. An "alarm silence" switch must be included. Each system must be capable of at least four (4) levels of password protection.
- D. The FACP must perform continuous testing of analog sensors including sensitivity tests with compensation for age and environmental conditions. Problems must be indicated for each device for "failed test, self-test abnormal, dirty, or very dirty" or similar, and must be recorded in the event log. Additionally, the LED on the sensor base must glow steady, giving a visible indication at the sensor location.
- E. The system must have the capability of networking with other Control Panels on single pair of copper wires, Ethernet, or fiber optic cables. The EVAC functions must include a microphone, control switches, and zoning as determined by the Owner (typical zone by floor minimum.)

- F. Additional microphone and control modules must be placed at remote annunciators as determined by the Owner. Local microphone must take priority over all messaging systems. EVAC messaging must be appropriate for the facility served and a sample of the factory recorded message provided to the Owner for review and approval.
- G. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.
 - 1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- H. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
 - 1. Batteries: Vented, wet-cell pocket, plate nickel cadmium.
- I. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.
- J. The system must be the current model for which replacement parts and local service are guaranteed to be readily available for a 10 year period.
- K. Programmable function keys shall be provided at the main FACP for each of the following actions, where applicable, and labeled accordingly: Alarm signals bypass, HVAC shutdown bypass, door hold-open device bypass, elevator recall bypass, and any other actions as determined by the Owner. Bypasses shall be toggle on/off. System resetting shall not alter the state of the bypass.
- L. Codes and addresses must be supplied to the Owner. The Owner must have programming capability for individual points and manual control. An “Alarm Silence” switch must be included. Each system must be capable of at least four (4) levels of password protection. The Contractor shall provide the Owner with all passwords associated with the system, including any programming passwords.
- M. The FACP must perform continuous testing of analog sensors including sensitivity tests with compensation for age and environmental conditions. Problems must be indicated for each device with “Failed Test, Self-Test Abnormal, Dirty, or Very Dirty” or similar, and must be recorded in the event log. Additionally, the LED on the sensor base must glow steady, giving a visible indication at the sensor location.
- N. Initiating control modules must be dedicated to the type of component served for individual programming control. HVAC shutdown and other control functions must be accomplished from the FACP rather than by individual smoke detector relays.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-Double-action mechanism, flush mounted, non-coded, pull-levertype; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit. Break rods are not permitted.
 2. Station Reset: System standard key is required for reset.
 3. Acceptable manufacturers: Safety Technology International (STI) Model No. STI-1100, or equivalent, with clear Lexan protective cover.

2.5 SYSTEM SMOKE DETECTORS

- A. General Requirements for System Smoke Detectors:
1. Comply with UL 268; operating at 24-V dc, nominal.
 2. Detectors shall be four-wire type.
 3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
 4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide point-addressable terminals in the fixed base for connection to building wiring.
 5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.
 7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
 - a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F per minute.
 - b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
 - c. Provide multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detectors shall be primarily photoelectric plug-in type. Ionization smoke detectors shall be used only as specified in special applications such as computer rooms or electrical rooms. Ionization smoke detectors must have two levels of sensitivity which can be easily set.
 2. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
 3. Provide security wire guard on detectors located in inmate areas, with Allen head tamper proof screws.

4. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Heat Detector, Combination Type: Bimetallic, restorable type device. Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections. Provide security wire guard on detectors located in inmate areas, with Allen head tamper proof screws.
 - a) Visible Notification Appliances: Notification appliances must have both audible (A) and visible (V) alarm signals. Visible signals must be the white strobe (flash discharge) type with a minimum intensity of seventy-five (75) candela. When installed in corridors, visible signal must be equipped with a side viewing lens. Devices must be combined AV where possible to reduce fixture counts. Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
 1. Rated Light Output:
 - (a) 110 cd, unless noted otherwise on drawings.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
 4. Flashing shall be in a temporal pattern, synchronized with other units.
 5. Strobe Leads: Factory connected to screw terminals.
 6. Mounting Faceplate: Factory finished, white.
 - b) Voice/Tone Notification Appliances:
 1. Appliances shall comply with UL 1480 and shall be listed and labeled by an NRTL.
 2. High-Range Units: Rated 2 to 15 W.
 3. Low-Range Units: Rated 1 to 2 W.
 4. Mounting: semi-recessed.
 5. Matching Transformers: Tap range matched to acoustical environment of speaker location.
 6. Must produce sound level signals 15dB above ambient noise and not more than 100 dB where ambient conditions do not require it. The tone must be distinctive, but moderate in nature; "shrill" sounding horn type appliances are not permitted.

2.8 REMOTE ANNUNCIATOR

- A. Description: Where indicated on the plan drawings, provide annunciator panel(s). The Annunciator Panel must be modular in design reflecting all status audible and visual indicators the same as the main FACP with a minimum eighty (80) character alpha-numeric LCD display. It must have review function capability and alarm reset/silence secured by key switch.
- B. Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

- C. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.9 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, to circuit-breaker shunt trip for power shutdown.

2.10 TAMPER SWITCHES & FLOW SWITCHES

- A. All sprinkler, standpipe and similar fire suppression control valves must be provided with monitored tamper switches (including pumps, PIV and BFP). Water flow switch monitoring must be provided at a minimum to identify flow by floor with an integral fifteen (15) second time-delay device to prevent nuisance alarms.

2.11 DIGITAL DATA GATHERING MODULE.

- A. Transmitter in this article is compatible with most central-station receiving equipment, but verify specific compatibility and acceptability of this signal-transmission method for each project. NFPA 72 and UL 632 require dual telephone lines.
- B. Fire alarm system must be connected to the Receiving Station for fire alarm monitoring at the Columbia County Sheriff's Department. Monitoring methods will be NRTL listed for NFPA 72 Proprietary Supervising Service. This is an Ethernet connection unless another Proprietary Listed method is accepted by the Owner and AHJ. VOIP, wireless, hardwire and similar technologies will be considered in accordance with their listings. A backup method of communications where mandated by Code or the Owner may be required.
- C. All system components requiring access for testing, maintenance and inspection must not be located in office, storage or instructional spaces used by building occupants. Maintenance-intensive items such as batteries and sprinkler testing controls must be located for easy access at finished floor level.
- D. Where provided as part of the project, gas utility service must have an automatic closing fire alarm solenoid and testing bypass.
- E. Where building sound systems are provided as part of the project, they must be provided with a relay for automatic shut off upon activation of the fire alarm system.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Equipment Mounting: Install fire-alarm control unit on finished floor with tops of cabinets not more than 60 inches above the finished floor. Annunciator panel shall be mounted at 60-inches to top. All panels must be mounted with sufficient clearance for observation and testing.
- C. Conduit (joints, through penetrations, and minimum 10' interval) and junction boxes must be identified as "Fire Alarm" and/or painted and conduit taped red, unless in finished areas.
- D. All conduits, mounting boxes, junction boxes and panels must be securely hung and fastened with appropriate fittings to ensure positive grounding throughout the entire system.
- E. Raceways: Minimum conduit size shall be $\frac{3}{4}$ inch and all system wiring shall be installed in conduit. Conduits shall be factory painted red, Allied "True Color", or equivalent. All conduit fittings shall be steel compression type, marked with red tape or paint to distinguish it for fire alarm use only. Die-cast type are prohibited. Flexible connectors, minimum $\frac{1}{2}$ " are only permitted for end sections less than six (6) feet in length between a box and a suspended or moveable device. No wiring other than directly associated fire alarm detection, alarm, or auxiliary fire protection functions will be permitted in fire alarm raceways. Wiring splices must be avoided other than in alarm devices, terminal strip junction boxes, and will use crimp connection or other approved method. Power limited, non-power limited, and AC power conductors must be run in separate conduit paths. In new construction, all raceways serving the fire alarm system must be run above slab enclosed within building construction in all finished areas. In renovations and remodeling, raceways must be enclosed where possible. Any exposed raceways in finished areas must be approved by the Owner prior to installation.
- F. Smoke- or Heat-Detector Spacing:
 - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
 - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
 - 3. Revise first subparagraph below to indicate how Contractor shall determine detector spacing.
 - 4. Smooth ceiling spacing shall not exceed 30 feet.
 - 5. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A in NFPA 72.
 - 6. See Editing Instruction No. 10 in the Evaluations for discussion about placement of smoke detectors for HVAC air inlets and outlets.
 - 7. HVAC: Locate detectors not closer than 5 feet from air-supply diffuser or return-air opening.
 - 8. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

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- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Duct detectors must be installed in a manner that provides easy access for periodic cleaning and calibration. Where provided, remote alarm indicator light and test switch must be located in the nearest corridor or a public area and adequately labeled with the location and type of device monitored. The Contractor must measure air velocity (CFM) across each duct to verify design and indicate CFM readings on the duct detector housing. All duct penetrations must be properly sealed.
- H. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position. Provide monitoring of all sprinkler, standpipe and similar fire suppression control valves (including pumps, PIV and BFP). Water flow switch monitoring must be provided at a minimum to identify flow by floor with an integral fifteen (15) second time delay device to prevent nuisance alarms. Coordinate with fire protection shop drawings and civil drawings for locations of flow, tamper, pressure switches.
- I. Provide monitoring of tamper switch(es) for fire department access boxes.
- J. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- K. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.
- L. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- M. Fire-Alarm Control Unit: Flush Surface mounted, with tops of cabinets not more than 60 inches above the finished floor.
- N. Annunciator: Flush mounted; Install with top of panel not more than 60 inches above the finished floor.
- O. All system panels, controls, pull stations, and cabinets must be keyed alike to a standard key typical of the chosen manufacturer. Provide ten (10) keys to the Owner plus one spare set in the fire department access box.
- P. The system must have a primary (main) power supply connected to dedicated branch circuit(s). The circuit(s) disconnecting means must be provided with a breaker lock clearly marked "FIRE ALARM" labeled in red on both the legend and circuit breaker. Circuits serving individual panels must be clearly indicated inside the panel access cover with indelible ink.
- Q. Batteries must be placed at finished floor level working height and not above ceilings or in hard to reach spaces.
- R. Surge protection must be provided and dedicated to the fire alarm control panel circuit feeds in addition to any general building protective systems. The device must be mounted at the main FACP or at the electrical panel with the FAS circuit breaker(s) and must be labeled. Additional devices must be provided to protect alarm circuits that extend to the exterior of the building (such as BFP, tamper, antennae). The device must incorporate a replaceable fuse design and failure

indicator. Acceptable devices are manufactured by EDCO model number HSP121BT-1RU or Facilities Operations approved equivalent.

3.2 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
 - a) All conductors in cabinets must be carefully formed and harnessed so that each conductor drops off directly opposite to its terminal.
 - b) Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
 - 2. Alarm-initiating connection to elevator recall system and components.
 - 3. Alarm-initiating connection to activate emergency lighting control.
 - 4. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 5. Supervisory connections at valve supervisory switches.
 - 6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 7. Supervisory connections at elevator shunt trip breaker.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Transposing or changing color-coding of wires is not permitted.
- C. All conductors in conduit containing more than one conductor must be labeled on each end with EZ markers or equivalent.
- D. Color codes of wires must be consistent throughout the system and depicted in a legend on the inside of the respective control panel or terminal cabinet as well as on the system as-built drawings. Provide the following wire types and colors:

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Circuit Type	Color*	Wire Size/Type
Horn/Strobe	Orange/Brown	Min. 14 gauge solid THHN
24V DC device power	Red/Black	Min. 14 gauge solid THHN
Door Holder	White/Black	Min. 14 gauge solid THHN
Initiating/SLC	2 conductor red/black, red jacketed	Min. 18 gauge solid FPLR
Speaker	2 conductor twisted shielded pair white/black blue jacketed	Min. 18 gauge solid FPLR
Strobe	Orange/Brown	Min. 14 gauge solid THHN
Control Points (HVAC shutdown, elevator recall, etc.)	Red/Blue	Min. 14 gauge solid THHN
PIV/BFP	Yellow/Blue	Min. 14 gauge solid THHN

*All individual separate circuits shall be additionally field identified with wire marker tags. A legend indicating wire colors and circuit identifiers shall be provided at all terminal cans and panels. Each panel shall also reflect the area of circuit coverage.

- E. All conductors in cabinets shall be carefully formed and harnessed so that each conductor drops off directly opposite to its terminal.
- F. Cabinet terminals shall be numbered and coded.
- G. All control, function switches, etc., must be clearly labeled on all equipment panels.
- H. All switches shall be labeled and identified.
- I. Install framed instructions in a location visible from fire-alarm control unit.
- J. Transposing or changing color coding of wires is not permitted.
- K. A unique identification number, reflected on the shop drawings, must be assigned to each initiating device and be professionally marked on the unit base and readily visible from the finished floor.
- L. All controls and specific sequences of operations required achieving reset, fan control, etc. must be permanently labeled in a professional manner.
- M. Identification shall be labeled as “FIRE ALARM” to be included on all junction boxes, raceways on both sides of a wall penetration, every minimum 10’ section of raceway.

- N. Raceways, junction boxes and panels must be securely fastened with appropriate fittings to ensure positive grounding throughout the entire system.
- O. All panels must be mounted with sufficient clearance for observation and testing.

3.4 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by Engineer authorities having jurisdiction.
- 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.
 - 2. If Owner selects and contracts with a central station or another remote alarm receiving station for continuing services, consider making the initial tests and inspections and reacceptance testing the obligation of Contractor, and the monthly, quarterly, semiannual, and annual tests and inspections the obligation of the remote alarm receiving station. Note that maintenance service is required for UL-certified and FMG-placarded systems.
 - 3. Tests and Inspections:
 - a) All wiring must be checked and tested to ensure that there are no grounds, opens or shorts.
 - b) Visual Inspection: Conduct visual inspection prior to testing.
 - 1. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
 - 2. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - c) System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

- d) Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - e) Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - f) Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - g) Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
 - h) In addition to standard test papers, local sensitivity readings of the installed devices must be provided for all smoke sensing devices. Certification papers must be prepared in advance and provided to the inspector for approval at the final test.
 - i) Final tests must include full performance of smoke evacuation, pre-action, and similar systems. All components, door operation, air flow, shut down, etc. must be verified on normal and standby power conditions.
- 4. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - 5. Initial and reacceptance testing of newly installed or re-located notification appliances shall include sound pressure levels measured as specified in NFPA 72. "Throughout" as noted by the code shall be defined as readings taken separately from within each new or newly divided occupied space. System pretesting and all record readings shall be completed and hardcopy/pdf provided to the owner for review prior to final acceptance testing. Additional copies to be included in turnover documents as required by other sections of this specification.
 - 6. Prepare test and inspection reports.
 - 7. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections
 - 8. Provide updated fire alarm maps in draft form for Owner review. Once approved, provide final framed maps at specified locations. Provide CAD files and pdf files used for producing the final maps as part of the closeout documentation.
 - 9. Prior to final acceptance, a hardback system log book with a copy of the final State Fire Marshal approval test papers, sensitivity reports, and two (2) copies of a simplified map of the building showing device locations and numeric address of each device must be provided. Additional framed copies of the system device map must be mounted professionally beside each FACP and annunciator.
 - 10. Prior to final acceptance, provide the Owner with a reproducible accurate system "as-built" package of electronic and hardcopy form. Drawings must be compatible with AutoCAD and contain conduit layout and wiring diagrams, including wire color code and tag number. "As-built" package must include a minimum of two (2) hard and two (2) digital media copies of comprehensive "Operation and Shop Maintenance Manual" and include a digital media (USB drive) copy of the site-specific software for each system and facility, including all passwords.

11. The Contractor shall provide the means for the Owner to make simple program changes such as label changes. This shall include any programming software, security devices to access the software and training to accomplish the task.
12. Warranty: The Contractor shall provide a warranty for all equipment and systems for a minimum period of one (1) year from the date of Final Acceptance, or the manufacturer's warranty period, whichever is greater. The warranty must include repair parts, labor, and prompt field service, pickup and delivery as coordinated with the Owner for access.
13. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72, including a sensitivity test. Use forms developed for initial tests and inspections. Such tests must be documented by the Contractor and included in the system log which is kept by the Owner.

3.6 DEMONSTRATION

- A. The fire alarm system must be successfully inspected, demonstrated and approved by the Engineer of Record prior to requesting inspection by the State Fire Marshal. Provide a Standard Fire Marshal Test and Information Book at final inspection to contain all life safety system tests and records, generator load tests, EWCC, NFPA 72, interior finish ratings for all pertinent finishes and acoustical fabrics, special situation narrative and/or ASI for any items not documented on the contractor drawings.

END OF SECTION 283111

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SECTION 284619 - PLC HARDWARE FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
1. Graphical User Interface (GUI) shall integrate control and monitoring of major subsystems and devices indicated in Project Documents. The GUI shall act as an operator interface to the major security control and monitoring subsystems. Include programming that implements control and monitoring functions defined in project documents.
 2. System shall include a complete IEEE 802.3 100/1000 BASE-T Local Area Network (LAN) that interfaces the GUI computers and the Programmable Logic Controllers (PLC), Intercom Control and Digital Video Recorders. This network is closed, only used by the Security Control Systems.
 3. All electronic equipment furnished and installed by the Integrator shall be protected by transient voltage surge suppression. See Specification Section 280526.
 4. Provide computer-based hardware and custom designed, application-specific, Microsoft Windows based software that operates in conjunction with Programmable Logic Controllers (PLC) specified below to integrate or interface to all devices and systems.
 5. Provide and install graphical control and annunciation icons on graphics mode video displays along with programming that provides the sequences of operation verified with the Owner and Architect Engineer during the software development process described in 284620-PLC Software for Electronic Security, Part - 3.1, Software Support.
 6. The GUI computer shall contain graphics and wavetable programs only. All control logic programs shall reside in the PLC.
 7. General Requirements of PLC System
 - a. Provide a Programmable Logic Controller (PLC) system that is the product of a single company, which has regularly manufactured PLC equipment for a period of 15 years.
 - b. Provide only components that are regularly used in industrial automation applications.
 - c. Components must be in stock from a distributor within 100 miles of this facility or be able to be shipped next day to this facility.
 - d. Provide only UL Listed components.
 - e. Provide PLC System that seamlessly integrates the Control system to the Private Security Control System Local Area Network.
 - f. Provide CPU(s) with a visual status indication of backup battery.
 - g. Provide alarm in the event of CPU low battery voltage before battery failure and for communication failure.

- h. Provide 25% spare PLC system capacity at the completion of the project. This includes program memory, I/O memory allocation, register memory, user memory, etc.
- i. Provide programming software memory usage summary with as-built documentation.
- j. Provide 25% spare PLC I/O module capacity at the completion of the project. Calculate inputs and outputs separately when figuring capacities.
- k. All Components must be mounted in a metal enclosure.
- l. All PLC interposing relays must be fused to protect relay and field device wiring from over-current caused by shorts or device failure.
- m. EMC filter must be installed on the power supply lines
- n. PLC racks and modules shall be Din Rail mountable.
- o. Din Rail must be mounted on a metallic surface that is grounded to earth using screws with star washers every 6 inches.
- p. All Safety and Reference grounds for PLC equipment shall be in compliance with IEEE 1100.
- q. Expansion and Remote Cables must be 100% shielded. A 100% shield means that the braided cable shield is connected to the metal shell of the connector.
- r. Termination Labeling
 - 1) Each wire shall be labeled with an industry standard thermal transfer wire marker. See Spec 2805013 Conductors and Cabling for Electronic Security. Section 3.2 Labeling.
 - 2) I/O wire number should reference wiring diagram and Software I/O list.
 - 3) Felt tip pen labels are unacceptable.
 - 4) Power wiring should reference wiring diagram.
 - 5) Communication cables should reference wiring diagram and node ID.
- s. The control architecture shall use distributed control over Ethernet. Each controller will share selected memory with all other controllers via broadcast messages over Ethernet.
- t. All Ethernet communication shall be configured using producer/consumer exchanges without requiring PLC logic to drive the communications.
- u. All Remote I/O shall be connected over Ethernet.
- v. Remote I/O shall use the exact same module types and same I/O module part numbers as those that are used at the PLC's CPU unit.
- w. PLC racks and Remote I/O drops shall be expandable up to 64 modules per Ethernet drop using local expansion cables.
- x. All I/O modules shall utilize terminal block style wire connections and support hot removal and insertion
- y. Output modules shall be available with Electronic Short Circuit Protection. The diagnostic status of the Electronics Short Circuit Protection (ESCP), for those discrete output modules containing ESCP, shall be indicated by a green LED during normal operation per point and amber during a fault. The fault should be auto-corrective without the need to cycle power.

8. Touch Screen Control Workstations

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- a. Provide single touch screen control work stations as indicated on the plans
 - b. Primary control location of each door is noted within the door lock symbol on the plans.
 - c. The touch screens located in central control shall be the fail over/takeover control location. Hierarchy and sequence of fail over/takeover shall be as defined during the phase I software development meeting.
 - d. Each touch screen station consists of a 32” or 24” LCD touch screen, computer CPU, mouse, keyboard and UPS.
 - e. Provide integration of the video surveillance system that allows control to be accomplished through the GUI. Functions to include but not be limited to:
 - 1) Camera call up
 - 2) Camera to monitor assignments
 - 3) Video follow audio functionality
 - 4) Video follow alarm functionality
 - f. Administrative level configuration and set up functions are not required to be accessible from the GUI
9. Integration with Intercom system
- a. Provide integration of the intercom system to allow automatic video follow audio functionality.
 - b. Provide programming that allows all intercom master control functions to be accomplished through the GUI including but not limited to:
 - 1) Answer
 - 2) Answer and zoom
 - 3) Page zone activation
 - 4) Clear call without answering
 - 5) Connect without a call being placed
 - 6) View Queuing log
 - 7) GUI shall annunciate a call placed at the station and by screen on the key plan.
 - c. Administrative level configuration and set up functions are not required to be accessible from the GUI.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.

2.2 GUI 32" TOUCHSCREEN MONITOR

A. Specifications

1. 32.0" diagonal
2. 1920 x 1080 native resolution
3. 16.7 million colors
4. 8ms Response time
5. 3000:1 contrast ratio
6. 100-240, 50/60 Hz
7. Surface Acoustic Wave Touch Technology

B. Acceptable manufacturers

1. ELO Touch 3243L
2. Planar
3. Approved Equal

2.3 GUI Touch Screen Computer

A. Specifications

1. Intel Xeon E5-1620, 10 Meg Cache, 3.6 GHz
2. Windows 8.1 64 bit
3. 4GB ECC PC3 1333 MHz uDIMM
4. NVIDIA NVS510 2GB DDR3 HP Win 10 (Owner requires latest version) Video Adaptor
5. 3.5" internal SATA HDD 1 TB, 7200 RPM
6. Integrated Ethernet Adaptor
7. USB Keyboard and Mouse
8. Speakers are integral to the monitor

B. Acceptable manufacturer

1. HP
2. Lenovo
3. Dell

2.4 FLOOR MOUNTED UPS

A. Specifications

1. Max Configurable Power (Watts):	1.0k Watts
2. Input voltage for mains:	82-144V
3. Input Connection:	NEMA 5-15P
4. Output voltage:	110, 125
5. Output Connections:	(8) NEMA 5-15R

B. Acceptable manufacturer

1. APC Smart-UPS 1500 VA LCD
2. Eaton
3. Tripp Lite

2.5 SECURITY SYSTEM MANAGEMENT COMPUTER (SSMC)

A. Specifications

1. Intel Xeon E5-1620, 10 Meg Cache, 3.6 GHz
2. Windows 8.11 64 bit
3. 4GB ECC PC3 1333 MHz uDIMM
4. NVIDIA NVS510 2GB DDR3 HP Win 7 Video Adaptor
5. 3.5” internal SATA HDD 1 TB, 7200 RPM
6. Integrated Ethernet Adaptor
7. USB Keyboard and Mouse
8. ThinkVision LT1952P 16:9 19” LED Monitor

B. Acceptable Manufacturers

1. HP
2. Lenovo
3. Dell

2.6 PRINTER

A. Specifications

1. 21 ppm color or B/W
2. 250 sheet input
3. Network ready
4. Standard 2.0 USB and Ethernet
5. 128 MB RAM
6. 417 MHz processor
7. 500 to 1500 pages per month recommended usage
8. 1200 x 1200 dpi printing
9. Weight – 54 lbs

B. Acceptable Manufacturers

1. Lexmark C540n
2. Canon
3. Equal by Epson

2.7 CONTROL SYSTEM LOCAL AREA NETWORK SWITCH

A. Specifications

1. (48) Ethernet 10/100/1000 ports
2. Forwarding Rate: 130.9 Gbps
3. Flash Memory: 128 MB
4. DRAM: 512 MB
5. MAC addresses: Up to 16,000
6. IGMP groups/Multicast routes: Up to 1000
7. Configurable MTU: 9216 Bytes with jumbo frames
8. 1000BaseT ports: RJ-45 connectors
9. Input power: 100 – 240 VAC, 50-60 Hz
10. Indicators:
 - a) Port link integrity
 - b) Port disabled
 - c) Port Activity
 - d) Port speed
 - e) Port full duplex
 - f) System status
 - g) System RPS
 - h) System link status
 - i) System link duplex
 - j) System PoE
 - k) System link speed
11. Operating Temp: 23° – 113° deg F
12. Operating relative humidity: 10 – 85% non-condensing
13. MTBF: 233,370 hours
14. Measured Power consumption: 66 watts
15. Certifications: UL listed, FCC part 15 Class A
16. POE: IEEE 802.3at

B. Acceptable Manufacturers

1. Cisco 9200 series PoE+ switch
2. HP
3. Extreme

2.8 PROGRAMMABLE LOGIC CONTROLLER

A. General Requirements

1. Provide a Programmable Logic Controller (PLC) system that is the product of a single company, which has regularly manufactured PLC equipment for a period of 15 years.
2. Provide only components that are regularly used in industrial automation applications.
3. Components must be in stock from a distributor within 100 miles of this facility or be able to be shipped next day to this facility.

4. Provide only UL Listed components.
5. Provide PLC System that seamlessly integrates the Control system to the Local Area Network switches.
6. Provide CPU(s) with a visual status indication of backup battery.
7. Provide CPUs and power supplies on all CPU and I/O racks.
8. Provide alarm in the event of CPU low battery voltage before battery failure.
9. Provide 25% spare PLC system capacity at the completion of the project. This includes program memory, I/O memory allocation, register memory, user memory, etc.
10. Provide programming software memory usage summary with as-built documentation.
11. Provide 25% spare PLC I/O module capacity at the completion of the project. Calculate inputs and outputs separately when figuring capacities.
12. All Components must be mounted in a metal enclosure.
13. All PLC interposing relays must be fused to protect relay and field device wiring from over-current caused by shorts or device failure.
14. PLC AC power supply must be supplied through an IEC-rated isolation transformer.
15. EMC filter must be installed on the power supply lines
16. PLC racks and modules shall be Din Rail mountable.
17. Din Rail must be mounted on a metallic surface that is grounded to earth using screws with star washers every 6 inches.
18. All Safety and Reference grounds for PLC equipment shall be in compliance with IEEE 1100.
19. Expansion and Remote Cables must be 100% shielded. A 100% shield means that the braided cable shield is connected to the metal shell of the connector.
20. Termination Labeling
 - a. Each wire shall be labeled with an industry accepted wire marker
 - b. I/O wire number should reference wiring diagram and Software I/O list.
 - c. Felt tip pen labels are unacceptable
 - d. Power wiring should reference wiring diagram.
 - e. Communication cables should reference wiring diagram and node ID
21. The control architecture shall use distributed control over Ethernet. Each controller will share selected memory with all other controllers via broadcast messages over Ethernet.
22. All Ethernet communication shall be configured using producer/consumer exchanges without requiring PLC logic to drive the communications.
23. All Remote I/O shall be connected over Ethernet.
24. Remote I/O shall use the exact same module types and same I/O module part numbers as the PLC's.
25. PLC racks and Remote I/O drops shall be expandable up to 64 modules per Ethernet drop using local expansion cables.
26. All I/O modules shall support hot removal and insertion.
27. Output modules shall be available with Electronic Short Circuit Protection. The diagnostic status of the Electronics Short Circuit Protection (ESCP), for those discrete output modules containing ESCP, shall be indicated by a green LED during normal operation per point and amber during a fault. The fault should be auto-corrective without the need to cycle power.

B. Specifications

1. PLC Central Processor Units
 - a. Maximum 2048 inputs and 2048 outputs I/O capacity
 - b. Maximum 64K word instruction memory
 - c. RS-232 ASCII configurable auxiliary com port
 - d. Bit instruction execution time of 0.80 μ s max
 - e. Built in real time clock and calendar
 - f. Built in 10BaseT 10Mb/sec Ethernet port
 - g. Battery backed EEPROM memory
 - h. Connectivity via Ethernet, Devicenet, Sysnet, Systlink, Mod Bus RTU master/slave over RS-485 and RS-232-C.
 - i. Shock rating, operating – 30.0g (3 pulses, 11 ms)
 - j. Vibration rating – 1.0g @ 5-2000 Hz
 - k. Operating Temperature range – 32 to 140 Degrees F
 - l. Operating Humidity range 5 – 95% RH non-condensing
2. PLC Digital DC Input Modules
 - a. 10 – 30 VDC operating range
 - b. Sourcing or Sinking type modules
 - c. Maximum on/off signal 0.5mS max with selectable 1 or 7mS filter
 - d. Maximum off state current 0.5mA
 - e. 32 point modules minimum
 - f. Maximum backplane current load – 50mA
3. PLC Digital DC Output Modules
 - a. 10.2 - 30 VDC operating range
 - b. Sourcing or Sinking type modules
 - c. Maximum continuous current per output, .5 amp sourcing/1.0 amp sinking
 - d. Maximum continuous current per module, 8 amp sinking or sourcing @ 60 degrees C
 - e. 32 point modules minimum
 - f. Maximum backplane current load – 90mA @ 5 VDC
 - g. Removable terminal blocks
 - h. Gold plated contacts
4. PLC Power Supplies
 - a. 120/220 VAC nominal input voltage
 - b. Maximum input power, 27 VA
 - c. Backplane output current, 1.5 amps total
 - d. Operating Temperature range – 0 to 60° C
 - e. Operating Humidity range 5 – 95% RH non-condensing

C. Acceptable Manufacturers

1. Allen Bradley
2. Omron
3. Modicon Momentum Series

2.9 LINEAR POWER SUPPLY

A. Specifications

1. AC Input: 120 VAC, +10%, -13%
2. DC Output: 24 VDC @ 12 amps
3. Line Regulation: +/- .05% for a 10% change
4. Load Regulation: +/- .05% for a 50% load change
5. Output Ripple: 3 mV peak-to-peak maximum.
6. Transient Response: 50 microseconds for 50% load change.
7. Short Circuit Protection: Automatic current limit/fold back
8. Stability: +/- .05% for 24 hours after warm up.
9. Efficiency: 55%
10. Provide back plates, mounting hardware and all appurtenances required to install the power supplies in the system equipment racks.
11. An individual homerun cable is required between each field device powered by the power supply.
12. The output of the power supply is to feed a series of fuses rated for the intended load one each per homerun cable/device load.

B. Acceptable Manufacturer

1. SL Power F2412A+
2. Sola SMP B6
3. Power One F24-12A

2.10 GENERAL PURPOSE RELAYS (LOW CURRENT LOAD < 6 AMPS)

A. Specifications

1. Switching Capacity: 6 Amp
2. Termination: Blade
3. Operating Indicator Light: Coil Rated Current:< 70 ma
4. Operating Voltage 24 VDC
5. Max. Cont. Applied Volt: 110%
6. Drop-out Voltage: 10%
7. DIN Rail Mountable Socket
8. Contacts Material Gold Plated Silver

B. Acceptable Manufacturer

1. Idec RH1B
2. Potter and Brumfield R_10

3. Finder 44 Series

2.11 GENERAL PURPOSE HIGH POWER CONTROL RELAYS (HIGH CURRENT LOADS < 10 AMP)

A. Specifications

1. The control relays shall do the actual switching of the power to high current devices - locks, receptacles, etc.
2. Relays contacts shall be U.L. listed for a continuous current of 10 amps (inrush of 16 amps)
3. Each relay contact to the control device shall be individually fused externally with an indicating fuse holder.
4. Termination: Screw compression
5. Operating Indicator Light
6. Coil Rated Current: < 70 ma
7. Operating Voltage 24 VDC
8. Max. Cont. Applied Volt: 110%
9. Drop-out Voltage: 10%
10. DIN Rail Mountable Socket
11. Relays shall be pluggable with diode protection across coils and LED indication of activated coil circuit.
12. Low voltage wiring in relay cabinet shall be separated from high voltage wiring and all wiring shall be color-coded and marked with approved wire markers.
13. Control wiring shall be routed through plastic wire duct and landed on terminal strips.
14. Relays shall be controlled directly by the PLC.
15. Peripheral interface cards with active circuitry shall not be approved.
16. Relays shall have integral manual activation switch to override PLC for circuit testing and troubleshooting.
17. 24 VDC coil 1.2 watts or less
18. SPST or DPDT as required.

B. Acceptable Manufacturer

1. Idec RH1B
2. Potter and Brumfield KUP
3. Finder 55 Series

2.12 FUSED TERMINAL BLOCKS

A. Specifications

1. Din Rail mountable IEC style
2. dead front safety (ie. touch safe)
3. Screw clamp and Spring Clamp are acceptable
4. All Fuse terminal blocks shall be sized according to the wire gauge and currents load required for the application.
5. All Fuse Holders shall have a blown fuse indicator

- a. DC circuits shall have LED
 - b. AC circuits shall have Neon or Trip lever
 - 6. Provide lever disconnect type IEC fuse blocks.
 - B. Acceptable Manufacturer
 - 1. Allen Bradley 1492-H5
 - 2. Phoenix Contact UK-5 HESI
 - 3. Square D AB1SF520
- 2.13 MODULAR TERMINAL BLOCKS
- A. Specifications
 - 1. Din Rail mountable IEC style
 - 2. dead front safety (ie. touch safe)
 - 3. Screw clamp and Spring Clamp are acceptable
 - 4. All terminal blocks shall be sized according to the wire gauge and currents load required for the application.
 - 5. Safety grounds should be identified with yellow/green color.
 - 6. One wire per termination point unless Ferrules are used for Special Applications
 - 7. All Ferrules are to be Crimped using the manufacturer's recommended Crimping tool.
 - B. Acceptable Manufacturer
 - 1. Allen Bradley 1492-J4
 - 2. Phoenix Contact UT-4
 - 3. Square D AB1VV

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All initial system programming shall be done at the Integrator's facility prior to installation on site.
- B. The System shall be installed by qualified personnel in strict compliance with manufacturer's instructions.
- C. Upon completion of system programming enable the write protect function of the PLC CPU
- D. Prevent unauthorized communications with the PLC CPUs by restricting the PLC to respond only to specific IP addresses. IE: "OMRON IP to FINS table set up."
- E. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.
- F. Equipment shall be firmly secured, plumb and level.

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- G. All cable runs to the main equipment rack shall be tagged and identified.
- H. Coordinate all work with the County's Facility Maintenance and Sheriff's Department staff.
- I. Grounding of electronics control cables, and peripheral equipment shall be installed per section 280526 and manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- J. Install and configure Security local area network as required for control and communication between system devices. When required, provide necessary coordination, termination, and programming associated with integrating Security local area network with facility network.
- K. Equipment cabinets shall be assembled in the Integrators shop prior to delivery to the job site.
- L. All cabling shall be continuous between field device and equipment cabinet. Terminations shall be to terminal boards with punch down blocks, or on screw terminals. Twisted and taped splices are unacceptable.

3.2 SOFTWARE SUPPORT

- A. Refer to Section 284620 – Software for Electronic Security for software support and programming requirements.

3.3 SYSTEM INITIALIZING AND PROGRAMMING

- A. All programming shall occur in the Integrator's shop prior to installation on site.
- B. The System shall be turned on and adjustment made to meet requirements of the specification and on-site conditions.
- C. The System shall be programmed to function as specified.
- D. Any special programming shall be documented and a written copy given to the Owner.
- E. Coordinate integration of other electronic systems as called for in the contract documents.

3.4 SYSTEM TEST PROCEDURES

- A. The system shall be completely tested to assure that all components are hooked up and in working order.
- B. The System shall be pre-tested by the Security Equipment Integrator and certified, in writing, to function in accordance with the plans and specification.
- C. The Integrator is to verify the system is communicating with all controlled devices.

- D. Testing to be performed in the integrator's shop prior to delivery-
 - 1. Test 120VAC power equipment and hardware internal to all equipment racks. Test all conductors for shorts, opens, and polarity.
 - 2. Fully charge all UPS systems. Test unit by removing power thereby causing the unit to switch to battery reserve.
 - 3. Utilizing a test jig, simulate the operation of every circuit required.
 - 4. Testing to be performed at the job site prior to delivery of the system
 - a. Verify all field wiring is free of shorts and opens prior to termination of head end electronics.
 - b. Test all 120VAC power sources for correct polarity and voltage. Test grounding system for continuity. Notify Engineer and Electrical Trade Contractor of any problems.
 - 5. Additional job site testing
 - a. After installation of head end electronics, verify proper operation of all field devices including locks, door position switches, card readers, push buttons, and intercom stations.
 - 6. Verify proper integration between control system and
 - a. Door control system
 - b. Video surveillance system
 - c. Intercom/Paging system
 - d. Overhead door controls
 - e. Elevator control
- E. The System shall be completely tested to assure that all components are hooked up and in working order. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the Division 28 series scope of work, promptly notify the Engineer in writing, indicating the cause of the defect and suggested corrective procedures.
- F. Provide written documentation showing all test results.
- G. The System shall be final tested in the presence of the Engineer.

3.5 FIELD QUALITY CONTROL

- A. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

- C. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Integrator's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 TRAINING

- A. Provide the facility personnel with training in the use and maintenance of the entire control system. Coordinate the training sessions with the Owner. Completed classroom sessions shall be documented by the Integrator, certified by the attending Owner representatives, and approved by the Engineer. Instruction shall take place during normal working hours (Monday through Friday, 8:00 a.m. to 5:00 p.m.). Instruction shall not begin until all systems are operational as designed.
- B. The training sessions shall cover the operation and the maintenance manuals and the control console operators manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain the control system.
- C. Integrator is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not be limited to the following-
 - 1. Review all O+M manuals with Owner representatives present for training.
 - 2. Perform a tour of the entire facility. During the tour the trainer shall point out all control equipment and provide a brief description of its purpose and use. This is to include but not be limited to control panels (graphic and pushbutton), all control system hardware, and devices controlled.

END OF SECTION 284619

SECTION 284620 - PLC SOFTWARE FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all software and programming labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Programming of Security Systems Management Computer (SSMC). Include programming that implements system transaction logging, access control functions, and database retrieval functions.
 - 2. Programming of Graphical User Interface Consoles (GUI). Include programming that implements Touch-screen control and monitoring functions defined in project documents.
 - 3. Programming of the video surveillance systems. Include programming that implements video surveillance system internal functions and integration with the GUI.
 - 4. Programming of Intercom systems. Include programming that implements Intercom internal functions and integration with the GUI.
 - 5. Computers shall be programmed such that any computer can be placed at any Touch Screen Location and reboot to that specific operator application without reprogramming.

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.

2.2 GUI SOFTWARE/GRAPHICS

- A. Basis of design
 - 1. These specifications are written using the Omron IWS or Omron Indusoft product. Any product by another manufacturer must include the same features and functions to those listed below.
- B. Specifications

1. Include the most recent PLC protocols from the PLC manufacturer and allows direct communication with ALL current, future and legacy OMRON networks (SYSNET, SYSLINK, ControllerLink, Ethernet and EthernetIP)
2. Provide software that is all-inclusive for communications, graphics, alarming, databasing, etc. No need for "add-on" software modules to provide these features.
3. Provide software that allows global changes to system icons
4. Provide software that allows changes to workstations/runtime licenses "on the fly"; software that requires a workstation to be shut down to make a change shall not be considered.
5. Software that includes third party I/O drivers shall not be considered.
6. Systems that utilize polling to determine the status of I/O points shall not be considered.
7. Provide displays utilizing accurately depicted, properly aligned floor plans. Floor plans must be displayed as seen from the GUI console operator's perspective (i.e.; rooms and doors in front of the operator at the top of the display, rooms and doors behind the operator at the bottom of the display). GUI consoles facing different directions must display accordingly different floor plans.
8. Provide displays that optimize the use of screen resolution and color to enhance and simplify the information displayed. Provide a textured, dull, light gray background for all displays. Provide displays that minimize the unnecessary use of highly saturated colors. Provide displays that utilize contrasting colors. Utilize color to clarify annunciation, highlight choices and indicate correct operator input. Saturated colors shall be used to annunciate conditions of devices other than their normal or secure state. Use red for alarm conditions, yellow for cautionary conditions and information such as the depiction of interlock groups, use green for intercom and blue for video surveillance devices.
9. Provide properly sized control icons that are a minimum 1/2" square. Control icons must be large enough to facilitate proper and easy operation. Where screens are congested and placement of icons becomes difficult, divide the screens and increase the scale of the background so that the icons can be properly placed.
10. Provide control icons and annunciation icons that provide an intuitive depiction of their purpose. Control icons and annunciation icons shall utilize color to indicate abnormal or "on" conditions only. Control icons and annunciation icons associated with devices that are in a normal or off state shall utilize muted, de-saturated colors.
11. Provide programming that uses a cursor to depict the control icon that has the current focus. Provide programming that allows the user to place a cursor on the screen and "drag" the cursor over the desired control icon, activating the associated function when the cursor is released ("activation on liftoff"). As the cursor moves over a control icon, the icon should "highlight" to indicate that if the cursor is released the icon shall activate. Annunciation only icons should not function in this fashion. Using the touch capability of the system, the operator shall be able to "drag" the cursor across the screen to the desired icon with the same effect as moving the mouse to control the cursor.
12. Provide a mouse for each GUI. Moving the cursor with the mouse shall provide the same highlighting function as described above. Touching or left clicking the mouse shall activate the highlighted device.
13. Screen display redraw/update/remote device response time thru-put shall be held to 0.5 seconds maximum. Activating a control icon shall cause the associated field device to operate within 0.5 seconds maximum. A field device that changes state must cause an annunciation icon to change state within 0.5 seconds maximum.
14. Provide the number of graphic "screens" that supports the sequences of operation verified with the Owner and Engineer during the software development process described in Part

- 3.1, Software Support. Any screen that the user or security consultant determines is too densely packed or too “busy” shall be subdivided at no expense to the Owner. Locate global control function icons in a “tool bar” configuration. Users shall have the ability to locate the tool bar on the top, bottom, right or left of the screen.
- 15. Tool bar functions may be divided into global functions and miscellaneous functions at the integrators discretion. Display of global and miscellaneous tool bars may be configured independently.
- 16. Place icons for "high traffic" functions on multiple screens as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support. Any icon that the user or security consultant determines is necessary on more than one screen shall be provided on more than one screen at no cost to the Owner.
- 17. Provide software that annunciates alarms until they are acknowledged, independent of screen displayed. Provide prioritization of alarms as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support.
- 18. Provide a method for unanswered alarms to move to a designated GUI as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support.
- 19. Graphical User Interface operators consoles are intended to operate in concert with each other, i.e.; Silencing an alarm on one screen causes the alarm to be silenced on all other screens displaying the same alarm. Multiple operations on multiple screens to silence the same alarm are not acceptable.
- 20. Hierarchy of Control - During the software development process described in Part - 3.1, designated GUI takeover scenarios shall be confirmed and provided by the integrator under Base Bid.
- 21. During the software development process described in Part - 3.1, interlock groups shall be confirmed and provided by the Integrator under Base Bid.
- 22. Provide a “Supervisors Utility Screen”, protected by a pin code to allow updating of modifiable system parameters as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support.
- 23. Provide for instant connection of the intercom system master station to the calling station selected from the GUI.
- 24. Provide instant display or manual selection of the screen showing the alarm location or the calling intercom location graphically as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support.
- 25. In addition to manual camera call up by touching a camera icon, provide for automatic video surveillance camera call-up to a designated monitor from the GUI. Provide automatic call-up of the nearest video surveillance camera upon intercom connection (“Video follow Audio”) or alarm “seek” display (Video follow Alarm”) as verified with the Owner and Engineer.
- 26. Provide automatic GUI calibration during System "boot-up" without operator input and manual calibration accessible from the Supervisors Utility Screen.
- 27. Provide user selectable audible feedback on all icon commands. This audible feedback shall be selectable between male voice, female voice, or a tone. This shall be selected from the miscellaneous function icons as described above. Menu of tones shall be reviewed and tones shall be selected by the Owner during the phase I software development process described in Part 3.1, Software Support.

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28. Provide unauthorized entry alarm for monitored or controlled door going unsecured with no corresponding unlock command from system; on GUI, provide visual and unique audible annunciation and location information on message text line.
29. Provide 2 step operations for activations of devices that reduce the security or safety of the facility. These operations include, but are not limited to unlocking doors, holding doors open, group release, isolating doors or intercoms, etc.
30. Provide 3 step operations for critical changes to secure status such as interlock overrides, emergency release, etc.
31. Provide single step operations for operations that increase or have no impact on secure status such as locking doors, camera call up, intercom select, etc.
32. Provide owner defined labeling of rooms and spaces.
33. Provide the ability to do hard copy and archival logging of all system events and transactions.
34. Provide programming that disables all methods of switching from the security control application to the operating system except with appropriate supervisory level password.
35. The development tools used for the graphical interface shall be that of a nationally recognized industrial applications software development package with a national support network.
36. Implement programming that initiates “video follow” functions for intercom devices and alarms. All intercoms and alarms within the field of view of a camera shall be automatically routed to the appropriate monitors when the alarm or intercom becomes active.

C. Acceptable Manufacturers

1. Omron Indusoft 512k
2. Wonderware
3. Approved Equal

D. Software design and implementation

1. All monitoring and login logic shall be programmed within the Omron Indusoft or other application. The security management system software and the Input/Output Data Access Servers shall be of the same manufacturer as the development tools. No proprietary approach shall be considered.
2. The finished software product shall be examined by the manufacturer and the Engineer for compliance with this specification. Should the examination reveal that proprietary code was created; the integrator shall remove such code and replace it at no additional cost to the owner. The process shall be repeated until the Owner and Engineer are satisfied that the system as developed contains no proprietary content that would prevent the system being maintained by another service provider.
3. The system integrator shall turn over all programming passwords, source code and programming schedules at the end of the project. Prior to final payment all software shall be authenticated as being non-proprietary by the Owner or the Owner’s designated representative as described above.
4. All PLC I/O addresses shall have continuous communication with the PLC. No programming tag PLC addresses shall be changed during runtime.

2.3 GUI CONTROL STATION ICON (SWITCH) FUNCTION AND DESCRIPTION

A. Specifications

1. GUI Switch Functions
 - a. Door Control Icons
 - b. Utility Control Icons (Lighting, Power,)
 - c. Log In/Out, Satellite GUI Takeover and GUI Disable Icons
 - d. Intercom Control and Call Disable Icons
 - e. Key Plan Zoom Window
 - f. Alarm Silence and Reset Icons
 - g. Monitor Selection/Camera call-up Icons
 - h. Elevator Control
 - i. Other functions as defined during the software development process described in Part - 3.1, Software Support.
2. Provide animation of actual control and annunciation icon as verified with the Owner and Engineer during the software development process described in Part - 3.1, Software Support.
3. Throughout the software design process linking of “follow” functions shall be accommodated as part of the basic scope of services. Follow functions shall be defined as camera calls to specified monitors based on intercom, alarm or door control functions; or, intercom talk paths automatically being established based on alarm functions. Automated “follow” functions shall be limited to camera and intercom functions. No automated door release functions shall be allowed.
4. Door Control Icons
 - a. Door Unlock
 - 1) Touch or left click the Unlock global function icon.
 - 2) Touch or left click the associated door icon.
 - 3) The security system momentarily applies power to the lock or electrically operated door to start the lock or door through its unlock or open cycle.
 - 4) The unlock function remains enabled for 3 seconds after each door icon is touched. If the timer lapses and no icon is selected, the unlock global must be selected again to reactivate the function.
 - b. Group Unlock
 - 1) Touch or left click the Unlock global function icon.
 - 2) Touch or left click the associated door group icon.
 - 3) The security system momentarily applies power to the locks or electrically operated doors in the group one at a time to start them through their unlock or open cycles.
 - 4) During a group unlock, an isolated door shall not be powered.
 - 5) The unlock function remains enabled for 3 seconds after each door icon is touched. If the timer lapse and no icon is selected, the unlock global must be selected again to reactivate the function.
 - c. Door Hold Open

- 1) Touch or left click the Hold Open global function icon.
 - 2) Touch or left click the associated door icon.
 - 3) The security system applies power to the lock or electrically operated door to maintain the lock or electrically operated door in the unlocked or open position.
 - 4) The held open function remains enabled for 3 seconds after each door icon is touched. If the timer lapses and no icon is selected, the hold open global function must be selected again to reactivate the function.
- d. Door Lock
- 1) Touch or left click the associated door icon.
 - 2) If necessary, the security system momentarily applies power to or removes power from the lock or electrically operated door to start the lock or door through its lock or close cycle.
- e. Isolate
- 1) Touch or left click the Isolate global function icon.
 - 2) Touch or left click the associated device icon. (doors or intercoms)
 - 3) The security system isolates the device from normal operation.
 - 4) The isolate function toggles each time a device is selected. The isolate global function remains active for 3 seconds after the last device selected.
 - 5) Provide group “synchronization.” Selecting the isolate global function and a group button the first time shall un-isolate any door in the group that is currently isolated. Selecting the group button the second time, shall isolate all doors in the group.
 - 6) Add visual note diagram box on the Touchscreen for user to “instruct/inform” others as to why the Door was isolated.
- f. Emergency Door Release
- 1) Touch or left click the EMERGENCY DOOR RELEASE miscellaneous function icon.
 - 2) When the EMERGENCY DOOR RELEASE icon is selected, a red pop up message box shall be displayed with a written warning and the audible annunciation shall warn the operator of the danger associated with an Emergency Door Release. The audible warning must reiterate the displayed text and must play in its entirety before the first level confirmation icon is displayed.
 - 3) A second, red EMERGENCY DOOR RELEASE warning box shall then appear on the current screen with a written warning.
 - 4) The function can be canceled at any time by selecting the CANCEL button.
 - 5) After the second confirmation is selected, the background around the EMERGENCY DOOR RELEASE icon shall flash and the audible annunciation shall continuously announce “EMERGENCY DOOR RELEASE”.
 - 6) All emergency release doors shall be unlocked. Those doors that are unlocked under the emergency door release, shall display as if opened via the control system. These doors are equipped with half cycle locks. See

detention hardware section for lock function description to be incorporated into the controls system.

- 7) Other control stations also monitoring or controlling the same doors as the panel initiating the release shall have an EMERGENCY DOOR RELEASE ACTIVE indication located on their screen and will alarm and flash as described previously.
- 8) Emergency Relock. Provide EMERGENCY DOOR RELEASE RELOCK miscellaneous function icon. This Icon releases the affected door to relock.
- 9) All system door locks shall fail to locked / secure in the event of system failure.

g. Interlock Override Icon

- 1) Touch or left click the Interlock Override miscellaneous function icon.
- 2) A yellow pop up message box shall be displayed with a written warning and the audible annunciation shall warn the operator of the danger associated with interlock override. The audible annunciation warning must reiterate the displayed text and must be capable of playing in its entirety before the second level confirmation icon is displayed. Delay must be adjustable and confirmed during phase I and II.
- 3) A second yellow interlock override warning box shall then appear with a written warning. The audible feedback warning must reiterate the displayed text and must be capable of playing in its entirety before the first level confirmation icon is displayed. Delay must be adjustable and confirmed during phase I and II.
- 4) Only after the second confirmation is made shall the interlock indications be removed from the screen.
- 5) Once any door icon is selected, the interlock override function shall cancel. If no door icons are selected within 10 seconds of the second confirmation, the interlock override function shall cancel. Also, the function can be canceled at any time by selecting the “CANCEL” icon.
- 6) Attempting to unlock a door that is interlocked shall cause the voice annunciation system to state, “Function not allowed. Door is interlocked.”

5. Utility Control: Lighting, Power Receptacles.

- a. Utility control icons are to be located on the utility control screen. The utility control screen shall segregate the utility icons from security icons such as door locks, intercom and video surveillance. Selection of the utility screen shall be via the global function tool bar.
- b. Touch or left click the global utility icon, the normal icons are hidden and the utility icons are displayed.
- c. Touch or left click the associated control icon.
- d. The security system removes power from the coil of the low voltage relay associated with the device to be controlled, and the utility comes on.
- e. Touch or left click the icon a second time.
- f. The security system applies power to the coil of the low voltage relay and maintains power until the icon is clicked again. When the relay is engaged the utility is off.
- g. Provide group control of cell lights.

- 1) Lower Tier
 - 2) Upper Tier
 - 3) Dayroom
 - h. Provide group “synchronization.” Selecting the group button the first time shall turn any utility in the group that is currently on to its off state. Selecting the group button the second time, shall turn all utilities in the group on.
 - i. Utility control shall be configured such that failure of the PLC/GUI control systems renders the utility “on”.
 - j. TV Receptacle.
 - k. Control (power) over the Video Visitation within the dayrooms.
 - l. Provide control over the Inmate phones, located within the dayrooms.
6. Log In, Satellite GUI Takeover and GUI Disable
- a. Log In/Out
 - 1) Touch or left click the Log in/out icon.
 - 2) Login validation shall be integrated with the SSMC’s database to allow the tracking of the operators name for all functions at each GUI until it is logged off.
 - 3) The GUI displays a “scrambled” numeric keypad for the operator to enter a PIN code.
 - 4) If the PIN code is valid the operator is logged in as the current operator of the station.
 - 5) An operator remains the current operator until a new operator is logged in or until the GUI is taken over or disabled (see below).
 - b. Satellite GUI Takeover
 - 1) Touch or left click the Satellite GUI Takeover icon.
 - 2) The security system disables all control and monitoring functions at the Satellite GUI, blocks all attempts to log in at the Satellite GUI and transfers control and monitoring responsibility to the initiating GUI. Icon shows “Off Line”.
 - 3) Touch or left click the icon a second time.
 - 4) The security system allows attempts to log into the Satellite GUI, but retains control and monitoring until an operator logs into the Satellite GUI.
 - 5) When an operator is logged in to the Satellite GUI the control system returns all previous control and annunciation to the Satellite GUI. Central Control shall still have the ability to view the locally controlled screens. Central Control’s icons in these locally controlled areas shall appear to be “sunken” into the screen with a passive or muted video color. The status of the DPS and LSS shall be dynamically displayed. The intent is to allow Central Control to be aware of door movement throughout the building, while leaving control of devices with the Satellite GUIs.
 - 6) Failure of the workstation or software at the satellite locations shall cause control to be transferred to the designated takeover station. A pop up window annunciating the failure and transfer shall be provided to alert the operator of the takeover station as to the transfer.

c. GUI Disable

- 1) Touch or left click the Disable icon.
- 2) The security system immediately logs out the current station operator and transfers responsibility for control and annunciation to central control. Satellite GUI shall still have the ability to view the locally controlled screens. The icons in these locally controlled areas shall appear to be “sunken” into the screen with a passive or reverse video color. The status of the DSS and LSS shall be dynamically displayed. The intent is to allow the Satellite GUI to be aware of door movement in their areas, while control is transferred to the designated control point.
- 3) Attempts to log into the station are not allowed until central control enables the satellite station.

7. Intercom Control

a. Intercom Control

- 1) Call-in from field device causes associated Intercom Station icon to flash and tone/VAS to sound.
- 2) Selecting the Intercom Station icon connects the Master Intercom to the associated intercom station in listening mode, turns the icon solid color and silences the call in tone/VAS.
- 3) Selecting the same icon a second time disconnects the call, and turns off the solid icon color.
- 4) Selecting a second intercom icon while connected to another station causes the connected station to disconnect and connects the selected station.
- 5) When a call is designated to route to more than one master, the establishing of a talk path by the first to answer the call, cancels the call at the other stations.
- 6) Implement video follow audio for adjacent cameras. When an intercom talk path is established, the associated camera (if any) shall be displayed on the Intercom Monitor, and the associated camera icon shall indicate it has been activated.
- 7) The intercom system incoming shall be routed through the GUI Audio System.

b. Communications Window

- 1) A portion of each screens tool bar, without obstruction to the floor plan, shall be allocated for intercom queue. This window shall contain a “Pending List” of the next (7) pending calls.
- 2) Call Control Icons and Indicators include:
 - a) ACTIVE STATION containing the text name of the active intercom call
 - b) Master to Master call (Caller ID)
 - c) Master call waiting/busy
 - d) CALL ANSWER button
 - e) CALL ANSWER AND ZOOM button,

- f) ZOOM ACTIVE button
 - g) CALL DISCONNECT button
- 3) This window shall allow the operator to answer calls without having to go to a particular screen (answer) unless it is desired to do so. (answer and zoom)
- c. Pending List
 - 1) The list of incoming pending calls designated for the particular GUI shall show the Owner-assigned text names for the oldest seven pending calls that have not been answered and in the order that they were initiated.
 - 2) As a call is answered it shall be removed from the list and the list shall be automatically updated with any new incoming calls.
 - 3) If a call-in is isolated, it should not be displayed in the Pending List.
 - 4) If a master to master call is placed, and the receiving master is busy, the calling master receives a busy prompt and is held in queue until call is accepted by the master being called.
- d. Call Answer Button
 - 1) Touch or left click the Call Answer Button
 - 2) Each time this button is selected, the active station shall automatically cancel and the first station on the pending list shall automatically connect.
 - 3) If there are no pending calls, this button shall be muted on the tool bar.
- e. Call Answer and Zoom Button
 - 1) Touch or left click the Call Answer and Zoom Button
 - 2) Each time this button is selected, the active station shall automatically connect to the first station in the call queue.
 - 3) The GUI shall automatically go to the screen where the answered intercom station is located.
 - 4) If there are no pending calls, this button shall be muted on the tool bar.
- f. Zoom Active Button
 - 1) Touch or left click the Zoom Active Button.
 - 2) When this button is selected, the GUI shall automatically go to the screen where the connected intercom station is located.
 - 3) If there is no active call, this button shall be muted on the tool bar.
- g. Call Disconnect Button
 - 1) Touch or left click the Call Disconnect Button
 - 2) When this button is selected, the active intercom call is disconnected.
 - 3) If no station is connected, this button shall be muted on the tool bar.
- h. Call Isolate
 - 1) Selecting the isolate button from the global function tool bar and then

- selecting an intercom station icon shall place the intercom station in isolate mode.
 - 2) In the isolate mode, calls placed from the station shall annunciate visually only and not via the tone/VAS.
 - 3) When placed in the isolate mode, the icon shall change state to reflect the mode.
 - 4) When placing an icon in the isolate mode, the operator shall be prompted to enter the reason the station was isolated using the occurrence log.
 - 5) All isolated icons shall reset to normal mode at a time selected by the Owner; the duration of an isolation shall not exceed 24 hours.
 - 6) Add visual note diagram box on the Touchscreen for user to “instruct/inform” others as to why the Door was isolated.
 - i. Paging. Provide icons associated with the paging zones. This shall include the intercoms themselves acting as paging speakers in certain areas.
8. Key Plan and Zoom Window
- a. Zoom Window
 - 1) A portion of the tool bar on each screen, without obstruction to the floor plan, shall be allocated for the key plan. This window shall contain a whole site plan and be located on every screen.
 - 2) All screens shall be accessible with no more than two touches of the site plan.
 - 3) Any screen can be accessed from any other screen with no more than two touches. A screens outlined area on the site plan shall highlight when the curser is placed over the associated section of the key plan.
 - 4) Each control screen shall be geographically outlined on the Zoom Window. The highlighted outline shall follow the shape and pattern of the zoom screen area.
 - 5) The Zoom Window shall contain -
 - a) Zoom Area
 - b) Site Plan Location Indicator
 - c) Site Plan Pending Call Indicator
 - d) Site Plan Alarm Indicator
 - b. Zoom Area
 - 1) Touch or left click outlined area of the site plan.
 - 2) Activation shall cause the GUI to go directly to the screen that controls the selected area or a more detailed zoomed area.
 - 3) A distinctive audible sound shall annunciate when this action is performed.
 - c. Site Plan Location Indicator
 - 1) The area on the site plan that represents the current screen shall be highlighted in white to indicate exactly what screen is active in relation to the whole facility.

- 2) The other areas shall be gray unless pending calls or alarms are active as explained in the Site Plan Pending Call Indicator and the Site Plan Alarm Indicator.
 - d. Site Plan Pending Call Indicator
 - 1) When calls are pending from areas other than the current screen, then the area of the call shall flash on the site plan.
 - 2) If both an alarm and a pending call are active at the same time in an area, then the respective area shall flash alternating colors.
 - e. Site Plan Indicator
 - 1) When alarms are active from areas other than the current screen, then the area of the alarm shall flash on the site plan.
 - 2) If both an alarm and a pending call are active at the same time in an area, then the respective area shall flash alternating colors.
 - f. Plan Navigation Arrows.
 - 1) Provide arrows on each map as an additional means to navigate through the facility.
9. Alarm Silence and Reset Icons
 - a. Alarm Silence
 - 1) When an audible alarm annunciation is sounding; touch or left click the Alarm Silence icon.
 - 2) The audio alarm stops.
 - 3) The audio alarm starts again if alarm conditions exist on other screens, or if new alarms are received on the same screen.
 - b. Alarm Reset
 - 1) Provide the Reset Icon to reset all alarmed icons to normal conditions if they are not of the self-resetting type.
 - 2) Touch or left click the Reset icon when the alarm conditions no longer exist.
 - 3) Reset function shall only operate on those alarms annunciated on the active screen. No global alarm reset icons shall be allowed.
10. Camera Selection
 - a. Camera Selection via icons
 - 1) In addition to automatic call up, Cameras can be selected via the GUI.
 - 2) Touch or left click the camera icon.
 - 3) Selecting the camera icon causes the icon to change color, and displays the video surveillance image on the active monitor.
 - 4) Selecting the same icon a second time disconnects the camera and returns

- the active monitor to its default scene.
- 5) Selecting a second camera icon while another camera is active causes the active camera to deactivate and activates the selected camera.
- 6) Camera selection is to the default “call up” monitor at the touch screen work station. Provide a means of selecting cameras to the overhead monitors by changing from the default monitor to a selected monitor from the tool bar. Only monitors within direct view of a touch screen location shall be selectable from the tool bar.

11. Occurrence Log

a. Entry of New Occurrence Logs

- 1) User can enter text via the attached keyboard.
- 2) As characters are selected on the keyboard they should be displayed on the appropriate field.
- 3) Select the submit button to save the entered text into the SSM computer.
- 4) After submitted, status should indicate that the text has been sent and saved successfully, and the title and log fields should be cleared. If the text is not sent and saved successfully, the status should indicate “Log Entry Failed”, and the title and log fields should not be cleared.
- 5) Select clear button to clear title and log fields.
- 6) Select view logbook button to view previous entries within the last 24 hours.
- 7) Occurrence log entry shall be as illustrated herein.
- 8) Title field shall be capable of 100 characters.

b. Viewing Previous Entries

- 1) Shall be capable of viewing 100 logged entries.
- 2) The retrieval time shall be less than 10 seconds.
- 3) Select the view log entry button to return to the new occurrence log entry screen.
- 4) All data is stored on the SSM computer.

12. Guard Tour

a. Guard Tour Icon on the touchscreen

- 1) Guard Tour icon on the touchscreen will be activated by either left mouse clicking on the icon or touching of the Guard Tour icon.
- 2) Once the icon has been “activated” the system will start a timing operation. This timing operation will give the guard a set amount of time to swipe the first physical Guard Tour Proximity reader. If the amount of time given has run out and the first swipe has not been activated then the system shall generate an alarm for the appropriate area.
- 3) Once the first swipe has been activated within the allotted time, then the system shall activate a second timing event for the next/last physical Guard Tour Proximity Reader to be activated. If the amount of time given has run out and the last swipe has not been activated then the system shall generate an alarm for the appropriate area.

- 4) If the last physical Guard Tour swipe has been activated in the required set amount of time, then the system will log the event, with date and time, as well as personnel involved in the tour.
- 5) Guard Tours may be programmed to automatically happen at certain points throughout the day, or the operator may start the tour as previously stated in step #1.

2.4 GUI CONTROL STATION INDICATOR CONDITONS

- A. Door Status - Provide red and gray (or white) animated graphic indicators on the screen at each door to be monitored, to indicate the status of the door. Monitor the Door Position Switch (DPS) and the Latch Bolt Monitor (LBM) switch independently, if possible. Independent monitoring of these switches is dependent on existing wiring configuration. Secure indication should only be displayed when both switches are in the secure condition. Differentiate between doors that are open, and doors that are closed but unlocked. Alarm is generated for unauthorized opening of doors; doors opened via unlock commands and doors left open too long. Timer for door open too long must be adjustable via supervisor's utility screen.
 1. Flashing Red - alarm
 2. Red - unsecured
 3. Gray or white – secured
- B. Utility Status – Provide yellow and gray animated graphic indicators on the screen at each utility location to indicate the utility status.
 1. Yellow – Utility On
 2. Gray - Utility Off
- C. Log In/Out, Satellite GUI Takeover, and GUI Disable – Provide a gray animated graphic indicator that contains the appropriate text.
- D. Intercom Control and Inmate Call Disable – Provide green, yellow, and gray animated graphic indicators on the screen at each intercom location, to indicate the intercom status.
 1. Flashing Green – Intercom call-in
 2. Green – Intercom active
 3. Yellow “X” - Intercom call-in isolated
 4. Gray – Intercom inactive
 5. “Sunken” – Intercom station calls to another master.
- E. Alarm Silence and Reset – Provide a gray animated graphic indicator that contains the appropriate text.
- F. Camera Selection - Provide a blue green red and gray animated graphic indicator on the screen at each camera location to indicate the camera status.
 1. Blue – Camera manually activated and video surveillance image displayed on active monitor.

2. Purple – Video follow audio activated and video surveillance image displayed on intercom monitor.
3. Red – Video follow alarm activated and video surveillance image displayed on alarm monitor.
4. Gray - Camera deactivated.

G. Interlock Status - Provide yellow color indicators at each door in an interlock group.

1. When a door in an interlocked group becomes un-secure, illuminate yellow indicators on all other doors in the interlock group.
2. VAS shall annunciate that door cannot be unlocked if interlock condition exists (see below)

H. Uninterruptible Power System Alarm and System Trouble Icon

1. UPS Power System Alarm
 - a. Upon loss of primary AC power, the UPS icon shall appear and begin to flash red “Inverter On”, accompanied by a unique tone.
 - b. Activating the alarm silence Icon shall silence the tone and cause the Icon to glow steadily. Upon return of primary AC power, activating the alarm reset Icon shall extinguish the red indication and hide the icon.
2. Similar function for Trouble indication. Flashing yellow “UPS Trouble” indication.

I. Duress Alarm/Panic Alarm - Provide red animated graphic indicators on the screen at each duress/panic switch on alarm only. Inactive or “normal” condition of the duress alarms hides the icon in lieu of muting it. Implement video follow alarm for cameras adjacent to duress or panic buttons. Duress or panic alarms with video follow alarm function shall call the camera to the alarm monitor at the associated GUI Operators post.

1. Flashing Red - alarmed
2. Red – acknowledged

J. Provide access to a system status screen with text display of the following:

1. Name of operator logged on to each console
2. List of all pending, silenced, and acknowledged alarms currently indicated through the entire system.

2.5 VOICE ANNUNCIATION SYSTEM

- A. Provide a Voice Annunciation System (VAS) as an additional interface between personnel and the computer system. The VAS shall use speech from a stored vocabulary to provide alert and annunciation messages, special direction or information to facility staff in staff areas (intercom speakers) and control rooms. Verify message requirements and locations during Phase-1 software meeting.

1. The VAS shall be entirely electronic, no tapes, and meet the following minimum requirements
2. The VAS shall speak individual words, phrases and sentences in addition to tones.
3. VAS shall provide output to audio amplifiers, speakers and intercom speakers that are also part of system.
4. The VAS shall be selectable between male voice, female voice, and a tone. This shall be selected from the miscellaneous function icons as described above.

2.6 SECURITY SYSTEM MANAGEMENT COMPUTER (SSMC) OPERATIONAL REQUIREMENTS:

A. Specifications

1. The Security System Management Computer (SSMC) shall perform functions including, but not limited to, the following:
 - a. Programming of PLC.
 - b. PLC system remote diagnostic capabilities.
 - c. Recording all security control system transactions and events.
 - d. Recording of incident reports.
2. The SSMC shall generate reports of the recorded transactions and events within the system. All data shall be recorded into a database and the SSMC shall have the capability to generate reports through selection of any data field or timeline. The SSMC shall have advanced search capabilities for any combination of data and can search the incident logs independently.

PART 3 EXECUTION

3.1 SOFTWARE SUPPORT

A. Phase I

1. Provide screen shots. The Integrator shall request, in writing, scheduling of the Phase I meeting within one (1) week of receiving the approved shop drawing submittal. Phase I meeting shall take place on site at the owner's facility. A proposed agenda shall be included with the request. The Phase I meeting shall be held within thirty (30) working days of receiving the approved shop drawing submittal.
2. The purpose of the Phase I meeting is to define the project specific functions and operational procedures of the control system with the Owner & Engineer. The Integrator shall present proposed operational procedures for every function specified in the Contract Documents or recognized as industry standard or convention for a correctional facility Control System. The Integrator will present proposed operational schemes to the Owner & Engineer, and modify those schemes based on the Owner's policies and procedures.
3. The Integrator shall address integration of the components and subsystems making up the control system when presenting the proposed operational procedures. The Integrator shall provide an operating GUI at the Phase I meeting (of an operating facility or this

facility) that demonstrates every control and annunciation function described in the specifications to help with Owner's design decisions. This demo shall not include any operational procedures that are not included in the Base Bid for this project. This operating GUI shall demonstrate all data capture and reporting features of the SSMC.

4. The Integrator shall prepare and present 4 sets of color screen drawings at this meeting. As a minimum, these screen drawings shall depict the following:
 - a. Overall building layout screen.
 - b. Area control screens. (These area screens should be drawn to represent actual orientation with control officer's view). Different orientation views should be created per each control post and the control officer's orientation view.
 - c. All special control and transition screens. (Utility, Administration, help, etc.)
 - d. Each sheet should be numbered for easy reference.
 - e. Actual size to show detail and all text legible.
5. The Integrator shall prepare a detailed report summarizing the operation of all icons. The report is to be submitted for approval by the Owner and Engineer no later than two (2) weeks after the date of the Phase I meeting. The software systems that make up the control system shall be designed specifically from this document.

B. Phase II

1. At least thirty (30) working days prior to the scheduled date for job site delivery of the first control system head end components, the Integrator shall request a Second meeting with the User (maximum of 4 representatives) and the Engineer (2 representatives) at the Integrator's manufacturing facility. The Integrator shall provide a full demonstration of the completed control system with fully functional control software. The Integrator shall provide means to simulate all real world conditions necessary to demonstrate each function and operating procedure agreed to in the Phase 1 meeting. The design and function of the software shall match the exact performance as specified in the revised Phase I report. The phase II meeting will take place at the integrator's facility. The Integrator shall be responsible for the cost of travel expenses incurred by the Owner and Engineer representatives for this trip. Travel expenses shall include airfare (if applicable), hotel accommodations, ground transportation, and meals.
2. All performance deviations and necessary changes identified at this meeting shall be documented by the Engineer on a "pre-punch list". The pre-punch list shall be 100% corrected by the Integrator prior to delivering the equipment to the job site.
3. During this time period the Integrator shall perform all shop testing as defined in the approved testing plan.

C. Phase III

1. Immediately following the installation and testing of the control system, the Integrator shall provide a formal demonstration of all systems to the Owner and Engineer that includes all operational elements covered in the Phase II meeting. The Integrator shall work with the Owner, facility personnel and the Engineer to correct any problems or operational deviations from the original Phase I and Phase II design documents. Deficiencies will be identified during the Engineer's punch list inspection, and documented to the Integrator. The Integrator shall perform all hardware and software

modifications necessary to correct any problems or operational deviations resulting from engineering, programming or installation services provided by the Integrator.

2. Upon achieving a 100% functional control system as determined by the Engineer, a documented release form provided by the Integrator shall be signed by the Owner, and retained on file with the Engineer. The Integrator shall continue to work on the installed system at no cost to the Owner until the Engineer has determined the Phase I and Phase II documents have been met and the system has been 100% field tested as defined in the approved testing plan, regardless of substantial completion. The system warranty shall begin after the Engineer has verified 100% compliance has been met.

3.2 INSTRUCTION PERIOD

- A. Provide the facility personnel with training in the use and maintenance of the entire control system. The first sessions to be prior to system turnover, the Second at turnover and the third immediately after turnover. Coordinate the training sessions with the Owner. Completed classroom sessions will be documented by the Integrator, certified by the attending Owner representatives, and approved by the Engineer. Instruction shall take place during normal working hours (Monday through Friday, 8:00 a.m. to 5:00 p.m.). Instruction shall not begin until all systems are operational as designed. See section 28 05 00 – Common Work Results for Electronic Security for additional information regarding training.
- B. The training sessions shall cover the operation and the maintenance manuals and the control console operators manuals and service manuals in detail, stressing all important operational and service diagnostic information necessary for the maintenance and operations personnel to efficiently use and maintain the control system.
- C. Integrator is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not be limited to the following-
 1. Review all O+M manuals with Owner's representatives present for training.
 2. Perform a tour of the entire facility. During the tour the trainer shall point out all control equipment and provide a brief description of its purpose and use. This is to include but not be limited to touch screen control stations, all control system hardware, and devices controlled.

END OF SECTION 284620

SECTION 285000 - MISCELLANEOUS SYSTEMS FOR ELECTRONIC SECURITY

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
 - 1. Overhead Door Position Switch
 - 2. Duress Alarms
 - 3. Detection Loops
 - 4. Door Release Push Button

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 01.
- C. Provide materials listed by UL or ETL.

2.2 OVERHEAD DOOR POSITION SWITCH

- A. Specifications
 - 1. 3' stainless steel armored cable
 - 2. SPDT contacts
 - 3. Wide gap read distance
 - 4. Heavy cast aluminum housing
 - 5. Floor-mounted
- A.
 - 1. UTC Fire & Security 2202
 - 2. Sentrol, Inc. – 2327A Series (Extra Heavy-duty, Aluminum Bar Stock)
 - 3. Nascom
 - 4. Approved Equal
- B. Acceptable Manufacturer:
 - 1. UTC Fire & Security 2202
 - 2. Sentrol, Inc. – 2327A Series (Extra Heavy-duty, Aluminum Bar Stock)
 - 3. Nascom
 - 4. Approved Equal

2.3 DOOR RELEASE PUSH BUTTON

- A. Specifications

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1. Momentary push button
2. Dry contact
3. 3 amp contact rating
4. Screw terminal connections
5. ¼" Aluminum face plate

B. Acceptable Manufacturers

1. Security Door Control SDC 450
2. ProDoor Hardware
3. Grainger
4. Approved Equal

2.4 DURESS ALARM, WALL MOUNT

A. Specifications

1. Silent, single-push switch, for sending an immediate signal to supervisory personnel.
2. The switching mechanism contains a double-pole, double-throw contact supplied with lock mounted switch and two keys.
3. The switch can be reset only with a key by an authorized person.
4. Mounted to single gang aluminum plate.

B. Acceptable Manufacturers

1. Bulletin 800 Series/ Allen Bradley with Mushroom Head. Button head engraved "DURESS".
2. Grainger
3. Van Tech
4. Approved Equal

2.6 LOOP DETECTOR CONTROLLER

A. Specifications

1. Enclosure:	Extruded anodized aluminum
2. Output Relay:	5A/125V AC
3. Surge Protection:	Neon discharge lamps, zenner diodes, surge arrestors.
4. Loop Input:	Transformer Isolated.
5. Loop Inductance Range:	20-2000 micro henries
with Q factor of 5 or higher.	
6. Tuning:	Detector automatically tunes to loop.
7. Sensitivity:	10 position rotary knob.
8. Tracking:	Detector automatically tracks

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and compensates for environment changes.

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9.	Frequency:	Three position switch.
10.	Infinite Presence Mode:	DIP switch
11.	Limited 4 Minutes:	DIP switch
12.	Presence Time:	DIP switch
13.	Second Presence Relay:	DIP switch
14.	Pulse on Exit/Entry:	DIP switch
15.	Fail Safe/Secure:	DIP switch

B. Acceptable Manufacturer

1. EMX Industries DTEK loop detector controller.
2. Apollo
3. Gate Depot
4. Approved Equal

2.7 DURESS ALARM PUSHBUTTON, UNDER COUNTER

A. Specifications

1. Momentary DPDT contacts
2. Switch Rating: 3 Amps at 28VDC

B. Acceptable Manufacturers

1. Ademco – 269.
2. Honeywell
3. JMAC supply
4. Approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All system programming shall be done at the contractor's facility prior to installation on site.
- B. Qualified personnel shall install the System in strict compliance with manufacturer's instructions.
- C. Wiring shall be color coded, uniform and in accordance with national electric codes and manufacturer's instructions.

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- D. Equipment shall be firmly secured, plumb and level.

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- E. All cable runs to the main equipment rack shall be tagged and identified.
- F. Coordinate all work with other trades and Contractors.
- G. Grounding of devices and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- H. Install and configure Security local area network as required for control and communication between system devices. When required, provide necessary coordination, termination, and programming associated with integrating Security local area network with facility network.
- I. Equipment cabinets shall be assembled in the Contractor's shop prior to delivery to the job site.

3.2 SOFTWARE SUPPORT

- A. Refer to Section 284620 for software support and programming requirements.

3.3 SYSTEM INITIALIZING AND PROGRAMMING

- A. All programming shall occur in the Contractor's shop prior to installation on site.
- B. The System shall be turned on and adjustment made to meet requirements of the specification and on-site conditions.
- C. The System shall be programmed to function as specified.
- D. Any special programming shall be documented and a written copy given to the Owner/User.
- E. Coordinate integration of other electronic systems as called for in the contract documents.

3.4 SYSTEM TEST PROCEDURES

- A. The System shall be completely tested to assure that all components are hooked up and in working order.
- B. The System shall be pre-tested by the security equipment contractor and certified, in writing, to function in accordance with the plans and specification.
- C. The contractor is to verify the system is communicating with all controlled devices.

3.5 FIELD QUALITY CONTROL

- A. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.

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- C. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

END OF SECTION 285000

SECTION 285123 - INTEGRATED INTERCOM/PAGING SYSTEM FOR ELECTRONIC SECURITY

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

- A. Furnish all materials and labor necessary to complete the installation of specific systems described herein and integration of all systems as indicated, specified herein or both. The work includes the following, as well as work not listed below but described elsewhere:
- B. Provide Intercom System that meets the following functional requirements
 - 1. The purpose of the intercom system shall be to provide clear, two-way, remote reply intercommunication between intercom master stations and remote intercom substations.
 - 2. System shall also accommodate zoned overhead paging to the areas identified throughout the facility with talk back capabilities provided. Source input is limited to the intercom push to talk master stations at the various control consoles.
 - 3. The extent, size, locations, and layout of the various systems shall be shown on the plans.
 - 4. The system is configured to allow for visual and audible notification to the operator of intercom call in and active intercom channels on the graphical user interface associated with each control console.
 - 5. Intercom substations shall be programmed to call a designated master based on the location of the station and the area of influence for each control console.
 - 6. System shall provide audio monitoring and of initiating an alarm when the voice being monitored at a certain location exceeds preset audio parameters as a means of call in for the speakers located on the bulkhead outside the cells.
 - 7. The intercom/paging system shall be a major sub-system of the overall integrated control system. Controlling the system, selecting stations, and integration with other sub-systems shall be accomplished through a communications interface (Ethernet) to the graphical user interface.
 - 8. Paging system shall be capable of routing to individual or groups of defined speaker zones. All call paging is also required.
 - 9. Manufacturer-approved personnel shall perform installation and maintenance.
- C. System Configuration
 - 1. Microprocessor based, network centric controllers and expanders are required. Controllers and expanders shall support 2 master stations each and be capable of fully independent talk paths for each.
 - 2. Ethernet communications and a separate audio trunk shall provide the capability to network individual exchanges with each other creating an integrated system. Transfer of station call between exchanges shall be accommodated via the network.
 - 3. Standard 25-volt output amplifiers shall provide audio power to IC stations.
 - 4. Tamper resistant substations shall be flush mounted as shown on the drawings or specified.

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5. Intercom master stations are required for control locations. Connection of the master stations shall be via Ethernet.
6. Controller software shall allow for individual level control, sensitivity, and equalization of each station.
7. Intercom system shall interface with video surveillance system.
8. When intercom station talk path is established, the video surveillance system shall display image of the nearest camera on call up monitor associated with the console establishing the talk path.
9. The ability to suspend a stations capability to call in shall be provided via integration with the graphical user interface shall be provided. This ability is necessary to prevent inmates from harassing console operators with continuous calls.
10. Console master stations shall be capable of listening to intercom stations or talk back page zones without privacy tones announcing that a console is listening.
11. Pages shall originate from the various consoles and shall include talkback capabilities.
12. Provide 25% spare capacity for future expansion.

PART 2 PRODUCTS

2.1 GENERAL

- A. Equipment specified is intended as a reference standard for level of quality.
- B. Substitutions of equal quality will be accepted. All substitutions are to be approved prior to bid and listed by addenda. Substitutions will not be accepted after the schedule bid time. Refer to Division 00 and Division 01.
- C. Provide materials listed by UL or ETL.
- D. Basis of Design
 1. Drawings and specifications included in these contract documents are based on the Harding Instruments DXL product.
 2. Equal by Zenitel is acceptable
 3. Equal by Tech Works
 4. All other manufacturer's products must be submitted for approval per 2.1.B above

2.2 DIGITAL COMMUNICATION CONTROLLERS (DCC's)

- A. Digital Communication Controllers to each form an intercom exchange capable of independent local operation. Exchange capacity to be increased by connecting up to four Digital Communication Expanders to each DCC.
- B. Multiple DCC's to be networked together via digital audio trunks and Ethernet data networks to form the larger system. VoIP enabled systems shall utilize IEEE 802.1p/Q Quality of Service (QoS) compliant Ethernet networking equipment.
- C. Each DCC to include:

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1. A Process Control Card (PCC)
2. A Master Control Card (MCC)
3. Two Station Control Cards (SCCs)
4. An internal PCI card (Lonworks or VoIP accelerator card)
5. A front panel keypad/display for system setup and maintenance.
6. A 110 VAC, 60 Hz power supply for internal functions.

D. Process Control Card:

1. Process Control Card to contain system configuration and data, control exchange operations and switching, and provide exchange network ports.
2. Process Control Card to include:
 - a. USB network ports for exchange expansion.
 - b. Ethernet network ports for system expansion and external control by touch screen computers and graphic control panels.
 - c. Fiber optic or copper digital audio trunk ports. (not required for VoIP over Ethernet audio trunking)
 - d. Two serial ports.
 - e. An internal modem for transmitting and receiving data over a telephone line.

E. Master Control Cards:

1. Include ports for any combination of two intercom or telephone set master stations.
2. Include two line level audio inputs with status and control.
3. Include two line level audio outputs with status and control.
4. Convert incoming audio signals to digital format and outgoing signals to analog format.
5. Intercom master station audio, press-to-talk and hook switch status transmitted over two single shielded pair cables with wiring supervision to detect open circuit and short circuit faults.
6. Telephone set master station functions transmitted over a single wiring pair.

F. Station Control Cards:

1. Each provide sixteen half-duplex intercom station ports which can be employed in adjacent pairs for full duplex devices.
2. Provide an interface for intercom stations. Units to convert incoming audio signals to digital format and outgoing signals to analog format. Each channel to monitor the status of up to two (2) switches associated with each intercom station.
3. Each card interfaces with 16 half-duplex channels. Each channel includes a separate audio power amplifier for non-blocking call operation and sixteen (16) independent software controlled volume settings.
4. Audio and switch functions on 300 Series (Generic Intercom) station control cards to be transmitted on separate wiring pairs.
5. The 300 Series Station Control Card will also monitor speakers.

G. Acceptable Manufacturers:

1. Harding DXL DCC
2. Zenitel
3. Tech Works
4. Appriooved equal

2.3 DIGITAL COMMUNICATION EXPANDERS (DCE's)

- A. Digital Communication Expanders to provide master station and intercom features similar to the DCCs to facilitate exchange expansion.
- B. Each DCE to include:
 1. A Process Control Card (PCC) without exchange control or network functions.
 2. A Master Control Card (MCC).
 3. Two Station Control Cards (SCCs).
 4. A 110 VAC, 60 Hz power supply for internal functions.
- C. Acceptable Manufacturers:
 1. Harding DXL DCE
 2. Zenitel
 3. Tech Works
 4. Approved equal

2.4 TALKBACK EXPANDERS (TBEs)

- A. Talkback Expanders to provide 8 amplified paging outputs that can drive 25 Vrms loudspeaker circuits.
- B. Each TBE is to;
 1. Provide 5 watts output per channel
 2. Allow adjacent channels to be bridged to obtain higher power.
 3. Provide talkback capability on all channels.
 4. Include Audio Level Alarm capability on all channels.
- C. Acceptable Manufacturers:
 1. Harding Instruments
 2. Zenitel
 3. Tech Works
 4. Approved equal

2.5 PAGE ZONE EXPANDERS (PZEs)

- A. Page Zone Expanders to provide 3 page inputs (from an audio amplifier) with each input having 6 selectable relay controlled outputs
- B. Each PZE input to include

1. 1 relay controlled output for each input that can be used to key an audio amplifier.

C. Acceptable Manufacturers:

1. Harding Instruments
2. Zenitel
3. Tech Works
4. Approved equal

2.6 ADMINISTRATOR SOFTWARE

- A. Administrator Software to function on a standard PC to support system configuration, diagnostics, maintenance, and logging but not be required for system operation.

- B. Administrator Software to employ Windows features including views of system tree structure, tables of devices, screens for system settings and adjustments, and tables of operational data.

C. Configuration features to include:

1. Creation of overall system architecture.
2. Creation of multiple device templates.
3. Copy and paste functions with auto-numbering and auto-assignment to create device schedules.
4. Configuration error detection and alerts.
5. Device naming and call routing functions.
6. Device setting and performance functions.

D. Diagnostic and Maintenance features to include:

1. Verification of system configuration and installation.
2. Verification of system networks.
3. Verification of device connections.
4. Verification of system operation.
5. Diagnostics via modem or Ethernet ports.

E. Logging features to include:

1. Display of system activity with filtering options.
2. Search by time and date.
3. Search by device.
4. Search by parameter.

F. Acceptable Manufacturers:

1. Harding Instruments
2. Zenitel
3. Tech Works
4. Approved equal

2.7 NETWORK REPEATERS

- A. Network repeaters are to extend LonWorks network cable limits or increase node limits. Each unit is to include four network ports. Data received on any port to be re-transmitted on the other ports.
- B. Units to be surface wall mounted and include de-pluggable screw terminal connectors, redundant power supply connections and internal fuse to protect circuitry.
- C. Six (6) LED's to indicate receiving port, network activity, and power supply status.

2.8 VoIP INTERCOM MASTER STATION

- A. Specifications
 - 1. Small desktop module with an brushed stainless steel top
 - 2. High sensitivity omni directional microphone available on a 12" or 18" flexible gooseneck or flush mounted
 - 3. Noise free rotary volume control
 - 4. Top surface PTT switch with contacts for an external switch
 - 5. Support for an external privacy handset
 - 6. Supports external PTT
 - 7. 3.5 mm stereo line level output jack for connecting an external amplifier or powered speaker
 - 8. Unit can be powered from a PoE capable Ethernet switch or an external power supply
 - 9. Front panel 2.5 mm headset jack
 - 10. Built in 10/100baseT Ethernet switch to facilitate a 2nd Ethernet connection
 - 11. Built in Automatic Gain Control (AGC)
 - 12. Supports remote firmware and configuration updates
- B. Acceptable Manufacturers
 - 1. Harding TMM-640 with Flush Microphone
 - 2. Zenitel
 - 3. Tech Works
 - 4. Approved Equal

2.9 VoIP MASTER AUDIO INTERFACE MODULE

- A. External
- B. ohm loudspeaker master audio interface module to consist of:
 - 1. 1 watt 8
 - 2. Two RJ-45 ethernet connectors, on provides PoE
 - 3. Electret microphone interface
 - 4. Telephone handset with press-to-talk switch interface.
 - 5. Telephone hook switch interface to activate handset
 - 6. Lifting telephone handset cuts off loudspeaker and microphone or headset

7. Headset interface to detect headset connection for loudspeaker and microphone cut off
8. Headset detection by jack switch or headset mic detection
9. Can be connected or removed while the system is operating without disrupting the rest of the system
10. Line level input and output
11. DPDT relay for status output
12. Power by PoE or 24-36 Vdc auxiliary power supply
13. Wall mount or din rail mount

C. Acceptable Manufacturers

1. Harding MAI-625
2. Zenitel
3. Tech Works
4. Approved Equal

2.10 VoIP INTERCOM STATIONS

A. Specifications:

1. Intercom stations are to be designed for mounting on standard 2-gang back boxes. Faceplates to be constructed of 11-gauge brushed stainless. Internal steel offset grille to restrict inserting objects through speaker grille. Stations to be ruggedly constructed and resistant to damage from soil and sprays.
2. Each intercom station is to incorporate an internal loudspeaker, microphone preamplifier and function multiplexing circuitry. One pushbutton is to be provided on each station. Pushbutton to be software assignable for placement of call request.
3. Pushbuttons to be vandal resistant and of stainless steel. Switch to have positive tactile action with 1 million-operation lifetime. (*Pushbuttons to be solid metal piezo-electric type with no moving parts and a 50 million operation lifetime*).
4. Loudspeakers to be waterproof mylar cone type.
5. All intercom station functions to be transmitted over a single CAT 6 cable. Stations to be provided with MTA type insulation displacement connector that requires no wire stripping for installation.
6. Outdoor intercom stations are to be identical in all respects to standard intercom stations except that all metal plates and hardware to be stainless steel, and internal circuitry and components to be conformally coated.

B. Acceptable Manufacturers:

1. Harding Instruments ICM 600
2. Zenitel
3. Tech works
4. Appoved equal

2.11 PAGING AMPLIFIERS

A. Specifications

1. Rack mount
2. 8 ohm 25 volt and 70 volt outputs
3. Two microphone inputs
4. One auxiliary input
5. Input level controls
6. Master volume control

B. Acceptable Manufacturers:

1. Harding Instruments AMP-035, AMP-060, AMP-100 Contractor shall select amplifier based on paging zones and number of devices per zone.
2. Zenitel
3. Tech works
4. Approved equal

2.12 WIRE AND CABLE

A. Factory manufactured field interface cables to be provided, as required, for all:

1. CBL-MST-A male DB-15 connector with 6 individually shielded twisted pairs for connecting to master station ports.
2. CBL-STN-A male DB-37 connector at one end with 16 individually shielded twisted pairs for connecting from station control card audio port to terminal blocks.
3. CBL-STQ-A with male DB-37 connectors at both ends and with 16 individually shielded twisted pairs. For connecting from station control card audio ports to QCB-120-1 Quick Connect Board.
4. CBL-SWT-A male DB-25 connector at one end with 16 individually unshielded twisted pairs for connecting from SCC- 300 station control card switch port to a terminal block.
5. CBL-SWQ-A with male DB-37 connectors at both ends and with 16 unshielded twisted pairs. For connecting from SCC- 300 station control card switch port to QCB-120-2 Quick Connect Board.

B. Field wiring to conform to manufacturer's recommendations.

2.13 QUICK CONNECT BOARDS

A. Quick Connect Boards are designed with a female DB connector to connect a cable from the station control card ports to screw clamp terminals that terminate the field wiring.

1. QCB-120-1 connects the audio port of either the SCC-300 or SCC-400/401 station control card to the field wiring.
2. QCB-120-2 connects the switch ports of an SCC-300 station control card to the field wiring.

2.14 STATION PORT ADAPTER

- A. Station Port Adapter provides a line-level output for use with external paging amplifiers.
1. Provides a single line-level output.
 2. Provides a single control output (when connected to a 400 or 401 series station card audio port).
 3. Screw terminal connections.

2.15 RECESSED CEILING PAGING SPEAKERS, NON-DETENTION AREAS

A. Specifications

1. Speaker

- a. Continuous Power Rating: 25 watts
- b. Frequency: 110 - 20KHz
- c. Impedance: 8 ohms
- d. Sensitivity: 88 dB, Avg./ 92 dB, Peak
- e. Coaxial: ½' post mounted domed tweeter, 4 inch paper cone speaker with poly-ether foam surround and a 10 oz magnet.

2. Transformer

- a. Primary Voltage: 70.7 volts
- b. Frequency Response: +/- 1 dB, 50-15 kHz
- c. Primary Taps: 1, 2, 4, and 8 watts
- d. Secondary Impedance: 4 and 8 ohms
- e. Insertion Loss: .6 dB

3. Back Box

- a. Enclosure Diameter: 5-3/8"
- b. Enclosure Depth: 7-5/8"
- c. Flange Diameter: 7-9/16"
- d. Internal Volume: .1 cubic feet
- e. Tile Bridge: 24 gauge electro-galvanized steel

4. Baffle: Perforated steel with welded/serrated studs
for push on installation

B. Acceptable Manufacturers

1. Soundolier FAP42T Strategy Series II speaker system package.
2. Lowell
3. Tech works
4. Atlas Sound C10 Series

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2.16 RECESSED CEILING PAGING SPEAKERS, DETENTION AREAS

A. Specifications

1. Speaker

a.	Continuous Power Rating:	16 watts
b.	Frequency:	110 - 20KHz
c.	Impedance:	8 ohms
d.	Sensitivity:	88 dB, Avg./ 92 dB, Peak

2. Transformer

a.	Primary Voltage:	70 volts
b.	Frequency Response:	+/- 1 dB, 50-15 kHz
c.	Primary Taps:	16 watts
d.	Secondary Impedance:	4 and 8 ohms
e.	Insertion Loss:	.6 dB

3. Back Box

a.	Enclosure Depth:	3-11/16"
b.	Internal Volume:	.1 cubic feet
c.	Tile Bridge:	24 gauge electro-galvanized steel

B. Acceptable Manufacturers

1. Quam H16/SVP.
2. Lowell
3. Tech Works
4. Atlas Sound

2.18 EXTERIOR INTERCOM PEDESTAL

A. Specifications

1. 2"x4" rectangular steel tubing
2. 8"x8" baseplate
3. Steel baseplate cover
4. Painted white
5. 8" tall x 12" wide x 6" deep housing with keyed door and shroud. (Contractor to verify the housing is sized to accommodate both the Intercom and the Card Reader that is required for the pedestals)

B. Acceptable Manufacturer

1. Engineered Parking Systems Dual Height custom S3S31272/35 Style 3 pedestal for car and truck traffic. Typical of gates and sally port entrance.
2. Viking
3. Zoro

4. Approved equal

2.19 INMATE / VISITOR PHONE

A. Specifications

1. Panel Size 5"W x 5"H
2. Weight 3 lbs
3. Mounting Flush Mount – 4" Electrical box
4. Input Power Telephone Line Powered
5. Jack RJ11C

B. Acceptable Manufacturer

1. Ceeco – SSP-350-X-M
2. Securus
3. ICS Solutions
4. Approved equal

2.20 INMATE /VISITOR PHONE Power Supply

A. Specifications

1. Power for up to 6 pairs (12 units)
2. Input 100-240 VAC
3. 50/60 HZ
4. Output +15 VDC
5. Size 6.25"L x 3.875"W x 1.75"D

B. Acceptable Manufacturers

1. Ceeco – 350-255
2. Securus
3. ICS Solutions
4. Approved Equal

PART 3 EXECUTION

3.1 INSTALLATION

- A. All system programming shall be done at the Integrator's facility prior to installation on site.

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- B. Qualified personnel shall install the System in strict compliance with the manufacturer's instructions.
- C. Wiring shall be color coded, uniform, and in accordance with national electric codes and manufacturer's instructions.
- D. Equipment shall be firmly secured, plumb, and level.
- E. All cable runs to the main equipment rack shall be tagged and identified.
- F. Coordinate all work with Engineer and other Trades Contractors.
- G. Grounding of cables and peripheral equipment shall be installed per manufacturer's direction to eliminate noise induction and achieve optimum system performance.
- H. Install and configure Security local area network as required for control and communication between system devices. When required, provide necessary coordination, termination, and programming associated with integrating Security local area network with facility network.
- I. Equipment cabinets shall be assembled in the Integrators shop prior to delivery to the job site.
- J. All cabling shall be continuous between field device and equipment cabinet. Terminations shall be to terminal boards with punch down blocks, or on screw terminals. Twisted and taped splices are unacceptable.
- K. Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.

3.2 SOFTWARE SUPPORT

- A. Refer to Section 284620 – PLC Software For Electronic Security for software support and programming requirements.

3.3 SYSTEM INITIALIZING AND PROGRAMMING

- A. All programming shall occur in the Integrator's shop prior to installation on site.
- B. The System shall be turned on and adjustment made to meet requirements of the specification and on-site conditions.
- C. The System shall be programmed to function as specified.
- D. Any special programming shall be documented and a written copy given to the Owner.
- E. Coordinate integration of other electronic systems as called for in the contract documents.

3.4 SYSTEM TEST PROCEDURES

- A. The System shall be completely tested to assure that all components are hooked up and in working order. The System shall be adjusted for optimum intelligibility at peak amplifier output before audio signal clipping occurs. Inspect communications quality between each remote device and master station for buzzes, rattles and audio distortion. Correct all causes of such defects. If the cause is outside of the intercom system, promptly notify the Engineer in writing, indicating the cause of the defect and suggested corrective procedures.
- B. The System shall be pre-tested by the Security Equipment Integrator and certified, in writing, to function in accordance with the plans and specification.
- C. The Integrator is to verify the system is communicating with all controlled devices.
- D. Testing to be performed in the Integrators shop prior to delivery-
 - 1. Test 120VAC power equipment and hardware internal to all equipment racks. Test all conductors for shorts, opens, and polarity.
 - 2. Fully charge all UPS systems that apply to this system. Test unit by removing power thereby causing the unit to switch to battery reserve.
 - 3. Perform impedance sweeps on all speakers. Verify results fall within manufacturer's specifications.
 - 4. Adjust all source level control components and signal processing for optimal gain structure. All components shall be set so they clip simultaneously.
- E. Testing to be performed at the job site prior to powering the system
 - 1. Verify correct polarity of all microphone inputs, line level inputs, and speaker cables.
 - 2. Verify all microphone inputs, line level inputs, and speaker cables are free of shorts and opens prior to termination of head end electronics.
 - 3. Repeat impedance sweeps on all speaker systems after they are installed and terminated. Include speaker cable in testing.
 - 4. Test all 120VAC power sources for correct polarity and voltage. Test grounding system for continuity. Notify the Engineer and Electrical Trade Contractor of any problems.
- F. Additional job site testing
 - 1. After installation of head end electronics, verify polarity of signal throughout system.
 - 2. Finalize gain structure of system. Adjust system gain and level so that all components clip at the same time. Adjust so system noise is minimized.
 - 3. Adjust all speaker components for consistency in sound pressure level.
- G. Prior to termination of head-end electronics, verify that all speaker lines are free from shorts and opens.
- H. Utilizing an impedance meter run test tone through speaker system verifying that all speakers are functioning properly.

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- I. Terminate head end electronics. Run test tone through system verifying adequate gain structure through electronic signal path.
- J. Using a sound level meter, confirm variation in sound pressure level is not more than +/-5 db in all areas. Adjust speaker taps to insure consistency in sound pressure levels throughout the facility.
- K. Adjust overall sound pressure level so minimum level is 10 dB above ambient noise level for facility during normal operating conditions.
- L. The System shall be completely tested to assure that all components are hooked up and in working order. The System shall be adjusted for optimum intelligibility at peak amplifier output before audio signal clipping occurs. Inspect system for defects. Correct all causes of such defects. If the cause is outside of the scope of the Div 28 series scope of work, promptly notify the Engineer and the Engineer in writing, indicating the cause of the defect and suggested corrective procedures.
- M. The system shall be capable of operating free of hums, buzzes, and rattles under normal operating conditions.
- N. Provide written documentation showing all test results.
- O. The System shall be final tested in the presence of the Engineer. Integrator is to provide all required testing equipment.

3.5 FIELD QUALITY CONTROL

- A. Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Make observations to verify that units and controls are properly labeled, and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Integrator's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 OCCUPANCY ADJUSTMENTS

- A. When requested by the Engineer within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, resetting matching transformer taps, and adjusting controls to suit actual occupied conditions. Provide up to three (3) visits to the site for this purpose.

3.7 TRAINING

- A. Integrator is responsible for providing operational and maintenance training applicable to the entire control system. Training is to include, but not be limited to the following-
1. Review all O+M manuals with Owner's representatives present for training.
 2. Perform a tour of the entire facility. During the tour the trainer shall point out all intercom/page equipment and provide a brief description of its purpose and use. This is to include but not be limited to intercom substations, intercom master stations, paging speakers, equipment cabinets, and graphic control panels.
 3. Typical of graphical user interface consoles-
 - a. Demonstrate basic functionality of console.
 - b. Demonstrate devices/systems controlled by console.
 - c. Review navigation of console screens.
Review control functions of each type.
 4. Typical of desktop push to talk microphones-
 - a. Demonstrate basic functionality of microphone.
 - b. Demonstrate devices/systems associated with microphone.
 - c. Review control functions of all push buttons.
 5. Explain functionality and operation of integrated systems-
 - a. Video follow audio
 - b. Answer and zoon, answer no zoom, queuing, etc.

END OF SECTION 285123

31 10 00 SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Clearing and protection of vegetation.
 - 2. Removal of existing debris.
- B. Related Requirements:
 - 1. Section 31 22 00 - Grading: Topsoil removal.
 - 2. Section 31 22 00 - Grading: Fill material for filling holes, pits, and excavations generated as a result of removal operations.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. The Work shall conform to the requirements of the Columbia County and the Florida Department of Environmental Protection – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.
 - 2. The work performed under this Section shall comply with all the requirements of the latest edition of the Florida Department of Transportation (FDOT) “Standard Specifications for Road and Bridge Construction”, which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.

1.3 REFERENCE STANDARDS

- A. Associated General Contractors (AGC) of America: Manual of Accident Prevention for Construction, Ninth Edition, 2009.
- B. Florida Department of Environmental Protection (FDEP) - National Pollutant Discharge Elimination System (NPDES): General Permit and Suwannee River Water Management District (SRWMD) Environmental Resource Permit.
- C. Occupational Safety and Health Administration (OSHA), United States Department of Labor (USDOL) Code of Federal Regulations (CFR).
- D. General Industry Standards (OSHA 2206 or 29 CFR Part 1900 to 1910).
- E. Construction Industry Standards (OSHA 2207 or 29 Part CFR 1926).

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- F. Florida Stormwater Erosion and Sedimentation Control Manual per Florida Department of Environmental Protection (FDEP) Nonpoint Source Management Section.
- G. Florida Department of Transportation (FDOT) Standard Specifications for Roadway and Bridge Construction dated 2018.

1.4 PROJECT CONDITIONS

- A. Existing Conditions: Prior to submitting their Bid, the Bidders shall visit the Site, inform themselves of the conditions, and make their own estimates of the facilities and difficulties attending the execution of the Work.

PART 2 - PART 2 PRODUCTS (NOT USED)

PART 3 - PART 3 EXECUTION

3.1 SITE CLEARING

- A. Minimize production of dust due to clearing operations; use of water trucks is acceptable if measures are taken to prevent flooding, sedimentation of public waterways or storm sewers, or other pollution.

3.2 EXISTING UTILITIES AND BUILT ELEMENTS

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are not to be removed.

3.3 VEGETATION

- A. Scope: Remove trees, shrubs, brush, and stumps in areas to be covered by building structure, paving, lawns, and planting beds.
- B. The Owner will exercise control over clearing and - if not indicated on the Drawings - will designate all trees, shrubs, and plants to be removed.
 - 1. Clear and completely remove the following from the limits of the Work:
 - a. Trees, roots, stumps, grass, weeds, and other vegetation.
 - b. Other surface objects and protruding obstructions.
 - c. Remove above items from the Site and dispose of in a safe, legal, and suitable manner.

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- C. Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
- D. In areas where vegetation must be removed but no construction will occur, remove vegetation with minimum disturbance of the subsoil.
- E. Vegetation Removed: Do not burn, bury, landfill, or leave on site, except as indicated.
 - 1. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; preference should be given to on-site uses.
 - 2. Trees: Sell if marketable; if not, treat as specified for other vegetation removed; remove stumps and roots completely.
 - 3. Sod: Re-use on site if possible; otherwise sell if marketable, and if not, treat as specified for other vegetation removed.
- F. Restoration: If vegetation outside removal limits or within specified protective fences is damaged or destroyed due to subsequent construction operations, replace at no cost to Owner.

3.4 DEBRIS

- A. Remove debris, junk, and trash from site.
- B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other project work.
- C. Leave site in clean condition, ready for subsequent work.
- D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION 31 10 00

SECTION 312000 – BUILDING EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Earthwork requires for this project may include, but is not necessarily limited to:
 - 1. Excavation
 - 2. Filling and backfilling to attain indicated grades.
 - 3. Trenching and trench backfilling.
 - 4. Rough and finish grade of the site.
 - 5. Conservation of topsoil.
 - 6. Proof Rolling.
 - 7. Compaction.
- B. Related work described elsewhere:
 - 1. Testing shall be in accordance with the project geotechnical report.
 - 2. Land disturbance activities and procedures shall be in accordance with project geotechnical report.

1.2 BENCHMARKS

- A. Maintain two existing benchmarks on the site for references. All vertical dimensions shall be checked from these benchmarks.

1.3 FINISHED GRADES

- A. Finished grades, as used herein, mean the final grade elevations indicated on the drawings. Should finished grades shown on spot elevations conflict with those shown by the contours, the spot elevations shall govern.

1.4 BORROW PITS

- A. Submit representative samples of all fill material requiring compaction to the Designated Testing Laboratory. **Material and borrow pits shall be approved by the Architect prior to filling operations.** If the quantity available from site grading is not sufficient, purchasing, hauling, and blending of fill shall be done by the Contractor.

1.5 CONTROLLED FILL

- A. Class I Fill is all Structural Fill to underside of slabs and to support foundations or footings. Class I Fill shall extend to 10 feet outside the building footprint.

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- B. Class II Fill is all Backfill below finish grade immediately behind walls and in trenches and embankments under walks, drives, parking areas, and all areas to be paved. The top two-feet of fill under drives and parking areas shall be Class I Fill. The area shall extend to 10 feet outside paved areas.
- C. Class III Fill is all Backfill used for filling trenches not under paved or building areas.

1.6 DESIGNATED TESTING LABORATORY

- A. Designated Testing Laboratory shall be selected by the Architect and paid by the Owner.
- B. Designated Testing Laboratory shall:
 - 1. Witness proof rolling and make recommendations concerning undercutting loose subgrade areas and surface scarification.
 - 2. Observe and make recommendations concerning surface drainage.
 - 3. Perform Modified Proctor and field density test.
 - 4. Provide advice concerning fill soils on site and the selection of borrow soils.
 - 5. Evaluate the suitability of the subgrade soils at the foundation bearing level.
 - 6. The Designated Testing Laboratory shall report to the Architect in writing, on a daily basis, the results of the tests including a statement that all tests have been performed as required by the specifications.

1.7 COMPACTION TESTING

- A. Existing Subgrade under Building Slabs: One field density test for each 5,000 sf of building slabs-on-grade.
- B. Class I Fill: One Field Density Test for each 5,000 sf of building area, and one test per 250 square foot of spread footing or 250 linear feet of strip footing per one foot lift of fill.
- C. Exact locations of tests shall be as directed by the Architect. Submit five copies of test reports.

1.8 DENSITY TESTING IN FOUNDATIONS

- A. One test per 250 linear feet of continuous grade beam and monolithic footing subgrade.
- B. One test for every 250 square foot of bearing surface.

1.9 INSUFFICIENT FILL MATERIAL

- A. If quantity of grading material is insufficient to provide finish grade elevations indicated on the drawings, obtain additional fill material of specified quality from an off-site source at no additional cost to the owner.

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1.10 EXCESS CUT MATERIAL

- A. If quantity of grading material is in excess of quantities required to provide finished grade elevations indicated on the drawings, any excess material shall be disposed of off-site at no additional cost to the owner.

1.11 DUST CONTROL

- A. Use all means necessary to control dust on and near the Work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the Work or is resulting from the condition in which the Contractor leaves the site.
- B. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors, and concurrent performance of other work on the site.

1.12 MATERIAL PROTECTION

- A. Use all means necessary to protect all materials and existing utilities before, during, and after installation and to protect all objects designated to remain.
- B. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

1.13 EXISTING UNDERGROUND FACILITIES

- A. Underground structures and utilities, as indicated, are located according to best available information.
- B. Locate all underground facilities in advance of excavation to avoid conflicts with new construction.

1.14 CONFLICTS

- A. Perform Work in such a manner as to cause a minimum of interference with the service rendered by the facility disturbed.
- B. Immediately repair or replace structures or facilities damaged.
- C. Restore to condition existing prior to damage in accordance with best standard practices as approved by the Engineer and at no additional cost to the Owner.

1.15 SCHEDULING

- A. The Engineer reserves the right to direct the order of work as may be in the best interest of the Owner.

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PART 2 - PRODUCTS

2.1 FILL MATERIAL

- A. All fill material shall be subjected to approval of the engineer.
- B. Sand Fill (capillary water barrier) material shall consist of a clean sand with a fineness modulus of 1.6 to 3.1 and containing not more than 12 percent by weight finer than No. 200 U.S. Standard Sieve.
- C. Structural Fill material shall consist of inorganic material free of roots, cobbles and boulders and classified as GM, GC, SW, SP, SM, SC, or CL by ASTM D2487-85 "Standard Methods for Classification of Soils for Engineering purposes". Earth Fill shall also conform to the following:
 - 1. Liquid Limit = 40 maximum
 - 2. Plasticity Index = 15 maximum
 - 3. Dry Unit Weight = 115 PCF minimum density
 - 4. Unsuitable material includes vegetable matter, sod, muck, roots, rubbish, highly plastic clay soils, and organic soils.
- D. Notification:
 - 1. For approval of imported fill material, notify the Engineer at least four (4) working days in advance of intention to import material, designate the proposed borrow area, and permit the Engineer to sample as necessary from the borrow area for the purpose of making acceptance tests to prove the quality of the material.

2.2 OTHER MATERIALS:

- A. All other materials not specifically described but required for proper completion of the Work of this Section, shall be as selected by the Contractor subject to the approval of the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Familiarization
 - 1. Prior to all Work of this Section, become thoroughly familiar with the site, the site conditions, and all portions of the Work falling within this Section.
- B. Backfilling prior to approvals
 - 1. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by Work of this Section prior to all required inspections, tests, and approvals.

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2. Should any of the Work be so enclosed or covered up before it has been approved, uncover all such Work at no additional cost to the Owner.
3. After the Work has been completely tested, inspected, and approved, make all repairs and replacements necessary to restore the Work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.

C. Conservation of topsoil

1. When indicated on plans or directed by the Engineer, remove topsoil and spread on areas already graded and prepared, or transport and deposit in storage piles at locations approved by the Engineer.
2. Excavate topsoil to a depth of six (6) inches.
3. Keep topsoil, when stored, separate from other excavated materials.
4. Store or place topsoil free from roots, stones and other undesirable material.
5. Top soil shall be stripped and stockpiled. Disturbed areas not designated as parking, building, sidewalks, or other impervious areas shall receive topsoil to a depth of 6 inches.

3.2 PREPARATION

A. Temporary Drainage

1. Maintain adequate drainage over site while construction is in progress.

B. Unfavorable weather

1. Do not place, spread, or roll any fill material during unfavorable weather conditions.
2. Do not resume fill operations until moisture content and fill density are satisfactory to the Engineer.

3.3 UNDERCUTTING OF UNSUITABLE MATERIALS

- A. The contractor shall undercut a depth of 10' of existing soils for an area extending 8' beyond the perimeter of the housing building (approximately 30,000 square feet).
- B. The soil below the connection corridor shall not be undercut.
- C. Undercut shall be observed and modified as necessary by the geotechnical engineer.

3.4 INSPECTION OF SUBGRADE, PROOF ROLLING, SCARIFYING, AND COMPACTION

- A. After stripping and excavation of the cut areas and removal on unsuitable materials as outlined in the preceding section of this Specification, and prior to filling, the exposed subgrade shall be approved by the Geotechnical Engineer. The exposed subgrade, enclosed by a line drawn 5 feet outside the building and paved areas, shall be predensified and proof rolled by rolling the surface with compaction equipment.

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- B. Rolling shall consist of a minimum of eight overlapping coverages in each of two perpendicular directions and shall continue until density test at a depth of 12 inches below the surface indicates the attainment of 95% of the Modified Proctor maximum, ASTM D 1557. In cut areas under building foundations and slabs and pavements, the top one foot of the subgrade shall be compacted to of 95% of the Modified Proctor maximum.
- C. The equipment used for rolling shall be a 10-ton, fully loaded, drum roller with a 5 foot diameter.
- D. Proof rolling shall be performed in the presence of the Designated Testing Laboratory Representative.
- E. Soft, loose or unstable surface zones which are detected during proofrolling and compaction shall be scarified and recompacted or undercut and replaced with controlled fill as directed.
- F. Stockpile undercut materials by Fill Material classification in on-site locations where it will not interfere with construction operations. Materials stockpiled shall be placed in a manner to afford drainage. Protect against erosion.
- G. Undercut materials which qualify as Structural Fill may be used in Class I & II Fill areas.

3.5 EXCAVATION

A. General

- 1. Conform to dimensions, lines, and grades indicated on plans.
- 2. Transport suitable excavated material and place in fill areas within specified limits of Work and compact as specified.
- 3. If directed by the Engineer, stockpile excavated material suitable for fill and backfill in approved locations.
- 4. Remove unsuitable material occurring within or below the limits of excavation to the depth directed by the Engineer. Dispose of excess and unsuitable material outside the limits of Work.
- 5. Backfill and compact all over excavated areas as specified at no additional cost to the Owner.
- 6. It shall be the Contractors responsibility to shore excavations where necessary to protect workmen, banks, adjacent paving, structures, utilities, and other existing facilities.

B. Structures

- 1. Excavated to elevations and dimensions indicated.
- 2. In stable soil sides and bottom of footing excavations may be cut clean in order that concrete may be poured without forming.
- 3. In unstable soil extend excavations sufficient distance from footings to allow for placing and removing forms.

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3.6 COMPACTION GENERAL

A. Topsoil

1. Scarify the compacted subgrade, in these areas to receive topsoil, prior to the placing of topsoil, to a depth of two (2) inches to allow the bonding of topsoil with the subsoil.
2. Spread topsoil evenly and compact to elevation, grade and thickness shown on the plans.

B. Plastic Pipe

1. Do not allow compacting equipment to come in direct contact with pipe.
2. Exercise extra care in obtaining adequate compaction under pipe to prevent injurious shear or bending loads.
3. No sharp gravel or object may be placed adjacent to plastic pressure pipe.
4. Remainder of backfill may be placed by standard procedures.
5. Dress off to conform to adjacent contours.
6. Where settlement occurs or improper filling is evident, refill and redress trench to grade.
7. Backfill areas of paving and walks immediately after testing and/or approval of pipe or conduit installation.
8. Maintain surface in paved areas in a smooth riding condition until paving is replaced.
9. Excavated and removed materials:
 - a. Do not include destroyed pavement or walk materials, curbs, and similar material in backfill.
 - b. Unsuitable material such as muck, mud, or other unstable material may be replaced in excavations after suitable material has been placed and compacted to provide two (2) feet of cover over the top of the bell of the pipe except under paved areas, structures or other areas so designated by the Engineer.
 - c. Excavated rock may be used under the same conditions as specified for unsuitable material, provided it is broken into pieces not larger than three (3) inches in diameter.

C. Protection:

1. Protect newly graded areas from the action of the elements.
2. Repair and reestablish to slope and grade any settlement, washing or other damage occurring prior to final acceptance.

3.7 METHOD OF MEASUREMENT

A. Excavation

1. Areas to be excavated will be measured in their original position and final section.
2. Earthwork volume will be determined by the average end-area method of computation.

B. Embankment and Fill Areas

1. Areas to be filled will be measure in their original position and final section.
2. Earthwork volume will be determined by the average end-area method of computation.

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C. Rock Excavation

1. Rock will be measured in its original position and final section and its volume determined by the average end-area method of computation except where otherwise noted.
2. Isolated rocks and boulders having a volume less than one half (1/2) cubic yard are not to be measured.
3. Rock excavation will only be measured after the Contractor demonstrates the material cannot be removed by hand pick or by power operated excavator or shovel with rock teeth.

3.8 INSTALLATION OF CLASS I FILL

- A. Class I Fill shall be Structural Fill material.
- B. Compact within + 3 percent of optimum moisture content in 8-inch (maximum) loose layers to a density equivalent to 95 percent of the Modified Proctor Maximum (ASTM D 1557).

3.9 INSTALLATION OF BACKFILL

- A. Shore Foundation Walls which are to be tied into floor slabs prior to installation of Backfill and until slabs have been in place sufficient time to achieve strength and provide structural stability against overturning.
- B. Where Backfill is required on both sides of walls, it shall be brought up in even layers so as not to provide an unequal lateral load.
- C. Install Backfill against Foundation Walls only when directed by the Architect, and elsewhere as construction progress permits.

3.10 CONSOLIDATION VERIFICATION TESTING

- A. After building fill has been placed the contractor shall install five fixed markers to evaluate the rate of soil consolidation.
- B. Markers shall consist of an 8" diameter hole augered a minimum of three feet into the ground and filled with concrete. The markers shall be reinforced with one #5 vertical that extends 4" above the concrete surface.
- C. Markers shall be located at the discretion of the geotechnical engineer.
- D. The contractor shall be responsible for surveying each marker at the following intervals.
 1. Every three days for the first 30 days.
 2. Every seven days thereafter until the Geotechnical engineer approve the fill.
 3. Contractor shall submit survey information to the Geotechnical engineer for review.

END OF SECTION 312000

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31 22 00 GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Under this Section of the Specifications, the Contractor shall provide all labor, tools, materials, and equipment required to complete the following items of work in accordance with the Drawings and Specifications:
 - 1. General excavation and site grading.
 - 2. Construction of fills.
 - 3. Subgrade preparation including proof-rolling, subgrade replacement where required, and subgrade compaction.

1.2 Related Requirements:

- A. All general site grading shall be completed within 20 feet of the outer walls of the foundation before work is started on the building foundations.
- B. The Contractor shall visit the site, prior to submitting his bid, inform himself of the conditions and make his own estimates of the facilities and difficulties attending the execution of the work.
- C. The Contractor shall be responsible for avoidance and cleanup of street spillage and tracking to the satisfaction of the local and state authorities.
- D. The Contractor shall be responsible for dust control on and near the site and at all off-site borrow areas if such dust is caused by the Contractor's operations or if resulting from the condition in which the Contractor leaves the site.
- E. The Contractor shall be responsible for any and all dewatering as may be required to satisfactorily construct all work detailed on the Drawings or specified herein.
- F. The right to make any inspections deemed necessary at the source of supply, and during preparation of any material used in this work, is reserved by the Owner.
- G. The Contractor shall obtain and pay for all permits, tests, inspections, etc. required by agencies that have jurisdiction over the project. All work shall be executed and inspected in accordance with all local and state codes, rules, ordinances, or regulations pertaining to the particular type of work involved. Should any changes in the Contract Drawings and Specifications be required to conform to such ordinances, notify the Owner at the time of submitting bid. After entering into the Contract, the Contractor shall be held responsible for the completion of all work necessary for a complete and approved installation without extra expense to the Owner. This Contractor shall prepare any supplementary detailed diagrams or drawings which may be required by any local or state authority at no additional cost to the Owner.

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1.3 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Site Clearing - See Section 311000.
- B. Erosion and Sediment Control - See Section 312500.
- C. Excavation and Fill - See Section 312300.
- D. Trenching Backfilling and Compacting - See Section 312333.

1.4 1.4 SUBMITTALS

- A. Samples: A 50 pound sample of each material to be used shall be submitted to the testing laboratory for approval and appropriate testing five days prior to the start of earthwork. No material shall be placed until the testing laboratory has approved the material for use on the project.
- B. The Contractor shall notify the testing laboratory and Owner, in writing, five days prior to the start of the project. The notice shall state the source of fill material to be used, the equipment to be used, the date and time that earthwork operations will start, and the name of the person who will be in charge of the operations in the field. If work is interrupted, the Contractor shall notify the testing laboratory 24 hours prior to the resumption of work.

1.5 REGULATORY REQUIREMENTS

- A. All grading shall comply with local, state, and federal regulations regarding erosion and sedimentation control wetlands requirements and the regulations and requirements in the National Pollutant Discharge Elimination System (NPDES) Storm Water Permit.
- B. All grading shall be adequately sloped or stabilized to protect the property of the Owner and the safety of the workers. All such protection shall be in accordance with Occupational Safety and Health Act (OSHA) requirements and all other applicable codes and ordinances.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. The Work shall conform to the requirements of the City of Lake City and the Florida Department of Environmental Protection – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.
 - 2. The work performed under this Section shall comply with all the requirements of the latest edition of the Florida Department of Transportation (FDOT) “Standard Specifications for Road and Bridge Construction”, which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.

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A. Testing

1. The Owner will provide and pay for continuous inspection and testing service by a qualified engineering testing laboratory. All earthwork shall be subject to the continuing inspection and acceptance of the testing laboratory and the Owner. It will be the testing laboratory's decision, in conjunction with the Owner, as to the acceptability of any materials or work containing those materials.
2. During the work, if the initial test results fail to meet the required specifications, the material shall be replaced or reworked and then re-compacted and retested. All costs of such remedial work shall be borne by the Contractor.
3. If, in the opinion of the testing laboratory, substandard conditions are encountered (such as questionable soil, poor moisture content, inadequate compaction, adverse weather, etc.) the testing laboratory will require that it be corrected at the expense of the Contractor.

2.2 REFERENCE STANDARDS

A. Some products and execution are specified in this Section by reference to published specifications or standards of the following (with respective abbreviations used): Florida Department of Environmental Protection (FDEP) - National Pollutant Discharge Elimination System (NPDES); General Permit and Suwannee River Water Management District (SRWMD) Environmental Resource Permit.

1. The American Society for Testing and Materials (ASTM)
2. Florida Department of Transportation (FDOT)
3. International Building Code, 2012 Edition
4. Occupational Safety and Health Act (OSHA)

B. Standard Specification

1. Compaction standards for required densities of fill compaction are expressed herein after in terms of percentages. Such terms shall mean percentages of maximum density at optimum moisture content, as determined and controlled in accordance with the following:
 - a. ASTM D1557 "Moisture - Density Relationship of soils - Modified Proctor
 - b. Method"
 - c. ASTM D1556 "Density of Soil in Place by the Sand Cone Method"
 - d. ASTM D2167 "Density and Unit Weight of Soil In-Place by the Rubber Balloon Method"
 - e. ASTM D2922 "Density of Soil and Soil-Aggregate in Place by
 - f. Nuclear Methods (Shallow Depth)"
 - g. ASTM D2937 "Density of Soil in Place by the Drive-Cylinder Method."

2.3 PROTECTION

A. Bench Marks and Monuments: Maintain carefully the integrity of all benchmarks, monuments, and other reference points. If disturbed or destroyed, replace as directed. If found at variance with Drawings, notify Owner before proceeding to lay out work.

B. Protection of Existing Work Remaining:

1. All existing structures, curbs, and pavements damaged in performance of this work shall be restored without extra cost to Owner.

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2. Existing utilities shall not be interrupted, except as authorized in writing by Owner, and only after temporary services have been installed by Contractor and approved by Owner, and applicable utility company.

2.4 DEFINITIONS

- A. Excavation shall mean the removal of soils, rock, or other materials as required to construct improvements as shown or noted on the drawings and/or specified herein.
- B. Grading shall mean the excavation and the use of or satisfactory disposal of all materials excavated within the limits of the work.
- C. Filling shall mean the prescribed placing and compaction of soil or aggregate materials beneath proposed improvements to raise the grade to the required level.
- D. Backfilling shall mean the prescribed placing and compaction of soils or aggregate materials in areas of foundations, utility trenches, or their component parts as shown on the Drawings and specified herein.
- E. Engineered fill shall mean selected fill or backfill materials systematically placed and uniformly compacted in accordance within these Specifications. Periodic and representative sampling, density testing, and other compliance checks will be provided by the Owner's testing laboratory to verify compliance.
- F. Benching shall mean the excavation of material in the existing ground beneath proposed embankments, as shown on the Drawing or described herein, in order to increase the bond between the existing ground and proposed embankment.
- G. Rock shall be defined as follows:
 1. Rock excavation shall be defined as the removal of a formation that cannot be excavated without systematic drilling and blasting or using equipment larger than specified below. Boulders larger than 1 cubic yard shall be classified as rock. The Contractor must demonstrate that the material cannot be ripped with a crawler tractor rated capable of 60,000 pounds drawbar pull at 1 mile per hour, pulling a single-tooth ripper. The Contractor may be required to provide equipment specification data verifying the above required minimum capacity for the equipment used for demonstration purposes. The equipment is to be in good repair and in proper working condition.
 2. Trench rock excavation shall be defined as the removal of a formation that cannot be excavated without systematic drilling and blasting or using equipment larger than specified below. Boulders larger than 1/2 half cubic yard shall be classified as rock. The Contractor must demonstrate that the material cannot be removed with a backhoe equipped with a minimum 1 cubic yard heavy duty trenching bucket placed on a machine capable of a curling force of 35,000 pounds, crowd force of 30,000 pounds and a lifting capacity of 15,000 pounds at a trench depth of 10 feet. The Contractor may be required to provide equipment specification data verifying the above required minimum capacities for the equipment used for demonstration purposes. The equipment is to be in good repair and in proper working condition.

PART 3 - PRODUCTS

3.1 FILL MATERIAL

- A. Except as otherwise specified for backfills and granular base beneath the floor slab, fills shall be constructed from approved cohesive or granular materials found on or off the site.
- B. All such material, unless noted otherwise herein, shall be a clean fill material free of debris and organic matter and shall have a plasticity index of less than 20. Material shall be free of rock fragments or stones larger than 4 inches in the largest dimension.

PART 4 - PART 3 EXECUTION

4.1 GENERAL

- A. The site shall be graded to the elevations shown on the Drawings. The rough grades shall be held down as required to receive the surfacing called for on the Drawings or specified herein.
- B. Rough grades in all areas to receive sodding shall be held ½ inch to allow for topsoil.
- C. Maintain surface drainage for the subgrade throughout the improvement area. No ponded water shall be allowed to collect on the subgrade to where it is rendered unsuitable for further work.

If at the time of performing further work the subgrade is judged by the testing laboratory or Owner to be unsuitable due to poor drainage, then Contractor shall remove such unsuitable material and replace it with acceptable material placed in accordance with these specifications at no additional cost to the Owner.

- D. Angle of all banks shall not exceed a slope of 1 foot vertical to 4 feet horizontal except where noted otherwise on the Drawings.

4.2 SUBGRADE PREPARATION

- A. Following the removal of the topsoil or pavements all areas requiring fills and pavement subgrades in cut areas shall be proof-rolled with a fully loaded tandem wheeled dump truck and observed by the testing laboratory representative. Soft or yielding soils shall be scarified and/or undercut and filled with an approved fill material as directed by the testing laboratory representative. The Contractor shall complete all required subgrade reworking or replacement in accordance with these Specifications.
- B. Following proof-rolling and subgrade replacement the upper 12 inches shall be compacted with a compactor approved by the testing laboratory to a minimum density of 95 percent of maximum laboratory dry weight as determined by ASTM Test Designation D-1557 (Modified Proctor).

4.3 CONSTRUCTION OF FILLS

- A. Fill material shall be spread in uniform layers having a maximum thickness, measured loose, of 8 inches. Each layer shall be thoroughly bladed and mixed during the spreading to insure uniformity of material in each layer.
- B. After each layer has been placed and spread evenly, it shall be mechanically compacted to a minimum density of 95 percent of maximum laboratory dry weight as determined by ASTM Test Designation D1557 (Modified Proctor). Install substantial, highly visible fences at least 3 feet high to prevent inadvertent damage to vegetation to remain:
- C. Sufficient passes of the approved compactor shall be made in order to obtain the specified densities. A minimum of three passes of the compactor shall be required over all portions of each lift. A "pass" shall be defined as one passage of the contact portion of the compactor over the entire surface of the layer.
- D. Field density tests shall be made by the testing laboratory representative to determine the actual density attained in each layer of fill. No fill shall be placed over a layer which has not been tested and approved. Should these tests indicate that the density of any layer of fill or portion thereof is below the required density, the particular layer or portion thereof shall be reworked until the required density has been obtained. Field density test procedures shall conform to ASTM D1556 (Sand-Cone Method), ASTM D2167 (Rubber Balloon Method), ASTM D2922 (Nuclear Density Method), or ASTM D2937 (Drive Cylinder Method).
- E. The moisture content of the granular fill materials shall be within 2 percent of the optimum moisture content for the soils being utilized during the entire time when the compactor is working on the fill. If in the opinion of the testing laboratory representative, the fill is too dry for proper compaction, the Contractor shall spray the fill with a sufficient quantity of clean water to bring the fill layer to the proper moisture content.
- F. The moisture content of cohesive fill materials shall be no more than 2 percent less than or 2 percent greater than optimum moisture content for the soil being utilized during the entire time when the compactor is working on the fill. Drying, when required, shall be performed by continually working the soil with a disk or harrow.
- G. No fill material shall be placed, spread, or compacted while the ground or fill is frozen or thawing or during unfavorable weather conditions. When work is interrupted by heavy rain or frost, operations shall not be resumed unless the moisture content and density of the fill are as previously specified. The fill surface must be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or on the completion of the compaction operations in that area in order to minimize infiltration and absorption of rainwater.

4.4 DEBRIS

- A. Maintain surface drainage for the subgrade throughout the improvement area. No ponded water shall be allowed to collect on the subgrade to where it is rendered unsuitable for further work. If at that time of performing further work the subgrade is judged by the testing laboratory or Owner to be unsuitable due to poor drainage, then Contractor shall remove such unsuitable material and

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replace it with acceptable material placed in accordance with these specifications at no additional cost to the Owner.

4.5 DUST CONTROL

- A. The Contractor shall use all means necessary to thoroughly moisten all surfaces as required to prevent dust being a nuisance to the Owner, neighbors, public, and concurrent performance of other work on the site. If necessary use of a water truck may be required to reduce dust.

4.6 CLEAN-UP

- A. Upon completion of the Work, all surplus materials, debris, tools, and equipment shall be removed from the site.

END OF SECTION 31 10 00

31 23 00 EXCAVATION AND FILL

PART 1 - GENERAL

1.1 SUMMARY

- A. Protection, modification and/or installation of utilities as site work progresses paying particular attention to grade changes and any necessary staging of work.
- B. Cutting, filling and grading to required lines, dimensions, contours and proposed elevations for proposed improvements.
- C. Scarifying, compaction, drying and removal of unsuitable material to ensure proper preparation of areas for fills or proposed improvements.

1.2 RELATED DOCUMENTS

- A. Geotechnical Report for boring locations and findings of subsurface materials and conditions: American Infrastructure Development, AID Report Number DEI20006, Dated May 18, 2020..
- B. Construction Drawings.
- C. Architectural Plans and Specifications as they relate specifically to the earthwork beneath the buildings, where the architectural requirements are more stringent than the civil requirements.
- D. Section 31 10 00 – Site Clearing
- E. Section 31 25 00 –Erosion and Sediment Control
- F. Section 31 22 00- Grading

1.3 APPLICABLE PUBLICATIONS AND STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
 - 1. D 422 Method for Particle Size Analysis of Soils
 - 2. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³) Moisture density relationship of soils, Standard Proctor Method.
 - 4. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Rammer and 18-inch (457 mm) Drop (Modified Proctor)
 - 5. D 1559 Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
 - 6. D 2167 Test for Density of Soil in Place by the Rubber Balloon Method
 - 7. D 2216 Laboratory Determination of Moisture content of Soil
 - 8. D 2487 Classification of Soils for Engineering Purposes
 - 9. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear

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Methods (Shallow Depth)

10. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
11. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
12. C 25 Chemical Analysis of Limestone, Quicklime and Hydrate Lime
13. C 110 Physical Testing for Quicklime and Hydrated Lime, Wet Sieve Method
14. C 618 Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
15. C 977 Quicklime and Hydrated Lime for Soil Stabilization

B. American Association of State Highway and Transportation Officials (AASHTO) latest edition

1. T 88 Mechanical Analysis of Soils
2. M 288-90 Geotextiles

1.4 QUALITY ASSURANCE

A. Independent Testing Laboratory selected and paid by Owner, shall be retained to perform construction testing on site based on the following:

1. Building Subgrade Areas, including 10'-0" Outside Exterior Building Lines: In cut areas, not less than one compaction test for every 2,500 square feet. In fill areas, same rate of testing for each 8" lift (measured loose).
2. Areas of Construction exclusive of building subgrade: In cut areas, not less than one compaction test for every 10,000 square feet. In fill areas, same rate of testing for each 8" lift (measured loose).

B. If compaction requirements are not complied with at any time during construction process, remove and re-compact deficient areas until proper compaction is obtained at no additional expense to Owner.

C. In all areas to receive pavement, a LBR test shall be performed for each type of material imported from off-site.

D. The following tests shall be performed on each type of on-site or imported soil material used as compacted fill as part of construction testing requirements.

1. Moisture & Density Relationship: ASTM D 698
2. Mechanical Analysis: AASHTO T-88
Plasticity Index: ASTM D 4318

E. Field density tests for in-place materials shall be performed according to one of the following standards as part of construction testing requirements.

1. Sand-Cone Method: ASTM D 1556
2. Balloon Method: ASTM D 2167
3. Nuclear Method: ASTM D 2922 (Method B-Direct Transmission)

F. Independent Testing Laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, Architect, and Contractor shall be provided with copies of reports within 96 hours of time test was performed. In event that any test performed fails to meet these Specifications, Owner and contractor shall be notified immediately by independent testing laboratory.

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- G. All costs related to retesting due to failures shall be paid for by the Contractor at no additional expense to Owner. Owner reserves the right to employ an Independent Testing Laboratory and to direct any testing that is deemed necessary. Contractor shall provide free access to site for testing activities.

1.5 SUBMITTALS

- A. Submit a sample of each type of off-site fill materials that is to be used at the site in an air- tight, 10-lb container for the testing laboratory.
- B. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the job requires approval of the Owner or Engineer.
- C. For use of fabrics or geogrids, a design shall be submitted for approval by the Owner.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Construct temporary erosion control systems as required to protect adjacent properties and water resources from erosion, pollution, sedimentation and other damage in conformance with related sections.

1.7 FILL MATERIAL

- A. Except as otherwise specified for backfills and granular base beneath the floor slab, fills shall be constructed from approved cohesive or granular materials found on or off the site.
- B. All such material, unless noted otherwise herein, shall be a clean fill material free of debris and organic matter and shall have a plasticity index of less than 20. Material shall be free of rock fragments or stones larger than 4 inches in the largest dimension.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill for Trenches:
 - 1. See section 31 23 33
- B. IMPORTED FILL MATERIAL
 - 1. Consist of low swell potential soil with a liquid limit less than 45 and plasticity index between 10 and 25.
 - 2. Imported fill material should be compacted to minimum dry density equal to 95% of the maximum dry density, and a moisture content range of -1 to +3% of optimum moisture content as determined by ASTM D 698, current version.
 - 3. Approval requires that a moisture-density relationship, hydrometer should analysis, and Atterberg limits be performed for each proposed fill material prior to their placement.

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4. Prior to placement of fill, sloping areas steeper than 5:1 (horizontal:vertical) should be benched to reduce the potential for slippage between existing slopes and new fills.
 5. Benches should be level and wide enough to accommodate compaction and earth moving.
 6. Final grades in excess of 3:1 (horizontal:vertical) should not be used for ease of maintenance.
- C. BACKFILLS AND GRANULAR BASE BENEATH FLOOR SLABS AND FOOTINGS
1. Backfill material shall be approved by the geotechnical engineer. Material shall be well graded gravel with a size distribution of minus 200 to at least $\frac{3}{4}$ inch. Backfill material shall be placed as per the geotechnical report or as directed in the Geotechnical Report.
 2. Select the equipment for backfilling the various materials in conformance with the requirements of this Section. However, promptly replace any equipment that results in waste of material, or results in inaccurate work, or is otherwise objectionable, as directed by the Owner at no additional cost to the Owner.
- D. Topsoil shall be clean free of debris, sticks, deleterious materials, and rocks larger than 1" in diameter.
- E. Geotextile stabilization and filter fabrics shall comply with AASHTO M 288.
- F. Geogrids shall be Miragrid; 5T, 7T, or 8T or approved equal.

PART 3 - PART 3 EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours and datum.
- B. Locate and identify existing utilities that are to remain and protect them from damage.
- C. Notify utility companies to remove and/or relocate any utilities that are in conflict with the 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 all other survey monuments from damage or displacement. If a marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same.
- F. Remove from site material encountered in grading operations that, in opinion of Owner or Owner's representative, is unsuitable or undesirable for backfilling, subgrade or foundation purposes. Dispose of in a manner satisfactory to Owner. Backfill areas with layers of suitable material and compact as specified.
- G. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform following procedures:
 1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low

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2. area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain same results.
3. 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 areas dry and undisturbed.
4. If proposed for fill, all muck, mud, and other materials removed from above low areas shall be dried on-site by spreading in thin layers for observation by Owner or Owner's representative. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under the building area or within 10'-0" of perimeter of building pad or paving subgrade. If, after observation by Owner or Owners representative, material is found to be unsuitable, all unsuitable material shall be removed from site.

3.2 EXCAVATION FOR FILLING AND GRADING

- A. Classification of Excavation: Contractor by submitting bid acknowledges that he has investigated the site to determine type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation.
- B. Perform excavation using capable, well maintained equipment and methods acceptable to Owner and governing agencies.
- C. When performing grading operations during periods of wet weather, provide adequate drainage and ground water management to control moisture of soils.
- D. Shore, brace, and drain excavations as necessary to maintain safe, secure, and free of water at all times.
- E. Excavated material containing rock or stone greater than 6" in largest dimension is unacceptable as fill to within the proposed building and paving area.
- F. Rock or stone less than 6" in largest dimension is acceptable as fill to within 24" of surface of proposed subgrade when mixed with suitable material.
- G. Rock or stone less than 2" in largest dimension and mixed with suitable material is acceptable as fill within the upper 24" of proposed subgrade.

3.3 FILLING AND SUBGRADE PREPARATION

- A. Fill areas to contours and elevations shown with unfrozen materials.
- B. Place fill in continuous lifts specified herein.
- C. Refer to other sections and drawings for filling requirements for structures.
- D. Refer to other sections and drawings for filling requirements for pavements.

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- E. Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of 8" and compacted to minimum of 95% of optimum density, in accordance with ASTM D 698 at a moisture content of not less than 1% below and not more than 3% above the optimum moisture content. These areas shall then be proof rolled to detect any areas of insufficient compaction. Proof rolling shall be accomplished by making a minimum of two (2) complete passes with a fully-loaded tandem-axle dump truck, or approved equivalent, in each of the two perpendicular directions under the supervision and direction of a field geotechnical engineer. Areas of failure shall be excavated and re-compacted as stated above.
- F. Fill materials used in preparation of subgrade shall be compacted to a minimum density of 95% of optimum density, in accordance with ASTM D 698, at a moisture content of not less than 1% below and not more than 3% above the optimum moisture.
- G. Material imported from off-site shall have a LBR (limerock bearing ratio) value equal to or above the pavement design subgrade per the geotechnical report.

3.4 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive wheel loading during construction, including concrete trucks and dump trucks.
- C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.5 TRENCH BACKFILL

- A. General for all Trench Backfill
 - 1. All trench backfill above pipe embedment shall be installed in accordance with the following requirements and in accordance with the plan details.
 - 2. Except for sanitary sewer and storm sewer pipes, detectable marking tape shall be required when non-metallic pipe is specified. Installation of the tape shall be in accordance with manufacturer's instruction and sound construction practice and shall be 18 inches below finish grade unless otherwise shown. The tape shall be manufactured with integral wires, foil backing or other means to enable detection by a metal detector when the tape is buried up to 3 feet deep. The tape shall be inductively locatable and conductively traceable using a standard pipe and cable locating device. The metallic core of the tape shall be encased in a protective jacket or provided with other means to protect it from corrosion.
 - 3. When bedding the pipe in rock or rocky ground, the pipe will be protected with a minimum 6-inch layer of sand below and on either side of the pipe. Where rock is used in backfilling, it shall be mixed with sufficient earth or sand to fill the voids between the rocks and allow compaction as required. No rock exceeding 3" in maximum dimension will be allowed.

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B. Compacted Backfill

1. Compacted backfill shall be required for the full depth of the trench above the embedment materials where beneath pavements, surfacing, driveways, walks, or other surface improvement or structures.
2. Compaction of trench backfill shall be completed by placing maximum one-foot lifts and compacting to 95 percent density in the top 3 feet of the trench, and to 90 percent density through the remainder of the trench, except as noted otherwise on the plans.
3. Where the trench for one pipe passes beneath the trench for another pipe, backfill for the lower trench shall be tamped to the level of the bottom of the upper trench, in accordance with compacted backfill requirements.
4. As an alternate to compaction of the backfill, the trench may be backfilled with crushed rock as specified in Section 2.1, and compacted by tamping or rolling in one-foot lifts until no further consolidation is evident.

C. Lightly Compacted Backfill

1. In all open areas, with no proposed improvements above the trenches, backfill shall be consolidated to minimize settlement using methods approved by the Engineer.
2. No compaction testing shall be required for lightly compacted backfill; however, the Contractor shall be responsible for using backfill methods to minimize settlement. It shall be the Contractor's responsibility to repair any trench settlement that may occur for a period of one year after completion of the project.
3. Compact masses of stiff mucky clay or other consolidated material more than one cubic foot in volume shall not be permitted to fall more than 5 feet into the trench unless cushioned by at least 2 feet of backfill above pipe embedment.
4. No un-compacted trench backfill material containing rocks shall be placed in the upper 18 inches of the trench except with specific permission of the Engineer, nor shall any hard rock or stone or boulder larger than 8 inches in its greatest dimension be placed within 3 feet on top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

3.6 PROJECT CLEAN-UP

- A. The Construction site shall be kept clean, neat, and as orderly as possible at all times. Stockpiles of debris and unsuitable material beyond normal working demands shall not be allowed. Immediately after construction operations are completed, all equipment, debris and unsuitable materials shall be completely removed from the site in order to minimize the damage to finished work and inconvenience to the public and adjoining property owners.
- B. All areas shall be leveled and graded by the Contractor upon completion of the project so as to present as neat and orderly an appearance as possible.
- C. All rock exposed by blasting and/or trenching shall be covered with soil or hauled to a waste area and covered as not to interfere with normal land use operations.

3.7 UTILITY AND SERVICE LINES

- A. On the Plans, known utility and service lines are shown in approximate location only. The Contractor shall expose all existing underground utilities at locations of possible conflict prior to

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any construction. The Engineer shall be immediately notified of any apparent conflicts with proposed new construction. It shall be the responsibility of the Contractor to watch for, protect and repair if damaged, all utility and service lines encountered during the project. Repair, if necessary, shall be in accordance with the Engineer's directions.

3.8 PAVEMENTS

During trenching through paved areas, trench widths shall be kept to a minimum, and not in excess of the dimensions allowed in the Plans. Pavement replacement shall be with materials and thicknesses equaling or exceeding those removed, and approved by the Engineer. Immediately prior to replacement of pavement, the edges of the original cut shall be trimmed using a saw to neat lines, in accordance with Plan details.

3.9 RIP RAP & ROCK DITCH LINING

- A. Place rip-rap or rock ditch lining in all areas where indicated on the Drawings. The stone for rip-rap or rock ditch lining shall consist of field stone or rough unhewn quarry stone as nearly uniform, in section as is practical. The stones shall be dense, resistant to the action of air and water, and suitable in all aspects for the purpose intended. Size of the rip-rap shall be as specified on the plans. Maximum extreme dimension shall not exceed the depth required by the drawings.
- B. Slopes and other areas to be protected shall be dressed to the line and grade shown on the plans prior to the placing of rip-rap. Contractor shall undercut the areas to receive rip-rap to an elevation equal to the final elevation less the average diameter of the stones before placing the rip-rap.
- C. Filter fabric and bedding stone shall be installed prior to the placement of the stones if so indicated on the drawings. The bedding stone shall be quarried and crushed angular limestone in accordance with these specifications and shall be 6" in depth. Filter fabric shall be as specified herein and as detailed on the plans.
- D. Stones shall be placed so that the greater portion of their weight is carried by the earth and not by the adjacent stones. The stones shall be placed in a single layer with close joints. The upright areas of the stone shall make an angle of approximately 90 degree with the embankment slope. The courses shall be placed from the bottom of the embankment upward, the larger stones being placed in the lower courses. Open joints shall be filled with spalls. Stones shall be embedded in the embankment as necessary to present a uniform top surface such that the variation between tops of adjacent stones shall not exceed three inches.

3.10 FINISH GRADING

- A. Grade all areas where finish grade elevations or contours are indicated on Drawings, other than paved areas and buildings, including excavated areas, filled and transition areas, and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Finished subgrade surface shall not be more than 0.10 feet above or below established finished subgrade elevation, and all ground surfaces shall vary uniformly between indicated elevations. Finish ditches shall be graded to allow for proper drainage without ponding and in a

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manner that will minimize erosion potential. For topsoil application, refer to Section on Landscaping.

- B. Correct all settlement and eroded areas within one year after date of completion at no additional expense to Owner. Bring grades to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation that appears dead, dying or disturbed by construction activities. Refer to other sections and plans for slope protection and erosion control.
- C. Refer to other sections and drawings for soil stabilization using lime, cement, fly ash and geotextile fabric methods for subbase materials.

END OF SECTION 31 23 00

SECTION 31 23 19 - CONSTRUCTION DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes performance criteria for active dewatering during construction.
- B. Related Requirements:
 - 1. Section 312200 "Grading" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

1.3 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in dewatering work within SRWMD.

1.5 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering according to the performance requirements.
 - 2. The geotechnical report is included elsewhere in Project Manual.
- B. Construction dewatering will be required to maintain dry working conditions in excavations that extend below the water table.
- C. Groundwater seepage will increase significantly with increased excavation depth below the level of the water table.

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- D. Design and construct a dewatering system consisting of dewatering wells located outside the excavation area in combination with sumps/trench drains inside the excavation area to lower the level of the groundwater below the base of the excavation or excavation support elements as required

1.6 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
 - 1. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
 - 4. Remove dewatering system when no longer required for construction.
- B. Construction dewatering system should be adaptable to varying flow and conditions and capable of lowering the groundwater level as necessary to maintain dry working conditions.
- C. Construct the dewatering system to be in place and operational for sufficient time to allow groundwater to be lowered prior to excavation.
- D. Route, treat and dispose of water collected during dewatering to a suitable discharge point and in accordance with SRWMD guidelines. Discharge of water shall be coordinated with the local SRWMD and county inspector.

PART 2 - EXECUTION

2.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

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- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 31 25 00 “Erosion and Sediment Control” during dewatering operations.

2.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

2.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Disposal of collected water is to be coordinated with the County/SRWMD inspectors.
- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells per SRWMD requirements.

2.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.

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1. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- C. Prepare reports of observations.

2.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 31 23 19

SECTION 31 23 33 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Trench, backfill, and compact as specified herein and as needed for installation of underground pipelines and utilities associated with the Work.
 - 1. Related work:
 - a. Reserved.
 - 2. References:
 - a. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2007.
 - b. ASTM D12937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method, 2010.
 - c. ASTM D4944 - Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester, 2011.
 - d. ASTM D1557 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, 2007.
 - e. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2009.
 - f. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.
 - g. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.2 SUBMITTALS

- A. Shop Drawing Submittals – None Required.
- B. Operation and Maintenance Manuals – None Required.
- C. Certificates and Guarantees – None Required.
- D. Lubricants – None Required.
- E. Spare Parts – None Required.

1.3 EXISTING UTILITIES

- A. The contractor shall locate existing utilities in the areas of work in accordance with Sunshine State One Call regulations, Chapter 556, “Underground Facility Damage Prevention and Safety Act”, FS. The contractor is responsible for subsurface verification of all existing utilities prior to construction.

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- B. If utilities are to remain in place, the contractor shall provide adequate means of protection.
- C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, the contractor shall be responsible for resolving the utility conflicts to utility owner's satisfaction.
- D. Damage and repair costs to such piping or utilities are the contractor's responsibility.
- E. Owner shall not be responsible for uncharted or incorrectly charted water, wastewater, and reclaimed water mains or other utilities

1.4 QUALITY ASSURANCE

- A. A. The Work shall conform to the requirements of the City of Lake City and the Florida Department of Environmental Protection – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - 1. Exception: If the requirements of this Section are more stringent, they shall apply.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- C. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- D. Comply with requirements of governmental agencies having jurisdiction.

PART 2 - PRODUCTS

2.1 GRANULAR PIPE BEDDING AND COVERING MATERIALS

- A. General:
 - 1. Materials for use as bedding and backfill, whether in-situ or borrow, shall be as described under this Section. The contractor shall, upon request by Lake City Utilities or the owner, make an appropriate sample of this material available for testing by the owner or its designated representative.
- B. Structural Fill:
 - 1. Materials for structural fill shall be bedding rock or select common fill as specified herein or other suitable material as approved by Lake City Utilities.
- C. Common Fill:
 - 1. Common fill shall consist of mineral soil, substantially free of clay, organic material, muck, loam, wood, trash and other objectionable material which may be compressible or which cannot be compacted properly. Common fill shall not contain stones larger 3-1/2 inches in any dimension in the top 12 inches or six inches in any dimension in the balance of fill area. Common fill shall not contain asphalt, broken concrete, masonry, rubble or other similar materials. It shall have physical properties such that it can be readily spread and

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compacted during filling. Additional common fill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve, unless finer material is approved for use in a specific location by Lake City Utilities.

2. Material falling within the above specifications that is encountered during the excavation may be stored in segregated stockpiles for reuse. Material that is not suitable for backfill shall be disposed as unsuitable materials.

D. Select Common Fill:

1. Select common fill shall be as specified above from common fill, except that the material shall contain no stones larger than 1/2 inches in largest dimension, and shall be no more than five percent by weight finer than the No. 200 mesh sieve.

E. Bedding Rock:

1. Bedding rock shall conform to FDOT No. 57 aggregate.

PART 3 - EXECUTION

3.1 EXCAVATION

A. General:

1. Excavation consists of removal, storage and disposal of material encountered when establishing required grade elevations.
 - a. If the sub-grade is unsuitable, the contractor shall remove and replace all unsuitable material below pipe with selected common fill or bedding rock, compacted to 95 percent of the maximum density as per AASHTO T-180 modified proctor.
 - b. If the contractor excavates below grade, then the contractor shall refill the excavation using select common fill or bedding rock.
 - c. Slope sides of excavations shall comply with local codes, ordinances, and with OSHA requirements. The contractor shall shore and brace where sloping is not possible due to space restrictions or stability of the material excavated. Sides and slopes shall be maintained in a safe condition until completion of backfilling.
 - d. The contractor shall stockpile satisfactory excavated materials at a location approved by the local municipality until required for backfill or fill.
 - e. Soil materials shall be located away from the edge of excavations.
2. Excavations for Structures:
 - a. All such excavations shall conform to the elevations and dimensions shown on drawing within a tolerance of plus or minus 0.10 feet.
3. Trench Excavation:
 - a. Excavation for trenches required for the installation of utility pipes shall be made to the depths indicated on the approved PLANS to provide suitable room for laying the size and type of pipe specified.
 - 1) Excavations shall not exceed normal trench width as specified in the City of Lake City standard detail drawings Q100 and Q101. Any excavation that exceeds the normal trench width shall require special backfill requirements as determined by Lake City Utilities.
 - b. Where the pipes are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery. The last of the material being excavated shall be done manually in such a manner that will give a shaped bottom,

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true to grade, so that pipe can be evenly supported on undisturbed material, as specified in the City of Lake City standard detail drawings Q100 and Q101. Bell holes shall be made as required.

B. Protection of Trees and Shrubs:

1. Protect trees and shrubs from damage.
2. Do not remove trees or shrubs unless indicated on the Drawings or authorized in the field by the Engineer.
3. Where trees which are to remain interfere with normal excavation operations, use the following procedures:
 - a. Prior to excavation, carefully remove trees with trunk diameters of less than 4 inches, shrubs, and other plantings in the way of construction.
 - b. Do not machine excavate within a distance of three trunk diameters or 12 inches (whichever is greater) of any tree, and do not cut roots over 2-inch diameter unless approved by the Engineer.
 - c. Excavate by hand when closer than three tree trunk diameters or 12 inches (whichever is greater).
 - d. Tree tunneling where necessary to be determined by the Engineer.
 - e. Tie back shrubs and tree limbs to prevent loss or damage.
 - f. Prune and seal damaged limbs and branches.
 - g. Provide plank wrappers wired in place to protect tree trunks from being damaged by trench machinery, tractors, or trucks; remove protective planking as soon as practical after work in vicinity has been completed.
 - h. Remove spoil banks from around trees by hand to prevent damage to trunks by construction machinery.
4. Replace trees and shrubs which cannot be protected or are damaged during construction:
 - a. Replant or replace with stock of like character, quality, variety, size, shape, color and condition upon completion of the construction.
 - b. Replace 4-inch diameter and larger trees with one 4-inch diameter size tree for each 6" of original tree diameter or fraction thereof.
 - c. Replace trees smaller than 4-inch diameter and shrubs with same kind and type.
 - d. As an option, replant trees smaller than 2-inch diameter or shrubs which are not damaged.
5. Remove and replace trees and shrubs which do not survive in good condition for a period of 18 months after time of planting.

C. Work on private property:

1. Work on private property shall be within easements obtained by the Owner as shown on the Drawings.
 - a. The Contractor will be permitted construction privileges within construction easement lines as shown on the Drawings.
 - b. Perform the work in a manner such as to minimize damage to lawns, shrubs, trees and other plantings, driveways, sidewalks, fences, outbuildings, and any other miscellaneous improvements, using proper size and type of equipment.
 - c. The Engineer has the authority to prohibit the use of any equipment which in his judgment is too large or otherwise unsuitable for the conditions of the work on private property.
2. Remove and replace fences, outbuildings and other miscellaneous improvements in the way of construction to the satisfaction of the property owner.

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3. When working in cultivated fields or gardens, remove original topsoil to a depth of 12 inches prior to excavation, and replace the topsoil to its original depth and grade upon completion of trench backfill.
4. Restore the private property to its original condition or better, free of debris, stones and excess materials.

3.2 3.03 SHORING

A. General:

1. Shoring is a method of construction to be utilized to prevent soil movement that could in any way diminish the width of the excavation. It is necessary for proper construction to protect adjacent structures, existing piping and/or foundation material from disturbance, undermining or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

B. Miscellaneous Requirements:

- C. Unless otherwise approved or indicated on the approved plans, all sheeting and bracing shall be removed after completion of the substructure. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools specially adapted to that purpose, by watering or otherwise as may be directed.

3.3 BEDDING AND COVERING OF PIPE

- A. General: Material placed in fill areas under and around structures and pipelines shall be deposited within the lines and to the grades shown on the approved plans making due allowance for settlement of the material. Fill shall be placed only on properly prepared surfaces that have been inspected and approved by the utility owner.

1. Fill shall be brought up in uniform 12-inch maximum level lifts starting the deepest portion of the fill. The entire surface of the WORK shall be maintained free from ruts and in such condition that construction equipment can readily travel over any section.
2. Fill shall be placed and spread in layers by an approved method. Prior to the process of placing and spreading, all materials not meeting those specified under this Section, shall be removed from the fill areas.
3. Fill materials shall be placed and compacted “in-the-dry.” The contractor shall dewater excavated areas as required to perform the WORK and in such manner as to preserve the undisturbed state of the natural inorganic soils. Prior to filling, the ground surface shall be prepared by removing vegetation, debris, unsatisfactory soil materials, obstructions and deleterious materials. When existing ground surface has a density less than that specified under this Section for the particular area classification, the CONTRACTOR shall break up the ground surface, pulverize, moisture-condition to the optimum moisture content and compact to required depth and percentage of maximum density.
4. The contractor shall moisture condition soils for proper compaction. Material that is too wet shall be replaced.

- B. Bedding and Backfill for Structures: Bedding rock shall be used for bedding under all structures, as indicated on the City of Lake City standard detail drawings Q100 and Q101, which can be found on sheet C18 of the construction plans. The contractor shall take all precautions necessary

to maintain the bedding in a compacted state and to prevent washing, erosion or loosening of this bed. Select common fill shall be used as backfill against the exterior walls of the structures. Fill shall be compacted sufficiently in accordance with this Section.

1. Backfilling shall be carried up evenly on all walls of an individual structure. No backfill shall be allowed against walls until the walls and their supporting slabs, if applicable, have attained sufficient strength.
2. In locations where pipes pass through structure walls, the contractor shall take precautions to consolidate the fill up to the spring line of the pipe. Select common fill in such areas shall be placed for a distance of not less than three feet either side of the centerline of the pipe in level layers not exceeding eight inches in depth.
3. The surface of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the approved plans. No soft spots or uncompacted areas will be allowed in the work.
4. Temporary bracing shall be provided as required during construction of all structures to protect partially completed structures against all construction loads, hydraulic pressure and earth pressure. The bracing shall be capable of resisting all loads applied to the walls as a result of backfilling.

C. Bedding and Backfill for Pipes: Bedding for pipe shall be as shown on the approved plans. The contractor shall take all precautions necessary to maintain the bedding in a compacted state and to prevent washing, erosion or loosening of this bed.

1. Backfilling over and around pipes shall begin as soon as practicable after the pipe has been laid, jointed and inspected. All backfilling shall be prosecuted expeditiously and as detailed on the City of Lake City standard detail drawings Q100 and Q101, which can be found on sheet C18 of the construction plans.
2. Any space remaining between the pipe and sides of the trench shall be carefully backfilled, spread by hand or approved mechanical device and thoroughly compacted with a tamper as fast as placed, up to a level of one foot above the top of the pipe. The filling shall be carried up evenly on both sides.
3. The remainder of the trench above the compacted backfill, as just described above, shall be filled and thoroughly compacted in uniform 12-inch maximum lifts layers.
4. Compaction shall be in accordance with the City of Lake City standard detail drawings Q100 and Q101 and this Section, which can be found on sheet C18 of the construction plans.
5. For gravity sanitary sewer construction, the first lift of backfill shall be placed to the spring line of the pipe and compacted by hand tamp.

3.4 COMPACTION

A. General:

1. Backfill trench from the top of pipe cover to topsoil, paving subgrade, or foundation level.
2. If trenches settle during the period of construction and within the guarantee period of the work, fill trench back to the surrounding grade, and restore the surfaces.
3. The contractor shall control soil compaction during construction to provide the percentage of maximum density specified. When utility work is conducted within FDOT right-of-way or other governing municipality, the more stringent minimum density standards shall apply.

B. Percentage of Maximum Density Requirements:

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1. Fill or undisturbed soil from the bottom of the pipe trench to one foot above the pipe to the finished grade elevation shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by AASHTO T-180. Right of way or easements with vehicular traffic on top of the pipe shall be compacted to a minimum density of 98% of maximum dry density as determined by AASHTO T-180.
- C. Compaction Tests: One compaction test location shall be required for each 300 linear feet of pipe and for every 100 square feet of backfill around structures as a minimum. The utility owner may determine that more compaction tests are required to certify the installation depending on field conditions. The locations of compaction tests within the trench shall be in conformance with the following schedule.
 1. One test at the spring line of the pipe.
 2. At least one test for each 12-inch layer of backfill within the pipe bedding zone for pipes 24 inches and larger.
 3. One test at an elevation of one foot above the top of the pipe.
 4. One test for each two feet of backfill placed from one foot above the top of the pipe to finished grade elevation.
 5. Density testing is required around sanitary manholes. Tests shall be staggered around the manhole within three feet of the structure's outside diameter.
 - a. First test shall be one foot above the structure base; and
 - b. Second test shall be two feet above first test and subsequent tests every two feet up to finished subgrade.
 6. The contractor shall provide additional compaction and testing prior to commencing further construction if the testing reports and inspection indicate that the fill that has been placed is below specified density
 7. Dewatering systems shall not be removed until compaction / density testing has been completed.

3.5 FINISH GRADING

- A. General:
 1. Provide finish grading and filling to achieve the lines and grades.
 2. Slope grades to drain away from structures.
 3. Replace culverts damaged during the construction with new culverts of the same size and type unless instructed differently in other sections of these Specifications.
- B. Finish grading:
 1. Except where mounding over trenches is specified, grade smooth areas of the Work including previously grassed areas that have been disturbed, and adjacent transition areas.
 2. Fill and compact depressions from settlement and round tops of embankments and breaks in grade.
 3. Protect newly graded areas from traffic and erosion. Repair settlement or washing away that may occur prior to surface restoration and re-establish grades to the required elevations at no additional cost to the Owner.
- C. Disposal of waste excavated material:
 1. Remove unsuitable and surplus excavated materials not used for backfilling from the project site.

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2. Do not deposit on public or private property without written permission from property owner or authorized representative of appropriate public agency.

3.6 WATER MAIN REPAIR

- A. Whenever existing water mains and water service pipes are damaged during construction, stop the pipe installation work and immediately contact the engineer and utility owner immediately to report the location and extent of the damage.
- B. Coordinate repair of existing utilities with the utility owner. All repairs will be made to the utility owner's specifications.
- C. Do not cover the repair until work is inspected and approved by the utility owner.

END OF SECTION 31 32 33

SECTION 31 23 33 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Trench, backfill, and compact as specified herein and as needed for installation of underground pipelines and utilities associated with the Work.
 - 1. Related work:
 - a. Reserved.
 - 2. References:
 - a. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2007.
 - b. ASTM D12937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method, 2010.
 - c. ASTM D4944 - Standard Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester, 2011.
 - d. ASTM D1557 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, 2007.
 - e. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN m/m³)); 2009.
 - f. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2005.
 - g. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth); 2005.

1.2 SUBMITTALS

- A. Shop Drawing Submittals – None Required.
- B. Operation and Maintenance Manuals – None Required.
- C. Certificates and Guarantees – None Required.
- D. Lubricants – None Required.
- E. Spare Parts – None Required.

1.3 EXISTING UTILITIES

- A. The contractor shall locate existing utilities in the areas of work in accordance with Sunshine State One Call regulations, Chapter 556, “Underground Facility Damage Prevention and Safety Act”, FS. The contractor is responsible for subsurface verification of all existing utilities prior to construction.

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- B. If utilities are to remain in place, the contractor shall provide adequate means of protection.
- C. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, the contractor shall be responsible for resolving the utility conflicts to utility owner's satisfaction.
- D. Damage and repair costs to such piping or utilities are the contractor's responsibility.
- E. Owner shall not be responsible for uncharted or incorrectly charted water, wastewater, and reclaimed water mains or other utilities

1.4 QUALITY ASSURANCE

- A. A. The Work shall conform to the requirements of the City of Lake City and the Florida Department of Environmental Protection – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - 1. Exception: If the requirements of this Section are more stringent, they shall apply.
- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- C. Use equipment adequate in size, capacity, and numbers to accomplish the work in a timely manner.
- D. Comply with requirements of governmental agencies having jurisdiction.

PART 2 - PRODUCTS

2.1 GRANULAR PIPE BEDDING AND COVERING MATERIALS

- A. General:
 - 1. Materials for use as bedding and backfill, whether in-situ or borrow, shall be as described under this Section. The contractor shall, upon request by Lake City Utilities or the owner, make an appropriate sample of this material available for testing by the owner or its designated representative.
- B. Structural Fill:
 - 1. Materials for structural fill shall be bedding rock or select common fill as specified herein or other suitable material as approved by Lake City Utilities.
- C. Common Fill:
 - 1. Common fill shall consist of mineral soil, substantially free of clay, organic material, muck, loam, wood, trash and other objectionable material which may be compressible or which cannot be compacted properly. Common fill shall not contain stones larger 3-1/2 inches in any dimension in the top 12 inches or six inches in any dimension in the balance of fill area. Common fill shall not contain asphalt, broken concrete, masonry, rubble or other similar materials. It shall have physical properties such that it can be readily spread and

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compacted during filling. Additional common fill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve, unless finer material is approved for use in a specific location by Lake City Utilities.

2. Material falling within the above specifications that is encountered during the excavation may be stored in segregated stockpiles for reuse. Material that is not suitable for backfill shall be disposed as unsuitable materials.

D. Select Common Fill:

1. Select common fill shall be as specified above from common fill, except that the material shall contain no stones larger than 1/2 inches in largest dimension, and shall be no more than five percent by weight finer than the No. 200 mesh sieve.

E. Bedding Rock:

1. Bedding rock shall conform to FDOT No. 57 aggregate.

PART 3 - EXECUTION

3.1 EXCAVATION

A. General:

1. Excavation consists of removal, storage and disposal of material encountered when establishing required grade elevations.
 - a. If the sub-grade is unsuitable, the contractor shall remove and replace all unsuitable material below pipe with selected common fill or bedding rock, compacted to 95 percent of the maximum density as per AASHTO T-180 modified proctor.
 - b. If the contractor excavates below grade, then the contractor shall refill the excavation using select common fill or bedding rock.
 - c. Slope sides of excavations shall comply with local codes, ordinances, and with OSHA requirements. The contractor shall shore and brace where sloping is not possible due to space restrictions or stability of the material excavated. Sides and slopes shall be maintained in a safe condition until completion of backfilling.
 - d. The contractor shall stockpile satisfactory excavated materials at a location approved by the local municipality until required for backfill or fill.
 - e. Soil materials shall be located away from the edge of excavations.
2. Excavations for Structures:
 - a. All such excavations shall conform to the elevations and dimensions shown on drawing within a tolerance of plus or minus 0.10 feet.
3. Trench Excavation:
 - a. Excavation for trenches required for the installation of utility pipes shall be made to the depths indicated on the approved PLANS to provide suitable room for laying the size and type of pipe specified.
 - 1) Excavations shall not exceed normal trench width as specified in the City of Lake City standard detail drawings Q100 and Q101. Any excavation that exceeds the normal trench width shall require special backfill requirements as determined by Lake City Utilities.
 - b. Where the pipes are to be laid directly on the trench bottom, the lower part of the trenches shall not be excavated to grade by machinery. The last of the material being excavated shall be done manually in such a manner that will give a shaped bottom,

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true to grade, so that pipe can be evenly supported on undisturbed material, as specified in the City of Lake City standard detail drawings Q100 and Q101. Bell holes shall be made as required.

B. Protection of Trees and Shrubs:

1. Protect trees and shrubs from damage.
2. Do not remove trees or shrubs unless indicated on the Drawings or authorized in the field by the Engineer.
3. Where trees which are to remain interfere with normal excavation operations, use the following procedures:
 - a. Prior to excavation, carefully remove trees with trunk diameters of less than 4 inches, shrubs, and other plantings in the way of construction.
 - b. Do not machine excavate within a distance of three trunk diameters or 12 inches (whichever is greater) of any tree, and do not cut roots over 2-inch diameter unless approved by the Engineer.
 - c. Excavate by hand when closer than three tree trunk diameters or 12 inches (whichever is greater).
 - d. Tree tunneling where necessary to be determined by the Engineer.
 - e. Tie back shrubs and tree limbs to prevent loss or damage.
 - f. Prune and seal damaged limbs and branches.
 - g. Provide plank wrappers wired in place to protect tree trunks from being damaged by trench machinery, tractors, or trucks; remove protective planking as soon as practical after work in vicinity has been completed.
 - h. Remove spoil banks from around trees by hand to prevent damage to trunks by construction machinery.
4. Replace trees and shrubs which cannot be protected or are damaged during construction:
 - a. Replant or replace with stock of like character, quality, variety, size, shape, color and condition upon completion of the construction.
 - b. Replace 4-inch diameter and larger trees with one 4-inch diameter size tree for each 6" of original tree diameter or fraction thereof.
 - c. Replace trees smaller than 4-inch diameter and shrubs with same kind and type.
 - d. As an option, replant trees smaller than 2-inch diameter or shrubs which are not damaged.
5. Remove and replace trees and shrubs which do not survive in good condition for a period of 18 months after time of planting.

C. Work on private property:

1. Work on private property shall be within easements obtained by the Owner as shown on the Drawings.
 - a. The Contractor will be permitted construction privileges within construction easement lines as shown on the Drawings.
 - b. Perform the work in a manner such as to minimize damage to lawns, shrubs, trees and other plantings, driveways, sidewalks, fences, outbuildings, and any other miscellaneous improvements, using proper size and type of equipment.
 - c. The Engineer has the authority to prohibit the use of any equipment which in his judgment is too large or otherwise unsuitable for the conditions of the work on private property.
2. Remove and replace fences, outbuildings and other miscellaneous improvements in the way of construction to the satisfaction of the property owner.

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3. When working in cultivated fields or gardens, remove original topsoil to a depth of 12 inches prior to excavation, and replace the topsoil to its original depth and grade upon completion of trench backfill.
4. Restore the private property to its original condition or better, free of debris, stones and excess materials.

3.2 3.03 SHORING

A. General:

1. Shoring is a method of construction to be utilized to prevent soil movement that could in any way diminish the width of the excavation. It is necessary for proper construction to protect adjacent structures, existing piping and/or foundation material from disturbance, undermining or other damage. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed.

B. Miscellaneous Requirements:

- C. Unless otherwise approved or indicated on the approved plans, all sheeting and bracing shall be removed after completion of the substructure. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools specially adapted to that purpose, by watering or otherwise as may be directed.

3.3 BEDDING AND COVERING OF PIPE

- A. General: Material placed in fill areas under and around structures and pipelines shall be deposited within the lines and to the grades shown on the approved plans making due allowance for settlement of the material. Fill shall be placed only on properly prepared surfaces that have been inspected and approved by the utility owner.

1. Fill shall be brought up in uniform 12-inch maximum level lifts starting the deepest portion of the fill. The entire surface of the WORK shall be maintained free from ruts and in such condition that construction equipment can readily travel over any section.
2. Fill shall be placed and spread in layers by an approved method. Prior to the process of placing and spreading, all materials not meeting those specified under this Section, shall be removed from the fill areas.
3. Fill materials shall be placed and compacted “in-the-dry.” The contractor shall dewater excavated areas as required to perform the WORK and in such manner as to preserve the undisturbed state of the natural inorganic soils. Prior to filling, the ground surface shall be prepared by removing vegetation, debris, unsatisfactory soil materials, obstructions and deleterious materials. When existing ground surface has a density less than that specified under this Section for the particular area classification, the CONTRACTOR shall break up the ground surface, pulverize, moisture-condition to the optimum moisture content and compact to required depth and percentage of maximum density.
4. The contractor shall moisture condition soils for proper compaction. Material that is too wet shall be replaced.

- B. Bedding and Backfill for Structures: Bedding rock shall be used for bedding under all structures, as indicated on the City of Lake City standard detail drawings Q100 and Q101, which can be found on sheet C18 of the construction plans. The contractor shall take all precautions necessary

to maintain the bedding in a compacted state and to prevent washing, erosion or loosening of this bed. Select common fill shall be used as backfill against the exterior walls of the structures. Fill shall be compacted sufficiently in accordance with this Section.

1. Backfilling shall be carried up evenly on all walls of an individual structure. No backfill shall be allowed against walls until the walls and their supporting slabs, if applicable, have attained sufficient strength.
2. In locations where pipes pass through structure walls, the contractor shall take precautions to consolidate the fill up to the spring line of the pipe. Select common fill in such areas shall be placed for a distance of not less than three feet either side of the centerline of the pipe in level layers not exceeding eight inches in depth.
3. The surface of filled areas shall be graded to smooth true lines, strictly conforming to grades indicated on the approved plans. No soft spots or uncompacted areas will be allowed in the work.
4. Temporary bracing shall be provided as required during construction of all structures to protect partially completed structures against all construction loads, hydraulic pressure and earth pressure. The bracing shall be capable of resisting all loads applied to the walls as a result of backfilling.

C. Bedding and Backfill for Pipes: Bedding for pipe shall be as shown on the approved plans. The contractor shall take all precautions necessary to maintain the bedding in a compacted state and to prevent washing, erosion or loosening of this bed.

1. Backfilling over and around pipes shall begin as soon as practicable after the pipe has been laid, jointed and inspected. All backfilling shall be prosecuted expeditiously and as detailed on the City of Lake City standard detail drawings Q100 and Q101, which can be found on sheet C18 of the construction plans.
2. Any space remaining between the pipe and sides of the trench shall be carefully backfilled, spread by hand or approved mechanical device and thoroughly compacted with a tamper as fast as placed, up to a level of one foot above the top of the pipe. The filling shall be carried up evenly on both sides.
3. The remainder of the trench above the compacted backfill, as just described above, shall be filled and thoroughly compacted in uniform 12-inch maximum lifts layers.
4. Compaction shall be in accordance with the City of Lake City standard detail drawings Q100 and Q101 and this Section, which can be found on sheet C18 of the construction plans.
5. For gravity sanitary sewer construction, the first lift of backfill shall be placed to the spring line of the pipe and compacted by hand tamp.

3.4 COMPACTION

A. General:

1. Backfill trench from the top of pipe cover to topsoil, paving subgrade, or foundation level.
2. If trenches settle during the period of construction and within the guarantee period of the work, fill trench back to the surrounding grade, and restore the surfaces.
3. The contractor shall control soil compaction during construction to provide the percentage of maximum density specified. When utility work is conducted within FDOT right-of-way or other governing municipality, the more stringent minimum density standards shall apply.

B. Percentage of Maximum Density Requirements:

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1. Fill or undisturbed soil from the bottom of the pipe trench to one foot above the pipe to the finished grade elevation shall be compacted to a minimum density of 95 percent of the maximum dry density as determined by AASHTO T-180. Right of way or easements with vehicular traffic on top of the pipe shall be compacted to a minimum density of 98% of maximum dry density as determined by AASHTO T-180.
- C. Compaction Tests: One compaction test location shall be required for each 300 linear feet of pipe and for every 100 square feet of backfill around structures as a minimum. The utility owner may determine that more compaction tests are required to certify the installation depending on field conditions. The locations of compaction tests within the trench shall be in conformance with the following schedule.
 1. One test at the spring line of the pipe.
 2. At least one test for each 12-inch layer of backfill within the pipe bedding zone for pipes 24 inches and larger.
 3. One test at an elevation of one foot above the top of the pipe.
 4. One test for each two feet of backfill placed from one foot above the top of the pipe to finished grade elevation.
 5. Density testing is required around sanitary manholes. Tests shall be staggered around the manhole within three feet of the structure's outside diameter.
 - a. First test shall be one foot above the structure base; and
 - b. Second test shall be two feet above first test and subsequent tests every two feet up to finished subgrade.
 6. The contractor shall provide additional compaction and testing prior to commencing further construction if the testing reports and inspection indicate that the fill that has been placed is below specified density
 7. Dewatering systems shall not be removed until compaction / density testing has been completed.

3.5 FINISH GRADING

- A. General:
 1. Provide finish grading and filling to achieve the lines and grades.
 2. Slope grades to drain away from structures.
 3. Replace culverts damaged during the construction with new culverts of the same size and type unless instructed differently in other sections of these Specifications.
- B. Finish grading:
 1. Except where mounding over trenches is specified, grade smooth areas of the Work including previously grassed areas that have been disturbed, and adjacent transition areas.
 2. Fill and compact depressions from settlement and round tops of embankments and breaks in grade.
 3. Protect newly graded areas from traffic and erosion. Repair settlement or washing away that may occur prior to surface restoration and re-establish grades to the required elevations at no additional cost to the Owner.
- C. Disposal of waste excavated material:
 1. Remove unsuitable and surplus excavated materials not used for backfilling from the project site.

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2. Do not deposit on public or private property without written permission from property owner or authorized representative of appropriate public agency.

3.6 WATER MAIN REPAIR

- A. Whenever existing water mains and water service pipes are damaged during construction, stop the pipe installation work and immediately contact the engineer and utility owner immediately to report the location and extent of the damage.
- B. Coordinate repair of existing utilities with the utility owner. All repairs will be made to the utility owner's specifications.
- C. Do not cover the repair until work is inspected and approved by the utility owner.

END OF SECTION 31 32 33

SECTION 31 25 00 - EROSION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. The Suwannee River Water Management District (SRWMD) has promulgated a General Environmental Resource Permit (ERP) hereafter referred to as the General Permit. The General Permit authorizes the discharge of stormwater associated with construction activity from project sites. The Contractor is required to obtain coverage under this permit. In order to obtain coverage under the General Permit, the Contractor shall submit a Notice of Intent (NOI) to the Florida Department of Environmental Protection (FDEP) for a National Pollutant Discharge Elimination System (NPDES) permit. A copy of the NOI is to be submitted to the owner. A Stormwater Pollution Prevention Plan (SWPPP) that addresses all of the required elements as stated in the General Permit, NOI – NPDES and outlined in this specification is required.
- B. Provide erosion control measures on the project and in the areas outside of where work is performed in conjunction with the project, so as to prevent pollution of water and wetlands, detrimental effects to public or private property adjacent to the project and damage to work on the project. Construct and maintain temporary erosion control measures or, where practical or as may be directed by the General Contract and/or Engineer construct and maintain permanent erosion control features.
- C. THIS SECTION INCLUDES:
 - 1. Prevention of erosion due to construction activities.
 - 2. Prevention of sedimentation of waterways, open drainage ways, wetlands, and storm and sanitary sewers due to construction activities.
 - 3. Restoration of areas eroded and remediation of sedimentation, due to insufficient preventive measures.
 - 4. Performance bond.
 - 5. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 REQUIREMENTS

- A. Coordinate the installation of temporary erosion control features with the construction of the permanent erosion control features to the extent necessary to ensure effective and continuous control of erosion and water pollution throughout the life of the project.

1.3 CONTROL OF CONTRACTOR'S OPERATION WHICH MAY RESULT IN WATER POLLUTION

- A. Prevent pollution of streams, canals, lakes, reservoirs, and other water impoundments with fuels, oils, bitumen, calcium chloride, or other harmful materials. Also, conduct and schedule

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operations to avoid or otherwise minimize pollution or siltation of such water impoundments. Do not dump any residue from dust collectors or washers into any water body.

- B. Restrict construction operations in rivers, streams, lakes, tidal waters, reservoirs, canals, wetlands and other water impoundments to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the Plans and to those areas, which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear rivers, streams, wetlands, and impoundments of all obstructions placed therein or caused by construction operations.
- C. Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water by one or more of the following methods prior to discharge into wetlands or State waters: pumping into grassed swales or appropriate vegetated areas or sediment basins, or confined by an appropriate enclosure such as turbidity barriers when other methods are not considered appropriate.
- D. Do not disturb lands or waters outside the limits of construction as shown on the plan and staked in the field, except as authorized by the Engineer.
- E. Obtain the Engineer's approval for the location of, and method of operation in, borrow pits, material pits, and disposal areas furnished for waste material from the project (other than commercially operated sources) such that erosion during and after completion of the work will not result in probability of detrimental siltation or water pollution.

1.4 RELATED REQUIREMENTS

- A. The Construction General Permit requires the development and implementation of a SWPPP. The SWPPP should contain a site map(s), which shows the construction site perimeter, existing and proposed buildings, roadways, stormwater collection system and discharge points, general topography both before and after construction, and drainage patterns across the project. The SWPPP must list Best Management Practices (BMPs) the discharger will use to protect stormwater runoff and the placement of BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment. Section A of the Construction General Permit describes the elements that must be contained in a SWPPP. Contractor shall pay all fees.

1.5 REFERENCE STANDARDS

- A. Numerous guidance documents and references are available for developing a SWPPP or for evaluating and selecting approved BMPs from FDEP and SRWMD. The Contractor is strongly urged to consult these resources or other appropriate resources for preparing the SWPPP and selecting BMPs. Templates for producing a SWPPP specifically for Construction Activities, guidance documents, and BMP handbooks are all available electronically from the following agencies:
 - 1. AASHTO – National Association of State Highway and Transportation Officials, Geotextile Specifications for Highway Applications (AASHTO M-288-96).

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2. Florida Department of Environmental Protection (FDEP) National Pollutant Discharge Elimination System (NPDES), Construction General Permit
3. The State Water Resources Control Board General Construction Stormwater Permit
4. Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction
5. Suwannee River Water Management District (SRWMD)
6. National Stormwater Best Management Practices (BMP) Database

1.6 PERFORMANCE REQUIREMENTS

- A. Comply with all applicable requirements of U.S. Environmental Protection Agency, FDEP & SRWMD for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2017 Construction General Permit (CGP).
- B. Develop and follow an Erosion and Sedimentation Prevention Plan and submit required and periodic inspection reports.
- C. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained. Furnish all documentation required to obtain applicable permits.
- D. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- E. Stormwater Runoff: Control increased stormwater runoff due to disturbance of surface cover due to construction activities for this project.
 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by Authorities Having Jurisdiction, whichever is less.
 2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.
- F. Erosion On-Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 1. Control movement of sediment and soil from temporary stockpiles of soil.
 2. Prevent development of ruts due to equipment and vehicular traffic.
 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- G. Erosion Off-Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 1. Prevent windblown soil from leaving the project site.
 2. Prevent tracking of mud/dirt onto public roads.
 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

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- H. Sedimentation of Waterways On-Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, wetlands, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - 2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.
- I. Sedimentation of Waterways Off-Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, wetlands, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - 2. If sedimentation basins are used as temporary preventative measures, pump dry and remove deposited sediment after each storm.
- J. Maintenance: Maintain temporary preventive erosion control measures until permanent measures have been established.

1.7 SUBMITTALS

- A. The Contractor is required to submit a NOI for FDEP NPDES permit for approval with a SWPPP detailing the placement of physical BMPs required for installation and the methods used to comply with those BMPs directed at operational procedures. A copy of the SWPPP must be kept at the site when conducting any Construction Activity.
- B. The SWPPP shall be in place before construction activity may start. In order to establish verification of delivery, Contractor shall send the NOI with a receipt request to the FDEP. The NOI should be sent at least two weeks prior to the start of construction to allow processing of the NOI and assignment of an Identification Number.
 - 1. The Contractor shall provide the Owner and the City with a copy of the SWPPP and the NOI.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Mulch: Use one of the following:
 - 1. Straw or hay.
 - 2. Erosion control matting or netting.
- B. Grass Seed for Temporary Cover: Select a species appropriate to climate, planting season, and intended purpose. If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

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- C. Bales: synthetic straw bales to meet the FDOT and FDEP requirements.
- D. Silt Fence: To meet all requirements of the FDEP. Polypropylene, nylon, polyester or polyethylene yarn geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible.
 - 1. It shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0-120 degrees Fahrenheit.
 - 2. The stakes for a silt fence shall be 1x2 inches wood or equivalent metal with a minimum length of 3 feet.
 - 3. Wire backed reinforcement for silt fences using standard-strength filter cloth shall be a minimum of 36 inches in height, shall be a minimum of 14 gauge, and shall have a maximum mesh spacing of 6 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.2 PRECONSTRUCTION REQUIREMENTS

- A. At the Preconstruction Conference, provide an Erosion Control Plan meeting the requirements or special conditions of all permits authorizing project construction.
- B. When a FDEP general permit is issued, the Contractor's Erosion Control Plan shall be prepared to accompany the SWPPP. Ensure the Erosion Control Plan includes procedures to control off-site tracking of soil by vehicles and construction equipment and a procedure for cleanup and reporting of non-stormwater discharges, such as contaminated groundwater or accidental spills. Do not begin any soil disturbing activities until approval of the Erosion Control Plan, including required signed certification statements.
- C. Failure to sign any required documents or certification statements will be considered a default of the Contract. Any soil disturbing activities performed without the required signed documents or certification statements may be considered a violation of the FDEP Permit.
- D. When the SWPPP is required, prepare the Erosion Control Plan in accordance with the planned sequence of operations. The Erosion Control Plan shall describe, but not be limited to, the following items or activities:
 - 1. For each phase of construction operations or activities, supply the following information:
 - a. Locations and types of all erosion control devices
 - b. Estimated time erosion control devices will be in operation
 - c. Monitoring schedules for maintenance of erosion control devices
 - d. Methods of maintaining erosion control devices
 - e. Containment or removal methods for pollutants or hazardous wastes
 - 2. The name and telephone number of the person responsible for monitoring and maintaining the erosion control devices.

3.3 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time. All disturbed areas must be stabilized within 7 days.

3.4 CONSTRUCTION REQUIREMENTS

- A. The Engineer may authorize temporary erosion control features when finished soils layer is specified in the Contract and the limited availability of that material from the grading operations will prevent scheduled progress of the work or damage the permanent erosion control features.
- B. Berms: Construct temporary earth berms to divert the flow of water from an erodible surface.
- C. General: Furnish, install, maintain, and remove silt fences, in accordance with the manufacturer's directions, these Specifications, the details as shown in the Plans, the Design Standards, and the Florida Stormwater Erosion and Sedimentation Control Inspectors Manual.
- D. Materials and Installation:
 - 1. Use a geotextile fabric made from woven or nonwoven fabric, meeting the physical requirements of FDEP according to those applications for erosion control.
 - 2. Choose the type and size of posts, wire mesh reinforcement (if required), and method of installation. Do not use products which have a separate layer of plastic mesh or netting. Provide a durable and effective silt fence that controls sediment comparable to the Design Standards.
 - 3. Install all sediment control devices in a timely manner to ensure the control of sediment and the protection of lakes, streams, or any wetlands associated therewith and to any adjacent property or right-of-way as required.
 - 4. At sites where exposure to such sensitive areas is prevalent, complete the installation of any sediment control devices damages at no expense to the Owner.
 - 5. Erect temporary silt fence at upland locations and at temporary locations shown in the Plans or approved by the Engineer where continuous construction activities change the natural contour and drainage runoff. Do not attach silt fence to existing trees.
- E. Inspection and Maintenance:
 - 1. Inspect all silt fences as required by the NPDES permit including immediately after each rainfall and at least daily during prolonged rainfall. Immediately correct any deficiencies. In addition, make a daily review of the location of silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure that the silt fences are properly located for effectiveness. Where deficiencies exist, install additional silt fences as directed by the Engineer.
 - 2. Remove sediment deposits as required by FDEP. Dress any sediment deposits remaining in place after the silt fence is no longer required to conform to the finished grade, and prepare and seed them in accordance with FDEP.
- F. Floating Turbidity Barriers and Staked Turbidity Barriers:
 - 1. Install, maintain, and remove turbidity barriers to contain turbidity that may occur as the result of dredging, filling, or other construction activities which may cause turbidity to occur in the wetlands or waters of the State. The Contractor may need to deploy turbidity barriers around isolated areas of concern. Place the barriers prior to the commencement of

any work that could impact the area. Install the barriers in accordance with the requirements of the FDEP. Ensure that the type barrier used and the deployment and maintenance of the barrier will minimize dispersion of turbid waters from the construction site. The Engineer may approve alternate methods or materials.

2. Operate turbidity barriers in such a manner to avoid or minimize the degradation of the water quality of the surrounding waters and minimize damage to areas where floating barriers installed.

G. Artificial Coverings:

1. Install artificial coverings in locations where temporary protection from erosion is needed. Two situations occur that require artificial coverings. The two situations have differing material requirements, which are described below.
2. Use artificial coverings composed of natural or synthetic fiber mats, plastic sheeting, or netting as protection against erosion, when directed by the Engineer, during temporary pauses in construction caused by inclement weather or other circumstances. Remove the material when construction resumes.
3. Use artificial coverings as erosion control blankets, at locations shown in the Plans, to facilitate plant growth while permanent grassing is being established. For the purpose described, use non-toxic, biodegradable, natural or synthetic woven fiber mats.

- H. Removal of Temporary Erosion Control Features: In general, remove or incorporate into the soil any temporary erosion control features existing at the time of construction of the permanent erosion control features in an area of the project in such a manner that no detrimental effect will result. The Engineer may direct that temporary features be left in place.

3.5 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. Construction Entrances: Traffic-bearing aggregate surface.
1. Width: As required; 24-feet, minimum.
 2. Length: 48-feet, minimum.
 3. Provide at each construction entrance from existing paved drive.
- C. Linear Sediment Barriers: Made of silt fences - located as shown on the drawings.
- D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:
1. Filter Fabric wrapped inlet grates or sock drains placed in front of inlet openings in compliance with FDEP.
- E. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and stormwater outlets.
- F. Soil Stockpiles: Protect using the following measures:
1. Seed the stockpiled topsoil and adjoining areas with fast growing temporary vegetation to prevent soil erosion and rapid runoff.
 2. Generally, stack topsoil at locations approved by the Owner.

- G. Temporary Seeding: Use where temporary vegetated cover is required.

3.6 INSTALLATION

A. Traffic-Bearing Aggregate Surface:

1. Place and compact at least 6 inches of 1.5-inches to 3.5-inches diameter stone.

B. Silt Fences:

1. Store and handle fabric in accordance with ASTM D4873.
2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16-inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.
3. Install with top of fabric at nominal height and embedment as specified.
4. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
5. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12-inches high with post spacing not more than 4-feet.

C. Synthetic Straw Bale Rows:

1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
2. Embed bales at least 4-inches in the ground.
3. Anchor bales with at least two stakes per bale, driven at least 18-inches into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
4. Fill gaps between ends of bales with loose straw wedged tightly.
5. Place soil excavated for trench against bales on the upslope side of the row, compacted.

D. Temporary Seeding:

1. When hydraulic seeder is used, seedbed preparation is not required.
2. When surface soil has been sealed by rainfall or consists of smooth undisturbed cut slopes, and conventional or manual seeding is to be used, prepare seedbed by scarifying sufficiently to allow seed to lodge and germinate.
3. If temporary mulching was used on planting area but not removed, apply nitrogen fertilizer at 1 pound per 1000-square feet.
4. On soils of very low fertility, apply 10-10-10 fertilizer at rate of 12 to 16 pounds per 1000-square feet.
5. Incorporate fertilizer into soil before seeding.
6. Apply seed uniformly.
7. Irrigate as required to thoroughly wet soil to depth that will ensure germination, without causing runoff or erosion.
8. Repeat irrigation as required until grass is established.

3.7 MAINTENANCE

- A. Provide routine maintenance of permanent and temporary erosion and sediment control features, at no expense to the Owner, until the project is complete and accepted. If reconstruction of such erosion and sediment control features is necessary due to the Contractor's negligence or

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carelessness or, in the case of temporary erosion and sediment control features, failure by the Contractor to install permanent erosion control features as scheduled, the Contractor shall replace such erosion control features at no expense to the Department.

- B. Inspect all erosion and sediment control features at least once every seven calendar days and within 24 hours of the end of a storm. Maintain all erosion control features as required in the SWPPP, Contractor's Erosion Control Plan and as specified in the State of Florida Department of Environmental Protection Generic Permit for Stormwater Discharge from Large and Small Construction Activities.
- C. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5-inches or more rainfall at the project site, and daily during prolonged rainfall.
- D. Repair deficiencies found in silt fences and straw bales immediately.
- E. Silt Fences:
 - 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 - 2. Remove silt deposits that exceed one-third of the height of the fence.
 - 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- F. Clean out temporary sediment control structures weekly, or as required by environmental conditions, and relocate soil on site.
- G. Place sediment in appropriate locations on site; do not remove from site.

3.8 5713-3.7 – CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Owner and Engineer.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION 31 25 00

SECTION 313116 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Soil treatment.
- B. Related Requirements:
 - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood preservative treatment by pressure process.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include the EPA-Registered Label for termiticide products.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of termite control product.
- C. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
 - 1. Date and time of application.
 - 2. Moisture content of soil before application.
 - 3. Termiticide brand name and manufacturer.
 - 4. Quantity of undiluted termiticide used.
 - 5. Dilutions, methods, volumes used, and rates of application.
 - 6. Areas of application.
 - 7. Water source for application.
- D. Sample Warranties: For special warranties.

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1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located.
- B. Regulatory Requirements: Comply with requirements of the Florida Building Code.

1.6 FIELD CONDITIONS

- A. Soil Treatment:
 - 1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
 - 2. Related Work: Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.7 WARRANTY

- A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work consisting of applied soil termiticide treatment will prevent infestation of subterranean termites, including Formosan termites (*Coptotermes formosanus*). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

- A. Termiticide: EPA-Registered termiticide acceptable to authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. BASF Corporation; Termidor.
 - b. Bayer Environmental Science; Premise 75.
 - c. FMC Corporation, Agricultural Products Group; Talstar.
 - d. Syngenta; Demon Max.

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2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
- B. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare work areas according to the requirements of authorities having jurisdiction and according to manufacturer's written instructions before beginning application and installation of termite control treatment(s). Remove extraneous sources of wood cellulose and other edible materials, such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
- B. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated, except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
 1. Fit filling hose connected to water source at the site with a backflow preventer, according to requirements of authorities having jurisdiction.

3.3 APPLICATION, GENERAL

- A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

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3.4 APPLYING SOIL TREATMENT

- A. Application: Mix soil treatment termiticide solution to a uniform consistency. Distribute treatment uniformly. Apply treatment at the product's EPA-Registered Label volume and rate for maximum specified concentration of termiticide to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction.
 - 1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
 - 2. Foundations: Soil adjacent to and along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing.
 - 3. Penetrations: At expansion joints, control joints, and areas where slabs and below-grade walls will be penetrated.
- B. Post warning signs in areas of application.
- C. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

3.5 PROTECTION

- A. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
- B. Protect termiticide solution dispersed in treated soils and fills from being diluted by exposure to water spillage or weather until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

3.6 MAINTENANCE SERVICE

- A. Continuing Maintenance Proposal: Provide from termite-control-treatment Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement. State services, obligations, conditions, and terms for agreement period and for future renewal options.
 - 1. Include annual inspection for termite activity and effectiveness of termite treatment according to manufacturer's written instructions.

END OF SECTION 313116

SECTION 32 10 00 - ROADS, DRIVEWAYS, AND WALKS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide roads, driveways and walks as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Construct roads, driveways, and walks in accordance with the FDOT "Standard Plans for Road Construction", except as herein modified.
- C. Related work
 - 1. Geotechnical information provided by American Infrastructure Development, AID Report Number DEI20006, Dated May 18, 2020.
- D. References:
 - 1. FDOT "Standard Plans for Road Construction"
 - 2. FDOT "Standard Specifications for Road and Bridge Construction"

1.2 SUBMITTALS

- A. Shop Drawing Submittals – None Required.
- B. Operation and Maintenance Manuals – None Required.
- C. Certificates and Guarantees – None Required.
- D. Lubricants – None Required.
- E. Spare Parts – None Required.

1.3 QUALITY ASSURANCE

- A. The work performed under this Section shall comply with all the requirements of the latest edition of the Florida Department of Transportation (FDOT) "Standard Specifications for Road and Bridge Construction", which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - 1. Exception: If the requirements of this Section are more stringent, they shall apply.
- B. Source quality control:
 - 1. Submit certificates from source of aggregate materials that aggregate meets specified standards.
 - 2. Submit certificates from geotextile manufacturer that fabric meets specified standards.
 - 3. Obtain hot-mix asphalt mixtures and Portland cement concrete from plants approved by the FDOT.

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4. Submit the name of the source of materials proposed for use on the Project to the Engineer at the Preconstruction Meeting.
5. Submit FDOT mix designs for hot-mix asphalt surface plant mix, hot-mix asphalt binder and surface courses, and Portland cement concrete proposed to be constructed.

C. Sampling and testing:

1. The Owner will provide the services of an independent testing laboratory for specified sampling and testing requirements.
2. Test one sample (minimum size of 4 lbs.) per each 250 tons of the following materials paved, for conformance with mix design:
 - a. Hot-mix asphalt surface plant mix.
 - b. Hot-mix asphalt, both binder and surface.
3. At the conclusion of paving operation, cut full depth samples (a minimum of 4 cores per day) of the following pavement types at locations directed by the Engineer, and test for compaction.
 - a. Hot-mix asphalt stabilized base.
 - b. Hot-mix asphalt surface plant mix.
 - c. Hot-mix asphalt.

1.4 DELIVERY, STORAGE, AND HANDLING – Reserved.

1.5 SITE CONDITIONS – Reserved.

1.6 MAINTENANCE – Reserved.

PART 2 - PRODUCTS

2.1 SUBBASE

A. Subbase granular materials:

1. In-Situ soils stabilized using a FDOT approved commercial stabilizing material. With any organic materials removed.
2. Compacted to 98% of the modified proctor.
3. Min LBR 40

2.2 BASE COURSE

A. Aggregate base:

1. Use limerock compacted to 98% of the modified proctor, crushed concrete is an acceptable alternative.
2. Min LBR of 100

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2.3 SURFACE COURSE

A. Hot-mix asphalt surface course:

1. Use 2" of FDOT SP-12.5

2.4 PORTLAND CEMENT CONCRETE SIDEWALK

A. Minimum compressive strength of 3,000 lbs unless otherwise specified on the plans.

2.5 DETECTABLE WARNINGS

A. Comply with Index 522-002 of the FDOT "Standard Plans for Road Construction" for materials, installation and certification requirements.

2.6 CURB AND GUTTER

A. Portland Cement concrete:

1. Comply with applicable requirements of Index 520-001 of the FDOT "Standard Plans for Road Construction".

2.7 PAVEMENT MARKINGS

A. Materials – Permanent:

1. Per FDOT Index 711

PART 3 - EXECUTION

3.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Comply with the thickness and width shown on the Drawings.

1. Construct elevation and crown of the finished surfaces to meet the required profile and section shown on the Drawings.

B. Compaction test for aggregate subbase, base, and surface courses:

1. Proof-roll for compaction by driving a rubber-tired, single-unit truck with 45,000-pound load slowly over the area to be inspected.
2. Repair areas which show depressions or deflections greater than:
 - a. 3/4-inch deep for subbase.
 - b. 1/2-inch deep for base.
 - c. 1/4-inch deep for surface.

C. Repeat proof-roll and/or repair until approved by the Engineer.

3.2 SURFACE COURSES

- A. Acceptable tolerances for the pavement surface:
 - 1. Longitudinal tolerance:
 - a. Sweep the surface clean and test for smoothness when finish surface is complete.
 - b. Remove high points exceeding ¼-inch in 10 feet to within the specified tolerance either by grinding or further rolling.
 - c. Remove and replace depressions which cannot be corrected by grinding or further rolling.
 - d. Grinding high points or repairing depressions shall be done at the Contractor's expense.

3.3 CURB AND GUTTER

- A. Install aggregate base course under the curb and gutter, as indicated on the Drawings.
- B. Cut contraction joints at intervals not to exceed 15 feet.
- C. Backfill behind curb and gutter once the concrete has cured for a minimum of 28-days.
- D. Construct depressed curb for wheelchair ramps and driveways at the locations designated by the Engineer. No additional compensation will be made for depressed curb at ramp or driveway locations.

3.4 SIDEWALKS

- A. Construction requirements:
 - 1. Construct to the lines and grades as shown on the Drawings.
- B. Portland Cement concrete sidewalks:
 - 1. Erect temporary forms for placement of concrete.
 - 2. Backfill over excavated area with approved granular material.
 - 3. Provide a minimum thickness of 4 inches of concrete.
 - 4. Provide ramps accessible to the disabled in locations as shown on the Drawings. Cross slopes not to exceed 2 percent at all locations.
 - 5. Provide detectable warnings at ramps as specified in index 522-002 of the FDOT “Standard Plans for Road Construction”.

3.5 CRACK AND JOINT REPAIR

- A. Description:
 - 1. Remove existing crack and joint fill material as directed by the Engineer and replace with a bituminous mixture.

3.6 TEMPORARY AGGREGATE

- A. Place, compact, and maintain coarse aggregate as a temporary driving surface where shown on the Drawings, as directed by the Engineer, and as specified herein:
 - 1. Place and compact additional material as directed by the Engineer.
 - 2. Provide dust control.
 - 3. Provide and maintain temporary culverts or other drainage devices.
 - 4. Shape the road bed to provide positive drainage.
 - 5. Completely remove the temporary aggregate. It may be reused for any of the following, if the Contractor receives approval from the Engineer:
 - a. Trench backfill or bedding.
 - b. Temporary aggregate at another location.
 - c. Fill material for subgrade removal and replacement.
 - d. Subbase granular material or aggregate base course if the Engineer determines that there is not significant segregation or contamination of the material and if it is constructed as specified in these Specifications.

3.7 PAVEMENT MARKINGS

- A. General:
 - 1. Replace all existing pavement markings that are removed or damaged during construction activities.
 - 2. Mark locations (by dimensions) on Job Plan of all existing pavement lane markings, turn arrow, stop bars, and parking stall markings prior to commencement of construction.
 - 3. Replace all damaged existing markings after placement of final surfaces.
 - 4. Replace pavement markings with same kind and type unless otherwise noted on the Drawings or in Contract Documents.
- B. Temporary – tape:
 - 1. Use temporary marking tape to delineate temporary lanes of traffic, stop bars, or parking stall lanes on temporary asphalt pavement, asphalt base courses, and surface courses if indicated on the Drawings or if so directed by the Engineer.
 - 2. Remove temporary marking tape prior to installation of permanent markings.

END OF SECTION 32 10 00

SECTION 323113 – HIGH SECURITY CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. High-security chain-link fences.
 - 2. Swing gates.
 - 3. Horizontal-slide, gates.
 - 4. Temporary security fence barriers.
 - 5. Soil sterilization.

- B. Related Requirements:

- 1. Section 087163 "Detention Door Hardware" for detention door hinges and locks for swing and slide gates.
 - 2. Section 281300 "Access Control" for gate controls.
 - 3. Section 284619 "PLC Electronic Detention Monitoring and Control Systems" for detection and alarm systems and for gate controls.

1.3 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. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Accessories: Barbed wire.
 - d. Gates and hardware.

- B. Shop Drawings: For each type of fence and gate assembly.

- 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include accessories, hardware, gate operation, and operational clearances.

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- C. Delegated-Design Submittal: For structural performance of chain-link fence and gate frameworks, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of chain-link fence and gate
- B. Product Test Reports: For framework strength according to ASTM F 1043, for tests performed by manufacturer
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For gate operators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Emergency Access Requirements: According to requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.

1.7 FIELD CONDITIONS

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure to comply with performance requirements.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - c. Faulty operation of gate operators and controls.
 - 2. Warranty Period: 10 years from date of Substantial Completion.

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PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to Florida Building Code:
 - 1. Design Wind Load: As indicated on Drawings.
 - a. Minimum Post Size and Maximum Spacing: Provide line posts of size and in spacing indicated, but not less than sizes and spacings determined according to CLFMI WLG 2445, based on mesh size and pattern specified.
- C. Lightning Protection System: Maximum resistance-to-ground value of 25 ohms at each grounding location along fence under normal dry conditions.

2.2 CHAIN-LINK FENCE FABRIC

- A. Perimeter Fence Chain Link Fence Fabric: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage. Comply with ASTM A491, CLFMI CLF 2445, and with requirements indicated below:
 - 1. Aluminized before weaving Steel Wire Fabric 2" mesh:
 - a. Wire Size: 9 gauge
 - b. Selvage: Twisted and barbed top and bottom
 - 2. Aluminized before weaving Anti-climb Steel Wire Fabric 1/2" mesh
 - a. Wire Size: 9 gauge.
 - b. Selvage: Twisted and barbed top and bottom
- B. Temporary Post Driven Fence
 - 1. Galvanized 2" mesh
 - 2. 11 Gage steel wire.
 - 3. Selvage: Twisted and barbed top and bottom.

2.3 Fence Grounding system.

- 1. By division 26. See electrical drawings.

B. SECURITY FENCE FRAMEWORK

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- C. Posts and Rails: ASTM F 1043 for framework, including rails, braces, and line; terminal; and corner posts.

1. Fence Height: 12 feet.
2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.
3. Rail Members: brace rails according to ASTM F 1043 for Heavy Industrial.
4. Metallic Coating for Steel Framework:
 - a. Type A: Not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating according to ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating according to ASTM A 653/A 653M.
 - b. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
 - c. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
 - d. Type C: Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
 - e. Coatings: Any coating above.
5. Polymer coating over metallic coating.
 - a. Color: Match chain-link fabric, according to ASTM F 934.

2.4 TEMPORARY POST DRIVEN FENCE.

- A. Posts, Rails. Comply with ASTM F1083-06 for framing the following material group and strength requirement for fence.
1. Framework material group. IA, round steel pipe, schedule 40.
 2. Strength requirements: 30,000 psi regular grade.
 3. Members
 - a. Top and Bottom Rail: Diameter shown on drawings, Schedule 40.
 - b. Line Post: Diameter shown on drawings, Schedule 40.
 - c. End, Corner, and Pull Post: Diameter shown on drawings, Schedule 40.

2.5 TENSION WIRE

- A. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire according to ASTM A 817 or ASTM A 824, with the following metallic coating:
1. Type I: Aluminum coated (aluminized).

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2.6 SWING GATES

- A. General: ASTM F 900 for gate posts and single swing gate types.
 - 1. Gate Leaf Width: As indicated on Drawings.
 - 2. Framework Member Sizes and Strength: Based on gate fabric height 72 inches (1830 mm) or less.
- B. Pipe and Tubing:
 - 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
 - 2. Gate Posts: Round tubular steel
 - 3. Gate Frames and Bracing: Round tubular steel
- C. Frame Corner Construction: assembled with corner fittings and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 60 inches (1520 mm) or wider.
- D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches (300 mm) above top of chain-link fabric at both ends of gate frame as required to attach barbed wire assemblies.
- E. Provisions for Electronic Detection System: Isolate gate from fencing to prevent transference of vibration. Gate hinge posts and latch posts may share the same footing but shall not be in contact with fence terminal posts.
 - 1. Separation between Hinge and Latch Posts and Fence Termination Posts: 2 inches (50 mm) minimum, 2-1/2 inches (63.5 mm) maximum.
- F. Hardware:
 - 1. Hinges: Non-lift-off type, offset to permit 180-degree gate opening.
 - 2. Latch: Permitting operation from either side of gate, with padlock eye.
 - 3. Lock: Manufacturer's standard electromechanical lock furnished in lieu of gate latch.

2.7 HORIZONTAL-SLIDE GATES

- A. General: ASTM F 1184 for gate posts and single sliding gate types.
 - 1. Classification: Type II Cantilever Slide, Class 1 with external roller assemblies.
 - a. Gate Frame Width and Height: As indicated on Drawings.
- B. Pipe and Tubing:
 - 1. Aluminum: ASTM B 429/B 429M; manufacturer's standard finish.
 - 2. Gate Posts: ASTM F 1184 Provide round tubular steel posts.
 - 3. Gate Frames and Bracing: Round tubular steel

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- C. Frame Corner Construction: assembled with corner fittings and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 60 inches (1520 mm) or wider.
- D. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) as required to attach barbed wire assemblies.
- E. Hardware:
 - 1. Secure Gate Catcher: To prevent gate from being pried open while gate is in closed and locked position.
 - 2. Lock: Electromechanical lock device furnished in lieu of gate latch.
 - 3. Hangers, roller assemblies, and stops fabricated from mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners.

2.8 SWING GATES

- A. General: Comply with ASTM F 900 for single swing gate types.
 - 1. Metal Pipe and Tubing: 50,000 psi Galvanized steel. Comply with ASTM F 1083 and ASTM F 1083 for materials and protective coatings
 - 2. Hot dipped after fabrication, consisting of not less than minimum **2.0 oz./sq ft average** zinc coating.
 - 3. Bond swing gates to adjacent fencing with braded copper strap.
 - 4. Welded corners with **1/2inch** diameter, adjustable truss rods.
 - 5. Hinges: Offset type, malleable iron, 180-degree swing.
 - 6. Closer: Manufacturer's standard.
 - 7. Latches permitting operation from both sides of gate. Fabricate latches with integral eye openings for padlock accessible from both sides of gate.
 - 8. For pairs of gates, provide cane bolt and strike pipe in concrete footing.
 - 9. Padlocks are by owner.

2.9 PEDESTRIAN CONTROLLED SWING GATE.

- A. General
 - 1. Prefabricated, self-standing, detention-controlled swing gate.
 - 2. Comply with ASTM F 1083 and ASTM F 1083 for materials and protective coatings
 - 3. Hot dipped, consisting of not less than minimum **2.0 oz./sq ft average** zinc coating.
 - 4. Bond swing gate to adjacent frame with braded copper strap.
 - 5. Tymetal 2150 is basis of design
 - 6. Or Approved Equals.
- B. Factory provided hardware specifications
 - 1. Provide with factory installed , remoted controlled, detention paracentric keyed Solenoid Gate lock and strike.
 - 2. Provide with factory installed Southern Steel Door Position Switch.

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3. Factory provided hinges.
4. Provide with owners standard keying system. Coordinate with owner.
5. Acceptable manufacturers: Southern Steel, Folger Adam, RR Brink, Airtec.

2.10 FITTINGS

- A. Provide fittings according to ASTM F 626.
- B. Post Caps: Provide for each post.
 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 1. Top-Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152 mm) long.
 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails to posts.
- E. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: According to ASTM F 2611.
- F. Barbed Wire Arms: Pressed steel or cast iron, with clips, slots, or other means for attaching strands of barbed wire, integral with post cap, for each post unless otherwise indicated, and as follows:
 1. Provide line posts with arms that accommodate top rail or tension wire.
 2. Provide corner arms at fence corner posts unless extended posts are indicated.
 3. Single-Arm Type: Type I, slanted arm.
 4. Use bolts or rivets for connection to posts.
- G. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 1. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
 - a. Metallic-Coated Steel: 0.148-inch- (3.76-mm-) diameter wire; aluminum coating.
 - b. Stainless steel.
- H. Power-Driven Fabric Fasteners: As recommended in writing by manufacturer.
- I. Finish:
 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g/sq. m) of zinc.
 - a. Polymer coating over metallic coating.
 2. Aluminum: Mill finish.

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2.11 BARBED WIRE

- A. Steel Barbed Wire: ASTM A 121, High Security Grade, two-strand barbed wire; 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 3 inches (76 mm) o.c.
 - 1. Aluminum Coating: Type A.
- B. Polymer-Coated, Galvanized-Steel Barbed Wire: ASTM F 1665, Type II, two-strand barbed wire; 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point, round aluminum-alloy barbs spaced not more than 3 inches (76 mm) o.c.
 - 1. Polymer Coating: Class 2b over aluminum-coated steel wire.
 - a. Color: Match chain-link fabric according to ASTM F 934.

2.12 GATE OPERATORS

- A. Operators: Factory-assembled, automatic gate-operating system designed for gate size, type, weight, and frequency of use. Control system shall have characteristics suitable for Project conditions, with control stations, safety devices, and weatherproof enclosures.
 - 1. Operator design shall allow for removal of cover or motor without disturbing limit-switch adjustment and without affecting auxiliary emergency operation.
 - 2. Electronic components shall have built-in troubleshooting diagnostic feature.
 - 3. Unit shall be designed and wired for both right-hand/left-hand opening, permitting universal installation.
- 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. UL Standard: Manufacture and label gate operators according to UL 325.
- D. Motors: Comply with NEMA MG 1.
 - 1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) above sea level.
 - 2. 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.
 - 3. Service Factor: 1.15.
 - 4. Electrical Characteristics:
 - a. Voltage: 208 V ac, single phase, 60 hertz.

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- E. Gate Operators: Equipment base/pad mounted and as follows:
 - 1. Hydraulic Gate Operators:
 - a. Duty: Maximum security.
 - b. Gate Speed: Variable speed.
 - c. Frequency of Use: 10 cycles per hour.
 - d. Operating Type: Wheel and rail drive with manual release.
 - e. Heater: Manufacturer's standard track and roller heater with thermostatic control.
 - 2. Mechanical Gate Operators:
 - a. Duty: Maximum security.
 - b. Gate Speed: Minimum variable speed.
 - c. Frequency of Use: 10 cycles per hour.
 - d. Operating Type: Roller chain, with manual release.
 - e. Drive Type: Enclosed worm gear and chain-and-sprocket reducers, roller-chain drive.
- F. Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA 250, Type 4 enclosure with space for additional optional equipment.
- G. Control Devices:
 - 1. Control Station: The gate will only be controlled from the security electronics system.
 - a. Function: Open, stop, and close.
- H. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
 - 1. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
 - 2. Photoelectric/Infrared Sensor: System designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
- I. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully open and fully closed positions.
- J. Emergency Release Mechanism: Quick-disconnect release of operator drive system, permitting manual operation if operator fails. Control circuit power is disconnected during manual operation.
 - 1. Type: Mechanical device, key, or crank-activated release.
- K. Operating Features:
 - 1. Automatic Closing Timer: With adjustable time delay before closing.
 - 2. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
 - 3. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.

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2.13 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.
- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

2.14 GROUNDING MATERIALS

- A. Comply with requirements in Section 260526 "Grounding and Bonding."
- B. Connectors and Grounding Rods: Listed and labeled for complying with UL 467.
 - 1. Connectors for Below-Grade Use: Exothermic welded type.
 - 2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

2.15 TEMPORARY BARRIERS

- A. Deployable concertina barrier system.
 - 1. Rapid Deployment System consists of a stack of one (1) 60" Barbed Tape Coil on top of two (2) 30" Barbed Tape Coils.
 - 2. A network of structural support trusses add rigidity and allow accessories to be fastened to deployment unit.
 - 3. Additionally, support trusses come with provisions for ground stakes and an integral cable system to assist in deployment over any type of terrain.
 - 4. Basis of design Razor Ribbon or similar equal.
- B. Contractor protection barrier.
 - 1. Perforated HDPE safety barrier. Orange in color. 5' tall. Tenax or other similar.
 - 2. Steel t-posts driven into ground. Spaced per safety barrier manufacturer recommendation.

2.16 SOIL-STERILIZATION MATERIALS

- A. Polyethylene Sheeting: 6 mils (0.15 mm) thick, black, and serving as soil-separation fabric.
- B. Stone Ground Cover: Random-size range of 3/4- to 2-inch (19- to 50-mm) crushed stone or washed gravel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
 - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.3 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than 500 feet (152 m). For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 10 feet (3 m) o.c.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.

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1. Locate horizontal braces at midheight of fabric **72 inches (1830 mm)** or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.
- H. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
 1. Extended along top of fence fabric. Install top tension wire through post cap loops.
- I. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- J. Bottom Rails: Secure to posts with fittings; anchor rail at midspan to concrete footing
- K. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
 1. Overlapping Fabric: Overlap ends of fence fabric at or between posts or rails; overlap 6 inches (152 mm) and secure with wire ties or steel strap method.
 2. Bottom Clearance: Leave 1-1/2 inches (38 mm) between finish grade or surface and bottom selvage unless otherwise indicated.
- L. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.
- M. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.
 1. Maximum Spacing: Tie fabric to line posts at 12 inches (305 mm) o.c. and to braces at 24 inches (610 mm) o.c.
- N. Power-Fastening of Fabric: Fasten 0.192- or 0.148-inch (4.87- or 3.76-mm) wire fabric with 2- or 1-inch (50- or 25-mm) mesh size. Fasten fabric to line posts 12 inches (300 mm) o.c. and to braces 24 inches (610 mm) o.c.
- O. Barbed Wire: Install barbed wire uniformly spaced. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
- P. Ground Barrier: Stake barbed-tape coils at **10 feet (3 m)** o.c., driven into ground to full depth.

3.4 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.5 GATE-OPERATOR INSTALLATION

- A. Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
- B. Excavation: Hand-excavate holes for posts, pedestals, and equipment bases/pads, in firm, undisturbed soil to dimensions and depths and at locations according to gate-operator component manufacturer's written instructions and as indicated.
- C. Ground electric-powered motors, controls, and other devices according to NFPA 70 and manufacturer's written instructions.

3.6 GROUNDING AND BONDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding."
- B. Fence and Gate Grounding:
 - 1. Ground for fence and fence posts shall be a separate system from ground for gate and gate posts.
 - 2. Install ground rods and connections at maximum intervals of 100 feet (30 m).
 - 3. Ground fence on each side of gates and other fence openings.
 - a. Bond metal gates to gate posts.
 - b. Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least **18 inches (457 mm)** below finished grade.
- C. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a ground rod located a maximum distance of **150 feet (45 m)** on each side of crossing.
- D. Fences Enclosing Electrical Power Distribution Equipment: Ground according to IEEE C2 unless otherwise indicated.
- E. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.
 - 1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.

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F. Connections:

1. Make connections with clean, bare metal at points of contact.
2. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
3. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
4. Make above-grade ground connections with mechanical fasteners.
5. Make below-grade ground connections with exothermic welds.
6. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Perform the following tests:

1. Fabric Testing: Test fabric tension according to "Deflection Limits" Paragraph in "Performance Requirements" Article.
2. Fence Post Rigidity Testing: Test line posts for rigidity according to "Deflection Limits" Paragraph in "Performance Requirements" Article.
3. Grounding Tests: Comply with requirements in Section 264113 "Lightning Protection for Structures."

C. Prepare test reports.

3.8 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Automatic Gate Operator: Energize circuits to electrical equipment and devices, start units, and verify proper motor rotation and unit operation.

1. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
2. Test and adjust operator, controls, alarms, and safety devices. Replace damaged and malfunctioning controls and equipment.
3. Lubricate operator and related components.

C. Lubricate hardware and other moving parts.

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3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 323113

SECTION 33 05 61 – CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide manholes and structures as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Related work:
 - 1. Reserved.
- C. References:
 - 1. FDOT “Standard Plans for Road Construction”

1.2 SUBMITTALS

- A. Shop Drawing Submittals – Submit in detail for all manholes within project limits.
- B. Operation and Maintenance Manuals – None Required.
- C. Certificates and Guarantees – None Required.
- D. Lubricants – None Required.
- E. Spare Parts – None Required.
- F. As-builts – Submit detailed as-built survey of all Manholes meeting City of Lake city requirements. May be included with as-builts for other Drainage and Sanitary Sewerage improvements listed in sections 33 42 00 “Stormwater Conveyance” and 33 31 00 “Sanitary Sewer Piping”

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. The Work shall conform to the requirements of the City of Lake City, Columbia County, and the Florida Department of Environmental Protection (FDEP) – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.
 - 2. Obtain and pay for all permits, tests, inspections, and the like, required by the authority having jurisdiction.
 - 3. Execute and inspect the Work in accordance with all local and state codes, rules, ordinances, or regulations pertaining to the particular type of work involved.
 - a. Should any changes in the Drawings and/or Specifications be required to conform to such ordinances, notify the Owner at the time of submitting the bid.

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- b. After entering into the Contract, the Contractor shall be held responsible for the completion of all work necessary for a complete and approved installation without additional cost to the Owner.
- c. If required by the authority having jurisdiction, prepare supplementary detailed diagrams or drawings, at no additional cost to the Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Reserved.

1.5 SITE CONDITIONS – Reserved.

1.6 MAINTENANCE – Reserved.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Sanitary Manholes
 - 1. Provide precast reinforced concrete manhole sections, bottoms, and flat slab top complying with ASTM C478 or reinforced concrete pipe sections complying with ASTM C76, unless otherwise indicated on the Drawings.
 - a. Use eccentric cone section for unless otherwise indicated on the Drawings.
 - b. Provide precast reinforced concrete monolithic base for manholes on new sewer lines.
 - c. Utilize the sanitary manhole cover depict in City of Lake City Detail Drawing #Q202
 - d. Provide the following to manholes if indicated on the drawings or manhole detail.
 - 1) External frame seal.
 - 2) Internal frame seal.
 - 3) Internal/external frame seal.
 - 4) Manhole exterior joint protection.
 - 5) Manhole exterior surface treatment.
 - 6) Bolted and gasketed watertight frame and cover.
- B. Drainage manholes and catch basins shall be constructed per specification listed in index 425-001 through 425-090 of FDOT's "Standard Plans for Road Construction."
- C. Concrete:
 - 1. Provide 4,000 psi concrete using Type I Portland Cement complying with ASTM C150.
- D. Mortar:
 - 1. Mix one part Portland cement to three parts fine aggregate.
- E. Joints for precast sections:

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1. Provide tongue and groove joints with either flexible watertight rubber gaskets or pre-formed bituminous plastic gaskets consisting of a homogeneous blend of refined hydrocarbon resins and plasticizing compound reinforced with inert mineral filler.

2.2 PIPE CONNECTIONS AND SEALS

- A. Utilize City of Lake City detail drawing # Q201 (provided in sheet C19 of the construction plans) for all sanitary sewer pipe connections.
- B. Pipes connected to drainage manholes shall be connected at the spigot end of the pipe and grouted into place.

PART 3 - EXECUTION

3.1 MANHOLES, CATCH BASINS, AND INLETS

A. General:

1. Shape the invert channels to be smooth and semicircular, conforming to the inside of the adjacent sewer section.
2. Make changes in direction of flow with a smooth curve of as large a radius as the size of the manhole will permit.
3. Make changes in size and grade of channels smoothly and evenly.
4. Form the invert channels directly in the concrete of the manhole base, with mortar, or by laying full section sewer pipe through the manhole and breaking out the top half after surrounding concrete has hardened. Do not use pre-formed invert channels.
5. Smooth the bench of the manhole outside the channels and slope toward the channels at not less than 1-inch per foot nor more than 2 inches per foot.
6. Provide outside drop inlets into sanitary manholes for incoming lines having inverts 2 feet or more above the inverts of the manhole outlet lines, and where indicated on the Drawings. Encase drop pipe and fittings in concrete extending from the manhole base to a point a minimum of 6 inches above the top of incoming sewer where drop pipe is of PVC material.
 - a. Encase only the drop elbow in concrete where ductile iron is utilized on large drop pipes.
 - b. Provide support for ductile iron drop pipe where drop exceeds 10 feet.
 - c. Utilize restrained ductile iron pipe and fittings acceptable to the engineer.
 - d. Utilize ductile iron tee at incoming sewer and provide water tight connection between incoming sewer and tee.
7. Provide external chimney seal where indicated on drawings.
8. Provide internal chimney seal where indicated on drawings.
9. Provide internal/external frame seal where indicated on the drawings.
10. Provide manhole exterior joint protection where indicated on drawings.
11. Provide manhole exterior surface treatment where indicated on drawings.
12. Provide bolt-down watertight frames and covers where indicated on the drawings.

3.2 JOINTING

- A. Use flexible watertight gaskets for each joint.
 1. Trim smooth surplus gasket material.

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3.3 FRAMES AND COVERS

- A. Unless otherwise shown on the Drawings or as directed by the Engineer, set frames and covers:
 - 1. In paved areas: Top of solid cover flush with finished pavement.
 - 2. In unpaved areas: To drain away from the manhole for solid covers; approximately ½-inch below grade for grate covers.
 - 3. Flexible watertight gaskets.
 - 4. Grade rings not to exceed 8 inches.
 - 5. Anchor bolt-down watertight frame and covers through grade rings to top of manhole cone or flat top with minimum of four ½-inch stainless steel anchors.

3.4 MANHOLE OVER EXISTING PIPE

- A. Storm Sewer:
 - 1. Construct new manhole as specified breaking upper half of existing pipe after base of manhole is completed so as not to obstruct flow of the existing pipe.

END OF SECTION 33 05 61

SECTION 33 14 00 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide water distribution system as shown on the Drawings, as specified herein, and as needed for a complete and proper installation.
- B. Provide labor, materials, tools, chemicals and equipment necessary to perform the pressure and leakage tests and disinfection.
- C. Related work:
 - 1. Reserved.
- D. References:
 - 1. American Waterworks Association (AWWA):
 - a. Geotechnical information provided by American Infrastructure Development, AID report Number DEI180004, Dated March 20, 2019.
 - b. Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings (AWWA C-111 / ANSI A-21.11-00).
 - c. Ductile-Iron Pipe, Centrifugally Cast, for Water (AWWA C-151 / ANSI A-21.51-02).
 - d. 4. Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution (AWWA C-900-97).
 - e. Metal-Seated Gate Valves for Water Supply Service (AWWA C-500-02).
 - f. Dry-Barrel Fire Hydrants (AWWA C-502-94).
 - g. Installation of Ductile-Iron Water Mains and Their Appurtenances (AWWA C-600-99).
 - h. Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water (AWWA C605-94).
 - 2. American Society of Testing Materials (ASTM):
 - a. Standard Specification for Gray Iron Castings (ASTM A-48/ A-48M-00).
 - b. Standard Specification for Polyvinyl Chloride (PVC) Pressure Rated Pipe, (SDR Series) (ASTM D-2241-04a).
 - c. Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals (ASTM D-3139-98).
 - d. Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe (ASTM F-477-02-e1)
 - e. Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds (ASTM D-1784-03).
 - 3. American Society of Sanitary Engineering: Double Check Detector Assembly Backflow Preventer (ANSI/ASSE 1048)
 - 4. City of Lake City Utility Standards

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1.2 SUBMITTALS

- A. Shop Drawing Submittals – Submit in detail for all water line work for approval by Engineer of Record and City of Lake City including but not limited to:
 - 1. Hydrants: If requested by the Project Manager and the Owner, submit a drawing of the lug construction.
 - 2. Double Check Detector Assembly: Submit product information to the Owner.
- B. As-builts – Submit detailed as-built survey of all Manholes meeting City of Lake city requirements. May be included with as-builts for Sanitary Sewerage improvements listed in sections 33 05 61 “Concrete Manholes” and 33 31 00 “Sanitary Sewer Piping”
- C. Furnish two (2) copies of bacteriological test reports.

1.3 QUALITY ASSURANCE

- A. All pipe, pipe fittings, pipe joint packing and jointing materials, valves, fire hydrants, and meters installed will confirm to applicable American Water Works Association (AWWA) standards.
- B. All public water system components, excluding fire hydrants, that will be installed and that will come into contact with drinking water will conform to NSF International Standard 61 as adopted in Rule 62-555.335, F.A.C., or other applicable standards, regulations, or requirements referenced in paragraph 62-55.320 (3)(b), F.A.C.
- C. All pipe and pipe fittings installed will contain no more than 8.0% lead, and any solder or flux used in this project will contain no more than 0.2% lead.
- D. All pipe and pipe fittings installed will be color-coded or marked in accordance with subparagraph 62-555.320 (21) (b) 3, F.A.C., using blue as a predominant color. (Underground plastic pipe will be solid-wall blue pipe, will have a co-extruded blue external skin, or will be white or black pipe with blue stripes incorporated into, or applied to, the pipe wall; underground metal or concrete pipe will have blue stripes applied to the pipe wall. Pipe striped during manufacturing of the pipe will have continuous stripes that run parallel to the axis of the pipe, that are located at no greater than 90-degree intervals around the pipe, and that will remain intact during and after installation of the pipe. If tape or paint is used to stripe pipe during installation of the pipe, the tape or paint will be applied in a continuous line that runs parallel to the axis of the pipe and that is located along the top of the pipe; for pipe with an internal diameter of 24 inches or greater, tape or paint will be applied in continuous lines along each side of the pipe as well as along the top of the pipe. Aboveground pipe will be painted blue or will be color-coded or marked like underground pipe.)
- E. All fire hydrants that have unplugged, underground drains will be located at least three feet from any existing or proposed storm sewer, stormwater force main, pipeline conveying reclaimed water regulated under Part III of Chapter 62-610, F.A.C., or vacuum-type sanitary sewer; at least six feet from any existing or proposed gravity- or pressure-type sanitary sewer, wastewater force main, or pipeline conveying reclaimed water not regulated under Part III of Chapter 62-10, F.A.C.; and at least ten feet from any existing or proposed "on-site sewage treatment and disposal system".

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- F. New or altered chambers, pits, or manholes that contain valves, blow-offs, meters, or other such water distribution systems appurtenances will not be connected directly to any sanitary or storm sewer, and blow-offs or air relief valves installed under this project will not be connected directly to any sanitary or storm sewer.
- G. New or altered water mains will be installed in accordance with applicable AWWA standards or in accordance with manufacturers' recommended procedures.
- H. A continuous and uniform bedding will be provided in trenches for underground pipe installed; backfill material will be tamped in layers around underground pipe installed and to a sufficient height above the pipe to adequately support and protect the pipe; and unsuitably sized stones (as described in applicable AWWA standards or manufacturer's recommended installation procedures) found in trenches will be removed for a depth of at least six inches below the bottom of underground pipe.
- I. All water main tees, bends, plugs, and hydrants installed will be provided with restrained joints to prevent movement.
- J. Water mains, including fire hydrant leads and including service lines that will be under the control of a public water system and that have an inside diameter of three inches or greater, will be disinfected and bacteriologically evaluated in accordance with Rule 62-555.340, F.A.C.
- K. New or relocated, underground water mains shall be laid to provide a horizontal distance of at least six feet, and preferably ten feet, between the outside of the water main and the outside of any existing or proposed gravity- or pressure-type sanitary sewer, wastewater force main, or pipeline conveying reclaimed water not regulated under Part III of Chapter 62-610, F.A.C. The minimum horizontal separation distance between water mains and gravity-type sanitary sewers shall be reduced to three feet where the bottom of the water main is laid at least six inches above the top of the sewer.

1.4 DELIVERY, STORAGE, AND HANDLING - Reserved.

1.5 SITE CONDITIONS - Reserved.

1.6 MAINTENANCE – Reserved.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. General:
 - 1. Provide ductile iron, PVC plastic, or high density polyethylene (HDPE), pipe materials in sizes 3-inch through 24-inch, unless otherwise indicated on the Drawings.
- B. PVC Plastic pipe:

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1. All PVC water mains less than 4 inches shall be in accordance with ASTM (schedule 40, 80, 120) or ASTM 2241 SDR 21 (200 psi). Threaded pipe and fittings shall be schedule 80 and conform to ASTM D2464. Unthreaded pipe and fittings shall be schedule 40 with solvent-cemented joints. Cemented joints and fittings shall comply with ASTM D2466 and D2855. All PVC water mains 2" or less shall be SDR21 (200 psi) unless otherwise noted.
2. Water mains shall comply with AWWA standards.
 - a. All PVC pipe 3 to 12 inches shall be AWWA C900 DR18
 - b. All PVC pipe 14 inches and larger shall comply with AWWA C905 DR25.
 - c. All water mains shall bear the NSF logo and shall be color-coded or marked using blue as a predominant color to differentiate drinking water from other water lines.
3. Provide restrained joint pipe system, at all tees, bends, plugs, and hydrants, that utilizes one of the following methods:
 - a. Lock rings welded into place around pipe barrel.
 - b. Bolted rings installed around pipe barrels that fit inside pipe bells.
 - c. Gaskets which include stainless steel locking segments vulcanized into the gasket.
 - d. Mechanical joint retainer gland systems that provide locking segments shaped to pipe barrel that do not create stress points on pipe barrel.
 - 1) Do not use setpoint type retainer glands.
 - e. Acceptable products:
 - 1) American Fastite, Flex-ring, Lok-ring, and MJ coupled joint.
 - 2) Clow Tyton Joint – Type A or Type B, and Super - Lock.
 - 3) U.S. Pipe TR-Flex Gripper.
 - 4) Griffin Bolt Lok or Snap Lok.
 - 5) Field Lok or Fast Grip Gasket Systems.
 - 6) Meg-A-Lug System.
 - a) Series 1100 Megalug for MJ to pipe.
 - b) Series 1700 Megalug Harness for push on joint.
 - c) As recommended by manufacturer for connection to existing pipes.

C. Conductivity appurtenances:

1. Provide wedges of serrated silicon bronze or #10-copper cable and tapping devices specifically designed for this purpose.
2. Use devices provided by the pipe manufacturer.
3. Standard mechanical joints, field lok, or meg-a-lug do not provide conductivity.

2.2 VALVES

A. Provide valves with clockwise closing direction.

B. Gate valves:

1. Valves smaller than 3-inch size:
 - a. Provide bronze body, wedge disc, screwed bonnet, non-rising stem, threaded-end type with hand wheel.
 - b. Design valves for 300-pound non-shock W.O.G.
2. Valves 3-inch and larger:
 - a. Design in accordance with AWWA C509 (cast iron body), or AWWA C515 (ductile iron body), bronze fitted, resilient wedge and seat type with non-rising stem and O-ring packing.
 - b. Provide gear operator for valves 14-inch and larger.

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3. Provide mechanical joint ends for buried valves and ANSI Class 125 flange ends or mechanical joint ends for valve installed in vaults as indicated on the Drawings.
 - a. Provide restrained type joints for all mechanical joint end valves.

2.3 VALVE BOXES

- A. Provide adjustable valve boxes on buried valves:
 1. Valve box compatible with size and type of valve protected.
 2. Extend box to finished grade.
 3. Mark valve box cover "WATER" for potable water piping valves. Other valve box covers unmarked.
 4. Bituminous coated carbon steel valve extension stems and 2-inch square operating nuts 2 inches below the cover.
 5. Two valve operating tee wrenches with 2-inch square socket, 24-inch long, 1½-inch pipe handle, and 48-inch long 1½-inch pipe stem.

2.4 VALVE VAULTS

- A. Precast:
 1. Provide precast reinforced concrete manhole sections, bottoms, and flat top slabs complying with ASTM C478 unless otherwise indicated on Drawings.
 2. Provide precast reinforced concrete monolithic or separate base.
 3. Design flat slab tops for AASHTO HS20-44 wheel loading.
- B. Concrete:
 1. Provide 4000 psi concrete using Type I Portland Cement complying with ASTM C150.
- C. Mortar:
 1. Mix one part Portland cement to three parts fine aggregate.

2.5 FIRE HYDRANTS

- A. General:
 1. Comply with AWWA C502.
 2. Paint hydrants in colors selected by the Owner.
 3. Match the hydrants generally installed in the Owner's water system.
- B. Materials:
 1. Provide compression type with a 5¼-inch minimum size main valve assembly, O-ring seals, two 2½-inch hose nozzles, and a 4½-inch pumper nozzle with National Standard threads, a National Standard operating nut, and an above ground break flange.
 2. Provide a 6-inch auxiliary resilient seat type gate valve with restrained type joints or bituminous coated metal tie rods between the valves and the tee fittings.
 3. Provide valve boxes with cover marked with the word "WATER".
 - a. Bituminous coated carbon steel valve extension stems and 2-inch square operating nuts 2 inches below cover.

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2.6 WATER SERVICES

A. General:

1. Provide service saddles, corporation stops, curb stops, service boxes, and water service tubing.
2. Comply with the most recent edition of AWWA C800 (or NSF/ANSI 372) for service lines and service line appurtenances.

2.7 TAPPING SLEEVES AND VALVES

A. Tapping sleeves:

1. Use two-piece bolted sleeve ductile iron or stainless steel type with mechanical joints.
2. Provide joint accessories.
3. Measure existing water main outside diameter to determine proper tapping sleeve size.
4. Acceptable manufacturers:
 - a. Per City of Lake City approved manufacturers listed in Appendix A of the City of Lake City Utility Standards.

PART 3 - EXECUTION

3.1 PIPE INSPECTION, HANDLING, STORAGE, AND INSTALLATION

A. Install in accordance with pipe manufacturer's recommendations.

B. Proximity to Sewers: Whenever possible, lay water mains at least 10 feet horizontally from any sanitary sewer, storm sewer or sewer manhole. The distance shall be measured edge to edge.

C. Water mains passing under sewers shall, in addition, be protected by providing:

1. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water main.
2. Adequate structural support of the sewers to prevent excessive deflection of joints and settling on and breaking the water mains.
3. That the length of water pipe be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.

D. Depth of Pipe Cover:

1. Lay water mains and water service lines with a minimum depth of cover of thirty six inches below finished grade ground level unless otherwise indicated on the Drawings.
2. Where new mains cross existing mains, install new main below existing main unless otherwise indicated on the Drawings.

E. The trench, unless specified otherwise, shall have a flat bottom conforming to the grade to which the pipe is to be laid. Lay the pipe on approved granular material true and even so that the barrel of the pipe will have a bearing for its full length. Excavate bell holes for joints. Any part of the trench excavation below grade shall be corrected with approved material and thoroughly compacted.

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- F. Where water is encountered in the trench, it shall be removed during pipe laying and jointing operations. Make provisions to prevent floating of the pipe. Do not allow trench water to enter the pipe at any time.
- G. Prevent dirt or other foreign material from entering the pipe or pipe joint during handling or laying operations. Any pipe or fitting that has been installed with dirt or foreign material in them shall be removed, cleaned and re-laid. When pipe-laying is not in progress, close the open ends of the pipe using a watertight plug or by other means approved by the Owner to ensure absolute cleanliness inside the pipe.
- H. Marking:
 - 1. All PVC pipe shall be marked in the trench with a continuous single sheathed strand of #12 copper wire adjacent to and above the main and a continuous two inch (2") wide detectable marking tape near the ground surface.
 - 2. The tape shall be a solid blue color with black letters permanently printed on both sides with a continuous warning message: "Caution: Buried Water Mains Below" repeated every 16 to 36 inches.
 - 3. The tape shall be installed in accordance with the manufacturer's recommendations.

3.2 CONNECTIONS TO EXISTING WATER MAINS

- A. Make connections to existing mains.
- B. Use non-pressure connections except where pressure connections are shown on the Drawings, or required by the conditions encountered at the time of construction.
- C. Make one connection at a time except as approved by the Engineer.
- D. Do not operate the valves on the existing mains. The employees of the Owner's Water Department will open and close the valves as required for the connections.
- E. Coordinate shutdown of existing mains with Owner's Water Department and Engineer with a minimum of 48 hours' notice prior to shutdown.

3.3 PIPE RESTRAINING SYSTEMS

- A. General:
 - 1. Provide protection from movement of water main piping, plugs, caps, tees, valves, hydrants, and bends of 11-1/4 degrees or greater.

3.4 SEWER CROSSING

- A. General:
 - 1. Separate water mains and water service lines from sanitary sewer, storm sewers, combined sewers, house sewer service connections, and drains in accordance with FDEP separation requirements.

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- B. Water service lines:
 - 1. Comply with the requirements of water main separation.

- C. Sewer manholes:
 - 1. Do not install water line through sewer manhole.

3.5 VALVE VAULTS

- A. General:
 - 1. Install pipe through valve vault as shown on the Detail.
 - 2. Make vault watertight with use of flexible manhole connectors as per the Detail.
- B. Steps:
 - 1. Provide each valve vault over 3 feet deep with individual wall-mounted steps as shown on the valve vault detail.
 - 2. Comply with the requirements of governmental agencies having jurisdiction.
- C. Jointing:
 - 1. Use flexible watertight gaskets for each joint.
 - 2. Trim smooth and free from surplus gaskets.
- D. Frames and covers: Unless otherwise shown on the Drawings or as directed by the Engineer, set frames and covers:
 - 1. In paved areas: So that the top of the solid cover will be flush with the finished pavement;
or
 - 2. In unpaved areas: To drain away from the valve vault.
 - 3. With flexible watertight gaskets.
 - 4. With grade rings not to exceed 8 inches.

3.6 HYDRANT INSTALLATION

- A. Install hydrants plumb with the lowest hose connection at least 18 inches but not more than 26 inches above the finished grade ground level.
- B. Set hydrant bases and auxiliary valve on a precast concrete block to provide firm support for the base.
- C. Brace the bases with solid concrete blocking between the base and undisturbed trench wall to counteract the reaction thrust of water pressure at the base.
- D. Provide mechanical joint anchoring fittings, or approved restrained joints.
- E. Brace the hydrant barrels during backfilling. Do not block the drain hole in hydrant.
- F. Place a minimum of 1/2 cubic yards of washed coarse stone at and around the base for proper drainage. Cover stone with plastic before backfilling.
- G. Place and compact backfill materials in 6-inch layers around the hydrant and auxiliary gate valve.

- H. Cover new hydrant with plastic bag until new system is in service.

3.7 WATER SERVICE CONNECTION

- A. General:
 - 1. Make service connections at locations shown on the Drawings or determined by the Engineer at the time of construction.
 - 2. Install water service pipe, corporation stop and curb stop as shown on the standard water service installation detail.
 - 3. Set curb stop on a precast concrete block.
 - 4. Do not splice the water service pipe.
 - 5. Sequence of installation: See TESTING AND INSPECTING section of these Specifications for outline of when, in the sequence of construction, the corporation stops, curb stops, and service boxes are to be installed, leakage tested, and disinfected.
- B. Service boxes:
 - 1. Install over the curb stop in a truly vertical position.
 - 2. Set the top of the box flush with the finished grade ground level.

3.8 PRESSURE CONNECTION

- A. Support the exposed existing water main on concrete pedestals at sufficient intervals to properly carry its own weight, plus the weight of the tapping machinery and fitting. Provide thrust blocking.
- B. Minimum tap hole diameter:
 - 1. For pipe 12-inch or smaller: 1/2-inch less than the nominal pipe diameter.
 - 2. For pipe 14-inch through 20-inch: 1½-inch less than the pipe diameter.
- C. Open valve to flush any foreign material after completion of the pressure tapping.

3.9 TESTING AND INSPECTING

- A. Sequence of installation:
 - 1. Install new water main but do not install corporation stops, service lines, curb stops, or service boxes; conduct pressure test, leakage test; and disinfection of new water main; flush main; after acceptance for use put main into service (while existing main continues to function): Install corporation stops, curb stops, and new service boxes; and connect new service box to existing service lines.
- B. Hydrostatic tests:
 - 1. Where any section of a water line is provided with concrete thrust blocking for fittings, do not make hydrostatic tests until at least 5 days after installation of the concrete thrust blocking, unless otherwise directed by the Engineer.
 - 2. Devise a method for disposal of waste water from hydrostatic tests, and for disinfection, as approved in advance by the Engineer.

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C. Pressure tests:

1. Subject the new water mains and service lines, including valves and hydrants, to a hydrostatic pressure of 125 psi.
2. Hold the test pressure for a duration of one hour without pressure loss or further pressure application.
3. Carefully examine exposed pipe, joints, fittings, and valves.
4. Replace or remake joints showing visible leakage.
5. Remove cracked pipe, defective pipe, and cracked or defective joints, fittings, and valves. Replace with sound material and repeat the test until results are satisfactory.
6. Make repair and replacement without additional cost to the Owner.
7. Use only solid stainless full-body repair clamps as approved by the Engineer.

D. Leakage test:

1. Conduct a metered leakage test after the pressure test has been satisfactorily completed.
2. Duration of each leakage test: At least 24 hours.
3. During the test, subject water lines to a normal water pressure of the Owner's water system.
4. Install water meter approved by the Engineer.
 - a. Provide double check valve assembly between water meter and existing water main.
5. Maximum allowable leakage: As recorded by a meter approved by the Engineer, with leakage to not exceed the number of gallons per hour (gph) as determined by the following formula:

$$\text{gph} = \text{LD} (P^{1/2}) / 14800$$

in which:

L = Length of pipe test, in feet

D = Diameter of water main, in inches

P = Average pressure, in pounds per square inch (gage)

6. Should any test of pipe disclose leakage greater than the maximum allowable amount, locate and repair the defective joint or joints and then repeat the 24-hour metered leakage test until the leakage is within the specified allowance, and at no additional cost to the Owner.

E. Time for making test:

1. Except for joint material setting, or where concrete reaction backing necessitates a 5 day delay, pipelines jointed with rubber gaskets, mechanical, or push-on joints, or couplings may be subjected to hydrostatic pressure, inspected, and tested for leakage at any time after partial completion of backfill.
2. Perform the pressure and leakage tests satisfactorily prior to requesting the Engineer to witness the official tests.
3. Notify the Engineer at least 48 hours prior to the time of the requested official tests.
4. Depending on traffic conditions, public hazard, or other reasons, the Engineer may direct when to conduct the tests, and may order the tests to be made in relatively short sections of water mains.

3.10 PRELIMINARY FLUSHING

A. Prior to disinfection, flush main as thoroughly as possible.

1. Flush main until water runs clear.
2. Provide a minimum flushing velocity of 2.5 fps in the water main.

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3. Where no fire hydrant exists on the end of a main, the plug (or cap) on the end of the main must be tapped with opening in the end for flushing purposes. After acceptance install threaded plug into tap.
 - a. 8", 10" and 12" mains: 2½-inch tap.
 - b. 16" mains: 3-inch tap.
 - c. Larger than 16" use temporary fire hydrants.
4. Contractor has the option to use temporary fire hydrants in lieu of taps. Temporary fire hydrants must be removed after testing is complete.

- B. Coordinate time of flushing with Owner and Engineer, at least 72 hours in advance of flushing.
 1. Do not initiate flush without Owner's permission.

3.11 DISINFECTION

- A. General:
 1. After the water main work has been satisfactorily completed and tested, disinfect the work in accordance with AWWA C651
- B. Application of chlorine:
 1. Apply chlorine by gas feed or solution feed chlorinator as approved by the Owner.
 - a. Provide effective diffusion of the gas or solution into the water .
 - b. Provide means for preventing the backflow of water into the feeder.
 2. Chlorine solution:
 - a. Apply solution of sodium hypochlorite into one end of the section of main to be disinfected while filling the main with water.
- C. Requirement of chlorine:
 1. Initial chlorine solution in pipe: At least 50 mg/l, but not more than 100 mg/l.
 2. Retain the disinfecting solutions in the work for at least 24 hours.
 3. Chlorine residual after the retention period: At least 25 mg/l.
- D. Flushing and testing:
 1. Following chlorination, flush treated water thoroughly from the water mains until the chlorine concentration in the water flowing from the main is no higher than generally prevailing in the Owner's system, or less than 1 mg/l.
 2. After flushing, collect two water samples on successive days at least 24 hours apart in sterile bottles treated with sodium thiosulfate. Notify the Engineer and the Owner to witness sample collection.
- E. Swabbing:
 1. Flush and swab the piping, valves, and fittings that must be placed in service immediately and cannot be disinfected by the above specified methods, with 5 percent solution of calcium hypochlorite prior to assembly.
 - a. Secure the Engineer's approval before applying this method of disinfection.

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3.12 DECHLORINATION

- A. Comply with AWWA C651-05 requirements to neutralize the residual chlorine in new water mains.
- B. After new water mains have passed disinfection requirements, utilize portable diffusing dechlorinators that utilize sulfur dioxide or other chemicals listed in Appendix C of AWWA C651 to lower chlorine residuals prior to discharge to the drainage system.
 - 1. Lower concentration to 1 mg/l or less.

END OF SECTION 33 14 00

SECTION 33 31 00 - SANITARY SEWER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide sanitary sewer system as shown on the Drawings, as specified herein, and as needed for a complete and proper installation, and in accordance with the latest revision of Lake City Utilities standards and specifications.
- B. Related work:
 - 1. Reserved.
- C. References:
 - 1. ASTM International
 - a. Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (PVC) Compounds (ASTM D-1784-03).
 - b. Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading (ASTM D-2412-02).
 - c. Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings (ASTM D-3034-04).
 - d. Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals (ASTM D-3212-96a(2003)).
 - e. Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe (ASTM F-477-02e1).

1.2 SUBMITTALS

- A. Shop Drawing Submittals – Submit in detail for all water line work for approval by Engineer of Record and City of Lake City
- B. As-builts – Submit detailed as-built survey of all Manholes meeting City of Lake city requirements. May be included with as-builts for Sanitary Sewerage improvements listed in sections 33 05 61 “Concrete Manholes” and 33 14 00 “Water Distribution System”

1.3 QUALITY ASSURANCE –

- A. The Work shall conform to the requirements of the City of Lake City and the Florida Department of Environmental Protection – which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - 1. Exception: If the requirements of this Section are more stringent, they shall apply.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect flexible thermoplastic pipes from direct sunlight.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. PVC plastic sewer pipe:
 - 1. For pipe and fittings 4-inch through 15-inch:
 - a. Comply with ASTM D3034 for Type PSM polyvinyl chloride (PVC) sewer pipe and fittings of minimum wall thickness SDR 26.
 - b. Joints: Use either the solvent-weld type complying with ASTM D2564 and ASTM D2855, or the elastomeric gasket type complying with ASTM F477 and ASTM D3212.
 - c. Fittings in sizes through 8-inch: Molded in one piece with elastomeric joints and minimum socket depths as specified in Section 6.2 and 7.3.2 of ASTM D3034.
 - d. Fittings 10-inch and larger: Molded or fabricated in accordance with Section 7.11 of ASTM D3034, with manufacturer's standard pipe bells and gaskets.
 - e. Gaskets for fittings and joints: Provide minimum cross-sectional area of 0.20 square inches complying with ASTM F477.
 - 2. Branch fittings: Use either factory fabricated type with attached main line coupling, or solvent welded saddle type attached to the pipe with cement and held in place with stainless steel bands.
 - a. Branch fittings: SDR 26.
 - 1) Acceptable manufacturers:
 - a) See City of Lake City approved manufacturers found in appendix A of the Lake City Utility Standards
 - 3. Risers and service pipe and fittings: Use SDR 26, solid wall type complying with ASTM D3034 for PVC pipe.

2.2 MANHOLES

- A. See Section 33 05 61 for Manhole Specifications

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

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- B. All excavations shall be adequately sloped or shored and braced to protect the property of the Owner and the safety of the workers. All such protections shall satisfy the requirements of OSHA 2207 and all other applicable codes and ordinances.
- C. The Contractor shall be responsible for avoidance and cleanup of street spillage and tracking to the satisfaction of the authority having jurisdiction.

3.2 PIPE INSTALLATION

- A. General:
 - 1. Trench, backfill, and compact for the work of this Section in strict accordance with pertinent provisions of Section 31 23 33 of these Specifications.
 - 2. Install pipe in accordance with pipe manufacturer's recommendations.
 - 3. Lay pipe by proceeding upgrade with the spigot ends of bell-and-spigot pipe pointing in direction of flow.
 - 4. Lay each pipe accurately to the indicated line and grade, aligning so the sewer has a uniform invert.
 - 5. Continually clear interior of the pipe free from foreign material.
 - 6. Before making pipe joints, clean and dry all surfaces of the pipe to be joined.
 - 7. Use lubricants, primers, and adhesives recommended for the purpose by the pipe manufacturer.
 - 8. Comply with ASTM D2321 for flexible thermoplastic sewer pipe installation.
 - 9. Comply with ASTM C-12 Bedding Class B for rigid pipe installation.

3.3 MANHOLES

- A. See Section 33 05 61 for Manhole Specifications

3.4 TESTING AND INSPECTING

- A. Test sewers and service connections for water tightness by the low pressure air testing, or exfiltration, or infiltration method as selected by the Engineer.
- B. Leakage tests:
 - 1. Low pressure air test:
 - a. Prior to testing for leakage, flush and clean the sewers by passing a snug-fitting inflated rubber ball through the sewer by upstream water pressure.
 - b. Seal pipe openings with airtight plugs and braces.
 - c. Whenever the sewer to be tested is submerged under groundwater, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the sewer to determine the groundwater hydrostatic pressure by forcing air to flow slowly through the probe pipe.
 - d. Add air to the plugged sewer sections under test until internal air pressure reaches 4.0 psig greater than any groundwater hydrostatic pressure.
 - e. Allow at least two minutes for air temperature to stabilize and adding air to maintain the initial test pressure.

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- f. Shut off the air supply after stabilizing the air temperature and record the time in seconds using an approved stopwatch for the internal sewer pressure to drop from 3.5 psig to 2.5 psig greater than any groundwater hydrostatic pressure.
- g. Air testing techniques shall be in accordance with the latest ASTM standard practice for testing sewer lines by low-pressure air test method for the appropriate pipe material, except that the minimum required time for the one pound per square inch pressure drop described in paragraph (f) shall not be less than that shown in Table 33 31 43-1.

Table 33 31 43-1

MINIMUM ALLOWABLE TIME (min:sec) FOR PRESSURE DROP FROM 3½ TO 2½ PSIG

Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft	Time for longer Length, s	Specification time for length (L) Shown, min:s							
				100 ft	150 ft	200 ft	250ft	300 ft	350 ft	400 ft	450 ft
4	3:46	597	0.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	0.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

- h. The required times will be adjusted by the Engineer for main line sewers larger than 24 inches and for lateral pipes connected and tested with the main line sewer.
- i. If the air test fails to meet these requirements, locate and repair, or remove and replace the faulty sections of sewer in a manner approved by the Engineer, as necessary to meet the allowable limits upon retesting.
- j. Do not use acrylamid gel sealant to correct leakage.
2. Allowable limits for water infiltration or exfiltration test: Not to exceed 200 gallons per inch of pipe diameter per 24 hours per mile of sewer, including building service connections, if installed under this Work.
3. Individual joint air pressure test:
 - a. Utilize individual joint tests only where large sewer pipes make standard air, infiltration, or exfiltration tests impossible, and only with approval of Engineer.
 - b. Comply with requirements of ASTM C1103-90.
 - c. Utilize commercially available test apparatus utilizing two separate inflatable sealing rings at least 2.50 inches, but not more than 2 feet apart.
 - d. Acceptable maximum air loss is 1 psi in 5 seconds.
 - e. Test pressure is 3.5 psi higher than groundwater pressure, but do not use the individual joint air pressure test if the required test pressure is greater than 6 psi.
 - f. Provide test apparatus that allows remote monitoring of test by Engineer.
 - g. Conduct all tests in the presence of the Engineer.
4. Provide and use measuring devices approved by the Engineer.
5. Provide water, materials, and labor for making required tests.

C. Sanitary Manhole Water Tightness Testing:

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1. Vacuum Testing Methods:
 - a. Test each sanitary manhole for leakage per ASTM C1244-93, no sooner than 30 days after installation.
 - b. Plug all lift holes with a non-shrink grout.
 - c. Do not place grout in horizontal joints before testing.
 - d. Seal all inlet and outlet pipes with airtight plugs, taking care to securely brace plugs to prevent the plugs from being drawn into the manhole.
 - e. Place the vacuum test equipment at the inside top of the cone section and inflate the seal to 40 psi.
 - f. Draw a vacuum of 10 inches of mercury and shut the vacuum pump off.
 - g. Close valves and measure the time for the vacuum to drop to 9 inches of mercury.
 - h. Allowable limits: the manhole shall pass if the time for the vacuum reading to drop from 10 inches to 9 inches exceeds 60 seconds for a 48-inch diameter manhole, 75 seconds for a 60-inch diameter manhole, and 90 seconds for a 72-inch diameter manhole.
 - i. Repair all manholes failing the initial test with a non-shrink grout.
 - j. If a manhole fails the initial test, retest until a satisfactory test is obtained.
 - k. Provide equipment, materials and labor necessary to conduct vacuum testing.
 - l. Make tests in the presence of the Owner, giving the Owner at least 48 hours' notice prior to testing.
2. Infiltration and Exfiltration Testing Method:
 - a. Comply with ASTM C969 (latest revision).
 - b. Provide all temporary plugs, materials, water, equipment, and labor necessary to conduct tests.
 - c. Make tests in presence of Owner, and, notify Owner a minimum of 48 hours in advance of test(s).
 - d. If manhole fails test, repair manhole and retest until satisfactory test is obtained.
 - e. Maximum allowable leakage: 200 gal./inch dia./mile/24 hr.

END OF SECTION 33 31 00

SECTION 33 42 00 – STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide storm sewer system as shown on the Drawings, as specified herein, and as needed for a complete and proper installation. This work includes but is not limited to storm sewers, catch basins, manholes, mitered end sections, rip rap.
- B. Related work:
 - 1. Geotechnical information provided by American Infrastructure Development, AID Report Number DEI20006, Dated May 18, 2020.
- C. Related Sections:
 - 1. Reserved
- D. References:
 - 1. American Association of State Highway and Transportation Officials (AASHTO): Geotextile Specifications for Highway Applications (AASHTO M-288-00).
 - 2. ASTM International:
 - a. Standard Specification for Concrete Aggregates (ASTM C-33).
 - b. Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (ASTM C-76).
 - c. Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (ASTM C-443).
 - 3. Occupational Safety and Health Administration (OSHA), United States Department of Labor (USDOL) Code of Federal Regulations (CFR): Construction Industry Standards (OSHA 2207 or 29 CFR 1926).
 - 4. State of Florida Department of Transportation: Latest edition of Construction and Material Specifications.
 - 5. American Concrete Pipe Association: Concrete Pipe Installation Manual.

1.2 SUBMITTALS

- A. Shop Drawing Submittals – Structures are to be submitted for review and approval by the Engineer of Record and forwarded to the County for review and approval.
- B. As-built Record Drawings - Submit detailed as-built survey of all Inlets, Manholes, Storm pipes, Outfall Structures and Pond and Swale contours and grades meeting Columbia County, FDEP and SRWMD requirements. May be included with as-builts of other Utilities improvements listed in sections 33 14 00 “Water Utility Transmission and Distribution” and 33 31 00 “Sanitary Sewer Piping.”

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1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. The work shall conform to the requirements of the Columbia County, SRWMD and the FDEP– which, in the event of a conflict, shall take precedence over the requirements of this Section.
 - a. Exception: If the requirements of this Section are more stringent, they shall apply.
2. Obtain and pay for all permits, tests, inspections, and the like, required by the authority having jurisdiction.
3. Execute and inspect the Work in accordance with all local and state codes, rules, ordinances, or regulations pertaining to the particular type of work involved.
 - a. Should any changes in the Drawings and/or Specifications be required to conform to such ordinances, notify the Owner at the time of submitting bid.
 - b. After entering into the Contract, the Contractor shall be held responsible for the completion of all work necessary for a complete and approved installation without additional cost to the Owner.
 - c. If required by the authority having jurisdiction, prepare supplementary detailed diagrams or drawings, at no additional cost to the Owner.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Reserved.

1.5 SITE CONDITIONS

- A. Existing Conditions: Prior to submitting a Bid, the Bidders shall visit the Site, inform themselves of the conditions and make their own estimates of the facilities and difficulties related to the execution of the Work.

1.6 MAINTENANCE – Owner Responsibility.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Concrete pipe:

1. Reinforced concrete pipe (RCP):
 - a. Shall conform to ASTM C-76, Class III, Wall B, with gasketed joints per ASTM C-443. All storm drainage pipes shall be Class III RCP unless noted otherwise on the plans.
 - b. Bedding shall be Type 3 per American Concrete Pipe Association and as indicated on the plans.

2.2 MANHOLES, CATCH BASINS, AND INLETS

A. Precast:

1. Provide precast reinforced concrete manhole sections, bottoms, and flat top slabs complying with ASTM C478, or reinforced concrete pipe sections complying with ASTM C76, unless otherwise indicated on Drawings.
2. For manholes provide eccentric cone section unless otherwise indicated on the Drawings.
3. Provide precast reinforced concrete monolithic or separate base.
4. Design flat top for H-20 loading.
5. Utilize the standard designs and specifications of FDOT Index No. 425.

B. Concrete:

1. Provide 4000 psi concrete using Type I Portland Cement complying with ASTM C150.

C. Mortar:

1. Mix one part Portland cement to three parts fine aggregate.

D. Joints for precast sections:

1. Provide tongue and groove joints with either flexible watertight rubber gaskets or preformed bituminous plastic gaskets consisting of a homogeneous blend of refined hydrocarbon resins and plasticizing compound reinforced with inert mineral filler.

E. Frames and covers:

Unless otherwise shown on the Drawings or as directed by the Engineer, set frames and covers:

1. Manhole frames and covers: Use Type 1 frame and closed lid unless otherwise indicated on the Drawings.
2. Catch basin frames and grates: Use the types indicated on the Drawings.
3. Type 1 frames and closed lids: Heavy duty, indented top solid lid, stamped with the word "STORM."
4. All frames, lids and grates to be traffic bearing unless otherwise noted.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Protection:

1. All excavations shall be adequately sloped or shored and braced to protect the property of the Owner and the safety of the workers. All such protections shall satisfy the requirements of OSHA 2207 and all other applicable codes and ordinances.
2. The Contractor shall be responsible for avoidance and cleanup of street spillage and tracking of sediment off of the Site.

3.2 CONSTRUCTION

A. Catch Basins and Manholes:

1. Place precast bases on a 6-inch thick bed of stone.
2. Form bottom channels in all manholes to the crown of the outlet pipe with concrete.

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3. Completely fill lift holes on precast elements with an approved mortar. Make joints between all precast elements with an approved bitumastic material or an approved rubber gasket.
4. Set castings in a full bed of Portland cement mortar.

3.3 PIPE INSTALLATION

A. General:

1. Trench, backfill, and compact for the work of this Section in strict accordance with pertinent provisions of Section 31 23 33 of these Specifications.
2. Trench width, measured at the top of the pipe, shall not exceed 12 inches on each side of the pipe.
3. Install pipe in accordance with pipe manufacturer's recommendations.
4. Set storm sewer pipe in Type 3 bedding, having a thickness of at least 3 inches below the bottom of the pipe and extending up around the pipe for a depth of not less than 30 percent of its outside diameter. The layer of bedding material shall be shaped to fit the pipe for at least 10 percent of the diameter of the pipe and shall have recess shaped to receive the bell of bell- and- spigot pipe.
5. Lay pipe by proceeding upgrade with the spigot ends of bell-and-spigot pipe pointing in direction of flow.
6. Lay each pipe accurately to the indicated line and grade, aligning so the sewer has a uniform invert.
7. Continually clear interior of the pipe free from foreign material.
8. Before making pipe joints, clean and dry all surfaces of the pipe to be joined.
9. Use lubricants, primers, and adhesives recommended for the purpose by the pipe manufacturer.

B. Stone Rip Rap: All rip rap shall be stone rip rap constructed as indicated on the Drawings and as specified herein.

1. Filter fabric shall be placed on the prepared and compacted subgrade within the limits shown on the plans for stone rip-rap. The filter fabric shall be laid loosely without wrinkles or creases. When more than one width or length of filter fabric is necessary, the joints shall be overlapped a minimum of 24 inches. Securing pins with washers shall be inserted through both strips of overlapped material and into the materials beneath until the washer bears against the fabric and secures it firmly to the base material. These securing pins shall be inserted through the overlapped fabric at not greater than 2 foot intervals along a line through the midpoint of the overlap. If the fabric is torn or damaged, a patch overlapping the edges of the damaged area by 2 feet shall be sewn securely to the fabric with a continuous, monofilament, rot-proof material.
2. Uniformly place stone filter blanket to the thickness and limits indicated on the Drawings and to a thickness tolerance of plus or minus 1/2 inch. Compact it to the extent necessary to hold it in place while stone rip rap is placed upon it.
3. Roughen the surface by letting the large stone project approximately 2 inches above the filler pieces.

C. Water main separation:

1. Whenever water mains are encountered in the course of storm sewer construction, notify the Engineer to determine the construction necessary to comply with the provisions of FDEP requirements.

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D. Public and private well separation:

1. Whenever public or private wells are encountered in the area during the course of sewer construction, notify the Engineer to determine the construction requirements necessary to comply with rules and regulations set forth by the governing authorities.

3.4 MANHOLES, CATCH BASINS, AND INLETS

A. General:

1. Shape the invert channels to be smooth and semicircular, conforming to the inside of the adjacent storm sewer section.
2. Make changes in direction of flow with a smooth curve of as large a radius as the size of the manhole will permit.
3. Make changes in size and grade of channels smoothly and evenly.
4. Form the invert channels directly in the concrete of the manhole base, with mortar, or by laying full section sewer pipe through the manhole and breaking out the top half after surrounding concrete has hardened. Do not use preformed invert channels.
5. Smooth the bench outside the channels, and slope toward the channels at not less than 1-inch per foot not more than 2 inches per foot.
6. Provide manhole exterior joint protection where indicated on drawings.
7. Provide manhole exterior surface treatment where noted on drawings.

B. Jointing:

1. Use flexible watertight gaskets for each joint.
2. Trim smooth surplus gasket material.

C. Frames and covers: Unless otherwise shown on the Drawings or as directed by the Engineer, set frames and covers:

1. So that the top of the solid cover will be flush with the finished pavement; or
2. With grade rings not to exceed 8 inches.

3.5 MANHOLE ADJUSTMENT

A. General:

1. Install manholes to an elevation that will allow installation of frame and grate at the final pavement grade at time of paving.

B. Utilize concrete adjusting rings to set frame and grates at temporary elevation until time of street paving work.

C. Adjust frames and grates to match final surface elevations at time of street paving.

3.6 TESTING AND INSPECTION

A. Pipe Inspection:

1. For pipes installed under the pavement, inspection is to be conducted when backfill reaches 3 feet above the pipe crown or upon completion of placement of the stabilized subgrade. For pipe installed within fills, including embankments confined by walls, inspection is to

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be conducted when compacted embankment reaches 3 feet above the pipe crown or the finished earthwork grade as specified in the Plans. Prior to conducting the inspection, submit to the Engineer a video recording schedule for videoing, dewater installed pipe, and remove all silt, debris and obstructions. Submit pipe videoing and reports to the Owner for review prior to the continuation of paving.

2. For pipe 48 inches or less in diameter, submit to the Engineer the video files and reports using low barrel distortion video equipment with laser profile technology, non-contact video micrometer and associated software.
3. For all pipe types, provide a Pipe Observation Summary Report for each pipe run that includes:
 - a. Actual recorded length and width measurements of all cracks within the pipe
 - b. Actual recorded separation measurement of all rigid pipe joints.
 - c. Detailed written observations of leaks, debris, or other damage or defects

B. Video Report:

1. Provide video files via digital media (DVD, flash drive, or other) or by online digital distribution with a minimum standard resolution of 720 x 480. Use a camera with lighting suitable to allow a clear picture of the entire periphery of the pipe. Center the camera in the pipe both vertically and horizontally and be able to pan and tilt to a 90 degree angle with the axis of the pipe and rotating 360 degrees. Use equipment to move the camera through the pipe that will not obstruct the camera's view or interfere with proper documentation of the pipe's condition.
2. The video image shall be clear, focused, and relatively free from roll, static, or other image distortion qualities that would prevent the reviewer from evaluating the condition of the pipe. The video will include identification before each section of pipe filmed. The identification will include the project number, the structure number corresponding to the structure number in the Plans for the project, size of pipe, the date and time, and indicate which pipe is being filmed if multiple pipes are connected to the structure. Notes should be taken during the video recording process. Submit these notes along with the video.
3. Move the camera through the pipe at a speed not greater than 30 feet per minute. Mark the video with the distance down the pipe. The distance shall have an accuracy of one foot per 100 feet. Film the entire circumference at each joint. Stop the camera and pan when necessary to document and measure defects. Position the camera head perpendicular to all defects requiring measurement by the video micrometer.

- C. Re-inspection: At any time after reviewing the submitted pipe inspection reports, the Engineer may direct additional inspections at no cost to the owner. Acceptance of all replacements or repairs will be based on video documentation of the completed work prior to Final Acceptance.

3.7 CLEANING

- A. Upon completion of the Work, remove all surplus materials, debris, tools and equipment from the Site.

END OF SECTION 33 42 00



REPORT OF GEOTECHNICAL EXPLORATION
COLUMBIA COUNTY DETENTION CENTER EXPANSION
LAKE CITY, COLUMBIA COUNTY, FLORIDA

PREPARED FOR
DEWBERRY ENGINEERS, INC.
ORLANDO, FLORIDA

MAY 18, 2020

Prepared by:



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AID Project No. DEI20006

May 18, 2020

Mr. Christopher J Allen, PE, Project Manager
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Orlando, Florida 32803

Reference: Report of Geotechnical Exploration Services
Columbia County Detention Center Expansion
389 NW Quinten Street, Lake City, Columbia County, Florida
AID Project No. DEI20006 / Dewberry Control No. 50101397

Mr. Allen:

American Infrastructure Development, Inc. (AID) has completed the geotechnical exploration for the proposed detention facility at the referenced site. Our work was planned and performed in general accordance with our proposal dated March 3, 2020. Acceptance to this proposal and authorization to proceed was provided by Mr. Jim Beight of Dewberry Engineers, Inc. on March 10, 2020.

The following report presents the results of our field exploration and testing, an evaluation of the subsurface conditions with respect to available project characteristics, and recommendations to aid in the design and construction of the Columbia County Detention Center expansion.

We have enjoyed assisting you on this project and look forward to serving as your geotechnical and construction materials testing consultant for the remainder of this and future projects. Should you have any questions concerning this report, please contact our office at 386-438-8058.

Sincerely,
American Infrastructure Development, Inc.

COPY
Nabil O. Hmeidi, P.E.
Senior Geotechnical Engineer
Licensed, Florida No: 57842

Distribution: File (1 copy)
Addressee (1 e-mailed copy in PDF format)

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ATTACHMENTS

Attachments: Vicinity Map (1 page)
Borings Location Map (1 page)
Record of Auger & SPT Borings (2 Sheets)
Limerock Bearing Ratio (LBR) Test (1 page)
USGS Seismic Design Summary Report (2 pages)

1.0 INTRODUCTION

This report presents the results of the geotechnical exploration performed for the proposed detention facility expansion at the referenced site. The services rendered by AID during this exploration can be summarized as follows:

- Performed a site reconnaissance to identify surface conditions and accessibility;
- Reviewed similar explorations and published information for the project area;
- Planned and performed ten (1) Standard Penetration Test (SPT) borings extending 20 to 30 feet below the existing ground surface;
- Planned and performed one (1) auger boring extending 20 feet below the existing ground surface;
- Performed one (1) in-place permeability test new the auger borings;
- Retrieved soil samples for laboratory testing;
- Performed laboratory testing on select soil samples;
- Reviewed and analyzed gathered data, and
- Prepared this report, that includes the results of the field exploration as well as recommendations with respect to general site development and quality control.

2.0 SITE CONDITION & PROJECT INFORMATION

2.1 Site Conditions

At the time of drilling on March 19, 2020, the ground surface within the proposed building expansion was mostly covered with grass and a few scattered trees. Existing grades within most of the building expansion area is at ± 3 feet below the grades within the western portion and existing facility. A security fence and an asphalt paved service road run along the western side of the proposed building expansion. In addition, a 6" sewer pipe (invert at about 4 feet below the land surface) runs along the eastern edge of the service road. Other buried and overhead utilities are present near or within the construction limits.

2.2 Project Information

We have been provided with a schematic depicting the proposed expansion on a Google Earth Map. Based on a review of this map and emailed information, we understand the Columbia County Board of County Commissioners is planning on expanding the occupancy capacity of the current detention center located at 389 NE Quinten Street in Lake City, Florida.

Available information indicates the proposed expansion will be $\pm 150'$ by $150'$, 2-story pre-engineered structures supported on conventional foundation and soil-supported concrete floor slab. The occupant's cells will be precast concrete with CMU walls. Two smaller "Accessory Structures" measuring $\pm 25'$ by $45'$ each will be attached to the north and south ends of the building expansion. In addition, a service roadway is proposed along the east side of the new building expansion. Stormwater management facility areas will be located to the south of the new building addition.

Detailed information regarding the proposed structures are not available at this time. However, we assumed these structures will be two-story constructed of CMU and steel-frame or modular cells with precast wall panels and soil-supported concrete floor slabs. We anticipate the proposed structures will have maximum column and wall loads on the order of 125 kips and 6 to 8 kips per linear foot, respectively. We also assume the new addition's finished grades will match that of the existing detention facility. This will necessitate the placement of about $3\frac{1}{2}$ feet of new fill to achieve these finished grades.

3.0 FIELD EXPLORATION

The subsurface condition within the proposed addition, parking, and stormwater management facility areas was explored by drilling a total of ten (10) SPT and one (1) auger borings extending 10 to 30 feet below the existing ground surface. The borings were performed at the approximate locations shown on the attached Borings Location Map. These locations were determined in the field and referenced from existing features (fence, utility structures, service road, etc.). Therefore, the locations should be considered only as accurate as the means and methods by which they were obtained. The following table summarizes the subsurface conditions encountered at each boring location:

SUMMARY OF FIELD EXPLORATION PROGRAM Columbia County Detention Center Expansion 389 NW Quinten Street, Lake City, Columbia County, Florida						
Boring No.	Location	Depth (feet)	Date Drilled Method	At-Completion Groundwater	Surface Material	Bottom Condition
B-01	See Borings Location Map	20	03/19/2020 SPT (Manual)	4.5'	4" Topsoil	Terminated (SP-SM)
B-02	See Borings Location Map	20	03/19/2020 SPT (Manual)	4'	4" Topsoil	Terminated (SC)
B-03	See Borings Location Map	30	03/19/2020 SPT (Manual)	3'	9" Topsoil	Terminated (SC)
B-04	See Borings Location Map	20	03/19/2020 SPT (Manual)	3'	6" Topsoil	Terminated (SC)
B-05	See Borings Location Map	20	03/19/2020 SPT (Manual)	4.5'	4" Topsoil	Terminated (SP-SM)
B-06	See Borings Location Map	30	03/19/2020 SPT (Manual)	4'	6" Topsoil	Terminated (SC)
B-07	See Borings Location Map	10	03/19/2020 SPT (Manual)	1.75'	4" Topsoil	Terminated (SP-SM)
B-08	See Borings Location Map	10	03/19/2020 SPT (Manual)	1.5'	9" Topsoil	Terminated (SP-SM)
B-09	See Borings Location Map	10	03/19/2020 SPT (Manual)	2'	9" Topsoil	Terminated (SP-SM)
B-10	See Borings Location Map	10	03/19/2020 SPT (Manual)	1.75	6" Topsoil	Terminated (SP-SM)
A-01	See Borings Location Map	20	03/19/2020 Auger	2'	6" Topsoil	Terminated (SC)

NOTES: Depths referenced from existing ground surface.

Sampling and penetration procedures of the SPT borings were accomplished in general accordance with ASTM D-1586, "Penetration Test and Split-Barrel Sampling of Soils", using a power rotary drill rig. The standard penetration tests were performed by driving a standard 1-3/8" I.D. and 2" O.D. split spoon sampler with a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler a total of 18 inches, in 6-inch increments, were recorded. The penetration resistance or "N" value is the summation of the last two 6-inch increments and is illustrated on the attached Record of Auger & SPT Borings adjacent to their corresponding sample depths. The "N" values are used as an index to derive soil parameters from various empirical correlations.

The auger boring was performed mechanically using a continuous flight auger in general accordance with ASTM D 1452-80 (*Soil Investigation and Sampling by Auger Borings*). Representative samples of the soils were brought to the ground surface by the auger process and transported to our office for visual evaluation and classification.

The field permeability test was performed by inserting a non-slotted casing into the augered boring that extended to the test depth. The casing was then filled with potable water and allowed to permeate vertically into the soils through the bottom of the casing by gravity for a period of 15 minutes. The drop-in water level was recorded for each 1-minute of elapsed time for a total of ten (10) readings. The coefficient of permeability (k) was calculated based on the amount of water permeated into the soils, water head height, and the pipe's inside diameter.

Refer to the attached Record of Auger and SPT Borings for description of the subsurface conditions encountered at the time of drilling. These records also provide the penetration resistances recorded during the drilling and sampling process. It should be noted that stratification lines and depth designations indicated on these records represent the approximate boundaries between the various soils encountered. In some cases, the transition between these soils may be gradual.

4.0 SUBSURFACE CONDITIONS

4.1 General Site Geology

Published information¹ regarding the geology in this area of Columbia County, Florida indicates the site is situated within the Statenville formation (Ths) of the Miocene epoch. Typically, the Statenville formation consists of interbedded sands, clays, and dolostones with common to very abundant phosphate grains. The sands in this area are light gray to olive gray, poorly indurated, phosphatic, fine- to coarse-grained with scattered gravel, and with minor occurrences of fossils. Clays are yellowish gray to olive gray, poorly consolidated, variably sandy, phosphatic and variably dolomitic. The dolostones are yellowish gray to light orange, poorly- to well-indurated, sandy, clayey and phosphatic.

4.2 Sinkhole Potential

Sinkholes are primarily caused by an advanced state of internal soil erosion or raveling action which under certain circumstances can lead to ground subsidence. This internal soil erosion is a very slow process by which soil particles migrate under the influence of a hydraulic gradient to underlying karsted and/or fractured limestone formation. There are several indicators generally associated with internal soil erosion such as noticeable surface depressions, very loose to soft soil zones just above the limestone rock formation, and/or presence of weathered to highly weathered limestone bedrock.

The USGS Map Series No. 110, Sinkhole Type, Development, and Distribution in Florida dated 1985 identifies the site near the contact of Areas I and III. Area I consist of ground with bare or thinly covered limestone. Gradually developed solution sinkholes in this area are few, broad and shallow. Area I consist of ground with bare or thinly covered limestone. Gradually developed solution sinkholes in this area are few, broad and shallow. Area III refers to ground with 30 to 200 feet of cover above the limestone. The overburden soils are mainly cohesive clayey sediments of low permeability. Cover-collapse sinkholes of varying size abruptly develop and are numerous.

The Sinkhole Database issued by the Florida Geological Survey (last updated May 6, 2013) indicates the nearest recorded sinkhole occurrence is approximately 3 miles west of the subject site (see Ref. No. 29-023, occurred in August 2000). However, the results of the test borings did not reveal evidence of sinkhole indicators within the explored profile.

¹ *Geologic Map of the State of Florida, Series MS 146, by the Florida Geological Survey (FGS), 2001, revised April 15, 2006 & Open-File Report 80, by FGS dated 2001.*

Due to the nature of sinkholes and limitations of current detection methods, it is possible that existing subsurface conditions which could be associated with future sinkholes were not detected or predicted by this exploration. Also, it must be understood that this exploration was not intended to predict or preclude future sinkholes from occurring within the subject site.

4.3 General Subsurface Conditions

4.3.1 Building Expansion [Borings B-01 through B-06]

SPT borings performed within the building expansion area were extended 20 to 30 feet below the existing ground surface. The soil profile as disclosed by these borings initially consisted of about 4 to 9 inches of moist grayish brown to dark brown sand with silt and organic (topsoil). This surface cover is underlain by alternating layers of gray sand (SP) with trace of silt, grayish brown sand with silt (SP-SM), gray with red mottles or gray with reddish brown mottled clayey sand (SC). These soils have relative densities varying from very loose to very dense with penetration resistance or "N" values ranging from 2 to exceeding 50 manual-hammer blows per foot (BPF).

4.3.2 Proposed Service Road [Borings B-07 through B-10]

The SPT borings in this area extended 10 feet each below the existing ground surface. These borings initially disclosed about 4 to 9 inches of moist grayish brown sand with silt and organic (topsoil). This surface cover is underlain by alternating layers of gray sand (SP) with trace of silt and grayish brown sand with silt (SP-SM). The relative density of these soils varies from very loose to dense with "N" values ranging from 2 to 32 BPF.

4.3.3 Stormwater Management Facility [Boring A-01]

Auger boring A-01 performed within the proposed stormwater management facility was extended 20 feet below the existing ground surface. This boring initially disclosed about 6 inches of grayish brown sand with silt and organic ((topsoil). Beneath this surface cover, the boring disclosed alternating layers of grayish brown sand with silt (SP-SM) and grayish tan to dark brown clayey sand (SC).

4.4 Groundwater

The depth to the groundwater table was measured immediately following completion of each boring. The "at-completion" groundwater levels were encountered in all borings at depths ranging from 1.5 to 4.5 feet below the existing ground surface. We note that due to the relatively short time frame of the field exploration, the at-completion groundwater levels may not have had sufficient time to stabilize. Fluctuation in groundwater levels should therefore be expected due to seasonal climatic changes, construction activity, rainfall variations, surface water runoff, and other site-specific factors.

5.0 SITE PREPARATIONS & RECOMMENDATIONS

5.1 General

The recommendations presented in this report are based upon available project information and data obtained during our field program. Discovery of any site or subsurface condition during construction, which deviates from the data collected during this exploration, should be further evaluated.

The existing ground surface within the construction zone is covered with grass, topsoil, vegetation, and a few scattered trees. Underground and overhead utility (6" sewer pipe, power lines, etc.) are also present within the construction zone. Therefore, the initial site preparations should include the complete removal of topsoil, vegetation, trees, underground utilities, and any other deleterious material that fall within the construction zone. The removal of buried utility lines, tree

stumps and associated root systems may create relatively deep open excavations. All loose soils in these excavations should be removed and the exposed surfaces (bottom and sides of excavations) should be recompact, tested and stabilized prior to backfilling.

We understand the existing 6" sewer pipe that bisects the building expansion (north to south) will be abandoned. To be abandoned in-place, the sewer pipe should be completely filled to the crown with grout having a minimum of 150 psi compressive strength. In addition, bulk heading/blocking the downstream end of the pipe along with pressure injection grouting may be required.

The at-completion groundwater levels were encountered as shallow as 1.5 feet below the existing ground surface within the eastern portions of the building expansion. Therefore, dewatering should be expected for proper preparations of the exposed surfaces, fill placement, and compaction of engineered fill within these areas. Proper backfilling and compaction should be performed in accordance with the guidelines presented herein (see Structural Fill/Backfill section for details).

5.2 Exposed Subgrade

All soils within the proposed building expansion footprint and paved areas (including a minimum of 5 feet outside the perimeter of all structures and paved areas) should be compacted with overlapping passes of a drum roller having a total operating static weight (including fuel and water) of at least 10 tons and a drum diameter of 5 feet. Exposed surfaces within the structures and pavement areas should be densified prior to placement of any new fill by providing a minimum of 8 full coverages of all surfaces to be compacted, and are satisfactorily stabilized to receive new structural fill. Prior to densification of the exposed soils, dewatering and/or stabilization by use of geofabric may be required.

5.3 Structural Fill/Backfill

In general, and beneath the surface cover of topsoil, the borings disclosed moist to wet loose sand (SP), sand with silt (SP-SM), and clayey sand (SC). The majority of these soils are considered suitable for the support of the proposed structures, however, for any of the in-situ soils to remain in place, densification and recompact of the exposed surfaces will be required. This densification may be accomplished by compacting the exposed subgrade as outlined above. After the complete removal of vegetation, topsoil/muck, trees and associated root systems, moisture conditioning of the surface soils should be expected, see Drainage Consideration section for more details.

The bottom of all excavated footings should be compacted and cleaned of all wet loose soils prior to placement of reinforcing steel and concrete. Loose materials found in excavations created by the rerouting of utility lines and uprooting of trees and vegetation should be removed from all footing excavations. The exposed subgrades should then be densified and compacted prior to placement of any new backfill needed to re-establish the original subgrade. Once the bottom of the excavation is satisfactorily densified, structural fill may be placed in thin loose lifts and compacted accordingly. Due to the presence of a relatively shallow groundwater, moisture conditioning of reused suitable soils and dewatering should be expected prior to earthwork operations and handling of materials.

Once all surfaces to receive engineered fill are properly prepared, then structural fill may be placed in thin loose lifts not exceeding 12 inches in thickness and compacted with a vibratory roller as described above. For walk-behind equipment (that may be used in utility trenches), a maximum loose lift thickness of 6 inches is recommended. Each lift of structural fill should be compacted to provide a minimum of 95 percent of the modified Proctor maximum dry density value (ASTM D-1557) within the proposed structures and pavement areas. Structural fill should consist of inorganic, non-plastic, granular soil containing less than 12 percent material passing the No. 200 sieve (Unified Soil Classification of SP or SP-SM).

To alleviate adverse effects on the near by existing foundation systems, it is recommended that the vibratory function of all earthmoving equipment be disengaged while operating on site, particularly, the compaction equipment.

5.4 Foundation Support Alternatives

Due to the presence of very loose to loose saturated soils to depths of about 10 feet below the existing ground surface, supporting the proposed building expansion on conventional shallow foundation will require a relatively considerable overexcavation, backfilling, and groundwater drawdown operations. Therefore, and as an alternative to the conventional shallow foundation, the new building expansion may be supported on a flat plate mat “raft” foundation system. Nevertheless, we offer these two foundation support alternatives for feasibility comparison:

5.4.1 Conventional Shallow Foundation System (Strip Footings / Isolated Columns)

As stated above, supporting the proposed building expansion on conventional shallow foundation system will require extensive overexcavation, backfilling, groundwater drawdown, and settlement monitoring operations as indicated in Sections 5.7 and 5.8. Provided the foundation and site soils are prepared in accordance with the guidelines presented in this report, the building expansion can be supported on a conventional shallow foundation system. This shallow foundation should be designed for an allowable bearing pressure of 2,500 pounds per square foot (psf) or less supported on recompacted in-situ soils or newly placed structural fill.

The borings disclosed very loose to loose saturated soils to a depth of about 10 feet below the existing ground surface. For this conventional shallow foundations system to perform as intended, these loose soils will need to be overexcavated and replaced with structural fill. Our laboratory tests indicate that a portion of the in-situ soils are considered suitable for reuse as structural fill, however, the majority of these soils will require moisture conditioning prior to proper placement and compaction.

Wall bearing footings can be designed with a minimum width of 18 inches while the individual column footings can have minimum dimensions of 2 feet by 2 feet. Exterior column footings and wall bearing footings should be designed with a minimum embedment depth of 18 inches as measured from the base of the footing to the lowest adjacent outside grade. The minimum depth of embedment of the interior footings should be 12 inches. In using net pressures, the weight of the footing and backfill over the footing need not be considered. Only loads applied at or above final grade need to be used for dimensioning footings.

5.4.2 Shallow Foundation – Flat Plate Mat “Raft” Foundation System

As an alternative to the conventional shallow foundations, the proposed building expansion may be supported on a flat plate mat or raft foundation bearing at a minimum depth of 3 feet below surrounding grades. This mat foundation should be designed for an allowable bearing pressure of 2,250 pounds per square foot (psf) or less supported on recompacted in-situ soils or newly placed structural fill. Excavation for the mat foundation may encounter groundwater and/or wet soils. Therefore, dewatering should be expected to accommodate cleanup and compaction of exposed soils in the bottom of the mat foundation. In addition, we recommend the placement of a 4” ASTM No. 57 stone in the bottom of the excavation to provide a working clean surface for the installation of reinforcing steel and concrete. Refer to Sections 5.7 and 5.8 for additional settlement and dewatering considerations.

5.5 Floor Slab Supported on Engineered Fill

For floor slabs supported on recompacted engineered, and after satisfactory completion of the site preparations, the finished subgrade soils within the floor slab areas should be proofrolled with a fully-loaded, tandem-axle dump-truck or similar pneumatic-tired equipment (tracked equipment should not be used for this task). Provided the recompaction and proofrolling operations do not indicate significant deflection or pumping of the existing subgrade, floor slabs may be designed as slabs-on-grade. All floor slabs should be supported on at least 4 inches of relatively clean granular material such as sand, sand and gravel, or crushed stone. This is to help distribute concentrated loads and equalize moisture beneath the slab. This granular material should have 100 percent passing the 1½ inch sieve and a maximum of 12 percent passing the No. 200 sieve.

After proper preparation of the subgrade soils, it is recommended, the floor slab bearing soils be covered by a properly lapped polyethylene sheathing of adequate thickness (minimum 6-mil). This will alleviate the potential for floor dampness which can affect the performance of floor coverings such as tiles and carpets. The polyethylene film should provide a sealed coverage of the bearing soils. Seams should be lapped a minimum of 6 inches and all cuts for pipes penetration and punctures should be sealed. Expansion and contraction joints should be used to isolate the floor slab from load bearing walls and/or isolated columns. This will allow for possible differential movement and minimize the potential for cracking of the floor slabs.

5.6 Recommended Soil Parameters

Based upon the soil conditions encountered at the subject site, the anticipated fill placement, and the recommended site preparation operations presented in this report, the following soil parameters may be used for designing structures resisting uplift and lateral forces:

- Total unit weight = ± 115 pcf (compacted to 95% of ASTM D-1557)
- Friction angle (ϕ) = 32°
- Cohesion (c) = 0 psf
- Coefficient of friction at the base of shallow footings = 0.40
- Coefficient of passive earth pressure (K_p) = 3.25
- Coefficient of active lateral earth pressure (K_a) = 0.31
- At-rest lateral earth pressure (K_o) = 0.47
- Horizontal movement to mobilize lateral resistance = $\frac{1}{4}$ inch
- Estimated vertical subgrade reaction (k) = 100 pci

The presence of water behind retaining walls (i.e. loading dock walls, etc.) due to surface water intrusion should be handled with the use of a drainage layer behind the walls with a collection pipe discharging accumulated water away from the walls. If this is not practical, then all structures bearing below the water level must be properly designed to resist hydrostatic pressures.

5.7 Settlement Considerations

5.7.1 Conventional Shallow Foundation System – Settlement Considerations

For conventional shallow foundations, the actual magnitude of settlement that will occur will depend upon variations within the subsurface soil profile, actual structural loading conditions, embedment depth of the footings, actual thickness of compacted fill or cut, and the quality of the earthwork operations. Due to the anticipated fill height and presence of very loose wet soils within the upper strata, we recommend the following:

1. After properly abandoning the existing sewer pipes, removal of trees and associated root systems, the in-situ soils within the upper 8 feet of the existing ground surface will require overexcavation, and the surrounding soils be benched into the open overexcavated areas and spread uniformly to create a relatively level surface. Densification of the exposed subgrades may commence only after creating this nearly level surface across the entire building footprint (including a minimum of 5 feet outside the perimeter of building). After densifying, testing, and stabilizing the exposed surface, uniform lifts of engineered fill may be placed and compacted accordingly. Settlement monitoring of the building pad will also be required as indicated below.
2. The new engineered fill should be allowed to consolidate prior to commencement of construction activities. This could be accomplished by monitoring the settlement of the newly placed fill and foundation soils. To monitor the settlement behavior of the new fill and foundation soils, we recommend installing five (5) surface settlement hubs within the building footprint [four corners and one center].

The settlement hubs consist of 8-inch diameter holes augered a minimum of three (3) feet into the ground and backfilled with concrete with a protruding piece of reinforcement steel in the middle. The monitoring of the settlement hubs should consist of readings to the nearest 1/100th of a foot, for a period of time to be determined by the anticipated loading conditions, consolidation properties of the underlying soils and new fill materials. The readings should be obtained by a Florida licensed surveyor and should be made twice a week for the first month, and weekly thereafter.

The readings should be forwarded to our office for continuous evaluation so that we can inform you as to when the consolidation "line" has stabilized. The hubs should be protected from disturbance and damage with the first "initial" reading be obtained immediately following the removal of all traffic and earthwork equipment from the monitored area. We note that careful field control of the fill placement will substantially contribute to expediting the consolidation process and minimizing the monitoring period. For estimation, a minimum monitoring period of 4 weeks should be expected. Refer to the attached Typical Surface Settlement Hub for more details.

5.7.2 Flat Plate Mat "Raft" Foundation System – Settlement Considerations

A net allowable bearing pressure of 2,250 psf was used for estimating the settlement of the rigid mat foundation. In addition, we assumed a mat width to length ratio (B/L) of about 1.

5.7.3 Total and Differential Settlement

Provided the foundation related site work and design are completed in accordance with our recommendations, we estimate the total settlement will be about 1 inch, with differential settlements of about one-half that of the total settlement. We also anticipate the majority of this settlement will be the result of the elastic compression of the supporting sandy soils, and should occur almost immediately following the application of the structural dead load.

5.8 Drainage Considerations

Adequate drainage should be provided at the site to minimize increase in the moisture content of the foundation soils and pavement subgrade. Excessive moisture can significantly reduce the soil's bearing capacity and contribute to foundation settlement. For the protection of the foundation soils, we recommend the ground surface be sloped away from all proposed structures and paved areas. Lack of proper surface water control could result in water ponding in footing excavations during construction. The ponded water will inhibit soil compaction operations and disturb previously compacted soils.

The at-completion groundwater levels were encountered at depths ranging from 1.5 to 5.5 feet below the existing ground surface. Therefore, excavations below these depths will require surface and groundwater control systems to maintain the groundwater at or below 3 feet of the exposed subgrade or below the bottom of trench/structure excavations prior to beginning of construction.

Based on the subsurface soil profile and the at-completion groundwater levels, drawdown of the groundwater may require installation of cut-off walls and/or a series of well-point systems connected to a pump and discharged away from the construction zone. Well-point dewatering system, if installed, should be activated well in advance prior to subgrade preparations or trench excavations. The depth of the wells below the water table will be contingent upon the pumping rate and well spacing. The contractor should maintain the system to ensure the groundwater is at an acceptable level. As an alternative, groundwater drawdown or dewatering of localized areas may be accomplished with the use of a perimeter ditch and/or sump pumps outside the limits of the excavations.

5.9 Temporary Slopes

Stability analysis for temporary slopes was beyond the scope of this study, however, we recommend that all Occupational Safety and Health Administration (OSHA) regulations regarding excavating slopes be met (see OSHA Document 2226 for more details). For the on-site soils, we recommend temporary construction slopes less than ten (10) feet deep be graded no steeper than 1.5(H):1(V). Shoring and bracing should be considered for deeper/steeper excavation and excavation at or

below the ground water level and coarse-grained soils. Proper management of groundwater seepage and surface water runoff around excavations will contribute to the stability of temporary slopes. Material removed from the excavations should not be stockpiled within a distance of twenty (20) feet from the crest of any temporary excavations.

Groundwater was encountered at depths ranging from 1.5 to 4.5 feet below the existing ground surface at the time of this exploration. However, the stabilized groundwater table may be encountered at shallower depths, particularly after periods of precipitation. In any event, dewatering should be expected during excavation and compaction operations at this site.

5.10 Seismic Considerations

Our exploration did not include field or laboratory testing for seismic evaluation. However, based on the results of the test borings, the 2015 International Building Code (IBC), and the American Society of Civil Engineers (ASCE) Structural Engineering Institute (SEI) 7-10, Table 20.3-1; the subject site may be classified as Site Class D^2 corresponding to a stiff soil profile (a Risk Category III was selected for this project and should be verified by the Engineer of Record). The following are some site-specific seismic design parameters based on the averages of the shear wave velocities (v_s), field SPT values, and undrained shear strength (S_u):

$$\begin{array}{lll} S_S = 0.097 \text{ g} & S_{MS} = 0.155 \text{ g} & S_{DS} = 0.103 \text{ g} \\ S_1 = 0.055 \text{ g} & S_{M1} = 0.131 \text{ g} & S_{D1} = 0.087 \text{ g} \end{array}$$

Note that the maximum depth of the explored profile during this geotechnical investigation was limited to 30 feet below the existing ground surface. The site classification and seismic design parameters presented above were based on assumed subsurface soil conditions to a depth of 100 feet below the ground surface. For a more accurate classification, at least one (1) SPT boring should be performed to a minimum depth of 100 feet below the ground surface.

5.11 Construction Monitoring and Testing Guidelines

Prior to initiating compaction operations, we recommend that representative samples of the on-site and any off-site materials to be used as structural fill be tested to determine their compaction and classification characteristics. The tests are needed for compaction quality control and acceptability of the structural fill/backfill. Also, a number of representatives in-place field density tests should be performed in the compacted soils and in each lift of structural fill or backfill to verify that the required degree of compaction has been achieved. The following table summarizes the minimum density testing frequencies required at the subject site:

Area	Recommended Minimum Density Test Frequency
Concrete Slab-On-Grade	1 test per 5,000 ft ² in each lift of compacted soils
Footing Bearing Level Soils - Spread Footings - Continuous/Strip Footings	1 test per 250 ft ² of bearing surface 1 test per 250 linear feet of bearing surface
Pavement Areas	1 test per 10,000 ft ²

² Site Class D was used since soil properties are not known in sufficient details, per 2015 IBC, Section 1613.3.2

6.0 PAVEMENT DESIGN CONSIDERATION

6.1 Pavement Areas

Removal of topsoil, tree stumps, root systems, and deleterious materials associated with removal and rerouting of buried utilities should be expected during subgrade preparations for the service road. After the removal of all unsuitable material from the paved areas, exposed surfaces should be thoroughly proofrolled by a qualified engineer prior to placement of any new fill.

The following pavement design is based upon estimated traffic patterns, anticipated traffic volume and quality control per the current Florida Department of Transportation (FDOT) Standard Specifications for Road and Bridge Construction; and the American Association of State Highway and Transportation Officials (AASHTO) criteria. The following pavement sections were designed based on an 85.0 percent level of reliability and 0.0 percent growth rate. Effect of frost heave or soil swelling was considered negligible for the project area.

6.1.1 Standard Duty Pavement

Traffic Volume: An EAL of 18 Kips per day of 4.66 or a total of 34,000 EALs for the design life.

Design Life: 20 years, terminal serviceability = 2.0

Subgrade: Minimum 12 inches of stabilized subgrade having LBR of 40 over recompacted in-situ soils or newly placed engineered fill

Flexible Pavement: Minimum 2.0 inches of Asphaltic Concrete over minimum 8.0 inches of limerock or aggregate base material (LBR=100)

Rigid Pavement: 5.0 inches of Concrete Pavement

6.1.2 Heavy Duty Pavement / Dumpster Pads

Traffic Volume: An EAL of 18 Kips per day of 9.32 or a total of 68,000 EALs for the design life.

Design Life: 20 years, terminal serviceability = 2.5

Subgrade: Minimum 12 inches of stabilized subgrade having LBR of 40 over recompacted in-situ soils or newly placed engineered fill

Flexible Pavement: Minimum 3.0 inches of Asphaltic Concrete over minimum 8.0 inches of limerock or aggregate base material (LBR=100)

Rigid Pavement: 6.0 inches of Concrete Pavement

6.2 Pavement Subgrade

Any fill utilized to elevate the pavement areas to final subgrade elevations should consist of relatively clean fine sands (inorganic, non-expansive/non-plastic sands containing less than 12 percent, by weight, of fines). Pavement subgrade should be uniformly compacted to a minimum density of 95 percent of the soil's modified Proctor maximum dry density (ASTM D-1557).

Laboratory tests should be performed on all fill placed within the pavement areas to confirm these soils meet the minimum requirements and can achieve the desired LBR values of 40. Where subgrade stabilization is necessary, stabilization should be used, as specified by the current Florida Department of Transportation (FDOT) "Standard Specifications for Road and Bridge Construction", Section 160. To avoid rutting, traffic should not be allowed on pavement subgrades prior to placement and compaction of the base course materials.

6.3 Base Course

A limerock or graded aggregate base material may be used on this project. In this area, it has been our experience that limerock base is the most economical and readily available base material. The selected base should meet the requirements of Section 911 of the current FDOT "Standard Specifications for Road and Bridge Construction", should be compacted to 98 percent of its maximum dry density as determined by the modified Proctor test (ASTM D-1557); and can achieve a Limerock Bearing Ratio (LBR) of 100 at the required compaction level. The use of base material other than limerock or graded aggregate is not recommended without prior approval of the Engineer.

6.4 Limerock Bearing Ratio (LBR) Test Results

During our field program, one (1) bulk sample was obtained from the upper 2 feet of the in-situ soils near boring B-09. The sample was delivered to our Lake City, Florida laboratory on March 19, 2020. A Limerock Bearing Ratio (LBR), (FDOT FM5-515) test was performed on this sample indicating the following results:

- Optimum Moisture Content = 11.1
- Maximum Dry Density (pcf) = 111.7 pcf
- $LBR_{0.1''}$ = 44
- Fines Content (- No. 200 sieve) = 4.3%

7.0 STORMWATER MANAGEMENT CONSIDERATIONS

One (1) in-place permeability test was performed at the subject site at about 3 feet below the land surface. The following table summarizes the results:

Boring No.	Location	Test Depth (feet)	Permeability Rate (ft./day)	At-Completion Groundwater (feet)	USDA Seasonal High Groundwater (feet)	USDA Soil Map Unit	Hydrologic Group
A-01	See Borings Location Map	3	3.1	2	1'	Mascotte fine sand (Soil Map Unit No. 37)	B/D

Test depths referenced from existing ground surface.

7.1 Design Parameters for Stormwater Management Facilities

Based on the results of the field exploration and review of the USDA/NRCS data, the following parameters may be used to aid in the design of the stormwater management facilities at the subject site:

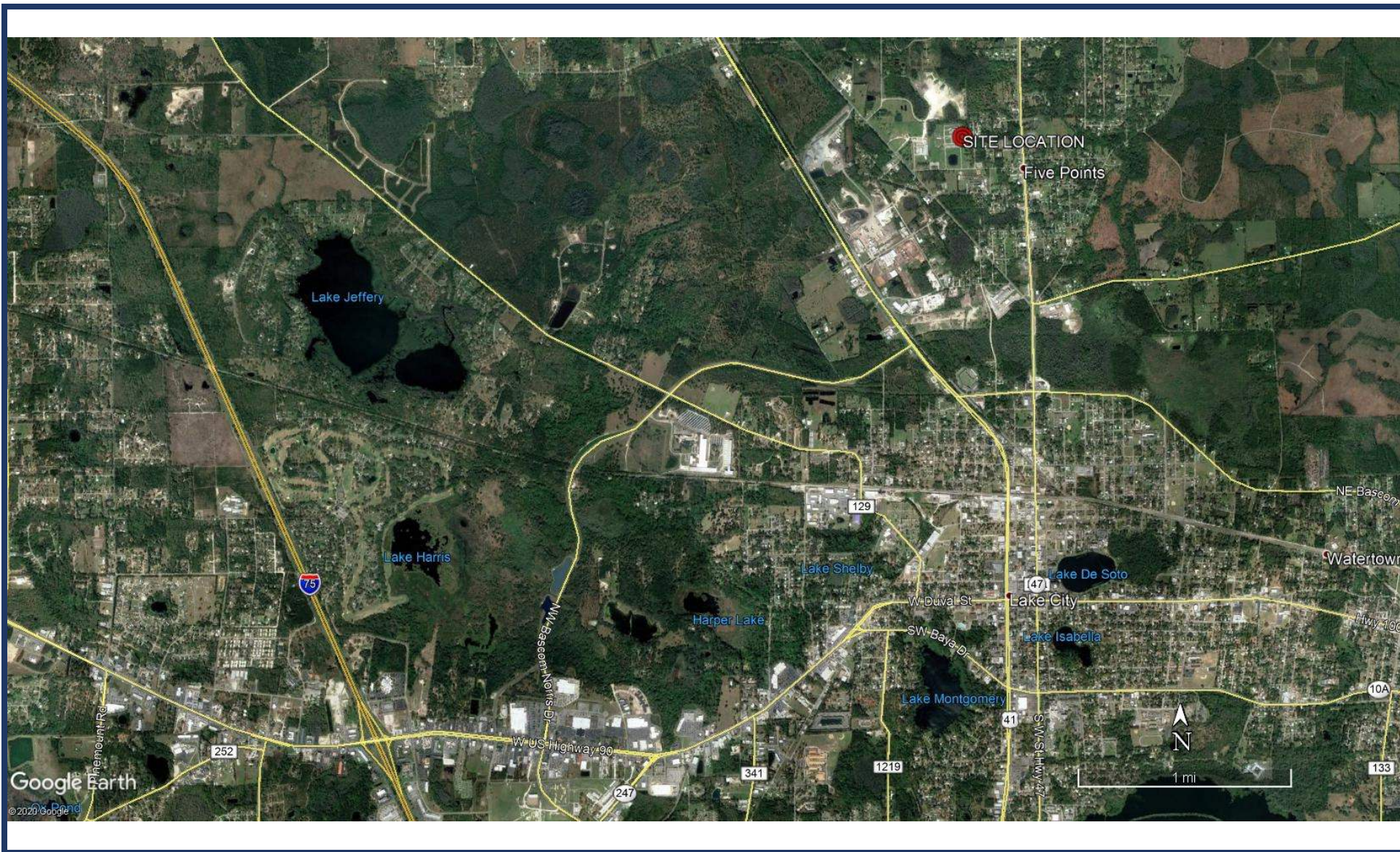
Vicinity of A-01

- Depth to confining layer = 12 feet
- Estimated permeability coefficient = 3.1 ft./day
- Suggested horizontal hydraulic conductivity = 4.7 ft./day
- Estimated depth to seasonal high-water table = 1.5 feet
- Fillable Porosity = 20%

8.0 REPORT LIMITATIONS

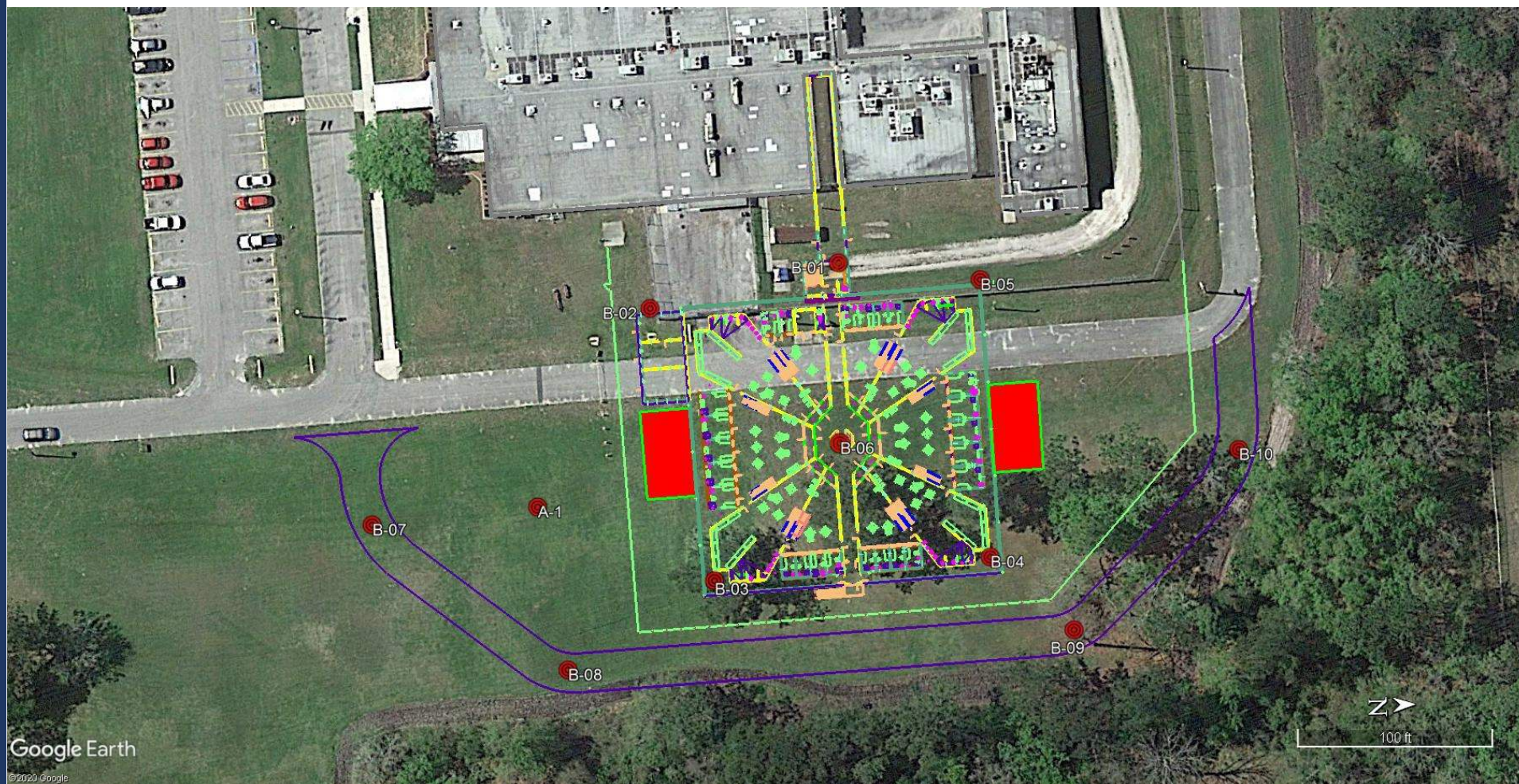
This report has been prepared for the exclusive use of Dewberry Engineers, Inc. of Orlando, Florida and for the specific application to the project discussed herein. Our conclusions and recommendations have been rendered using generally accepted standards of geotechnical engineering practice in the State of Florida. No other warranty is expressed or implied. AID is not responsible for the interpretations, conclusions, opinions, or recommendations of others based on the data contained herein. Environmental assessment for the presence of pollutants within the subject site was beyond the scope of this exploration. Samples collected during our field program that were not destructed in the process of testing will remain in our storage facility for a period of 180 calendar days starting from the date of this report. Should you require a longer storage period, this office should be notified in writing prior to the termination of the 180-day storage period

ATTACHMENTS



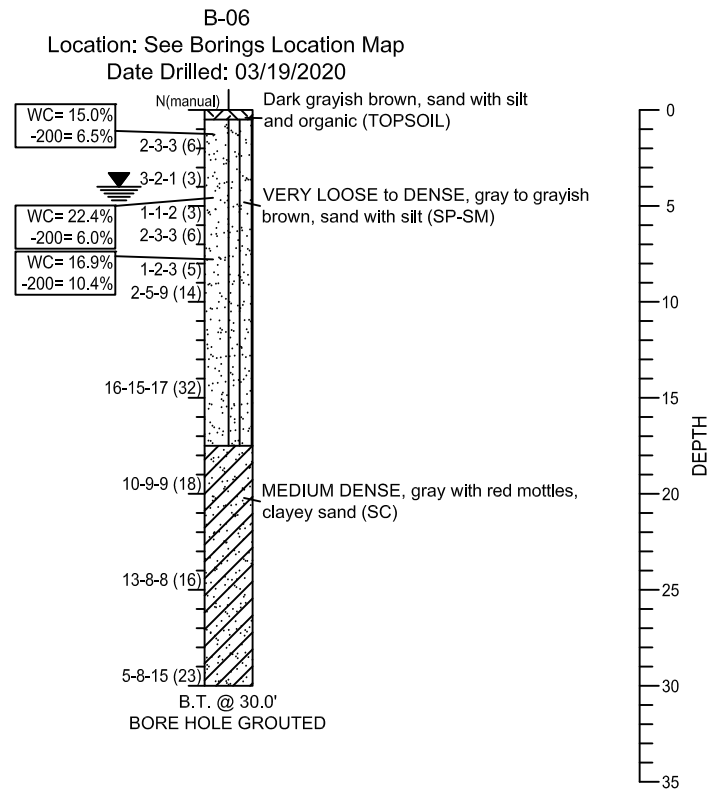
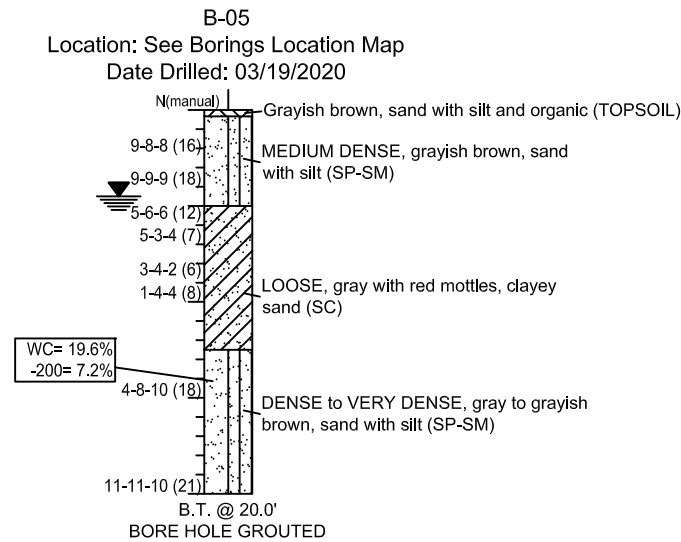
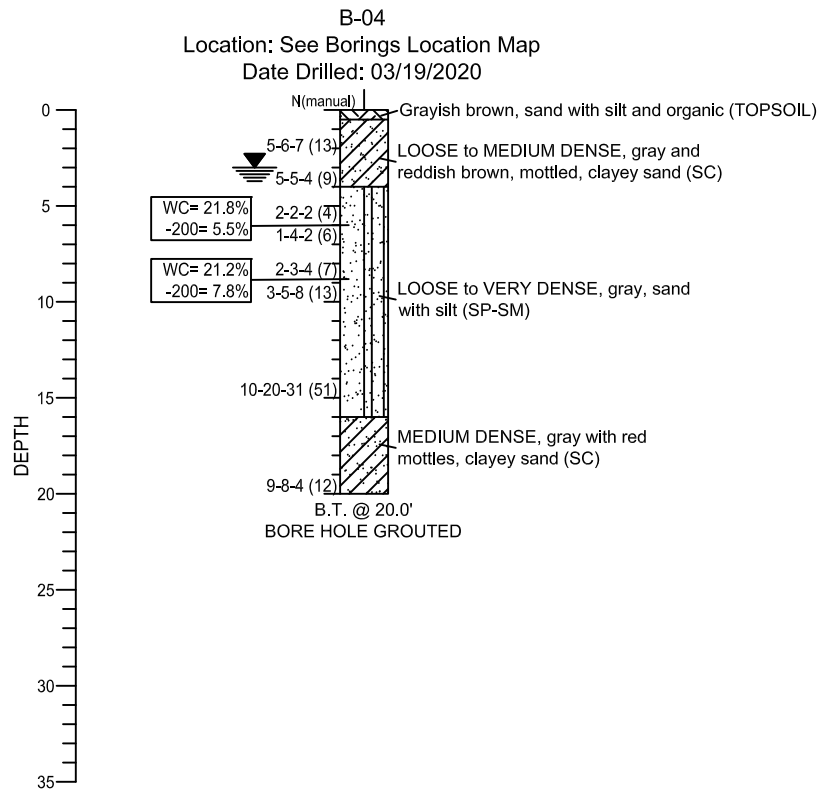
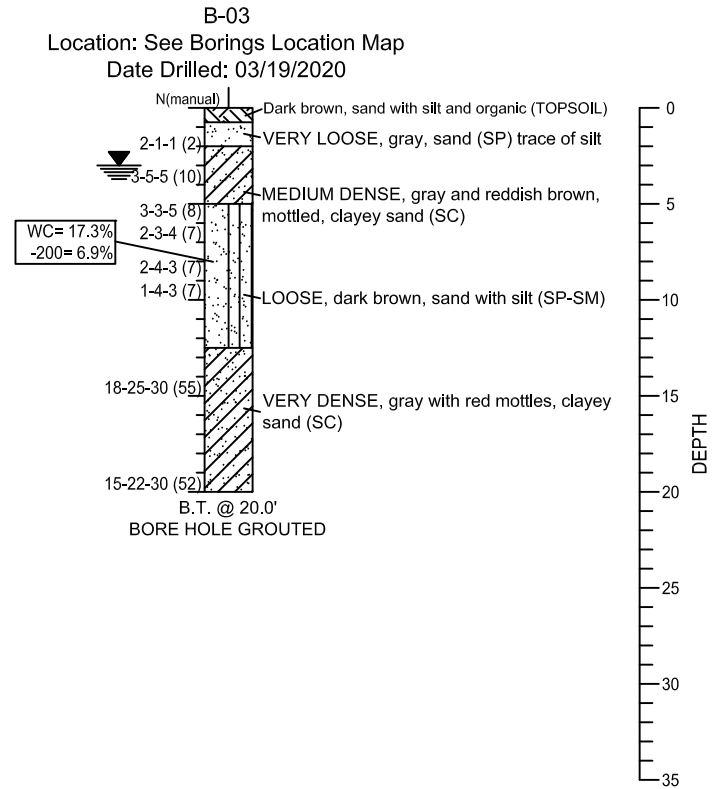
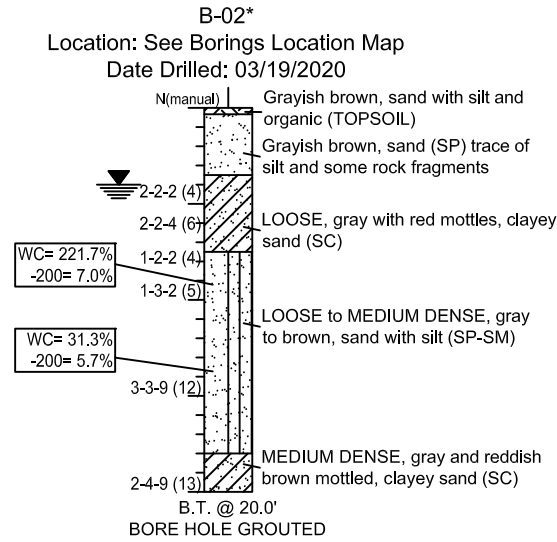
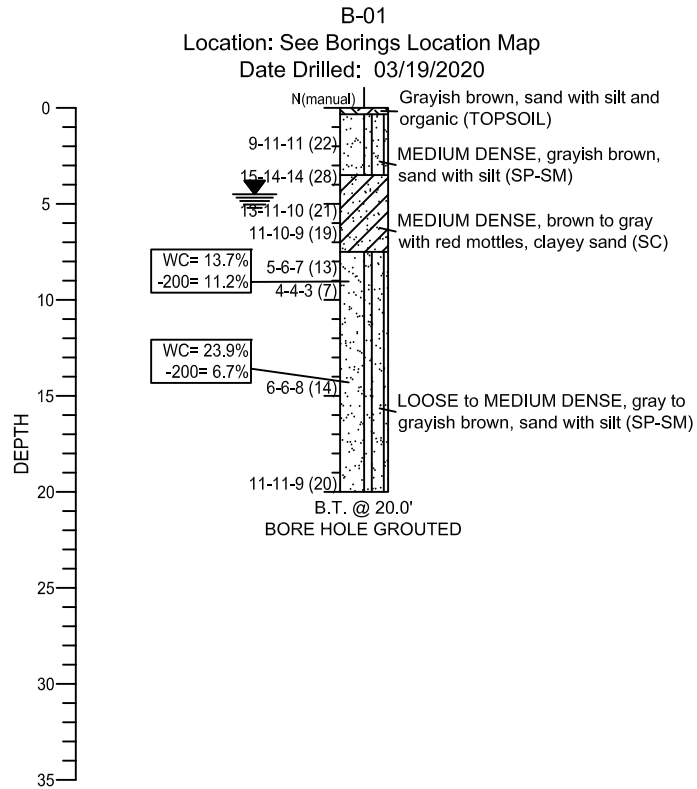
American Infrastructure Development, Inc.
 3810 Northdale Boulevard, Suite 170
 Tampa, Florida 33624
 Phone: (813) 374-2200

Vicinity Map
 Columbia County Detention Center Expansion
 389 NW Quinten Street
 Lake City, Columbia County, Florida
 AID, Inc. Project No. DEI20006



American Infrastructure Development, Inc.
3810 Northdale Boulevard, Suite 170
Tampa, Florida 33624
Phone: (813) 374-2200

Boring Location Map
Columbia County Detention Center Expansion
389 NW Quinten Street
Lake City, Columbia County, Florida
AID, Inc. Project No. DEI20006



ENGINEERING CLASSIFICATION		
	Safety Hammer (SPT N-Value)	Automatic Hammer (SPT N-Value)
RELATIVE DENSITY OF GRANULAR MATERIALS		
Very Loose	Less than 4	Less than 3
Loose	4 - 10	3 - 8
Medium Dense	10 - 30	8 - 24
Dense	30 - 50	24 - 40
Very Dense	Greater than 50	Greater than 40
CONSISTENCY OF SILTS & CLAYS		
Very Soft	Less than 2	Less than 1
Soft	2 - 4	1 - 3
Firm	4 - 8	3 - 6
Stiff	8 - 15	6 - 12
Very Stiff	15 - 30	12 - 24
Hard	Greater than 30	Greater than 24
STANDARD PENETRATION TEST DATA		
SPOON INSIDE DIAMETER - 1.4"		
SPOON OUTSIDE DIAMETER - 2.0"		
AVERAGE HAMMER DROP HEIGHT - 30"		
HAMMER WEIGHT - 140 pounds		
ASTM STANDARD DROP HAMMER (MANUAL & AUTOMATIC)		

LEGEND:	
B.T.	Boring Terminated
—	Existing Ground Surface
▲	Ground Water at Time of Drilling
▲	Wet Season Water Table
N	Sta. Penetration Resistance in Blows Per foot (18- inch Spoon, ASTM D-1586)
WOR	Weight of Rod
WOH	Weight of Hammer
W	Moisture Content (%)
OC	Organic Content (%)
-200	Fines Passing No. 200 U.S. Sieve (%)
LL	Liquid Limit
PI	Plasticity Index
RCP	Reinforced Concrete Pipe
SL	Survey Line
(SP)	Unified Soil Classification Based on Visual Observation and Laboratory Tests

TOPSOIL	Sandy clay (CL)
Sand (SP)	Clay (CH)
Sand with silt (SP-SM)	Asphalt
Sandy Silt (ML)	Limerock
Clayey sand with silt (SC-SM)	Limestone
Clayey sand (SC)	

* BORING B-02 WAS HAND AUGERED TO ±3 FEET DUE TO SUSPECTED PRESENCE OF BURIED UTILITIES

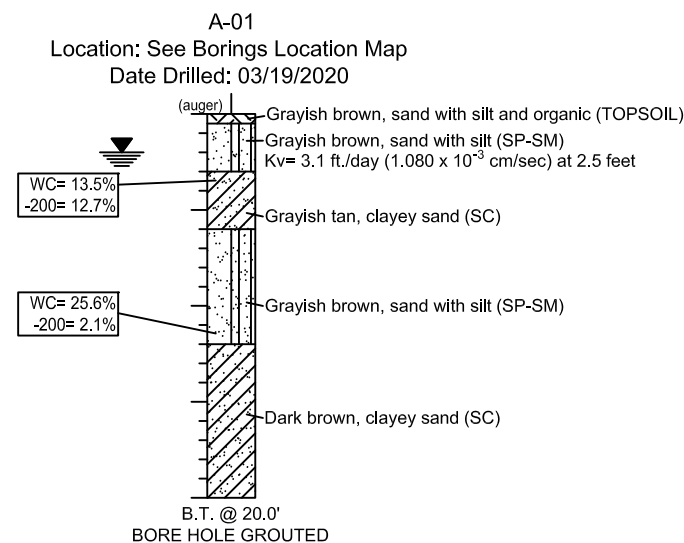
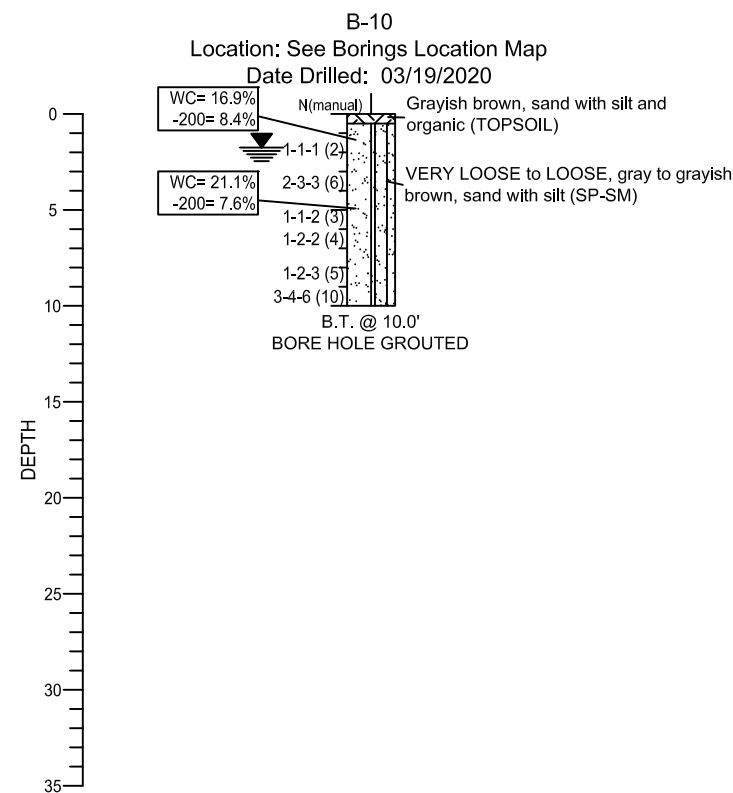
COLUMBIA COUNTY DETENTION CENTER
EXPANSION
LAKE CITY, COLUMBIA COUNTY, FLORIDA



AMERICAN INFRASTRUCTURE DEVELOPMENT, INC.
3810 NORTHDAL E BOULEVARD, SUITE 170
TAMPA, FLORIDA 33624
PHONE: (813) 374-2200

RECORD OF AUGER & SPT BORINGS

Project No. DEI20006		DATE: 05/18/2020	FIGURE: 3
DRAWN:	APPROVED:	SCALE: As Shown	SHEET: 1 of 2



<u>ENGINEERING CLASSIFICATION</u>		
	<i>Safety Hammer (SPT N-Value)</i>	<i>Automatic Hammer (SPT N-Value)</i>
RELATIVE DENSITY OF GRANULAR MATERIALS		
Very Loose	Less than 4	Less than 3
Loose	4 - 10	3 - 8
Medium Dense	10 - 30	8 - 24
Dense	30 - 50	24 - 40
Very Dense	Greater than 50	Greater than 40
CONSISTENCY OF SILTS & CLAYS		
Very Soft	Less than 2	Less than 1
Soft	2 - 4	1 - 3
Firm	4 - 8	3 - 6
Stiff	8 - 15	6 - 12
Very Stiff	15 - 30	12 - 24
Hard	Greater than 30	Greater than 24

<u>STANDARD PENETRATION TEST DATA</u>	
SPoon INside DIAMETER	- 1.4"
SPoon OUTside DIAMETER	- 2.0"
AVERAGE HAMMER DROP HEIGHT	- 30"
HAMMER WEIGHT	- 140 pounds
ASTM STANDARD DROP HAMMER (MANUAL & AUTOMATIC)	

B.T.	Boring Terminated
————	Existing Ground Surface
	Ground Water at Time of Drilling
	Wet Season Water Table
N	Sta. Penetration Resistance in Blows Per foot (18- inch Spoon, ASTM D-1586)
WOR	Weight of Rod
WOH	Weight of Hammer
W	Moisture Content (%)
OC	Organic Content (%)
-200	Fines Passing No. 200 U.S. Sieve (%)
LL	Liquid Limit
PI	Plasticity Index
RCP	Reinforced Concrete Pipe
SL	Survey Line
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	TOPSOIL		Sandy clay (CL)
	Sand (SP)		Clay (CH)
	Sand with silt (SP-SM)		Asphalt
	Sandy Silt (ML)		Limerock
	Clayey sand with silt (SC-SM)		Limestone
	Clayey sand (SC)		



**AMERICAN
INFRASTRUCTURE
DEVELOPMENT, INC.**

RECORD OF AUGER & SPT BORINGS

Project No. DEI20006		DATE: 05/18/2020	FIGURE: 3
DRAWN:	APPROVED:	SCALE: As Shown	SHEET: 2 of 2



American Infrastructure Development, Inc.
122 SW Midtown Place, Unit 101, Lake City, Florida 32025-
Phone: (386) 438-8058 / Fax: (386) 438-8058

Record ID: 170

Issue Date:
Monday, May 18, 2020

**Report of Limerock Bearing Ratio (FDOT FM 5-515) Test
Modified Proctor (AASHTO 1T-180)**

Project No.: 2000007 / DEI20006
Project Name: Columbia County Detention Center Expansion
City/State: Lake City, Florida 32055
County/Parish: Columbia

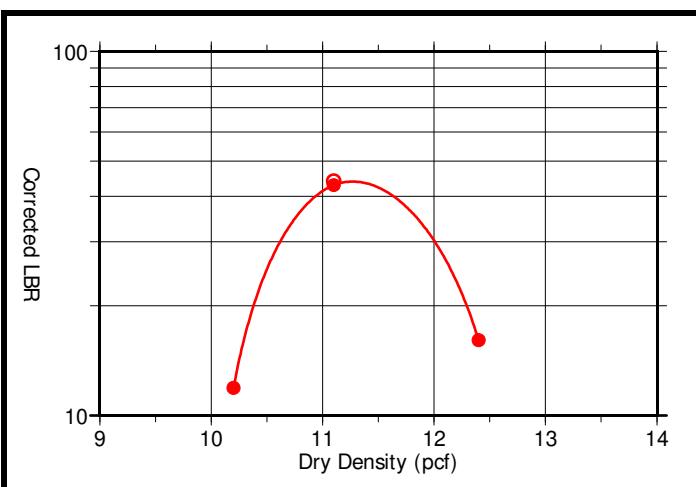
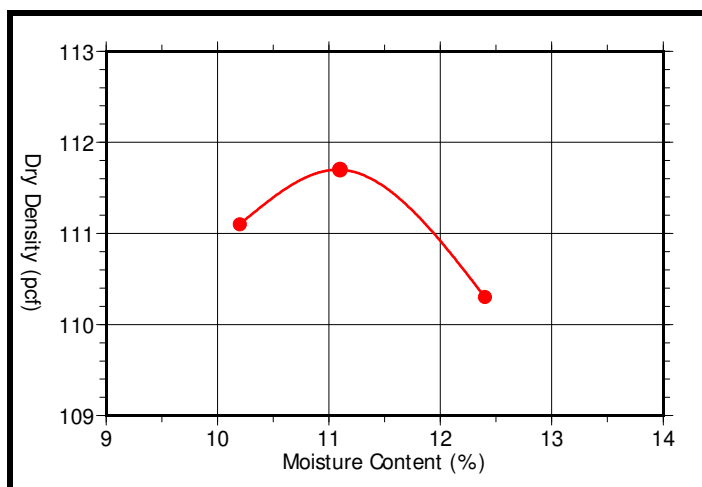
Company: Dewberry Engineers, Inc.
Contact: Christopher J. Allen
Address: 800 North Magnolia Ave., Suite 1000
Orlando, Florida 32803

Date Sampled: Thursday, March 19, 2020
Sampled By: Jackie M. Curry
Date Tested:
Tested By: Nabil O. Hmeidi

Date Delivered: Thursday, March 19, 2020
Delivered By: Jackie M. Curry
Received By: Nabil O. Hmeidi
Contractor:

Proposed Use: Pavement Subgrade
Location: Near boring B-09 top 2' of existing ground surface
Description: Grayish brown, sand (SP) trace of silt
Remarks: ===

Weather:



Hammer No. : 134

Sample No. : 0001

Test Method: Method D

Optimum Moisture (%): 11.1

Max. Dry Density (pcf): 111.7

Max. LBR: 44

Water Content (%): ===

Liquid Limit (%): ===

Plastic Limit (%): ===

Plasticity Index (%): ===

Specific Gravity (Gs): ===

Carbonates (%): ===

-3" Sieve (%): 100.0

-No. 4 Sieve (%): 100.0

-No. 10 Sieve (%): 100.0

-No. 40 Sieve (%): ===

-No. 200 Sieve (%): 4.3

The test results and observations presented in this report are specific only to the samples tested at the time of testing. The test(s) were performed in accordance with generally accepted methods and standards. Since material conditions can vary between test locations and change with time, sound judgement should be exercised with regard to the use and interpretation of the data.

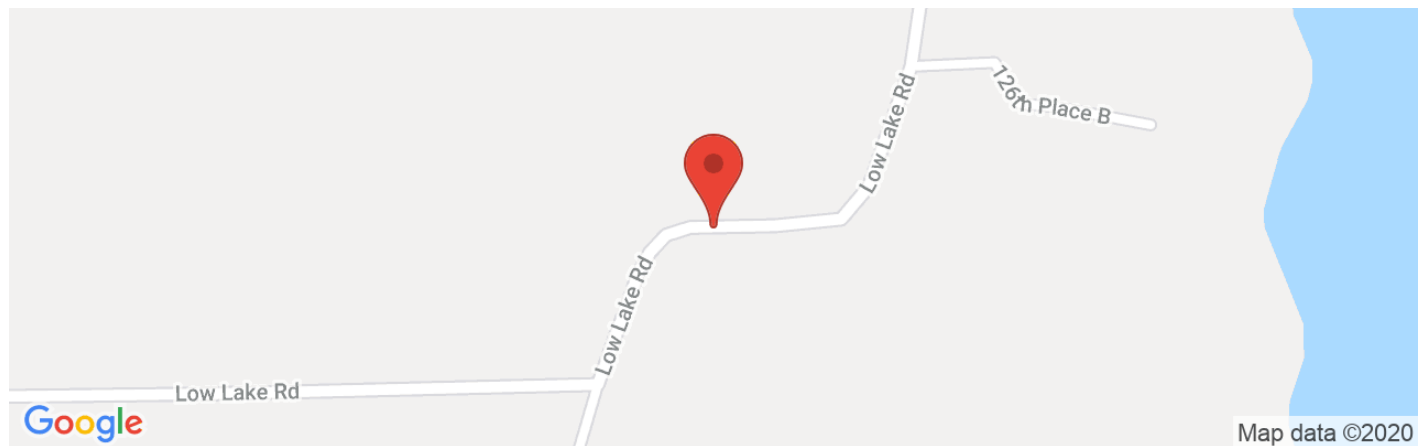
Respectfully Submitted,
American Infrastructure Development, Inc.

Nabil O. Hmeidi, P.E.
Senior Geotechnical Engineer
Licensed, Florida No. 57842



DEI20006 - Columbia County Detention Center

Latitude, Longitude: 30.220524, -82.843003



Date	4/24/2020, 3:39:17 PM
Design Code Reference Document	ASCE7-10
Risk Category	III
Site Class	D - Stiff Soil

Type	Value	Description
S_S	0.097	MCE_R ground motion. (for 0.2 second period)
S_1	0.055	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.155	Site-modified spectral acceleration value
S_{M1}	0.131	Site-modified spectral acceleration value
S_{DS}	0.103	Numeric seismic design value at 0.2 second SA
S_{D1}	0.087	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	B	Seismic design category
F_a	1.6	Site amplification factor at 0.2 second
F_v	2.4	Site amplification factor at 1.0 second
PGA	0.045	MCE_G peak ground acceleration
F_{PGA}	1.6	Site amplification factor at PGA
PGA_M	0.072	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
S_{sRT}	0.097	Probabilistic risk-targeted ground motion. (0.2 second)
S_{sUH}	0.108	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
S_{sD}	1.5	Factored deterministic acceleration value. (0.2 second)
S_{1RT}	0.055	Probabilistic risk-targeted ground motion. (1.0 second)
S_{1UH}	0.062	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S_{1D}	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.894	Mapped value of the risk coefficient at short periods

Type	Value	Description
C _{R1}	0.878	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

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Columbia County Detention Facility

Lake City, Florida

7-23-2020

RE: Technology Narrative for new housing unit

Based on conversations with the owner and common technology needs required by detention centers, the following security technology disciplines and product solutions will be designed for the new housing unit.

Programmable Logic Controller (PLC):

This solution will be used to control locking and unlocking of doors, door and latch position monitoring, day lighting control, cell lighting control, video visitation control and television control. This system is also the engine that creates and operates the graphical user interface (GUI) presented on the touchscreen monitors used to operate the PLC system. Duress/panic buttons will be connected to this system to provide indication of officers or inmates in need. At the time of final design, the upper tier rover station, C202, will be equipped with 2 workstations and 2 touchscreen monitors providing control and monitoring of the PLC solution. 1 workstation and 1 touchscreen monitor will be placed in the existing master control station in room A171 as this location will be used as a backup to the rover station in the new housing unit. 1 duress/panic button will be placed at each rover station. This solution will also include guard tour functionality using credential (card) readers. As the guard makes their round, that person's proximity card will be presented at each guard tour location. This presentation will be logged and may be reviewed at any given time to ensure complete guard tours are being accomplished. An access control system will be used as the interface between the guard tour credential readers and the PLC system.

The PLC will also be connected to the new gate equipment providing opening and closing of the gate along with monitoring of vehicle presence using detection loops installed within the road outside and inside the gate.

All head end gear will be placed in the SEC./Data room C206

The PLC solution will integrate with the new intercom and video surveillance (CCTV) solution.

Video Surveillance (CCTV)

New data network (IP) based cameras will be placed around the perimeter and within the new detention housing unit. Pin hole cameras will also be placed in 2 dual height pedestals located at the new gate. All cameras in this solution will be high definition, vandal resistant and rated for their installed environment. 2 workstations and 4 monitors will be placed in the upper tier rover station,

C202. 2 workstations and 4 monitors will be placed in the existing master control room A171 for remote monitoring and backup purposes. All head end gear will be placed in the SEC./Data room C206.

The video surveillance (CCTV) solution will integrate with the new intercom and PLC solutions.

Intercommunication System (Intercom)

New data network (IP) based intercom units will be placed throughout the facility providing direct communications from these locations to the 2 master intercom units installed in the upper tier rover station C202. Intercom units will also be placed in the dual height pedestals located at the new gate. This solution will also provide overhead paging for mass verbal notification and pre-programmed messages.

All head end gear will be placed in the SEC./Data room C206.

The intercom solution will be integrated with the PLC and CCTV solution.

Information Transport System (ITS)

ITS is the cabling solution that connects all devices mentioned above. This solution includes category 6 data cabling required for connectivity of the surveillance cameras, intercom stations, workstations and head end connectivity. THHN cabling will be used to connect PLC control to day lighting, cell lighting, video visitation control and television control. Fiber optic cable will be installed to extend the network from the new housing facility to the existing master control room. Typical data network switches will be used to connect the data systems together; as power over ethernet (PoE) data switched will be used as a network connection and power source for the surveillance cameras and the intercom stations. The winning bidder of this project will be required to test all cabling installed.