

DOCUMENT 004113 - BID FORM - STIPULATED SUM (SINGLE-PRIME CONTRACT)

1.1 BID INFORMATION

- A. Bidder: _____.
- B. Bidder License Number: _____.
- C. Bidder Phone: _____.
- D. Project Name: Transylvania County New Courthouse Building.
- E. Project Location: Public Safety Way, Brevard, NC 28712.
- F. Owner: Transylvania County, 101 South Broad Street, Brevard, NC 28712.
- G. Architect: Sizemore Group, LLC, 9 SW Pack Square, Suite 302, Asheville, NC 28801.

1.2 CERTIFICATIONS AND BASE BID

- A. Base Bid, Single-Prime (All Trades) Contract: The undersigned Bidder, having carefully examined the Procurement and Contracting Requirements, Conditions of the Contract, Drawings, Specifications, and all subsequent Addenda, as prepared by Sizemore Group, LLC and Architect's consultants, having visited the site, and being familiar with all conditions and requirements of the Work, hereby agrees to furnish all material, labor, equipment and services, including all scheduled allowances, necessary to complete the construction of the above-named project, according to the requirements of the Procurement and Contracting Documents, for the stipulated sum of:
 - 1. _____ Dollars (\$_____).
 - 2. The above amount may be modified by amounts indicated by the Bidder on the attached Document 004322 "Unit Prices Form" and Document 004323 "Alternates Form."

1.3 BID GUARANTEE

- A. The undersigned Bidder agrees to execute a contract for this Work in the above amount and to furnish surety as specified within 10 days after a written Notice of Award, if offered within 75 days after receipt of bids, and on failure to do so agrees to forfeit to Owner the attached cash, cashier's check, certified check, U.S. money order, or bid bond, as liquidated damages for such failure, in the following amount constituting five percent (5%) of the Base Bid amount above:
 - 1. _____ Dollars (\$_____).
- B. In the event Owner does not offer Notice of Award within the time limits stated above, Owner will return to the undersigned the cash, cashier's check, certified check, U.S. money order, or bid bond.

1.4 SUBCONTRACTORS AND SUPPLIERS

A. The following companies shall execute subcontracts for the portions of the Work indicated:

1. Plumbing Subcontractor:_____.
2. Mechanical (HVAC) Subcontractor:_____.
3. Electrical Subcontractor:_____.
4. Detention Equipment Contractor:_____.
5. Security Control Systems Contractor:_____.
6. Grading/Earthwork Subcontractor:_____.
7. Masonry Subcontractor:_____.
8. Roofing Subcontractor:_____.
9. Fire Protection Subcontractor:_____.

1.5 TIME OF COMPLETION

A. The undersigned Bidder proposes and agrees hereby to commence the Work of the Contract Documents on a date specified in a written Notice to Proceed to be issued by Architect, and shall fully complete the Work within 730 calendar days.

1.6 ACKNOWLEDGEMENT OF ADDENDA

A. The undersigned Bidder acknowledges receipt of and use of the following Addenda in the preparation of this Bid:

1. Addendum No. 1, dated _____.
2. Addendum No. 2, dated _____.
3. Addendum No. 3, dated _____.
4. Addendum No. 4, dated _____.

1.7 BID SUPPLEMENTS

A. The following supplements are a part of this Bid Form and are attached hereto.

1. Bid Form Supplement - Alternates.
2. Bid Form Supplement - Unit Prices.
3. Bid Form Supplement - Bid Bond Form (AIA Document A310).

1.8 CONTRACTOR'S LICENSE

- A. The undersigned further states that it is a duly licensed contractor, for the type of work proposed, in North Carolina, and that all fees, permits, etc., pursuant to submitting this proposal have been paid in full.

1.9 SUBMISSION OF BID

- A. Respectfully submitted this ____ day of _____, 2026.
- B. Submitted By: _____ (Name of bidding firm or corporation).
- C. Authorized Signature: _____ (Handwritten signature).
- D. Signed By: _____ (Type or print name).
- E. Title: _____ (Owner/Partner/President/Vice President).
- F. Witness By: _____ (Handwritten signature).
- G. Attest: _____ (Handwritten signature).
- H. By: _____ (Type or print name).
- I. Title: _____ (Corporate Secretary or Assistant Secretary).
- J. Street Address: _____.
- K. City, State, Zip: _____.
- L. Phone: _____.
- M. License No.: _____.
- N. Federal ID No.: _____ (Affix Corporate Seal Here).

END OF DOCUMENT 004113

DOCUMENT 004322 - UNIT PRICES FORM

1.1 BID INFORMATION

- A. Bidder: _____.
- B. Project Name: Transylvania County New Courthouse Building.
- C. Project Location: Public Safety Way, Brevard, NC 28712.
- D. Owner: Transylvania County, 101 South Broad Street, Brevard, NC 28712.
- E. Architect: Sizemore Group, LLC, 9 SW Pack Square, Suite 302, Asheville, NC 28801.

1.2 BID FORM SUPPLEMENT

- A. This form is required to be attached to the Bid Form.
- B. The undersigned Bidder proposes the amounts below be added to or deducted from the Contract Sum on performance and measurement of the individual items of Work.
- C. If the unit price does not affect the Work of this Contract, the Bidder shall indicate "NOT APPLICABLE."

1.3 UNIT PRICES

- A. Unit-Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.
 - 1. _____ Dollars (\$) per unit.
- B. Unit-Price No. 2: Rock excavation and replacement with satisfactory soil material.
 - 1. _____ Dollars (\$) per unit.
- C. Unit-Price No. 3: Replacement cost of satisfactory soil material.
 - 1. _____ Dollars (\$) per unit.

1.4 SUBMISSION OF BID SUPPLEMENT

- A. Respectfully submitted this ____ day of _____, 2026.
- B. Submitted By: _____ (Insert name of bidding firm or corporation).
- C. Authorized Signature: _____ (Handwritten signature).

D. Signed By: _____ (Type or print name).

E. Title: _____ (Owner/Partner/President/Vice President).

END OF DOCUMENT 004322

DOCUMENT 004323 - ALTERNATES FORM

1.1 BID INFORMATION

- A. Bidder: _____.
- B. Project Name: Transylvania County New Courthouse Building.
- C. Project Location: Public Safety Way, Brevard, NC 28712.
- D. Owner: Transylvania County, 101 South Broad Street, Brevard, NC 28712.
- E. Architect: Sizemore Group, LLC, 9 SW Pack Square, Suite 302, Asheville, NC 28801.

1.2 BID FORM SUPPLEMENT

- A. This form is required to be attached to the Bid Form.

1.3 DESCRIPTION

- A. The undersigned Bidder proposes the amount below be added to or deducted from the Base Bid if particular alternates are accepted by Owner. Amounts listed for each alternate include costs of related coordination, modification, or adjustment.
- B. If the alternate does not affect the Contract Sum, the Bidder shall indicate "NO CHANGE."
- C. If the alternate does not affect the Work of this Contract, the Bidder shall indicate "NOT APPLICABLE."
- D. The Bidder shall be responsible for determining from the Contract Documents the affects of each alternate on the Contract Time and the Contract Sum.
- E. Owner reserves the right to accept or reject any alternate, in any order, and to award or amend the Contract accordingly within 60 days of the Notice of Award unless otherwise indicated in the Contract Documents.
- F. Acceptance or non-acceptance of any alternates by the Owner shall have no affect on the Contract Time unless the "Schedule of Alternates" Article below provides a formatted space for the adjustment of the Contract Time.

1.4 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Morris Road Stormwater Improvements:
 - 1. ADD____ DEDUCT____ NO CHANGE____ NOT APPLICABLE____.
 - 2. _____ Dollars (\$_____).

3. ADD ___ DEDUCT ___ calendar days to adjust the Contract Time for this alternate.

B. Alternate No. 2: Level 2 EV Charging Stations chargers and electrical service:

1. ADD ___ DEDUCT ___ NO CHANGE ___ NOT APPLICABLE ___.

2. _____ Dollars (\$_____).

3. ADD ___ DEDUCT ___ calendar days to adjust the Contract Time for this alternate.

C. Alternate No. 3: Firefighter Radio Amplifier (ERRC BDA) System:

1. ADD ___ DEDUCT ___ NO CHANGE ___ NOT APPLICABLE ___.

2. _____ Dollars (\$_____).

3. ADD ___ DEDUCT ___ calendar days to adjust the Contract Time for this alternate.

D. Alternate No. 4: Lightning Protection System:

1. ADD ___ DEDUCT ___ NO CHANGE ___ NOT APPLICABLE ___.

2. _____ Dollars (\$_____).

3. ADD ___ DEDUCT ___ calendar days to adjust the Contract Time for this alternate.

1.5 SUBMISSION OF BID SUPPLEMENT

A. Respectfully submitted this ___ day of _____, 2026.

B. Submitted By: _____ (Insert name of bidding firm or corporation).

C. Authorized Signature: _____ (Handwritten signature).

D. Signed By: _____ (Type or print name).

E. Title: _____ (Owner/Partner/President/Vice President).

END OF DOCUMENT 004323

AIA® Document A310™ – 2010

Bid Bond

CONTRACTOR:

(Name, legal status and address)

SURETY:

(Name, legal status and principal place of business)

OWNER:

(Name, legal status and address)

BOND AMOUNT:**PROJECT:**

(Name, location or address, and Project number, if any)

Transylvania County New Courthouse Building
Public Safety Way, Brevard, NC 28712

Project Number, if any:

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

Any singular reference to Contractor, Surety, Owner or other party shall be considered plural where applicable.

The Contractor and Surety are bound to the Owner in the amount set forth above, for the payment of which the Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, as provided herein. The conditions of this Bond are such that if the Owner accepts the bid of the Contractor within the time specified in the bid documents, or within such time period as may be agreed to by the Owner and Contractor, and the Contractor either (1) enters into a contract with the Owner in accordance with the terms of such bid, and gives such bond or bonds as may be specified in the bidding or Contract Documents, with a surety admitted in the jurisdiction of the Project and otherwise acceptable to the Owner, for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof; or (2) pays to the Owner the difference, not to exceed the amount of this Bond, between the amount specified in said bid and such larger amount for which the Owner may in good faith contract with another party to perform the work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect. The Surety hereby waives any notice of an agreement between the Owner and Contractor to extend the time in which the Owner may accept the bid. Waiver of notice by the Surety shall not apply to any extension exceeding seventy-five (75) days in the aggregate beyond the time for acceptance of bids specified in the bid documents, and the Owner and Contractor shall obtain the Surety's consent for an extension beyond seventy-five (75) days.

If this Bond is issued in connection with a subcontractor's bid to a Contractor, the term Contractor in this Bond shall be deemed to be Subcontractor and the term Owner shall be deemed to be Contractor.

When this Bond has been furnished to comply with a statutory or other legal requirement in the location of the Project, any provision in this Bond conflicting with said statutory or legal requirement shall be deemed deleted herefrom and provisions conforming to such statutory or other legal requirement shall be deemed incorporated herein. When so furnished, the intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

Signed and sealed this _____ day of _____

(Witness)

(Principal)

(Seal)

(Title)

(Witness)

(Surety)

(Seal)

(Title)

Init.

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SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. **Owner-Designated Equipment Suppliers.**
4. Access to site.
5. Work restrictions.
6. Specification and Drawing conventions.
7. Miscellaneous provisions.

B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.

1.3 PROJECT INFORMATION

A. Project Identification: Transylvania County New Courthouse Building.

1. Project Location: Public Safety Way, Brevard, NC 28712.

B. Owner: Transylvania County, 101 South Broad Street, Brevard, NC 28712.

1. Owner's Representative: Ms. Jaime Laughter, Transylvania County Manager, 101 South Broad Street, Brevard, NC 28712.

C. Architect: Sizemore Group, LLC, 9 SW Pack Square, Suite 302, Asheville, NC 28801.

D. Architect's Consultants: Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Civil and Landscape Engineers: RVE, Inc.; 90 Southside Avenue, Suite 300, Asheville, NC 28801.
2. Structural Engineer: Britt Peters and Associates; 1725 Electric Avenue, Unit 320, Watkinsville, GA 30677.

3. Mechanical, Electrical, Plumbing, and Fire Protection Engineers: RVE, Inc.; 90 Southside Avenue, Suite 300, Asheville, NC 28801.
 4. Audio Visual, Telecom, and Security Engineering: Newcomb & Boyd; 303 Peachtree Center Avenue, NE, Suite 525, Atlanta, GA 30303.
- E. Other Owner Consultants: Owner has retained the following design professionals who have prepared designated portions of the Contract Documents:
1. S&ME, Inc; 44 Buck Shoals Road, Suite 603, Arden, NC 28704, has prepared the following portions of the Contract Documents:
 - a. Site retaining wall designs.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
1. Project consists of a new Type II-B, fully sprinklered, steel-framed, 67,500 SF two-story plus basement courthouse building with associated site work and other Work indicated in the Contract Documents.
- B. Type of Contract:
1. Project will be constructed under a single prime contract.

1.5 **OWNER-DESIGNATED EQUIPMENT SUPPLIERS**

- A. Transylvania County has determined, pursuant to N.C.G.S. §143-129(e)(6), that standardization and compatibility are overriding considerations for the systems identified below. To maintain compatibility, coordinated operation, system reliability, warranty, commissioning, service, and maintenance requirements, the County has approved procurement from the following Owner-designated sources, subject to the terms and conditions approved by the County Attorney:
- B. Owner-Designated Equipment Suppliers include:
1. Fire alarms and building automation.
 - a. Johnson Controls.
 - 1) Mary McMerty.
 - 2) mary.elizabeth.mcmerty@jci.com.
 - 3) 864-376-7491.
 2. Detention security hardware, software, and systems.
 - a. Cornerstone Detention Products.
 - 1) Mike Suriano.
 - 2) msuriano@cornerstoneinc.com
 - 3) 919-325-4332.
 3. Security cameras and systems outside of detention areas.
 - a. Security Camera Warehouse.

- 1) Cory Anderson.
 - 2) Cory.anderson@getscw.com.
 - 3) 828-492-2004.
4. Locking hardware and cores.
 - a. Best Locks.
 - 1) Cook and Boardman, now CBX Solutions.
 - 2) John McLaughlin.
 - 3) 336-962-0198.
5. HVAC chillers, boilers and associated controls.
 - a. Carrier HVAC Systems
6. Access control hardware and software.
 - a. Supreme Incorporated.
 - 1) Scott Tobin.
 - 2) stobin@supremainc.com.
 - 3) 407-341-6922.
7. Emergency power systems and power management and switchgear.
 - a. Atlantic South Power.
 - 1) Joel Crook.
 - 2) joel@atlanticsouthpower.com
 - 3) 828-226-1451.
 - b. Emergency power systems and power management and switchgear to include:
 - 1) Emergency generator.
 - 2) Stairs and Platforms in order to provide service for the Emergency Generator.
 - 3) Dual-Purpose Docking Station.
 - 4) All Emergency Power Transfer Switch Gear.
 - 5) The Commissioning of the Emergency Power Generation System.
 - 6) All Electrical Distribution Equipment and Gear as Described Below:
 - a) All main electrical distribution panels and switchboards, as shown on the Single Line Drawings.
 - b) All electrical panels and switchboards shown on the Panel Schedule List.
 - c) All listed over current protective devices, breakers, and fuses.
 - d) All electrical disconnects.
 - e) All safety switches.
 - f) All lighting contactors and timers.
 - c. Responsibilities:
 - 1) Atlantic South Power Engineering shall provide all required equipment submittals to Electrical Engineer of Record, the selected General Contractor, and the selected Electrical Contractor.
 - 2) Atlantic South Power shall schedule delivery of all equipment listed above with the Electrical Contractor of Record.
 - 3) The Electrical Contractor shall not include allowances in their bid for any equipment listed above.
 - 4) Atlantic South Power is an equipment supplier only, all labor and materials, other than equipment listed above shall be provided and installed by the Electrical Contractor.

- d. REFER TO DIVISION 26 – ELECTRICAL EQUIPMENT SECTIONS for additional responsibilities of Owner-Designated Equipment Suppliers.

1.6 ACCESS TO SITE

- A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Owner's right to perform work or to retain other contractors on portions of Project.
- B. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.7 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations.
 - 1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
- B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 7 a.m. to 6 p.m., Monday through Saturday, unless otherwise indicated.
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
 - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
 - 2. Obtain Owner's written permission before proceeding with utility interruptions.
- D. Restricted Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
- E. Employee Identification: Provide identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.
- F. Employee Screening: Comply with Owner's requirements for drug and background screening of Contractor personnel working on Project site.
 - 1. Maintain list of approved screened personnel with Owner's representative.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
 2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.
- C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:
1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
 2. Abbreviations: Materials and products are identified by abbreviations published as part of the U.S. National CAD Standard and scheduled on Drawings.
 3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for unit prices.
- B. Related Requirements:
 - 1. Section 012100 "Allowances" for procedures for using unit prices to adjust quantity allowances.
 - 2. Section 012600 "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
 - 3. Section 014000 "Quality Requirements" for field testing by an independent testing agency.

1.3 DEFINITIONS

- A. Unit price is a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

- A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
- B. Measurement and Payment: See individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.
- C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
- D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

- A. Unit Price No. 1: Removal of unsatisfactory soil and replacement with satisfactory soil material.
1. Description: Unsatisfactory soil excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 312000 "Earth Moving."
 2. Unit of Measurement: Cubic yard (Cubic meter) of soil excavated, based on in-place surveys of volume before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- B. Unit Price No. 2: Rock excavation and replacement with satisfactory soil material.
1. Description: Classified rock excavation and disposal off-site and replacement with satisfactory fill material or engineered fill from off-site, as required, according to Section 312000 "Earth Moving."
 2. Unit of Measurement: Cubic yard (Cubic meter) of rock excavated, based on survey of in-place surveys volume of before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- C. Unit Price No. 3: Replacement of satisfactory soil material.
1. Description: Replacement of satisfactory fill material or engineered fill from off-site, as required, according to Section 312000 "Earth Moving."
 2. Unit of Measurement: Cubic yard (Cubic meter) of soil excavated, based on in-place surveys of volume before and after removal.
 3. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."
- D. Unit Price No. 4: Unit-Cost Allowance for brick veneer.
1. Description: Include the sum of \$585.00 per thousand for red flashed-colored wirecut face brick as specified in Section 042000 "Unit Masonry" and as shown on Drawings.
 2. Quantity Allowance: Coordinate unit price with allowance adjustment requirements in Section 012100 "Allowances."

END OF SECTION 012200

SECTION 012300 - ALTERNATES

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if the Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
 - 1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
 - 2. The cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternates into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the alternate into Project.
 - 1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
- B. Execute accepted alternates under the same conditions as other work of the Contract.
- C. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF ALTERNATES

- A. Alternate No. 1: Morris Road Stormwater Improvements.
1. Alternate: All stormwater improvements detailed in the attached Morris Road Stormwater Improvements plans as designed by High County Engineering. See Civil sheets C-131 and C-132, Site Drainage and Utility Plans, within the Transylvania County Courthouse plans. The base bid shall include proposed 30" RCP outfall pipe, concrete headwall 2 (HW-2), and rip rap at HW-2. For alternate 1, proposed 30" RCP outfall pipe, HW-2, and rip rap at HW-2 shall not be included. Proposed outlet pipe shall be 24" RCP sloped at 1.30% and tied into gate inlet A-1 added per Morris Road Stormwater Improvements plans at invert = 2135.93 (NW)."
- B. Alternate No. 2: Two (2) Level 2 EV Charging Units and Electrical Service.
1. Base Bid: EV parking area signage, parking striping, concrete pads and bollards.
 2. Alternate: The furnishing and installation of two (2) Level 2 EV charging units with associated electrical service infrastructure.
 - a. BASIS OF DESIGN: PowerCharge 32A-40A Commercial Energy Series (32A-40A); Open-Access Type.
 - b. Application: Commercial.
 - c. Voltage: 208-240VAC, Single Phase.
 - d. Frequency: 60 Hz.
 - e. Current: 32A/7.6 kW – 40A/9.6 kW.
 - f. Circuit Breaker: 16A=20A/24A=30A/32A=40A/40A=50A.
 - g. Charging Connector: SAE J1772.
 - h. Charging Cable Length: 18 ft.
 - i. Display: Color LED Status Lights.
 - j. Mounting Type: Dual Pedestal Mount.
 - k. Warranty: 3 years parts warranty.
- C. Alternate No. 3: Firefighter Radio Amplifier (ERRC BDA) System.
1. Alternate: The furnishing and installation of a complete Firefighter Radio Amplifier (ERRC BDA) System. Provide all labor, equipment, materials, and supervision to install, calibrate, adjust, document, and test the total system as required herein and on the drawings.
- D. Alternate No. 4: Lightning Protection System.
1. Alternate: The furnishing and installation of a complete Lightning Protection System. Provide all labor, equipment, materials, and supervision to install, calibrate, adjust, document, and test the total system as required herein and on the drawings.

END OF SECTION 012300

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 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.

1.2 SUMMARY

- A. Section includes administrative and procedural requirements for quality assurance and quality control.
- B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
 - 1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
 - 2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide quality-assurance and quality-control services required by Architect, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.3 DEFINITIONS

- A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
 - 1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

- D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
 - 1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements, consisting of multiple products, assemblies, and subassemblies.
- E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
- G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.
- H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.
- J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Architect.

1.4 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
 - 1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to Architect.

1.5 CONFLICTING REQUIREMENTS

- A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements are specified and the standards or requirements establish different or conflicting

requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for direction before proceeding.

- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.6 ACTION SUBMITTALS

- A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.7 INFORMATIONAL SUBMITTALS

- A. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:
 - 1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
 - 2. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.
- B. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
- C. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
 - 1. Specification Section number and title.
 - 2. Entity responsible for performing tests and inspections.
 - 3. Description of test and inspection.
 - 4. Identification of applicable standards.
 - 5. Identification of test and inspection methods.
 - 6. Number of tests and inspections required.
 - 7. Time schedule or time span for tests and inspections.
 - 8. Requirements for obtaining samples.
 - 9. Unique characteristics of each quality-control service.
- D. Reports: Prepare and submit certified written reports and documents as specified.

- E. Permits, Licenses, and Certificates: For Owner's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

1.8 REPORTS AND DOCUMENTS

- A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
 - 1. Date of issue.
 - 2. Project title and number.
 - 3. Name, address, telephone number, and email address of testing agency.
 - 4. Dates and locations of samples and tests or inspections.
 - 5. Names of individuals making tests and inspections.
 - 6. Description of the Work and test and inspection method.
 - 7. Identification of product and Specification Section.
 - 8. Complete test or inspection data.
 - 9. Test and inspection results and an interpretation of test results.
 - 10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
 - 11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
 - 12. Name and signature of laboratory inspector.
 - 13. Recommendations on retesting and reinspecting.

1.9 QUALITY ASSURANCE

- A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.
- E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed

for installations of the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

- F. Specialists: Certain Specification Sections require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.
 - 1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.
- G. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented according to ASTM E 329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
 - 1. Contractor responsibilities include the following:
 - a. Provide test specimens representative of proposed products and construction.
 - b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 - c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
 - d. Build site-assembled test assemblies and mockups using installers who will perform same tasks for Project.
 - e. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.
 - 2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.
- K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Architect.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Architect's approval of mockups before starting corresponding work, fabrication, or construction.
 - a. Allow seven days for initial review and each re-review of each mockup.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed unless otherwise indicated.

1.10 QUALITY CONTROL

- A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
 1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.
 2. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor.
- B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.
 1. Engage a qualified testing agency to perform quality-control services.
 - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
 2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspection will be performed.
 3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
 4. Testing and inspection requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
 5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- C. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- D. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including

service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

- E. Associated Contractor Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
 - 1. Access to the Work.
 - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
 - 3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
 - 4. Facilities for storage and field curing of test samples.
 - 5. Delivery of samples to testing agencies.
 - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
 - 7. Security and protection for samples and for testing and inspection equipment at Project site.
- F. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.
 - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- G. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents. Coordinate and submit concurrently with Contractor's Construction Schedule. Update as the Work progresses.
 - 1. Distribution: Distribute schedule to Owner, Architect, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.11 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections: Owner will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Owner, as indicated in the Statement of Special Inspections on Sheets S0.02 and S0.03 in the Contract Documents, and as follows:
 - 1. Notifying Architect and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
 - 2. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect with copy to Contractor and to authorities having jurisdiction.
 - 3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
 - 4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
 - 5. Retesting and reinspecting corrected work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

- A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:
 - 1. Date test or inspection was conducted.
 - 2. Description of the Work tested or inspected.
 - 3. Date test or inspection results were transmitted to Architect.
 - 4. Identification of testing agency or special inspector conducting test or inspection.
- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's reference during normal working hours.
 - 1. Submit log at Project closeout as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

- A. General: On completion of testing, inspection, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
 - 1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."
- B. Protect construction exposed by or for quality-control service activities.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 014000

SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. Owner's Project Requirements and Basis-of-Design Document are included by reference for information only.

1.2 SUMMARY

A. Section Includes:

- 1. General requirements for coordinating and scheduling commissioning activities.
- 2. Commissioning meetings.
- 3. Commissioning reports.
- 4. Use of commissioning process test equipment, instrumentation, and tools.
- 5. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
- 6. Commissioning tests and commissioning test demonstration.
- 7. Adjusting, verifying, and documenting identified systems and assemblies.

B. Related Requirements:

- 1. Section 011000 "Summary" for Commissioning Authority responsibilities.
- 2. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
- 3. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
- 4. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.
- 5. Section 220800 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
- 6. Section 230800 "Commissioning of HVAC" for technical commissioning requirements for HVAC.
- 7. Section 260800 "Commissioning of Electrical Systems" for technical commissioning requirements for electrical systems.

1.3 DEFINITIONS

- A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

- B. Basis-of-Design Document: A document prepared by Architect that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.
- C. Commissioning Authority: An entity engaged by Owner, and identified in Section 011000 "Summary," to evaluate Commissioning-Process Work.
- D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.
- E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Owner's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities. The scope of the commissioning process is defined in Section 011000 "Summary."
- F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished. Owner will establish in writing the date construction-phase commissioning-process completion is achieved. See Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
 - 1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:
 - a. Completion of tests and acceptance of test results.
 - b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
 - c. Comply with requirements in Section 017900 "Demonstration and Training."
 - d. Completion and acceptance of submittals and reports.
- G. Owner's Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Owner or for the Owner by the Architect or Commissioning Authority.
- H. Owner's Witness: Commissioning Authority, Owner's Project Manager, or Architect-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.
- I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.
- J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.
- K. Sampling Procedures and Tables for Inspection by Attributes: As defined in ASQ Z1.4.

1.4 COMPENSATION

- A. If Architect, Commissioning Authority, other Owner's witness, or Owner's staff perform additional services or incur additional expenses due to actions of Contractor listed below, compensate Owner for such additional services and expenses.
 - 1. Failure to provide timely notice of commissioning activities schedule changes.
 - 2. Failure to meet acceptance criteria for test demonstrations.
- B. Contractor shall compensate Owner for such additional services and expenses at the rate of \$150 per labor hour, plus \$1,000 per round trip for personnel travelling more than 200 miles, plus per diem allowances for meals and lodging according to current U.S. General Services Administration (GSA) Per Diem Rates.

1.5 COMMISSIONING TEAM

- A. Members Appointed by Contractor(s):
 - 1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
 - 2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
 - 3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
 - 4. Appointed team members shall have the authority to act on behalf of the entity they represent.
- B. Members Appointed by Owner:
 - 1. Commissioning Authority, plus consultants that Commissioning Authority may deem appropriate for a particular portion of the commissioning process.
 - 2. Owner representative(s), facility operations and maintenance personnel, plus other employees, separate contractors, and consultants that Owner may deem appropriate for a particular portion of the commissioning process.
 - 3. Architect, plus employees and consultants that Architect may deem appropriate for a particular portion of the commissioning process.

1.6 INFORMATIONAL SUBMITTALS

- A. Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.
- B. Commissioning Plan Information:
 - 1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
 - 2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 013200 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.

3. Contractor personnel and subcontractors participating in each test.
 4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.
- C. Commissioning schedule.
- D. Two-week look-ahead schedules.
- E. Commissioning Coordinator Letter of Authority:
1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:
 - a. Make inspections required for commissioning process.
 - b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
 - c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
 - d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.
- F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.
1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.
- G. List test instrumentation, equipment, and monitoring devices. Include the following information:
1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
 2. Brief description of intended use.
 3. Calibration record showing the following:
 - a. Calibration agency, including name and contact information.
 - b. Last date of calibration.
 - c. Range of values for which calibration is valid.
 - d. Certification of accuracy.
 - e. Certification for calibration equipment traceable to NIST.
 - f. Due date of the next calibration.
- H. Test Reports:
1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
 2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.

3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

I. Construction Checklists:

1. Material checks.
2. Installation checks.
3. Startup procedures, where required.

1.7 CLOSEOUT SUBMITTALS

A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:
 - a. Pre-startup reports.
 - b. Approved test procedures.
 - c. Test data forms, completed and signed.
 - d. Progress reports.
 - e. Commissioning issue report log.
 - f. Commissioning issue reports showing resolution of issues.
 - g. Correspondence or other documents related to resolution of issues.
 - h. Other reports required by commissioning process.
 - i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
 - j. Report shall include commissioning work of Contractor.

B. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Commissioning Coordinator Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.
2. Certification of commissioning-process expertise. The following certifications are acceptable. Owner reserves the right to accept or reject certifications as evidence of qualification.
 - a. Certified Commissioning Authority, by AABC Commissioning Group (ACG).

- b. Commissioning-Process Management Professional, by American Society of Heating, Refrigerating and Air-Conditioning Engineers.
 - c. Certified Commissioning Professional, by Building Commissioning Association.
- B. Calibration Agency Qualifications: Certified by The American Association for Laboratory Accreditation that the calibration agency complies with minimum requirements of ISO/IEC 17025.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.
- B. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:
 - 1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
 - 2. Calibrated and certified.
 - a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
 - b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.
 - 3. Maintain test equipment and instrumentation.
 - 4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

2.2 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

- A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.
 - 1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
 - 2. Proprietary test equipment, instrumentation, and tools shall become the property of Owner at Substantial Completion.

2.3 REPORT FORMAT AND ORGANIZATION

A. General Format and Organization:

1. Record report on compact disk.
2. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

1. Include a table of contents and an index to each test.
2. Include major tabs for each Specification Section.
3. Include minor tabs for each test.
4. Within each minor tab, include the following:
 - a. Test specification.
 - b. Pre-startup reports.
 - c. Approved test procedures.
 - d. Test data forms, completed and signed.
 - e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Review preliminary construction checklists and preliminary test procedures and data forms.

3.2 CONSTRUCTION CHECKLISTS

- A. Construction checklists cannot modify or conflict with the Contract Documents.
- B. Create construction checklists based on actual systems and equipment to be included in Project.
- C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.
 1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
 2. Included optional features.
 3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
 4. Installation Checks:
 - a. Location according to Drawings and approved Shop Drawings.

- b. Configuration.
 - c. Compliance with manufacturers' written installation instructions.
 - d. Attachment to structure.
 - e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
 - f. Utility connections are of the correct characteristics, as applicable.
 - g. Correct labeling and identification.
 - h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.
- D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.
- E. Performance Tests:
- 1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
 - 2. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
 - 3. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
 - 4. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
 - 5. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.
- F. Deferred Construction Checklists: Obtain Owner approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
- 1. Identify deferred construction checklists by number and title.
 - 2. Provide a target schedule for completion of deferred construction checklists.
 - 3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.
- G. Delayed Construction Checklists: Obtain Owner approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:
- 1. Identify delayed construction checklist by construction checklist number and title.
 - 2. Provide a target schedule for completion of delayed construction checklists.

3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

3.3 GENERAL EXECUTION REQUIREMENTS

- A. Schedule and coordinate commissioning process with the Construction Schedule.
- B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.
- C. Perform test demonstrations for Owner's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
 1. Where sampling is specified, the sampling plan and procedure for the test demonstration shall be determined using ASQ Z1.4.
 - a. General Inspection: Level I.
 - b. Special Inspection: Level S-1.
 - c. Acceptance Quality Limit (AQL) of 1.5.
 2. The "lot size" in ASQ Z1.4 is the sum of the number of items to which the test demonstration applies, as described in the scope subparagraph of each test.
 3. On determination of the sample size, the samples shall be selected randomly by Owner's witness at the time of the test demonstration.
 4. Include in the Commissioning Plan a detailed list of the test demonstrations with lot and sample quantities for each test.
- D. Report test data and commissioning issue resolutions.
- E. Schedule personnel to participate in and perform Commissioning-Process Work.
- F. Installing contractors' commissioning responsibilities include, but are not limited to, the following:
 1. Operating the equipment and systems they install during tests.
 2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

3.4 COMMISSIONING COORDINATOR RESPONSIBILITIES

- A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:
 1. Coordinate with subcontractors on their commissioning responsibilities and activities.
 2. Obtain, assemble, and submit commissioning documentation.
 3. Conduct periodic on-site commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."
 4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.

5. Review and comment on preliminary test procedures and data forms.
6. Report inconsistencies and issues in system operations.
7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
8. Direct and coordinate test demonstrations.
9. Coordinate witnessing of test demonstrations by Owner's witness.
10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 017900 "Demonstration and Training."
11. Prepare and submit specified commissioning reports.
12. Track commissioning issues until resolution and retesting is successfully completed.
13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Owner's representative access to these records on request.
14. Assemble and submit commissioning report.

3.5 COMMISSIONING TESTING

- A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.
- B. Owner's witness will be present to witness commissioning work requiring the signature of an owner's witness, including, but not limited to, test demonstrations. Owner's project manager will coordinate attendance by Owner's witness with Contractor's published Commissioning Schedule. Owner's witness will provide no labor or materials in the commissioning work. The only function of Owner's witness will be to observe and comment on the progress and results of commissioning process.
- C. Construction Checklists:
 1. Complete construction checklists as Work is completed.
 2. Distribute construction checklists to installing contractors before they start work.
 3. Installers:
 - a. Verify installation using approved construction checklists as Work proceeds.
 - b. Complete and sign construction checklists weekly for work performed during the preceding week.
 4. Provide Commissioning Authority access to construction checklists.
- D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.
- E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.

F. Test Procedures and Test Data Forms:

1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
3. Completed test data forms are the official records of the test results.
4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:
 - a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
 - b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.
6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."
7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100 percent unless otherwise indicated in the individual test specification.
2. Notify Owner's witness at least three days in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.

5. Provide full access to Owner's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Owner's witness at the time of the test to authenticate the reported results.
 6. Test demonstration data forms not signed by Contractor and Owner's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.
 - a. Exception for Failure of Owner's Witness to Attend: Failure of Owner's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Owner's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Owner's witness, and shall note the absence of Owner's witness at the scheduled time and place.
 7. False load test requirements are specified in related sections.
 - a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Architect's written approval.
- I. Deferred Tests:
1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:
 - a. Identify deferred tests by number and title.
 - b. Provide a target schedule for completion of deferred tests.
 2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
 3. Where deferred tests are specified, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.
- J. Delayed Tests:
1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Owner approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process

Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:

- a. Identify delayed tests by test number and title.
 - b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.
2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Architect and Commissioning Authority at least three working days (minimum) in advance of tests.
 3. Where delayed tests are approved, coordinate participation of necessary personnel and of Architect, Commissioning Authority, and Owner's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Architect's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Owner for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:
 - a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
 - b. Submit commissioning compliance issue report form within 24 hours of the test.
 - c. Determine the cause of the failure.
 - d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.
5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.
 - a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.
 - b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
 - c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.

- d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.
- 6. Diagnose and correct failed test demonstrations as follows:
 - a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
 - b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
 - c. Record the results of each step of the diagnostic procedure.
 - d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
 - e. Determine and record corrective measures.
 - f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.
- 7. Retest:
 - a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Owner's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Owner for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
 - b. For each repeated test demonstration, submit a new test data form, marked "Retest."
- 8. Do not correct commissioning compliance issues during test demonstrations.
 - a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than five minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

3.6 COMMISSIONING MEETINGS

- A. Schedule and conduct commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."

3.7 SEQUENCING

- A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:
 - 1. Construction Checklists:

- a. Material checks.
 - b. Installation checks.
 - c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
 - d. Performance Tests:
 - 1) Static tests, as appropriate.
 - 2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
 - 3) Equipment and assembly performance tests.
 - 4) System performance tests.
 - 5) Intersystem performance tests.
2. Commissioning tests.
- B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.
- C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Architect if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.
- D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

3.8 SCHEDULING

- A. Commence commissioning process as early in the construction period as possible.
- B. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 013200 "Construction Progress Documentation."
1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
 2. Schedule the start date and duration for the following commissioning activities:
 - a. Submittals.
 - b. Preliminary operation and maintenance manual submittals.
 - c. Installation checks.
 - d. Startup, where required.
 - e. Performance tests.
 - f. Performance test demonstrations.
 - g. Commissioning tests.
 - h. Commissioning test demonstrations.

3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.

C. Two-Week Look-Ahead Commissioning Schedule:

1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
3. Use two-week look-ahead schedules to notify and coordinate participation of Owner's witnesses.

D. Owner's Witness Coordination:

1. Coordinate Owner's witness participation via Architect.
2. Notify Architect of commissioning schedule changes at least two work days in advance for activities requiring the participation of Owner's witness.

3.9 COMMISSIONING REPORTS

A. Test Reports:

1. Pre-startup reports include observations of the conditions of installation, organized into the following sections:
 - a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
 - b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.
 - c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
 - d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
 - e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Owner completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.
2. Test data reports include the following:

- a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
 - b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
 - c. Signatures of individuals performing and witnessing tests.
 - d. Data trend logs accumulated overnight from the previous day of testing.
3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Owner. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:
 - a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.
 - b. Action distribution list.
 - c. Report date.
 - d. Test number and description.
 - e. Equipment identification and location.
 - f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
 - g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
 - h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
 - i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
 - j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
 - k. Schedule for retesting.
4. Weekly progress reports include information for tests conducted since the preceding report and the following:
 - a. Completed data forms.
 - b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
 - c. Activities scheduled but not conducted per schedule.
 - d. Commissioning compliance issue report log.
 - e. Schedule changes for remaining Commissioning-Process Work, if any.
5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.
 - a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis

- scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
- b. Attach to the data form printed trend log data collected during the test or test demonstration.
 - c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.
6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."
- a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

3.10 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

- A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Owner agrees to accept separately, is complete, Contractor shall prepare and submit to Owner and Commissioning Authority through Architect a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to complete commissioning process.
- B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.
- C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Architect's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.
- D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Substantial Completion.

END OF SECTION 019113

SECTION 042000 - UNIT MASONRY

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. Concrete masonry units.
2. Clay face brick.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry-joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:

1. Cast-stone trim in unit masonry.
2. Steel lintels in unit masonry.
3. Steel shelf angles for supporting unit masonry.
4. Cavity wall insulation.

C. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for dovetail slots for masonry anchors.
2. Section 044200 "Exterior Stone Cladding" for stone trim secured with stone anchors.
3. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
4. Section 071900 "Water Repellents" for water repellents applied to unit masonry assemblies.
5. Section 072100 "Thermal Insulation" for cavity wall insulation.
6. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 ALLOWANCES

- A. Face brick is part of the Face Brick Allowance.

1.4 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
 - 3. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315.
 - 4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Verification: For each type and color of the following:
 - 1. Clay face brick.
 - 2. Special brick shapes.
 - 3. Stone trim.
 - 4. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 - 5. Weep holes and cavity vents.
 - 6. Accessories embedded in masonry.

1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
 - 1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include data on material properties.
 - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
 - c. For exposed brick, include test report for efflorescence according to ASTM C 67.
 - d. For masonry units, include data and calculations establishing average net-area compressive strength of units.

2. Integral water repellent used in CMUs.
 3. Cementitious materials. Include name of manufacturer, brand name, and type.
 4. Mortar admixtures.
 5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 6. Grout mixes. Include description of type and proportions of ingredients.
 7. Reinforcing bars.
 8. Joint reinforcement.
 9. Anchors, ties, and metal accessories.
- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- E. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.7 QUALITY ASSURANCE

- A. Sample Panels: Build sample panels to verify selections made under Sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
1. Build sample panels for typical exterior wall in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness.
 2. Build sample panels facing south.
 3. Where masonry is to match existing, build panels adjacent and parallel to existing surface.
 4. Clean exposed faces of panels with masonry cleaner indicated.
 5. Protect approved sample panels from the elements with weather-resistant membrane.
 6. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.
 - a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless Architect specifically approves such deviations in writing.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockup of typical wall area as shown on Drawings.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in exterior wall mockup.

- b. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
 - c. Include metal studs, sheathing, water-resistive barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
2. Clean exposed faces of mockups with masonry cleaner as indicated.
3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls, and hold cover securely in place.
 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is **40 deg F (4 deg C)** and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.2 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
 1. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.3 UNIT MASONRY, GENERAL

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.
- C. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 - 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C 90.
 - 1. Size (Width): Manufactured to dimensions **3/8 inch (10 mm)** less than nominal dimensions.

2.5 CONCRETE AND MASONRY LINTELS

- A. General: Provide one of the following:
- B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated.
- C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.
- D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.6 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 - 3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 - 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C 216.
 - 1. **Products:**
 - a. BASIS OF DESIGN: Palmetto Brick (Flashed Wirecut).
 - b. Cherokee Brick.
 - c. Lee Brick.

- d. Taylor Clay Brick.
- e. Triangle Brick.
- f. Watsontown Brick.
- 2. Grade: SW.
- 3. Type: FBX.
- 4. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67.
- 5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
- 6. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.
- 7. Application: Use where brick is exposed unless otherwise indicated.
- 8. Color and Texture: As selected by Architect.

2.7 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
 - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
- E. Mortar Cement: ASTM C 1329/C 1329M.
- F. Aggregate for Mortar: ASTM C 144.
 - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 - 2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 - 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 - 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C 404.
- H. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- I. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.

- J. Water: Potable.

2.8 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, **Grade 60 (Grade 420)**.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from **0.148-inch (3.77-mm)** steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement, General: ASTM A 951/A 951M.
1. Interior Walls: Hot-dip galvanized carbon steel.
 2. Exterior Walls: Hot-dip galvanized carbon steel.
 3. Wire Size for Side Rods: **0.148-inch (3.77-mm)** diameter.
 4. Wire Size for Cross Rods: **0.148-inch (3.77-mm)** diameter.
 5. Wire Size for Veneer Ties: **0.148-inch (3.77-mm)** diameter.
 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than **16 inches (407 mm)** o.c.
 7. Provide in lengths of not less than **10 feet (3 m)**, with prefabricated corner and tee units.
- D. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder type with single pair of side rods.
- E. Masonry-Joint Reinforcement for Multiwythe Masonry:
1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum horizontal play of **1/16 inch (1.5 mm)** and maximum vertical adjustment of **1-1/4 inches (32 mm)**. Size ties to extend at least halfway through facing wythe but with at least **5/8-inch (16-mm)** cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.
- F. Masonry-Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single **0.187-inch (4.76-mm)** diameter, hot-dip galvanized carbon-steel continuous wire.

2.9 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least **1-1/2 inches (38 mm)** into veneer but with at least a **5/8-inch (16-mm)** cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
 2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304].
 3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 4. Stainless-Steel Sheet: ASTM A 240/A 240M or ASTM A 666, Type 304.

5. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 6. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
- C. Corrugated-Metal Ties: Metal strips not less than **7/8 inch (22 mm)** wide with corrugations having a wavelength of **0.3 to 0.5 inch (7.6 to 12.7 mm)** and an amplitude of **0.06 to 0.10 inch (1.5 to 2.5 mm)** made from **0.030-inch- (0.76-mm-)** thick steel sheet, galvanized after fabrication.
- D. Individual Wire Ties: Rectangular units with closed ends and not less than **4 inches (100 mm)** wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than **2 inches (50 mm)** long may be used for masonry constructed from solid units.
 2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of **1-1/4 inches (32 mm)**.
 3. Wire: Fabricate from **3/16-inch- (4.76-mm-)** diameter, hot-dip galvanized steel wire.
- E. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped **1/4-inch- (6.35-mm-)** diameter, hot-dip galvanized steel wire.
 2. Tie Section: Triangular-shaped wire tie made from **0.187-inch- (4.76-mm-)** diameter, hot-dip galvanized steel wire.
- F. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from **0.060-inch- (1.52-mm-)** thick steel sheet, galvanized after fabrication.
 2. Tie Section: Triangular-shaped wire tie made from **0.187-inch- (4.76-mm-)** diameter, hot-dip galvanized steel wire.
- G. Partition Top Anchors: **0.105-inch- (2.66-mm-)** thick metal plate with a **3/8-inch- (9.5-mm-)** diameter metal rod **6 inches (152 mm)** long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- H. Rigid Anchors: Fabricate from steel bars **1-1/2 inches (38 mm)** wide by **1/4 inch (6.35 mm)** thick by **24 inches (610 mm)** long, with ends turned up **2 inches (51 mm)** or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.
- I. Adjustable Masonry-Veneer Anchors:

1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch (1.5 mm).
2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch- (1.90-mm-) thick steel sheet, galvanized after fabrication.
3. Fabricate wire ties from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
4. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
5. Screw-Attached, Masonry-Veneer Anchors: Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with a projecting vertical tab having a slotted hole for inserting wire tie.
6. Seismic Masonry-Veneer Anchors: Connector section and rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having slotted holes for inserting vertical leg of connector section. Connector section consists of a rib-stiffened, sheet metal bent plate with down-turned leg designed to fit in anchor section slot and with integral tabs designed to engage continuous wire.
7. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours according to ASTM B 117.

2.10 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.016 inch (0.40 mm) thick.
2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.
4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate metal drip edges for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches (76 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
7. Fabricate metal drip edges from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.

8. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
9. Solder metal items at corners.

B. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
4. Where flashing is fully concealed, use metal flashing.

C. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from UV-resistant, high-density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

D. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, chemically curing urethane sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.

E. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

F. Termination Bars for Flexible Flashing: Stainless steel bars **0.075 inch by 1 inch (1.90 mm by 25 mm)**.

2.11 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D 226/D 226M, Type I (No. 15 asphalt felt).
- D. Weep/Cavity Vent Products: Use the following unless otherwise indicated:
 1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth **1/8 inch (3 mm)** less than depth of outer wythe, in color selected from manufacturer's standard.

- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Configuration: Provide one of the following:
 - a. Strips, full depth of cavity and 10 inches (250 mm) high, with dovetail-shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.

2.12 MASONRY-CELL FILL

- A. Loose-Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).
- B. Lightweight-Aggregate Fill: ASTM C 331/C 331M.

2.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type M.
 - 2. For reinforced masonry, use Type N.
 - 3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
 - 4. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
 3. Provide grout with a slump of 8 to 11 inches (200 to 280 mm) as measured according to ASTM C 143/C 143M.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
1. Application: Use epoxy pointing mortar for exposed mortar joints with the following units:
 - a. Pre-faced CMUs.
 - b. Glazed brick.
 - c. Glazed structural clay facing tile.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
 4. Verify that substrates are free of substances that impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp,

unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

- 1. For dimensions in cross section or elevation, do not vary by more than plus **1/2 inch (12 mm)** or minus **1/4 inch (6 mm)**.
- 2. For location of elements in plan, do not vary from that indicated by more than plus or minus **1/2 inch (12 mm)**.
- 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus **1/4 inch (6 mm)** in a story height or **1/2 inch (12 mm)** total.

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than **1/4 inch in 10 feet (6 mm in 3 m)**, or **1/2-inch (12-mm)** maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 3. For vertical lines and surfaces, do not vary from plumb by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than **1/8 inch in 10 feet (3 mm in 3 m)**, **1/4 inch in 20 feet (6 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 5. For lines and surfaces, do not vary from straight by more than **1/4 inch in 10 feet (6 mm in 3 m)**, **3/8 inch in 20 feet (9 mm in 6 m)**, or **1/2-inch (12-mm)** maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than **1/4 inch in 10 feet (6 mm in 3 m)**, or **1/2-inch (12-mm)** maximum.
- 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than **1/16 inch (1.5 mm)** except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**, with a maximum thickness limited to **1/2 inch (12 mm)**.
- 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than **1/8 inch (3 mm)**.
- 3. For head and collar joints, do not vary from thickness indicated by more than plus **3/8 inch (9 mm)** or minus **1/4 inch (6 mm)**.
- 4. For exposed head joints, do not vary from thickness indicated by more than plus or minus **1/8 inch (3 mm)**.

5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than **1/16 inch (1.5 mm)** from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than **2 inches (50 mm)**. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal **4-inch (100-mm)** horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout **24 inches (600 mm)** under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide **1/2-inch (13-mm)** clearance between end of anchor rod and end of tube. Space anchors **48 inches (1200 mm)** o.c. unless otherwise indicated.
 3. Wedge nonload-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
 4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 "Joint Firestopping."

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.
2. Bed webs in mortar in all courses of piers, columns, and pilasters.
3. Bed webs in mortar in grouted masonry, including starting course on footings.
4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Wet joint surfaces thoroughly before applying mortar.
3. Rake out mortar joints for pointing with sealant.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer **3/4 inch (19 mm)** or more in width.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

F. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.6 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for **4.5 sq. ft. (0.42 sq. m)** of wall area spaced not to exceed **36 inches (914 mm)** o.c. horizontally and **16 inches (406 mm)** o.c. vertically. Stagger ties in alternate courses. Provide additional ties within **12 inches (305 mm)** of openings and space not more than **36 inches (915 mm)** apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than **24 inches (610 mm)** o.c. vertically.
 - a. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) ties.
 - b. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) ties to allow for differential movement regardless of whether bed joints align.

2. Masonry-Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use tab-type reinforcement.
 - b. Where bed joints of wythes do not align, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable-type (two-piece-type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
 3. Header Bonding: Provide masonry unit headers extending not less than **3 inches (76 mm)** into each wythe. Space headers not more than **8 inches (203 mm)** clear horizontally and **16 inches (406 mm)** clear vertically.
 4. Masonry-Veneer Anchors: Comply with requirements for anchoring masonry veneers.
- B. Bond wythes of cavity walls together using bonding system indicated on Drawings.
- C. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- D. Parge cavity face of backup wythe in a single coat approximately **3/8 inch (10 mm)** thick. Trowel face of parge coat smooth.
- E. Installing Cavity Wall Insulation: Place small dabs of adhesive, spaced approximately **12 inches (300 mm)** o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.7 ANCHORED MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Embed tie sections in masonry joints.
 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 4. Space anchors as indicated, but not more than **18 inches (458 mm)** o.c. vertically and **24 inches (610 mm)** o.c. horizontally, with not less than one anchor for each **2 sq. ft. (0.2 sq. m)** of wall area. Install additional anchors within **12 inches (305 mm)** of openings and at intervals, not exceeding **8 inches (203 mm)**, around perimeter.

- B. Provide not less than 2 inches (50 mm) of airspace between back of masonry veneer and face of insulation.
 - 1. Keep airspace clean of mortar droppings and other materials during construction. Bevel beds away from airspace, to minimize mortar protrusions into airspace. Do not attempt to trowel or remove mortar fins protruding into airspace.

3.8 MASONRY-JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
 - 1. Space reinforcement not more than 16 inches (406 mm) o.c.
 - 2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
 - 3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at corners by using prefabricated L-shaped units.
- D. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.9 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
 - 1. Provide an open space not less than 2 inches (50 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control- and expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.

- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than **3/8 inch (10 mm)**.

- 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 LINTELS

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than **12 inches (305 mm)** for brick-size units and **24 inches (610 mm)** for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of **8 inches (200 mm)** at each jamb unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, AND CAVITY VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape.
 - 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of **8 inches (200 mm)**, and through inner wythe to within **1/2 inch (13 mm)** of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately **2 inches (50 mm)** on interior face.
 - 3. At masonry-veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least **8 inches (200 mm)**; with upper edge tucked under water-resistive barrier, lapping at least **4 inches (100 mm)**.
 - 4. At lintels and shelf angles, extend flashing a minimum of **6 inches (150 mm)** into masonry at each end. At heads and sills, extend flashing **6 inches (150 mm)** at ends and turn up not less than **2 inches (50 mm)** to form end dams.
 - 5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than **1-1/2 inches (38 mm)** or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 - 6. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of

wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- E. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.
 - 1. Use specified weep/cavity vent products to form weep holes.
 - 2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
 - 3. Space weep holes **24 inches (600 mm)** o.c. unless otherwise indicated.
 - 4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
 - 5. Trim wicking material flush with outside face of wall after mortar has set.
- F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than **2 inches (50 mm)**, to maintain drainage.
- G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- H. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.13 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in TMS 602/ACI 530.1/ASCE 6 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than **60 inches (1520 mm)**.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level C in TMS 402/ACI 530/ASCE 5.
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.
- I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.15 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in two uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat, and scarify first coat to ensure full bond to subsequent coat.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.16 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 6. Clean stone trim to comply with stone supplier's written instructions.
 - 7. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.17 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

- D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 07 9219 - ACOUSTICAL JOINT SEALANTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Acoustical joint sealants where indicated on Drawings.

1.02 DEFINITIONS

- A. Acoustic Joint Sealant: "Acoustic Joint Sealant or Spray: Material or combination of materials used to achieve specified acoustical rating of non fire-rated assembly by providing an effective barrier against sound transmission through construction joint and through penetration openings."

1.03 RELATED WORK OF OTHER SECTIONS

- A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
 - 1. Section 03 3000 – Cast-in-Place Concrete
 - 2. Section 07 8443 – Joint Firestopping
 - 4. Section 07 9000 – Joint Sealants

1.04 REFERENCES

- A. Test Requirements:
 - 1. ASTM C734, Standard Test Method for Low-Temperature Flexibility of Latex Sealants After Artificial Weathering
 - 2. ASTM C834, Standard Specification for Latex Sealants
 - 3. ASTM C919, Standard Practice for Use of Sealants in Acoustical Applications
 - 4. ASTM D217, Standard Test Methods for Cone Penetration of Lubricating Grease
 - 5. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
 - 6. ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements
 - 7. ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi
 - 8. ISO 11600, Building construction -- Jointing products -- Classification and requirements for sealants

1.06 QUALITY ASSURANCE

- A. Installing contractor shall arrange for the acoustic joint sealant manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of acoustic sealant and spray systems to train appropriate contractor personnel in proper selection and installation procedures.
- B. Acoustical sealants shall be installed per manufacturer's written recommendations published in their literature and drawing details.

1.07 SUBMITTALS

- A. Submit Product Data: Manufacturer's specifications and technical data for each material including documentation of STC testing and manufacturer's installation instructions in accordance with Section 01 30 00.
- B. Submit material safety data sheets provided with product delivered to job-site.

1.08 INSTALLER QUALIFICATIONS

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the acoustic sealant and acoustic spray manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its acoustical sealant products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

- A. Do not use materials that contain flammable solvents.
- B. Schedule installation of acoustical sealants after completion of gypsum wall board but prior to covering or concealing of joints.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- D. Weather conditions: Do not proceed with installation of acoustical sealant materials when temperatures are outside the manufacturers recommended limitations.
- E. During installation, provide masking and drop cloths to prevent acoustical sealant materials from contaminating any adjacent surfaces.

PART 2 - PRODUCTS

2.01 ACOUSTICAL SEALANTS

- A. Acoustic Sealant for Exposed and Concealed Joints and annular spaces around through-penetrations: Provide manufacturer's standard non-sag, paintable, non-staining, non-hardening, non-bleeding, non-drying, resilient latex sealant complying with ASTM C834, ASTM C919 and the following:

- a. Sealant effectively reduces airborne sound transmission through head-of-wall and bottom-of-wall joints and openings to accommodate through-penetrations in building construction as demonstrated by testing representative assemblies in accordance with ASTM E90.
- b. Acoustical Sealant to maintain STC ratings at sound rated partitions as indicated on the drawings.
- c. Sealant has flame-spread and smoke-developed ratings of less than 25 as tested in accordance with ASTM E84.
- d. Sealant is mold and mildew resistant per ASTM G21 with a rating of zero (0), "no growth".
- e. Sealant has movement capability of minimum 12.5% in accordance with ISO 11600. Latex sealant according to ASTM C 834 class OP -18°C with shrinkage according to ASTM C 1241 < 25 % C.
- f. Proposed acoustic sealant materials and methods shall conform to applicable governing codes having local jurisdiction.

2.02 ACOUSTICAL SPRAYS

- A. Acoustic Spray for exposed and concealed joints: Provide manufacturer's standard sprayable latex material complying with ASTM C919 and the following:
 - a. Spray effectively reduces airborne sound transmission through head-of-wall joints in building construction as demonstrated by testing representative assemblies in accordance with ASTM E90.
 - b. Acoustical Spray to maintain STC ratings at sound rated partitions as indicated on the drawings.
 - c. Spray has flame-spread and smoke-developed ratings of less than 25 as tested in accordance with ASTM E84.
 - d. Spray is mold and mildew resistant per ASTM G21 with a rating of zero (0), "no growth".
 - e. Spray has movement capability of minimum 12.5%.
 - f. Proposed acoustic spray materials and methods shall conform to applicable governing codes having local jurisdiction.

2.03 ACCEPTABLE MANUFACTURERS

- A. Basis of Design: Dow Corning 790 Silicone Building Sealant, GE 1200 Construction Silicone Sealant; STI SpecSeal Series ES Elastomeric Sealant; 3M Fire Barrier Silicone Sealant 2000+.
- B. Substitutions: As indicated in Section 01 6000 – Product Requirements.

2.04 MATERIALS

- A. Products: Subject to compliance with requirements, provide the following:
 1. Hilti CP 506 Smoke and Acoustic Sealant
 2. Hilti CP 572 Smoke and Acoustic Spray
 3. Hilti CP605 bottom of wall sealant

2.05 ACCESSORIES

- A. Pre-formed mineral wool:
 1. CP 767 Speed Strips
 2. CP 777 Speed Plugs
- B. Mineral wool

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 - 1. Verify acoustic joints are properly sized and in suitable condition for application of materials.
 - 2. Surfaces to which acoustic sealant and spray materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - 3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by acoustic sealant and spray materials.
 - 4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of acoustic sealant and spray.
 - 5. Do not proceed until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Comply with acoustic sealant and spray manufacturer's written installation instructions for products and applications indicated.
- B. Standards: Comply with recommendations of ASTM C919 for use of joint sealants in acoustical applications as applicable to materials, applications and conditions indicated.
- C. Install acoustic sealant backings of type indicated to support sealant and spray during application in accordance with manufacturer's written installation instructions.
- D. Install acoustic sealant and spray free of air pockets, embedded foreign matter, sags and ridges.
- E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess acoustic sealant from surfaces adjacent to joint.
 - 2. Remove excess acoustic spray from surfaces adjacent to joint as indicated on the drawings.
 - 3. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 4. Provide concave joint configuration per Figure 8A in ASTM C1193, unless otherwise indicated.

3.03 FIELD QUALITY CONTROL

- A. Examine acoustic joints and penetrations to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.

3.04 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturer of acoustical joint sealants.
- B. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises.

3.05 PROTECTION

- A. Protect acoustic joints during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Contract Completion.

END OF SECTION

SECTION 083113.53 - SECURITY ACCESS DOORS AND FRAMES

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 security access doors and frames for walls and ceilings.
- B. Related Requirements:
 - 1. Section 083113 "Access Doors and Frames" for access doors and frames for nonsecurity applications.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details materials, individual components and profiles, and finishes.
- B. Samples: For each type of security access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches (150 by 150 mm) in size.
- C. Product Schedule: For security access doors and frames.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- A. Cornerstone Detention Products.
 - 1. Mike Suriano.
 - 2. msuriano@cornerstoneinc.com
 - 3. 919-325-4332.

2.2 SECURITY ACCESS DOORS AND FRAMES

- A. High-Security Flush Access Doors:
 - 1. Acceptable Manufacturers: Subject to compliance of the requirements.
 - a. American Steel Products.
 - b. Hallman Sales, LLC.

- c. Tital Metal Products.
- 2. Locations: Wall and ceiling.
- 3. Uncoated Steel Sheet for Door: Nominal 0.134 inch (3.42 mm), 10 gage; factory primed.
- 4. Frame Material: Minimum 3/16-by-2-by-2-by-3-inch (4.7-by-50-by-50-by-76-mm) angle welded with joints ground smooth; factory prime.
- 5. Hinges: Manufacturer's standard security hinge.
- 6. Latch and Lock: Detention deadbolt with parametric key.

2.3 MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A 879/A 879M, with cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.
- D. Frame Anchors: Same type as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.4 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
- D. Latch and Lock Hardware:
 - 1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
 - 2. Keys: Furnish two keys per lock and key all locks alike.

2.5 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Factory-Primed Finish: Apply manufacturer's standard lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.

3.3 ADJUSTING

- A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 083113.53

SECTION 088300 - MIRRORS

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 silvered flat glass mirrors:
 - 1. Annealed monolithic glass mirrors.
- B. Related Requirements:
 - 1. Section 102800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.
- B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.
- C. Samples: For each type of the following:
 - 1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
 - 2. Mirror Trim: 12 inches (300 mm) long.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avalon Glass and Mirror Company.
 - b. Binswanger Mirror; a division of Vitro America, Inc.
 - c. Bobrick Washroom Inc. (BASIS OF DESIGN).
 - 1) 290.MLK 24" X 48"
 - d. D & W Incorporated.
 - e. Donisi Mirror Company.
 - f. Gardner Glass, Inc.
 - g. Guardian Glass; SunGuard.
 - h. Head West.
 - i. Independent Mirror Industries, Inc.
 - j. Lenoir Mirror Company.
 - k. National Glass Industries.
 - l. Stroupe Mirror Co., Inc.
 - m. Sunshine Mirror.
 - n. Virginia Mirror Company, Inc.
 - o. Walker Glass Co., Ltd.
- B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.
- C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

- A. Mirrors, General: ASTM C 1503.
- B. Annealed Monolithic Glass Mirrors: Mirror Glazing Quality, ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.

1. Nominal Thickness: 6.0 mm.

2.3 MISCELLANEOUS MATERIALS

- A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.
- C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Franklin International.
 - b. Laurence, C. R. Co., Inc.
 - c. Liquid Nails Adhesive.
 - d. Macco Adhesives.
 - e. OSI Sealants; Henkel Corporation.
 - f. Palmer Products Corporation.
 - g. Pecora Corporation.
 - h. Royal Adhesives & Sealants.
 - i. Sommer & Maca Industries, Inc.

2.4 MIRROR HARDWARE

- A. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
- B. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
- C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

- A. Fabricate mirrors in the shop to greatest extent possible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

- B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers with mirror mastic.
- C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

- A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

- A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.
 - 1. GANA Publications: "Glazing Manual" and "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
- B. Provide a minimum airspace of **1/8 inch (3 mm)** between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.
- C. Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
 - 1. Install mastic as follows:
 - a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
 - b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
 - c. After mastic is applied, align mirrors and press into place while maintaining a minimum airspace of **1/8 inch (3 mm)** between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

- A. Protect mirrors from breakage and contaminating substances resulting from construction operations.
- B. Do not permit edges of mirrors to be exposed to standing water.
- C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

- D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300

SECTION 093013 - CERAMIC TILING

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. Porcelain tile.
 - 2. Glazed wall tile.
 - 3. Stone thresholds.
 - 4. Tile backing panels.
 - 5. Waterproof membrane for thinset applications.
 - 6. Metal edge strips.
 - 7. Resilient floor underlayment.
- B. Related Requirements:
 - 1. Section 071326 "Self-Adhering Sheet Waterproofing" for waterproofing under thickset mortar beds.
 - 2. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
 - 3. Section 092900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

1.4 ACTION SUBMITTALS

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

B. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required. For ceramic mosaic tile in color blend patterns, provide full sheets of each color blend.
2. Full-size units of each type of trim and accessory for each color and finish required.
3. Stone thresholds in 6-inch (150-mm) lengths.
4. Metal edge strips in 6-inch (150-mm) lengths.

1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of product.
- B. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Build mockup of each type of floor tile installation.
 2. Build mockup of each type of wall tile installation.
 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
 - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
 - 2. Obtain waterproof membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
 - 1. Stone thresholds.
 - 2. Waterproof membrane.
 - 3. Cementitious backer units.
 - 4. Metal edge strips.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced

by TCNA installation methods specified in tile installation schedules, and other requirements specified.

- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

A. Ceramic Tile Type PT-1: Glazed porcelain tile.

- 1. Manufacturer: Daltile.
- 2. Style: Famed.
- 3. Color: Diamond.
- 4. Face Sizes: 24" x 24".
- 5. Finish Treatment: Matte.
- 6. Composition: Porcelain.
- 7. Certification: Tile certified by the Porcelain Tile Certification Agency.
- 8. Face Size Variation: Rectified.
- 9. Thickness: 3/8 inch (9.5 mm).
- 10. Face: Plain with square edges.
- 11. Dynamic Coefficient of Friction: Not less than 0.42.
- 12. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
- 13. Grout Color: As selected by Architect from manufacturer's full range.
- 14. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.

B. Ceramic Tile Type PT-2: Glazed porcelain tile.

- 1. Manufacturer: Daltile.
- 2. Style: Famed.
- 3. Color: Diamond.
- 4. Face Sizes: 12" x 24".
- 5. Finish Treatment: Matte.
- 6. Composition: Porcelain.
- 7. Certification: Tile certified by the Porcelain Tile Certification Agency.
- 8. Face Size Variation: Rectified.
- 9. Thickness: 3/8 inch (9.5 mm).

10. Face: Plain with square edges.
 11. Dynamic Coefficient of Friction: Not less than 0.42.
 12. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
 13. Grout Color: As selected by Architect from manufacturer's full range.
 14. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.
- C. Ceramic Tile Type PT-3: Glazed porcelain tile.
1. Manufacturer: Daltile.
 2. Style: Famed.
 3. Color: Diamond.
 4. Face Sizes: 3" x 24" Bullnose Tile.
 5. Finish Treatment: Matte.
 6. Composition: Porcelain.
 7. Certification: Tile certified by the Porcelain Tile Certification Agency.
 8. Face Size Variation: Rectified.
 9. Thickness: 3/8 inch (9.5 mm).
 10. Face: Plain with square edges.
 11. Dynamic Coefficient of Friction: Not less than 0.42.
 12. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
 13. Grout Color: As selected by Architect from manufacturer's full range.
 14. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.
- D. Ceramic Tile Type PT-4: Glazed porcelain mosaic tile.
1. Manufacturer: Daltile.
 2. Style: Artefino, Saffron Floret Apex.
 3. Color: Safron Floret Apex AR46.
 4. Face Sizes: 2" x 2".

5. Finish Treatment: Glossy.
 6. Composition: Porcelain.
 7. Certification: Tile certified by the Porcelain Tile Certification Agency.
 8. Face Size Variation: Rectified.
 9. Thickness: 3/8 inch (9.5 mm).
 10. Face: Plain with square edges.
 11. Dynamic Coefficient of Friction: Not less than 0.42.
 12. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
 13. Grout Color: As selected by Architect from manufacturer's full range.
 14. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.
- E. Ceramic Tile Type PT-5: Glazed porcelain tile.
1. Manufacturer: Daltile.
 2. Style: Articulo.
 3. Color: As selected by Architect from manufacturer's full range.
 4. Face Size: 12" x 24".
 5. Finish Treatment: Matte.
 6. Composition: Porcelain.
 7. Certification: Tile certified by the Porcelain Tile Certification Agency.
 8. Face Size Variation: Rectified.
 9. Thickness: 3/8 inch (9.5 mm).
 10. Face: Plain with square edges.
 11. Dynamic Coefficient of Friction: Not less than 0.42.
 12. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
 13. Grout Color: As selected by Architect from manufacturer's full range.
 14. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-buttet square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.

- F. Ceramic Tile Type PT-6: Glazed porcelain tile.
1. Manufacturer: Daltile.
 2. Style: Articulo.
 3. Color: As selected by Architect from manufacturer's full range.
 4. Size: 3" x 24" Bullnose.
 5. Face Sizes: As selected by Architect from manufacturer's full range.
 6. Finish Treatment: Matte.
 7. Composition: Porcelain.
 8. Certification: Tile certified by the Porcelain Tile Certification Agency.
 9. Face Size Variation: Rectified.
 10. Thickness: 3/8 inch (9.5 mm).
 11. Face: Plain with square edges.
 12. Dynamic Coefficient of Friction: Not less than 0.42.
 13. Tile Color, Glaze, and Pattern: As selected by Architect from manufacturer's full range.
 14. Grout Color: As selected by Architect from manufacturer's full range.
 15. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. Wainscot Cap for Flush Conditions: Regular flat tile for conditions where tile wainscot is shown flush with wall surface above it, same size as adjoining flat tile.
 - d. External Corners: Surface bullnose, module size same as adjoining flat tile.
 - e. Internal Corners: Field-butt square corners.
 - f. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.4 mm) across nominal 4-inch (100-mm) dimension.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch (1.5 mm) above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch (12.7 mm) or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C 503/C 503M, with a minimum abrasion resistance of [10] [12] according to ASTM C 1353 or ASTM C 241/C 241M and with honed finish.
1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, Type A, in maximum lengths available to minimize end-to-end butt joints.
1. Products: Subject to compliance with requirements, provide one of the following:

- a. Custom Building Products: Wonderboard.
 - b. FinPan, Inc.: Util-A-Crete Concrete Backer Board.
 - c. USG Corporation: DUROCK Cement Board.
2. Thickness: 5/8 inch (15.9 mm).

2.6 WATERPROOF MEMBRANE

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. Ardex: 8+9 Rapid Waterproofing and Crack Isolation Compound.
 - b. Custom Tile Installation Systems: RedGard Waterproofing and Crack Prevention Membrane.
 - c. Laticrete: Hydro Barrier Plus.
 - d. Proflex: Hydra Max.
 - e. Sika: Sika Tile Moisture Guard 100.

2.7 SETTING MATERIALS

- A. Standard Dry-Set Mortar (Thinset): ANSI A118.1.
1. **Products:** Subject to compliance with requirements, provide the following:
 - a. BASIS OF DESIGN: Mapei Corporation.
 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.1.

2.8 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
1. **Products:** Subject to compliance with requirements, provide one of the following:
 - a. BASIS OF DESIGN: Mapei Corporation; Epoxy Grout.
 - b. Acceptable Manufacturers:
 - 1) Laticrete International.
 - 2) W. R. Bonsai Corporation.
 - c. Thickness: 1/8 inch.
 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F (60 and 100 deg C), respectively, and certified by manufacturer for intended use.

2.9 RESILIENT FLOOR UNDERLAYMENT

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pliteq GenieMat RST05 (BASIS OF DESIGN).

- b. ECOsurfaces, ECOsilence 5, or approved equal.
- B. Locations: All spaces using PT indicated above.
- C. Thickness: Install PT on 5mm acoustic resilient underlayment.

2.10 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D 4397, 4.0 mils (0.1 mm) thick.
- C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless-steel, ASTM A 666, 300 Series exposed-edge material.
- D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- E. Floor Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

2.11 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.

2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped **1/4 inch per foot (1:50)** toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors consisting of tiles **8 by 8 inches (200 by 200 mm)** or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Ceramic Mosaic Tile: **1/16 inch (1.6 mm)**.
 - 2. Glazed Wall Tile: **1/8 inch (3.2 mm)**.
 - 3. Porcelain Tile: **1/4 inch (6.4 mm)**.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
 - 1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in modified dry-set mortar (thinset).
 - 2. Do not extend waterproofing under thresholds set in standard dry-set mortar. Fill joints between such thresholds and adjoining tile set on waterproofing with elastomeric sealant.
- K. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.
- L. Floor Sealer: Apply floor sealer to grout joints according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 WATERPROOFING INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproofing to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.6 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.7 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.8 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F115; thinset mortar; epoxy grout.
 - a. Thinset Mortar: Standard dry-set mortar.
 - b. Grout: Water-cleanable epoxy grout.
 - 2. Ceramic Tile Installation: TCNA F122; thinset mortar on waterproof membrane.
 - a. Thinset Mortar: Modified dry-set mortar.
 - b. Grout: High-performance sanded grout.
- B. Interior Wall Installations, Masonry or Concrete:

1. Ceramic Tile Installation: TCNA W202; thinset mortar.
 - a. Thinset Mortar: Standard dry-set mortar.
 - b. Grout: Standard sanded cement grout.
- C. Interior Wall Installations, Wood or Metal Studs or Furring:
 1. Ceramic Tile Installation: TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units or fiber-cement backer board.
 - a. Thinset Mortar: Standard dry-set mortar.
 - b. Grout: Sand-portland cement grout.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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 acoustical panels and exposed suspension systems for interior ceilings.
- B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.
- C. Samples for Initial Selection: For components with factory-applied finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
 - 2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage

from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: Class A according to ASTM E 1264.
 - 2. Smoke-Developed Index: 450 or less.

2.3 ACOUSTICAL PANELS (STANDARD)

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; ULTIMA High NRC (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Color: White.
- D. Light Reflectance (LR): Not less than 0.90.
- E. Acoustical Ceiling Type B.1:
 - 1. Ceiling Attenuation Class (CAC): Not less than 35.
 - 2. Noise Reduction Coefficient (NRC): Not less than 0.70.

3. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; ULTIMA High NRC (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- F. Acoustical Ceiling Type B.2:
 1. Ceiling Attenuation Class (CAC): Not less than 35.
 2. Noise Reduction Coefficient (NRC): Not less than 0.70.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; Clean Room VL (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- G. Acoustical Ceiling Type B.4:
 1. Ceiling Attenuation Class (CAC): Not less than 35.
 2. Noise Reduction Coefficient (NRC): Not less than 0.80.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; ULTIMA High NRC (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- H. Acoustical Ceiling Type B.5:
 1. Ceiling Attenuation Class (CAC): Not less than 35.
 2. Noise Reduction Coefficient (NRC): Not less than 0.90.
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; OPTIMA (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- I. Edge/Joint Detail: Beveled Tegular 9/16".
- J. Thickness: 3/4 inch (19 mm).
- K. Modular Size: 24 by 24 inches (610 by 610 mm).
- L. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 ACOUSTICAL PANELS (LARGE FORMAT) TYPE B.3

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; Optima (Basis of Design Product).
 - c. CertainTeed Corporation.

- d. USG Corporation.
- B. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E 1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- C. Color: White.
- D. Light Reflectance (LR): Not less than 0.88.
- E. Ceiling Attenuation Class (CAC): Not less than 35.
- F. Articulation: 190.
- G. Noise Reduction Coefficient (NRC): Not less than 0.80.
- H. Edge/Joint Detail: Beveled Tegular 9/16".
- I. Thickness: **1 inch**.
- J. Modular Size: 48" x 96" and as indicated on drawings.
- K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273, ASTM D 3274, or ASTM G 21 and evaluated according to ASTM D 3274 or ASTM G 21.
- L. Metal Suspension System.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; SUPRAFINE XL 7/16" Exposed Tee (Basis of Design Product).
 - b. CertainTeed Corporation.
 - c. USG Corporation.

2.5 RESILIENT ISOLATED CEILING

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Amber-Booth.
 - b. Kinetics Noise Control.
 - c. Mason Industries.
 - d. Pac International.
 - e. Pliteq.
 - f. Vibration Mountings & Control.
- B. System: Neoprene or natural rubber ceiling hanger or clip, with neoprene or natural rubber grommet between hanger bracket or other metal mounting elements and ceiling support. Neoprene or natural rubber element shall have neoprene- or natural rubber-coated metal surfaces.
- C. Isolators: Provide isolators with a minimum static deflection of 0.12".

2.6 SECURITY CEILINGS

- A. Tamper-resistant for non-accessible plenum areas.
- B. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Gypsum.
 - b. Armstrong World Industries, Inc; Metalworks Securelock Plus Custom Ceilings (Basis of Design Product).
 - c. CertainTeed Corporation.
 - d. USG Corporation.
- C. Noise Reduction Coefficient (NRC): Not less than 0.80.
- D. Panels: Perforated with acoustical infill.

2.7 METAL SUSPENSION SYSTEM (STANDARD)

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Armstrong World Industries, Inc.; SUPRAFINE XL 9/16" Exposed Tee (Basis of Design Product).
 - b. CertainTeed Corporation.
 - c. USG Corporation.
- B. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C 635/C 635M and designated by type, structural classification, and finish indicated.
- C. Narrow-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized, **G30 (Z90)** coating designation; with prefinished **9/16-inch- (15-mm-)** wide metal caps on flanges.
 - 1. Structural Classification: Intermediate-duty system.
 - 2. Face Design: Flat, flush.
 - 3. Cap Material: Cold-rolled steel or aluminum.
 - 4. Cap Finish: Painted in color as selected from manufacturer's full range.

2.8 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
 - 1. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than ~~0.135-inch-~~ (3.5-mm-) diameter wire.

2.9 METAL EDGE MOLDINGS AND TRIM

- A. Products: Subject to compliance with requirements, provide one of the following:
- a. Armstrong World Industries, Inc.; SUPRAFINE XL 9/16" Exposed Tee (Basis of Design Product).
 - b. CertainTeed Corporation.
 - c. USG Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.

2.10 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, provide one of the following:
- a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C 636/C 636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 - 6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 - 7. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. Space hangers not more than **48 inches (1200 mm)** o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than **8 inches (200 mm)** from ends of each member.
 - 10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 - 1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends. Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.
1. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096519 - RESILIENT TILE FLOORING

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. Solid luxury vinyl floor tile.
 - 2. Resilient floor underlayment.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For each type of floor tile indicated.
- C. Samples for Verification: Full-size units of each color and pattern of floor tile required.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
 - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than **50 deg F (10 deg C)** or more than **90 deg F (32 deg C)**. Store floor tiles on flat surfaces.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than **70 deg F (21 deg C)** or more than **95 deg F (35 deg C)**, in spaces to receive floor tile during the following periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than **55 deg F (13 deg C)** or more than **95 deg F (35 deg C)**.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 SOLID VINYL FLOOR TILE

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Altro Group.
 - b. American Biltrite.
 - c. Armstrong World Industries, Inc.
 - d. Congoleum Corporation.
 - e. Ecomoso, Centive Vinyl Flooring.
 - f. Gerflor.
 - g. IVC US.
 - h. Johnsonite; a Tarkett company.
 - i. Karndean Design Flooring.
 - j. Mannington Mills, Inc.
 - k. Mohawk Group (BASIS OF DESIGN).
 - l. Patcraft; a division of Shaw Industries, Inc.
 - m. Philadelphia Commercial; a division of Shaw Industries, Inc.
 - n. Polyflor, Ltd.; distributed by Gerbert Limited.
 - o. Shaw Contract Group; a Berkshire Hathaway company.
 - p. TOLI International.
 - q. VPI Corporation.

- B. Tile Standard: ASTM F 1700.
 - 1. Class: Class III, Printed Film Vinyl Tile.
 - 2. Type: B, Embossed Surface.
- C. Thickness: 0.18 inch (4.5 mm).
- D. LVT-1 Style: Mohawk Group; Planked 5.0.
 - 1. Color: 832 Harvest Oak.
 - 2. Size: 6" x 36"
- E. LVT-2 Style: Mohawk Group; Chromascope 5.0.
 - 1. Color: 250 Cozy Linen.
 - 2. Size: 6" x 36"
- F. LVT-3 Style: Mohawk Group; Planked 5.0.
 - 1. Color: 852 Clay Oak.
 - 2. Size: 18" x 36"

2.2 RESILIENT FLOOR UNDERLAYMENT

- A. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pliteq GenieMat RST (BASIS OF DESIGN).
 - b. ECOsurfaces, ECOsilence.
- B. Locations: All spaces using LVT indicated above.
- C. Thickness: Install LVT on 2mm acoustic resilient underlayment.

2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 4. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. (304.8 sq. m), and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
 - a. Anhydrous Calcium Chloride Test: ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
 - b. Relative Humidity Test: Using in-situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until materials are the same temperature as space where they are to be installed.
 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.

- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 096723 - RESINOUS FLOORING

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 resinous flooring systems.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.
- B. Samples for Initial Selection: For each type of exposed finish required.
- C. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

- B. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

PART 2 - PRODUCTS

2.1 PERORMANCE REQUIREMENTS

- A. Flammability: Self-extinguishing according to ASTM D 635.

2.2 MANUFACTURERS

- A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

2.3 RESINOUS FLOORING

- A. Resinous Flooring System: Abrasion-, impact-, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor and integral cove base.

- 1. Manufacturers:

- a. Arizona Polymer Flooring, Inc.
- b. BASF Construction.
- c. CornerStone Flooring & Linings.
- d. Crawford Laboratories Inc.
- e. Crown Polymers, LLC.
- f. Delta Polymers, inc.
- g. DUDICK Inc.
- h. Duraflex, Inc.
- i. FLEXMAR COATINGS. Inc.
- j. Garland Company, Inc. (The).
- k. HP Spartacote.
- l. International Coatings, Inc.
- m. ITW Polymers Sealants North America (formerly Pacific Polymers, Inc.).
- n. Key Resin Company.
- o. Neogard; a division of Jones-Blair, Inc.
- p. Northern Industries, Inc.
- q. Nox-Crete Products Group.
- r. Polymerica, Incorporated.
- s. PolySpec.
- t. Protective Floorings & Linings, Inc.; a division of Milamar Coatings, LLC.
- u. ROCK-TRED Corporation.
- v. Saueresin.
- w. Sika Corporation.

- x. Stonehard, Inc.
- y. Tamms; a brand of Euclid Chemical Company; an RPM Company.
- z. The Sherwin Williams Company (BASIS OF DESIGN).
 - 1) Crylaflor DecoQuartz SL.
- aa. Tennant Company.
- bb. Tnemec Company, Inc.
- cc. Tufco International Inc.

B. System Characteristics:

- 1. Color and Pattern: As selected by Architect from manufacturer's full range.
- 2. Wearing Surface: Smooth.
- 3. Overall System Thickness: 3/16 inch (4.8 mm).

C. Primer: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.

- 1. Formulation Description: 100 percent solids.

D. Waterproofing Membrane: Type recommended by resinous flooring manufacturer for substrate and resinous flooring system indicated.

- 1. Formulation Description: 100 percent solids.

E. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.

F. Body Coats:

- 1. Resin: Epoxy.
- 2. Formulation Description: 100 percent solids.
- 3. Type: Clear.
- 4. Application Method: Self-leveling slurry.
- 5. Number of Coats: One.
- 6. Thickness of Coats: 1/16 inch (1.6 mm).
- 7. Aggregates: Colored quartz (ceramic-coated silica).

G. Grout Coat:

- 1. Resin: Epoxy.
- 2. Formulation Description: 100 percent solids.
- 3. Type: Clear.
- 4. Thickness of Coat: 1/16 inch (1.6 mm).

H. Topcoats: Sealing or finish coats.

- 1. Resin: Epoxy.
- 2. Formulation Description: 100 percent solids.
- 3. Type: Clear.
- 4. Number of Coats: One.
- 5. Thickness of Coats: 1/16 inch (1.6 mm).
- 6. Finish: Matte.

I. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 8,300 psi minimum according to ASTM C 579.
2. Tensile Strength: 1,350 psi minimum according to ASTM C 307.
3. Flexural Modulus of Elasticity: 4.7×10^5 minimum according to ASTM C 580.
4. Water Absorption: 0.04% percent maximum according to ASTM C 413.
5. Indentation: 0.025 percent maximum according to MIL-D-3134J.
6. Impact Resistance: No chipping, cracking, or delamination and not more than 1/16-inch (1.6-mm) permanent indentation according to MIL-D-3134J.
7. Resistance to Elevated Temperature: No slip or flow of more than 1/16 inch (1.6 mm) according to MIL-D-3134J.
8. Abrasion Resistance: 29 mg maximum weight loss according to ASTM D 4060.
9. Hardness: 88-92, Shore D according to ASTM D 2240.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry substrate for resinous flooring application.
- B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.
 1. Roughen concrete substrates as follows:
 - a. Comply with ASTM C 811 requirements unless manufacturer's written instructions are more stringent.
 2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
 3. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.
 - a. Relative Humidity Test: Use in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
 4. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.
- C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.
 1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
- D. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.2 APPLICATION

- A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.
 - 1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
 - 2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.
- B. Primer: Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Waterproofing Membrane: Apply waterproofing membrane in manufacturer's recommended thickness.
 - 1. Apply waterproofing membrane to integral cove base substrates.
- D. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and topcoating of cove base. Round internal and external corners.
 - 1. Integral Cove Base: 4 inches (100 mm) high.
- E. Self-Leveling Body Coats: Apply self-leveling slurry body coats in thickness indicated for flooring system.
 - 1. Aggregates: Broadcast aggregates at rate recommended by manufacturer and, after resin is cured, remove excess aggregates to provide surface texture indicated.
- F. Grout Coat: Apply grout coat, of type recommended by resinous flooring manufacturer, to fill voids in surface of final body coat.
- G. Topcoats: Apply topcoats in number indicated for flooring system and at spreading rates recommended in writing by manufacturer and to produce wearing surface indicated.

3.3 PROTECTION

- A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

END OF SECTION 096723

SECTION 098433 - SOUND-ABSORBING WALL 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 shop-fabricated, acoustical panel units tested for acoustical performance, including the following:
 - 1. Sound-absorbing wall panels.

1.3 DEFINITIONS

- A. NRC: Noise Reduction Coefficient.
- B. SAA: Sound Absorption Average.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: For unit assembly and installation.
 - 1. Include plans, elevations, sections, and mounting devices and details.
 - 2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
 - 3. Include details at cutouts and penetrations for other work.
 - 4. Include direction of fabric weave and pattern matching.
- B. Samples for Verification: For the following products:
 - 1. Fabric: Full-width by approximately **36-inch-** (900-mm-) long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
 - 2. Panel Edge: **12-inch-** (300-mm-) long Sample(s) showing each edge profile, corner, and finish.
 - 3. Core Material: **12-inch-** (300-mm-) square Sample at corner.
 - 4. Mounting Devices: Full-size Samples.
 - 5. Assembled Panels: Approximately **36 by 36 inches** (900 by 900 mm), including joints and mounting methods.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Electrical outlets, switches, and thermostats.
 - 2. Items penetrating or covered by units including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Alarms.
 - e. Sprinklers.
 - f. Access panels.
 - 3. Show operation of hinged and sliding components covered by or adjacent to units.
- B. Product Certificates: For each type of unit.
- C. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 sq. yd. (9 sq. m), full width of bolt.
 - 2. Mounting Devices: Full-size units equal to 5 percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.
- B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Lighting: Do not install units until a permanent level of lighting is provided on surfaces to receive the units.
- C. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.
- D. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace units and components that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to the following:
 - a. Acoustical performance.
 - b. Fabric sagging, distorting, or releasing from panel edge.
 - c. Warping of core.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall units specified in this Section from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.

- b. Smoke-Developed Index: 450 or less.
- 2. Fire Growth Contribution: Comply with acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 Method B Protocol or NFPA 286.

2.3 SOUND-ABSORBING WALL UNITS

- A. Sound-Absorbing Wall Panel AP-1: Manufacturer's standard panel construction consisting of facing material stretched over front face of edge-framed core and bonded or attached to edges and back of frame.
 - 1. Manufacturer: Ezo Bord; Stretch Fabric Wall System.
 - 2. Panel Shape: Flat.
 - 3. Color: Light Beige (LB01).
 - 4. Mounting: Edge mounted with splines secured to substrate.
 - a. Finish Color at Exposed Edges: Match color of facing material.
 - 5. Mounting: Back mounted with manufacturer's standard metal clips or bar hangers secured to substrate.
 - 6. Core: Manufacturer's standard.
 - a. Core-Face Layer: Manufacturer's standard tackable, impact-resistant, high-density board.
 - 7. Edge Construction: Manufacturer's standard chemically hardened core with no frame.
 - 8. Edge Profile: Long edges kerfed and rabbeted to receive splines.
 - 9. Corner Detail in Elevation: Square with continuous edge profile indicated.
 - 10. Reveals between Panels: Flush.
 - 11. Acoustical Performance: Sound absorption NRC of not less than 0.70 according to ASTM C 423 for Type A mounting according to ASTM E 795.
 - 12. Nominal Core Thickness: 1 inch (25.4 mm).
 - 13. Panel Width: As indicated on Drawings.
 - 14. Panel Height: As indicated on Drawings.
- B. Sound-Absorbing Acoustic Felt AP-2. Manufacturer's standard acoustic felt.
 - 1. Manufacturer: Ezo Felt; Stretch Fabric Wall System.
 - 2. Color: Flint.

2.4 MATERIALS

- A. Core Materials: Manufacturer's standard.
- B. Facing Material: Fabric from same dye lot; color and pattern as selected by Architect from manufacturer's full range.
 - 1. Manufacturer: Ezo Bord.
 - 2. Product Line/Pattern: Stretch Fabric Wall System.
 - 3. Color: Light Beige (LB01).
 - 4. Applied Treatments: Stain resistance flame retardant.

- C. Mounting Devices: Concealed on back of unit, recommended by manufacturer to support weight of unit, and as follows:
 - 1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the unit, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.
 - 2. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of unit and the other part to substrate, designed to permit unit removal.

2.5 FABRICATION

- A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.
- B. Edge Hardening: For glass-fiber board and mineral-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.
- C. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.
- D. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.
 - 1. Square Corners: Tailor corners. Heat-seal vinyl fabric seams at corners.
 - 2. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.
- E. Dimensional Tolerances of Finished Units: Plus or minus **1/16 inch (1.6 mm)** for the following:
 - 1. Thickness.
 - 2. Edge straightness.
 - 3. Overall length and width.
 - 4. Squareness from corner to corner.
 - 5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.
- B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.
- C. Align fabric pattern and grain with adjacent units.

3.3 INSTALLATION TOLERANCES

- A. Variation from Plumb and Level: Plus or minus [**1/16 inch (1.6 mm)**] **<Insert dimension>** in **48 inches (1200 mm)**, noncumulative.
- B. Variation of Joint Width: Not more than **1/16-inch (1.6-mm)** variation from reveal line in **48 inches (1200 mm)**, noncumulative.

3.4 CLEANING

- A. Clip loose threads; remove pills and extraneous materials.
- B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 098433

SECTION 260410
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers, rated 600 V and less, used for disconnecting and protection functions.
- B. See Division 262813 Section "Fuses" for fuses for fusible disconnect switches.
- C. See Division 260548 Section "Vibration And Seismic Controls For Electrical Systems" for seismic requirements.

1.2 SUBMITTALS

- A. Product Data and shop drawings: For each type of switch and circuit breaker.
- B. Field quality-control test reports.
- C. Operation and maintenance data.

1.3 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. Source Limitations: Obtain switches and circuit breakers through one source from a single manufacturer.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- 1. Supplier to Furnish Equipment, Contractor to Install.
- 2. Refer to Section 011000 "Summary"
- 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
- 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.

5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
- a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 MANUFACTURERS

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton Corp.; Cutler-Hammer Products.
 2. Siemens.
 3. Square D Co.

2.3 ENCLOSED SAFETY SWITCHES

- A. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD and HP, with lockable handle, interlocked with cover.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD and HP, with clips to accommodate specified fuses, and lockable handle, interlocked with cover.
- C. Exterior mounted switches: NEMA 3R rated enclosures with watertight hubs.
- D. Corrosive environments, Kitchens or Division 2 locations: NEMA 4X-SS, Type HD and HP with watertight hubs

2.4 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, 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 250 A and larger. KAIC ratings as required by system conditions.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Current-Limiting Circuit Breakers: Frame sizes 600 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 4. GFCI Circuit Breakers: Single-, two-, and three-pole configurations with 5-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
1. Lugs: Suitable for number, size, trip ratings, and material of conductors.
 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Shunt Trip: 120-V trip coil (unless otherwise noted) energized from separate circuit, set to trip at 75 percent of rated voltage
- C. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings.
1. Instantaneous trip.
 2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I-squared t response.

2.5 ENCLOSURES

- A. Listed for environmental conditions of installed locations, including:
1. Outdoor Locations: NEMA 250, Type 3R/12.
 2. Food Service Areas: NEMA 250, Type 4X, stainless steel.
 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Temporary Provisions: Remove temporary lifting provisions and blocking of moving parts.
- B. Identify components; provide warning signs as specified in Division 260510 Section "Common Work Results."

3.2 FIELD QUALITY CONTROL

- A. Testing: After installing disconnect switches and circuit breakers and after electrical circuits have been energized, demonstrate product capability and compliance with requirements.
- B. Inspections and Tests for Switches and Circuit Breakers: Make internal and external inspections and perform tests, including the following:
1. Inspect for freedom from physical damage, proper unit rating, mechanical condition, enclosure integrity, cover operation, unit anchorage, clearances, and tightness of electrical connections. If a loose electrical connection is observed on any unit, check each electrical connection for each switch and circuit breaker with a torque wrench for compliance with manufacturer's torquing instructions.
 2. Test insulation resistance of each pole, phase-to-phase, and phase-to-ground, following manufacturer's written instructions. Test insulation resistance of shunt trip circuits. Use 500-V minimum test voltage for units and circuits rated up to 250 V, 1000-V minimum test voltage for units rated more than 250 V. Measured insulation resistance must be 25 megohms, minimum, for switches rated up to 250 V, and 100 megohms, minimum, for switches rated more than 250 V.
 3. Test cover and other interlocks and interlock release devices for proper operation.
- C. Additional Inspections and Tests for Switches: Include the following:
1. Inspect for proper rating and fuse provisions.
 2. Check adequacy and integrity of fuse-holders.
 3. Check integrity of phase barriers.
 4. Inspect blade alignment visually while operating switch to observe adequacy of blade pressure.
- D. Additional Inspections and Tests for Circuit Breakers: Include the following:
1. Inspect for proper frame, trip, and fault current interrupting rating.
 2. Test shunt trip devices, circuits, and actuating components for proper operation
 3. Tests for service main circuit breakers and feeder circuit breakers:
 - a. Phase trip tolerance, with 20% of UL requirements

- b. Trip time (per phase) in seconds
 - c. Instantaneous trip (amps) per phase.
 - d. Insulation resistance (in megaohms) at 1000VDC, phase to phase and line to load
 - e. Tabulate results and submit to Engineer. Include in Closeout Documents.
- E. Correct defective and malfunctioning units on-site, where possible, and re-inspect and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

SECTION 262213
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:

1. Section 260000 "Electrical General Requirements" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260548 "Vibration And Seismic Controls For Electrical Systems" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, Listed by a third-party testing agency. Third-party agencies shall be one of those accredited by the NCBCC (North Carolina Building Code Council) to label electrical and mechanical equipment and marked for intended use.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

- B. Source quality-control reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.
 - 1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.
- B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.
- C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.
- D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- 1. Supplier to Furnish Equipment, Contractor to Install.
- 2. Refer to Section 011000 "Summary"
- 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
- 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
- 5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 MANUFACTURERS

- A. Subject to compliance with the specifications, furnish products by the following manufacturers or approved equal:
 - 1. Schneider Square D
 - 2. Eaton

3. Siemens
4. ABB

B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

E. Fabricate, test and anchor transformers in accordance with IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration And Seismic Controls For Electrical Systems."

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70 and list and label as complying with UL 1561.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings without splices except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

D. Encapsulation: Transformers smaller than 30 kVA must have core and coils completely resin encapsulated.

E. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:
 - a. Indoor: UL 50E, Type 2.
 - b. Outdoor: UL 50E, Type 3R.
5. Finish Color: Gray weather-resistant enamel.

F. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- I. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- J. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 115 deg C rise above 40 deg C ambient temperature.
- K. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.
- L. K-Factor Rating: Transformers indicated to be K-factor rated must comply with UL 1561 requirements for nonsinusoidal load current-handling capability to degree defined by designated K-factor.
 - 1. Unit may not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding indicated insulation class in 40 deg C maximum ambient and 24-hour average ambient of 30 deg C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit must comply with requirements of DOE 2016 efficiency levels when tested in accordance with NEMA TP 2 with K-factor equal to one.
- M. Electrostatic Shielding: Windings must have independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
 - 1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
 - 2. Include special terminal for grounding shield.
- N. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- O. Wall Brackets: Manufacturer's standard brackets.
- P. Low-Sound-Level Requirements: Maximum sound levels when factory tested in accordance with IEEE C57.12.91, as follows:
 - 1. 9.00 kVA and Less: 40 dB(A-weighted).
 - 2. 9.01 to 30.00 kVA: 45 dB(A-weighted).
 - 3. 30.01 to 50.00 kVA: 45 dB(A-weighted) for K-factors of 1, 4, and 9 48 dB(A-weighted) for K-factors of 13 and 20.
 - 4. 50.01 to 150.00 kVA: 50 dB(A-weighted) for K-factors of 1, 4, and 9 53 dB(A-weighted) for K-factors of 13 and 20.
 - 5. 150.01 to 300.00 kVA: 55 dB(A-weighted) for K-factors of 1, 4, and 9 58 dB(A-weighted) for K-factors of 13 and 20.
 - 6. 300.01 to 500.00 kVA: 60 dB(A-weighted) for K-factors of 1, 4, and 9 63 dB(A-weighted) for K-factors of 13 and 20.

2.5 IDENTIFICATION

- A. Nameplates:
 - 1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260075 "Electrical Identification."

2.6 SOURCE QUALITY CONTROL

- A. Testing Administrator: Engage qualified electrical testing agency to evaluate transformer.
- B. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in

accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
 2. Ratio tests at rated voltage connections and at tap connections.
 3. Phase relation and polarity tests at rated voltage connections.
 4. No load losses, and excitation current and rated voltage at rated voltage connections.
 5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
 6. Applied and induced tensile tests.
 7. Regulation and efficiency at rated load and voltage.
 8. Insulation-Resistance Tests:
 - a. Line-side to ground.
 - b. Load-side to ground.
 - c. Line-side to load-side.
 9. Temperature tests.
 10. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.
- C. Nonconforming Work:
1. System equipment that does not pass tests and inspections will be considered defective.
- D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published 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 Section 260510 "Grounding and Bonding" have been met. Maximum ground resistance must be 5 Ω at location of transformer.
- E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
 2. Brace wall-mounted transformers as specified in Section 260548 "Vibration And Seismic Controls For Electrical Systems".
- B. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

- C. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions, seismic requirements applicable to Project, and requirements in Section 260529 "Hangers and Supports for Electrical Systems."
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base in accordance with manufacturer's published instructions.
- E. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment in accordance with Section 260510 "Grounding And Bonding."
- B. Connect wiring in accordance with Section 260120 "Conductors And Cables."
- C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Engineer.
- B. Tests and Inspections:
 - 1. Dry-Type Transformer Field Tests:
 - a. Visual and Mechanical Inspection.
 - 1) Inspect physical and mechanical condition.
 - 2) Inspect anchorage, alignment, and grounding.
 - 3) Verify that resilient mounts are free and that shipping brackets have been removed.
 - 4) Verify that unit is clean.
 - 5) Perform specific inspections and mechanical tests recommended by manufacturer.
 - 6) Verify that as-left tap connections are as specified.
 - 7) Verify presence of surge arresters and that their ratings are as specified.
 - b. Electrical Tests:
 - 1) Measure resistance at windings, taps, and bolted connections.
 - 2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
 - 3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
 - 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

- C. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.
- D. Nonconforming Work:
 - 1. Transformer will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Assemble and submit test and inspection reports.
- F. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

- A. Record transformer secondary voltage at 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 5 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 written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

- A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.
 - 1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
 - 3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262213

SECTION 262413 SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Switchboards.
 - 2. Surge protection devices.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Instrumentation.
 - 5. Control power.
 - 6. Accessory components and features.
- B. Related Requirements
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 260548 "Vibration And Seismic Controls For Electrical Systems" for seismic-load, wind-load, acoustical, and other field conditions applicable to Work specified in this Section.
 - 3. Section 260573.19 "Arc-Flash Hazard Analysis" for arc-flash analysis and arc-flash label requirements.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Switchboards.
 - 2. Overcurrent protective devices.
 - 3. Surge protection devices.
 - 4. Ground-fault protection devices.
 - 5. Accessories.
 - 6. Other components.
 - 7. 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 UL 50E, 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 utility company's metering provisions with indication of approval by utility company.
 - 7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
 - 8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 9. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
 - 11. Include diagram and details of proposed mimic bus.
 - 12. Include schematic and wiring diagrams for power, signal, and control wiring.

- C. Field Quality-Control Submittals:
 - 1. Field Quality-Control Reports:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Handling, storing, and providing temporary heat.
 - 2. Mounting accessories and anchoring devices.
 - 3. Testing and adjusting overcurrent protective devices.
- B. Sample warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
 - 2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
 - 3. Fuses and Fusible Devices for Fused Circuit Breakers: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 - 4. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 - 5. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
 - 6. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.
- B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to switchboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. 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. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

1.6 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed switchboard perform in accordance with specified requirements and agrees to repair or replace components that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

- B. Special Manufacturer Extended Warranty: Manufacturer warrants that switchboard perform in accordance with specified requirements and agrees to provide repair or replacement of components that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Five years from date of Substantial Completion; prorated coverage for labor, materials, and equipment.
 - 2. Follow-On Extended-Warranty Period: Five years from date of Substantial Completion; prorated coverage for materials only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 GENERAL

- A. OWNER-DESIGNATED EQUIPMENT SUPPLIER
 - 1. Supplier to Furnish Equipment, Contractor to Install.
 - 2. Refer to Section 011000 "Summary"
 - 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
 - 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
 - 5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.
- B. Manufacturers
 - 1. Eaton
 - 2. Schneider / Square D
 - 3. Siemens
 - 4. ABB
- 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 in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application.
- E. Seismic Performance
 - 1. Products shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 2. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
- F. Comply with NEMA PB 2.
- G. Comply with NFPA 70.
- H. Comply with UL 891.
- I. Front-Connected, Front-Accessible Switchboards:
 - 1. Main Devices: Panel mounted.
 - 2. Branch Devices: Panel mounted.
 - 3. Sections front and rear aligned.
- J. Nominal System Voltage: 480Y/277 V.
- K. Main-Bus Continuous: 800 A.
- L. Indoor Enclosures: Steel, UL 50E, Type 1.
- M. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over rust-inhibiting primer on treated metal surface.
- N. Space Heaters: Factory-installed electric space heaters of sufficient wattage in each vertical section to maintain enclosure temperature above expected dew point.
 - 1. Space-Heater Control: Thermostats to maintain temperature of each section above expected dew point.
 - 2. Space-Heater Power Source: Transformer, factory installed in switchboard.
- O. Service Entrance Rating: Switchboards intended for use as service entrance equipment may contain from one to six service disconnecting means with overcurrent protection, neutral bus with disconnecting link, grounding electrode conductor terminal, and main bonding jumper.
- P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.
- Q. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- R. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- S. Pull Box on Top of Switchboard:
 - 1. Adequate ventilation to maintain temperature in pull box within same limits as switchboard.
 - 2. Set back from front to clear circuit-breaker removal mechanism.

3. Removable covers may form top, front, and sides. Top covers at rear must be easily removable for drilling and cutting.
 4. Bottom must be insulating, fire-resistive material with separate holes for cable drops into switchboard.
 5. Cable supports must be arranged to facilitate cabling and adequate to support cables indicated, including those for future installation.
- T. Buses and Connections: Three phase, four wire unless otherwise indicated.
1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from front of switchboard.
 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: 1/4 by 2 inch (6 by 50 mm-) Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
 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. Disconnect Links:
 - a. Isolate neutral bus from incoming neutral conductors.
 - b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
 6. Neutral Buses: 100 percent of ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
- U. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

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. 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 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic trip circuit breakers with RMS sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long and short time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 6. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6 mA trip).
 7. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30 mA trip).
 8. MCCB 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. Shunt Trip: 120 V trip coil energized from separate circuit, set to trip at [55] [75] percent of rated voltage.
- g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
- h. 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.
- i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.

2.3 INSTRUMENTATION

- A. Instrument Transformers: NEMA EI 21.1, and the following:
 - 1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy must be consistent with connected metering and relay devices.
 - 2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy must be consistent with connected metering and relay devices.
 - 3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
 - 4. Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.
- B. 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 0.5 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
 - d. Megawatts: Plus or minus 1 percent.
 - e. Megavars: Plus or minus 1 percent.
 - f. Power Factor: Plus or minus 1 percent.
 - g. Frequency: Plus or minus 0.1 percent.
 - h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
 - i. Megawatt Demand: Plus or minus 1 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.
- C. Watt-Hour Meters and Wattmeters:
 - 1. Comply with ANSI C12.1.
 - 2. Three-phase induction type with two stators, each with current and potential coil, rated 5 A, 120 V, 60 Hz.

3. Suitable for connection to three- and four-wire circuits.
 4. Potential indicating lamps.
 5. Adjustments for light and full load, phase balance, and power factor.
 6. Four-dial clock register.
 7. Ratchets to prevent reverse rotation.
 8. Removable meter with drawout test plug.
 9. Semiflush mounted case with matching cover.
 10. Appropriate multiplier tag.
- D. 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 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 15-minute integrated demand of totalized system.

2.4 CONTROL POWER

- A. Control Circuits: 120 V(ac), supplied through secondary disconnecting devices from control-power transformer.
- B. Electrically Interlocked Main and Tie Circuit Breakers: Two control-power transformers in separate compartments, with interlocking relays, connected to primary side of each control-power transformer at line side of associated main circuit breaker. 120 V secondaries connected through automatic transfer relays to ensure fail-safe automatic transfer scheme.
- C. Control-Power Fuses: Primary and secondary fuses for current-limiting and overload protection of transformer and fuses for protection of control circuits.
- D. Control Wiring: Factory installed, with bundling, lacing, and protection included. Provide flexible conductors for 8 AWG and smaller, for conductors across hinges, and for conductors for interconnections between shipping units.

2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Mounting Accessories: For anchors, mounting channels, bolts, washers, and other mounting accessories, comply with requirements in Section 260548.16 "Seismic Controls for Electrical Systems" or manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
1. Switchboards and Accessories: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NECA 400 and NEMA PB 2.1.
 2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting: Install switchboards on concrete base, 4 inch (100 mm) nominal thickness. Comply with requirements for concrete base specified in Section 260529 "Hangers and Supports for Electrical Systems."
 - a. Install conduits entering underneath switchboard, entering under vertical section where conductors will terminate. Install with couplings flush with concrete base. Extend 2 inch (50 mm) above concrete base after switchboard is anchored in place.
 - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around full perimeter of concrete base.
 - c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, published instructions, and directions furnished with items to be embedded.
 - e. Install anchor bolts to elevations required for proper attachment to switchboards.
 - f. Anchor switchboard to building structure at top of switchboard if required or recommended by manufacturer.
2. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.
3. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."
4. Operating Instructions: Frame and mount 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.
5. Install filler plates in unused spaces of panel-mounted sections.
6. Install overcurrent protective devices, surge protection devices, and instrumentation.
 - a. Set field-adjustable switches and circuit-breaker trip ranges.
7. Install spare-fuse cabinet.

3.2 CONNECTIONS

- A. Comply with requirements for terminating feeder bus specified in Section 262500 "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.
- B. Comply with requirements for terminating cable trays specified in Section 260536 "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.
- C. Bond conduits entering underneath switchboard to equipment ground bus with bonding conductor sized in accordance with NFPA 70.
- D. Support and secure conductors within switchboard in accordance with NFPA 70.
- E. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- B. Switchboard Nameplates: Label each switchboard compartment with nameplate complying with requirements for identification specified in Section 260553 "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 nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Service Equipment Label: Labeled, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

3.4 FIELD QUALITY CONTROL

- A. Field tests and inspections must be witnessed by Engineer.
- B. Tests and Inspections:
 - 1. Acceptance Testing:
 - a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within switchboard and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
 - b. Test continuity of each circuit.
 - 2. Test ground-fault protection of equipment for service equipment in accordance with NFPA 70.
 - 3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 5. Perform the following infrared scan tests and inspections, and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Nonconforming Work:
 - 1. Switchboard will be considered defective if it does not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports, including certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION

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.
- B. Section 260548 "Vibration And Seismic Controls For Electrical Systems"

1.2 SUMMARY

- A. This Section includes the following: Distribution panelboards, and lighting and appliance branch circuit panelboards.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. Features, characteristics, ratings, and factory settings of individual overcurrent protective device and auxiliary components.
- C. Field quality-control test reports including the following:
 - 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.
- D. Panelboard Schedules: On drawings for installation in panelboards.
- E. 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 "Closeout Procedures" or "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 over-current protective device.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories 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 NEMA PB 1.

- D. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not exceeding 104 deg F.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 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, and encumbrances to workspace clearance requirements.

1.7 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. Keys: Six spares for each panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- A. Supplier to Furnish Equipment, Contractor to Install.
- B. Refer to Section 011000 "Summary"
- C. Supplier:
 - Atlantic South Power – Joel Crook,
 - joel@atlanticsouthpower.com,
 - 828-226-1451.
- D. Supplier responsibilities
 - 1. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - 2. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - 3. Purchase equipment
 - 4. Store equipment offsite.
 - 5. Coordinate installation schedule with Contractor.
 - 6. Deliver equipment to site.
 - 7. Test equipment on site.
 - 8. Manage equipment startup.
 - 9. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - 10. Warranty of equipment.
- E. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - 1. Receive equipment on site.
 - 2. Move equipment from receiving point to installation location.
 - 3. Install equipment.
 - 4. Connect and prepare for testing and energizing.

- 5. Energize equipment.
- 6. Warranty connection.

2.2 Manufacturers

- A Eaton
- B Schneider / Square D
- C Siemens
- D ABB

2.2 MANUFACTURED UNITS

- A. Enclosures: Flush, and surface mounted cabinets, as indicated. NEMA PB 1, Type 1 or rated for environmental conditions at installed location.
- B. Outdoor Locations: NEMA 250, Type 3R.
- C. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
- D. Finish: Manufacturer's standard enamel finish over corrosion resistant treatment or primer coat.
- E. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- F. Phase and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Phase Buses: Copper bus bars are to be used, OEM standard product with all associated, and appropriately sized accessories /hardware.
- G. Equipment Ground Bus: Adequate for feeder and branch circuit equipment ground conductors; bonded to box. Bar shall be copper.
- H. Conductor Connectors: Suitable for use with conductor material.
- I. Main and Neutral Lugs: Mechanical type.
- J. Ground Lugs and Bus Configured Terminators: Compression type
- K. Service Equipment Label: UL labeled for use as service equipment for panelboards with service disconnect switches.
- L. Future Devices: Mounting brackets, bus connections, and necessary appurtenances, provisions required for future installation of devices.
- M. Fabricate, test and anchor panelboards in accordance with IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration And Seismic Controls For Electrical Systems."

2.2 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals. See panel schedules on drawings.
- B. Series rated breakers may be used but relying on them for fault protection is not permitted.
- C. Short circuit (Arc Fault) current shall be labeled on door.

2.3 DISTRIBUTION PANELBOARDS

- A. Doors: Secured with vault type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices in MDP:
 - 1. Circuit breaker where MDP fault does not exceed 40 KAIC.
 - 2. Current limiting breaker or fuses where fault current exceeds 40 KAIC.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- C. Series ratings are not acceptable to obtain required fault ratings.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breaker: 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.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- B. Molded Case Circuit Breaker, Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Multiple units enclosed in a single housing or factory assembled to operate as a single unit.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mount top of trim not more than 78 inches above finished floor and not less than 72 inches, unless otherwise indicated. Bottom of large panelboards shall not be closer than 6" from floor.
- C. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Install overcurrent protective devices.
 - 1. Set field adjustable switches and circuit breaker trip ranges: (unless fault study provided)
 - a. Panelboard Feeders: LT: Maximum, ST: Minimum
 - b. Transformers: LT: Minimum, ST: Maximum
 - c. Elevators: LT: Maximum, ST: Maximum
 - d. Service MCB: LT: Mid-range, LTD: Mid-range, ST: Maximum, STD: Maximum, GF: 200 Amps, GFD: 0.5 Seconds
- E. Install filler plates in unused spaces.
- F. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

- A. Create a directory to indicate installed circuit loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated plastic nameplate mounted with corrosion resistant screws.

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 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. The panelboards shall be tested according to the manufacturer's recommendations.
 - 2. Balance loads, at full load conditions, to not worse than +/- 10% (20% total). Move circuits as needed.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 262813
FUSES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions.

1.2 MAINTENANCE

- A. Spare Parts:
1. Six spare fuses of each size and category, including any accessories required for a complete installation.
 2. Special tools if required for installation or removal of fuses.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

1. Supplier to Furnish Equipment, Contractor to Install.
2. Refer to Section 011000 "Summary"
3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 FUSEHOLDERS

- A. Equipment provided shall be furnished with fuseholders to accommodate the fuses specified.

2.3 FUSES RATED 600V OR LESS

- A. Fuses for Safety Switches (Lighting and Heating Circuits):
 - 1. Cartridge Type (250 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc./Bussmann Div., Type KTN-R.
 - b. Gould Inc./Circuit Protection Div. (Shawmut) Type A2K-R.
 - c. Littlefuse Inc. Type KLN-R.

2.4 FUSE CABINET

- A. Steel with hinged cover. Factory painted red with white lettering. Sized to accommodate spare fuses.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses, in identical sets, in readable orientation.
- B. Verify that fuse clips fit tightly on fuse.
- C. Provide minimum of 10% spare fuses to owner's on-site rep.
- D. Install spare fuse cabinet on wall in main electrical room.

END OF SECTION

SECTION 263213.13
DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Diesel-engine-driven generator sets.
 - 2. Diesel engine.
 - 3. Diesel fuel-oil system.
 - 4. Control and monitoring.
 - 5. Generator overcurrent and fault protection.
 - 6. Generator, exciter, and voltage regulator.
 - 7. Vibration isolation devices.
- 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.
 - 2. Section 263610 "Generator Docking Station" for manual transfer switches including for portable generator and load bank connection.
 - 3. Section 26548 "Vibration and Seismic Controls for Electrical Systems"

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
 - 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 engine generators and functional relationship between all electrical components.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer manufacturer and testing agency.
- B. Seismic Qualification Data: Certificates, for engine generator, accessories, and components, from manufacturer.
- C. Source quality-control reports.
- D. Field quality-control reports.
- E. Warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 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.

1.6 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 final acceptance.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- 1. Supplier to Furnish Equipment, Contractor to Install.
- 2. Refer to Section 011000 "Summary"
- 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
- 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
- 5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 DIESEL-ENGINE-DRIVEN GENERATOR SETS

- A. Kohler
- B. Cummins
- C. Bluestar

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, subbase fuel tank, engine generator, batteries, battery racks, silencers, load banks, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels. Water shall be substituted for diesel fuel in fuel tank during test.
 - 3. Component Importance Factor: 1.0.
- B. B11 Compliance: Comply with B11.19.
- C. NFPA Compliance:
 - 1. Comply with NFPA 37.
 - 2. Comply with NFPA 70.
 - 3. Comply with NFPA 99.
 - 4. Comply with NFPA 110 requirements for Level 1 EPSS.
- D. UL Compliance: Comply with UL 2200.
- E. Engine Exhaust Emissions: Comply with EPA Tier 4 requirements and applicable state and local government requirements.
- F. Noise Emission: Limit sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- G. 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 3000 feet.

2.4 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 qualified testing agency, and marked for intended location and use.
- C. Power Rating: Standby.
- D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.
- E. EPSS Class: Engine generator shall be classified as a Class 2 according to NFPA 110.
- F. Service Load: 450kW / 500 kVA.
- G. Power Factor: 0.8, lagging.
- H. Frequency: 60 Hz.
- I. Voltage: 480-V ac.

- J. Phase: Three-phase, four wire, wye.
- K. Induction Method: Turbocharged.
- L. Governor: Adjustable isochronous, with speed sensing.
- M. 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 engine generator center of gravity.
- N. 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.
- O. 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:
 - a. Comply with NFPA 110, Type 10 system requirements.
 - b. 10 seconds.

2.5 DIESEL ENGINE

- A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.
- 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: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499 and with NFPA 110 requirements for Level 1 equipment for heater capacity.
- 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.
 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-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), 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 23 feet from exhaust discharge after installation is complete shall be 74 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 12-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: As required by NFPA 110 for system level specified.
 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 (10 deg C) 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.
 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 to 140 deg F (minus 40 to plus 60 deg C) 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.

2.6 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 37.
- B. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- C. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- D. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- E. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.
 - 3. Leak detection in interstitial space.
 - 4. Vandal-resistant fill cap.
 - 5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.7 CONTROL AND MONITORING

- A. 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 engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. 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 engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 90 minutes with override only by operation of a remote emergency-stop switch.

- D. Comply with UL 508A.
- E. 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 engine generator vibration. Panel shall be powered from the engine generator battery.
- F. Control and Monitoring Panel:
1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
 3. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.
 - b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, for each phase connected to a phase selector switch.
 - f. AC ammeter, for each phase connected to a phase selector switch.
 - g. AC frequency meter.
 - h. Generator-voltage adjusting rheostat.
 4. Controls and Protective Devices: Controls, shutdown devices, and common 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.
 - 1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required for the indicated EPSS class.
 - 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 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.
 - 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. Generator overcurrent-protective-device not-closed alarm.
 - ff. Hours of operation.

- gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

G. 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.

H. Remote Alarm Annunciator: 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. Location indicated in the Drawings.

1. Overcrank alarm.
2. Low water-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 alarm.

I. 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.

J. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source. Coordinate generator breaker with Docking Station and downstream emergency breakers.
2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.

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.
 - C. 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 engine generator 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 engine generator 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.
 - D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
 1. Indicate ground fault with other engine generator alarm indications.
 2. Trip generator protective device on ground fault.
- 2.9 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 or Class F.
 - D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.
 - E. Range: Provide limited range of output voltage by adjusting the excitation level.
 - F. 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.
 - G. Enclosure: Drip-proof.
 - H. Instrument Transformers: Mounted within generator enclosure.
 - I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified and as required by NFPA 110.
 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.
 - J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
 - K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

- L. Subtransient Reactance: 12 percent, maximum.
- M. Neutral – Ground Bond: Removable with bond link removed but included in shipment.

2.10 VIBRATION ISOLATION DEVICES

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
 - 1. Material: Standard neoprene separated by steel shims.
 - 2. Shore A Scale Durometer Rating: 30.
 - 3. Number of Layers: One.
 - 4. Minimum Deflection: 1 inch (25 mm).
- B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
 - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Minimum Deflection: 1 inch (25 mm).
- C. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with IEEE 115 and with NFPA 110, Level 1 Energy Converters.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Engineer no fewer than two working days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Engineer's written permission.
- B. Comply with NECA 1 and NECA 404.
- C. Comply with packaged engine generator manufacturers' written installation and alignment instructions and with NFPA 110.
- D. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases."
 4. Remote Radiators:
- E. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
- G. Drain Piping: Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.
- H. Fuel Piping:
1. Copper and galvanized steel shall not be used in the fuel-oil piping system.
- I. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.
- C. Connect cooling-system water piping to engine generator and heat exchanger with flexible connectors.
- D. Connect engine exhaust pipe to engine with flexible connector.
- E. Connect fuel piping to engines with a gate valve and union and flexible connector.
- F. Ground equipment according to Section 260510 "Grounding and Bonding."
- G. Connect wiring according to Section 260120 "Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.3 IDENTIFICATION

- A. Identify system components according to Section 260075 "Electrical Identification."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with Drawings and the Specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify that the unit is clean.
 - b. Electrical and Mechanical Tests:
 - 1) Perform insulation-resistance tests according to IEEE 43.
 - 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. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.
 - 3. 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.
 - 4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 5. 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.
 - 6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). 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.
 - 7. Exhaust Emissions Test: Comply with applicable government test criteria.
 - 8. 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.
 - 9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 - 10. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure, and compare measured levels with required values.

- F. Coordinate tests with tests for transfer switches and run them concurrently.
- G. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
- H. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
- I. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
- J. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- K. Remove and replace malfunctioning units and retest as specified above.
- L. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.
- M. 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.

3.5 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

SECTION 263600
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less.

1.2 RELATED REQUIREMENTS

- A. Section 26548 "Vibration and Seismic Controls for Electrical Systems"

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for transfer switches, accessories, and components, from manufacturer.
- B. Source quality control reports.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 5 from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 OWNER-DESIGNATED EQUIPMENT SUPPLIER

- 1. Supplier to Furnish Equipment, Contractor to Install.
- 2. Refer to Section 011000 "Summary"
- 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
- 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.

- b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
- a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 99.
- D. Comply with NFPA 110.
- E. Comply with UL 1008 unless requirements of these Specifications are stricter.
- F. SEISMIC REQUIREMENTS
 - 1. Products shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 2. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
- G. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- H. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
 - 1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.
 - 2. Short-time withstand capability for three 30 cycles.

- I. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- J. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- K. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- L. Service-Rated Transfer Switch:
 - 1. Comply with UL 869A and UL 489.
 - 2. Provide terminals for bonding the grounding electrode conductor to the grounded service conductor.
 - 3. In systems with a neutral, the bonding connection shall be on the neutral bus.
 - 4. Provide removable link for temporary separation of the service and load grounded conductors.
 - 5. Surge Protective Device: Service rated.
 - 6. Ground-Fault Protection: Comply with UL 1008 for normal bus.
 - 7. Service Disconnecting Means: Externally operated, manual mechanically actuated.
- M. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- N. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- O. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.
- P. Battery Charger: For generator starting batteries.
 - 1. Float type, rated 2 10 A.
 - 2. Ammeter to display charging current.
 - 3. Fused ac inputs and dc outputs.
- Q. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations. Color-coding, wire and cable markers are specified in Section 260075"

Section 260075 " Electrical Identification."

- 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
- 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
- 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- 4. Accessible via front access.
- R. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers
 - 1. ASCO
 - 2. Kohler

3. Cummins
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Hard-drawn copper, 98 percent conductivity.
 6. Main and Neutral Lugs: Mechanical type.
 7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
 8. Ground bar.
 9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.
1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
 2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
 3. Fully automatic break-before-make operation with center off position.
 4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.
- F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- G. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.
 2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
 3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
 4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
 5. Test Switch: Simulate normal-source failure.
 6. Switch-Position Pilot Lights: Indicate source to which load is connected.

7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
 8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
 9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
 10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
 11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
 12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
 13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.
- H. Large-Motor-Load Power Transfer:
1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
 2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
 3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 SOURCE QUALITY CONTROL

- I. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and

voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

- J. Prepare test and inspection reports.
 - 1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.
 - c. Loss of supply voltage.
 - d. Reduction of supply voltage.
 - e. Alternative supply voltage or frequency is at minimum acceptable values.
 - f. Temperature rise.
 - g. Dielectric voltage-withstand; before and after short-circuit test.
 - h. Overload.
 - i. Contact opening.
 - j. Endurance.
 - k. Short circuit.
 - l. Short-time current capability.
 - m. Receptacle withstand capability.
 - n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
 - 3. Provide workspace and clearances required by NFPA 70.
- B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.
- C. Identify components according to Section 260553 "Electrical Identification."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260130 "Raceways and Boxes."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260510 "Grounding and Bonding."

- E. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.
- F. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches (457 mm) in length.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.
 - h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
 - 2. Electrical Tests:
 - a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.
 - g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
 - 3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use

- test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 4. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
 - f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
 - B. Coordinate tests with tests of generator and run them concurrently.
 - C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.
 - D. Transfer switches will be considered defective if they do not pass tests and inspections.
 - E. Remove and replace malfunctioning units and retest as specified above.
 - F. Prepare test and inspection reports.
 - G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
 3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- 3.4 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
 - B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where

ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

- C. Coordinate this training with that for generator equipment.

END OF SECTION

SECTION 263610

GENERATOR DOCKING STATION

PART 1 - GENERAL

1.1 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 and all sections of Division 26.
- B. Section 26548 "Vibration and Seismic Controls for Electrical Systems"

1.2 SUMMARY

- A. This Section is also referenced by related Work specified in other Divisions.
- B. Sections Includes
 - 1. Generator Docking Stations.

1.3 SUBMITTALS

- A. Product Data: For each Docking Station 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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For circuit breakers. Include plans, elevations, sections, details, and attachments to other works.
 - 1. Wiring diagrams: For power, signal, and control wiring.
- C. Qualification Data: For qualified testing agency.
 - 1. List of Part 2 equipment materials and devices.
 - 2. Continue the list

- D. 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.
- E. Manufacturer's field service report.
- F. Operation and Maintenance Data: For enclosed circuit breakers 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. Manufacturer's written instructions for testing and adjusting enclosed circuit breakers.
- G. 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.

1.4 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. Source Limitations: Obtain enclosed circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- 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.
- E. ETL/UL Listed to 1008 Standards.
- F. UL 50 Listed.

1.5 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°F and not exceeding 104°F.
 - 2. Altitude: Not exceeding six thousand six hundred (6,600) feet.

1.6 COORDINATION

- A. Coordinate layout and installation of Docking Station with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.7 WARRANTY/GUARANTEE

- 1. See Division 26 Specification Section "Basic electrical Requirements" for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERATOR DOCKING STATION:

- A. OWNER-DESIGNATED EQUIPMENT SUPPLIER
 - 1. Supplier to Furnish Equipment, Contractor to Install.
 - 2. Refer to Section 011000 "Summary"
 - 3. Supplier:
 - a. Atlantic South Power – Joel Crook,
 - b. joel@atlanticsouthpower.com,
 - c. 828-226-1451.
 - 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Include in Coordination Study and Short Circuit Study, and Arc-flash Hazard Analysis.
 - j. Warranty of equipment.
 - 5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.
- B. Approved Manufacturer's: Subject to compliance with requirements, provide products by the following:

1. TRYSTAR: Docking Station or approved equal.
- C. Enclosure:
1. NEMA 4X Metallic Enclosure.
 2. Pad-lockable front door shall include a hinged access plate at the bottom for entry of temporary cabling that prevents unauthorized tampering while in use.
 3. NEMA 3R Integrity shall be maintained while temporary cabling is connected during use.
 4. Front and Side shall be accessible for maintenance.
 5. Top, Side, and Bottom shall be accessible for permanent cabling.
 6. Life Safety Load Breaker shall be in separate compartment.
 7. Pad Mounted.
- D. Powder Coat
1. Paint after fabrication shall be Hammer tone Gray.
- E. Phase, Neutral, and Ground Busbar:
1. Material: Silver-plated Copper.
 2. Equipment Ground Bus: bonded to box.
 3. Ground bus: 100% of phase size.
 4. Neutral Bus: Neutral bus rated 100% of phase bus.
- F. Temporary generator Load Bank connectors shall be Camlok style mounted on gland plate.
1. Camlok shall be 16 Series model and color coded according to system voltage requirements.
 2. Camlok connections shall be Bus Bar Style. Cabling, or Double Set Screw is not acceptable.
 3. Camlok connections shall be protected against accidental contact while not in use.
 4. Camlok shall be suitable for wire size and quantities indicated on the drawings.
- G. Permanent Connection shall be factory installed board range set-screw mechanical type, located behind a physical barrier. Mechanical connectors shall be suitable for the new wire size and quantities indicated on the drawings.
- H. Short Circuit & Withstand Ratings
1. Shall be minimum 65 KAIC unless otherwise indicated on the drawings.
- I. Voltage & Amperage
1. 480/277V 1200A, 3 Phase, 4 Wire + Ground.
- J. Factory Installed Phase Rotation Device:
1. Phase monitoring relay to be Siemens 3U4512-1AR20 or equal and factory installed
 2. Must be UL 489 Listed Breaker – see drawings for additional information.
 3. Breaker shall be removable for service and maintenance.

4. Breaker shall be equipped with LSI trip unit.
 5. Breaker shall be key interlocked with permanent generation system.
- K. Additional Accessories shall be included in submittal drawing as follows:
1. A: Two Wire Auto Start.
 2. C: Battery Charger Receptacle 20A GFCI 125V.
 3. G: 100% Ground.
 4. M: Phase Monitor Relay.
 5. N: Strip heater.
 6. Q: Load Dump Receptacle
- L. Fabricate, test and anchor generator docking station in accordance with IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration And Seismic Controls For Electrical Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive Docking Stations for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after conditions affecting performance have been corrected.

3.2 INSTALLATION

- A. Provide housekeeping Pad for mounting Docking Station.
- B. Install Pad Mounted Docking Station utilizing properly secured channels anchored to housekeeping pad.
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- 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 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Engage a factory-authorized service representative to inspect 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. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder and control circuit.
 - 2. Test continuity of each circuit.
- D. 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. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than sixty (60) days after Final Acceptance, perform an infrared scan of each enclosed circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed circuit breaker eleven (11) months after sate of Substantial Completion.
 - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Verify Phase Rotation.
- E. Enclosed circuit breakers will be considered defective if they to not pass tests and inspections.
- F. Prepare test and inspection reports including a certified report that identifies enclosed circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.5 ADJUSTING

- A. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

END OF SECTION 263610

SECTION 284621.11

ADDRESSABLE FIRE-ALARM SYSTEMS WITH SMOKE 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. Existing fire-alarm system to be modified.
2. Addressable fire-alarm system.
3. Fire Alarm System control equipment
 - a. Fire-alarm control unit (FACU). Also known as Fire Alarm Control Panel (FACP).
 - b. Fire Alarm Power Supplies (FAPS) also known as NAC Extender Cabinets
 - c. Fire Alarm Terminal Cabinet.
 - d. Digital alarm communicator transmitters (DACTs).
 - e. Fire-alarm radio transmitters.
4. Initiation Devices
 - a. Manual pull stations.
 - b. System smoke detectors.
 - c. Duct smoke detectors.
 - d. Projected beam smoke detectors.
 - e. Carbon monoxide detectors.
 - f. Heat detectors.
 - g. Continuous linear heat detector system.
 - h. Multicriteria and multisensor fire detectors.
 - i. Nonsystem smoke detectors.
 - j. Air-sampling smoke detectors.
 - k. Video smoke detection.
5. Notification appliances for fire alarm system
 - a. Horn strobe, strobe
 - b. Exit-marking, audible.
6. Firefighters' two-way telephone communication service.
7. Emergency responder radio coverage system.
8. Firefighters' smoke-control system.
 - a. Firefighters' smoke control station, graphic.
9. Annunciators
 - a. Fire-alarm graphic annunciators.
 - b. Fire-alarm remote annunciators.
10. Fire-alarm addressable interface devices.
 - a. Relay Modules
 - b. Monitor Modules
 - c. Control Modules
 - d. Remote interface relays

B. Related Requirements:

1. Section 087100 "Door Hardware" for magnetic door holders that release in response to fire-alarm outputs.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables"
3. Section 260523 "Control Voltage Electrical Power Cables" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS AND ABBREVIATIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. ERRC: Emergency responder radio coverage.
- D. FAAP: Fire Alarm Annunciator Panel.
- E. FACP: Fire-alarm control panel. Equal to FACU.
- F. FACU: Fire-alarm control unit. Equal to FACP.
- G. FAPS: Fire Alarm Power Supply.
- H. FATC: Fire-alarm terminal cabinet
- I. FSCS: Firefighters Smoke Control Station. Equal to FSCP, Firefighters Smoke Control Panel.
- J. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
- K. IDC: Initiating Device Circuit.
- L. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- M. NAC: Notification Appliance Circuit.
- N. NICET: National Institute for Certification in Engineering Technologies.
- O. PC: Personal computer.
- P. RAIL: Remote Annunciator Indicator Light
- Q. FSCS: Firefighters Smoke Control Station, Also known as a Firefighters Smoke Control Panel.
- R. SLC: Signaling Line Circuit
- S. SNAC Panel: Supplementary Notification Appliance Circuit Panel. Also known as a NAC Panel.
- T. TWTC: Two Way Telephone Communications

U. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.5 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.
- B. Product Data: For each type of product, including furnished options and accessories.
 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
 1. Shop drawings shall be prepared by personnel with NICET Level IV certification.
 2. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 3. Include plans, elevations, sections, and details, including details of attachments to other Work.
 4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 5. Graphic Annunciator panel details as required by authorities having jurisdiction.
 6. Graphic Firefighters Smoke Control Station.
 7. Detail assembly and support requirements.
 8. Include voltage drop calculations for notification-appliance circuits. Use "end of line method" not "mid-point" method.
 9. Include battery-size calculations.
 10. Include input/output matrix.
 11. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
 12. Include performance parameters and installation details for each detector.

13. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 14. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
 15. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
 - c. Locate detectors in accordance with manufacturer's written instructions.
 - d. Show air-sampling detector pipe routing.
 16. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.
1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
 2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.
 4. Include basis of design for wall, ceiling and floor acoustic reflection/absorption and through-partition acoustic attenuation.

1.6 INFORMATIONAL SUBMITTALS

- A. Certificates:
1. Seismic Performance Certificates: For FACU, accessories, and components, from manufacturer. Include the following information:
 - a. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - b. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - c. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Qualification Statements: For Installer and Designer including proof of Certification within minimum dates.
- D. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components 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. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram with FACU and FAA control panels, modules, annunciators, communication panels, FATC, and NAC.
 - e. Device addresses.
 - f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
 - g. Record copy of site-specific software in USB memory.
 - h. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - i. Manufacturer's required maintenance related to system warranty requirements.
 - j. Abbreviated operating instructions for mounting at FACU and each annunciator unit.
 - k. System Report
 - 1) Two bound copies and pdf in USB
 - 2) As-Built wiring diagram
 - 3) Floor plans with as-built wiring, conduit and pathway plans.
 - 4) Riser diagram
 - 5) Equipment detailed maintenance requirements.
 - 6) Equipment data sheets.
 - 7) As-built calculation sheets.
- B. Software and Firmware Operational Documentation:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On USB media.
 3. Device address list.
 4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Manual Pull Stations: Quantity equal to 2% percent of amount installed, but no fewer than one unit.
2. Addressable Relay and Monitor Modules: 4%
3. Notification Appliances: 4%
4. Isolation Modules: 4%
5. Heat Detectors: 4%
6. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 6% of amount of each type installed, but no fewer than one unit of each type.
7. Detector Bases: Quantity equal to 4% of amount of each type installed, but no fewer than one unit of each type.
8. Keys and Tools: One extra set for access to locked or tamperproofed components.
9. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.
10. Filters for Air-Sampling Detectors, Air Sampling Fan, Duct Detectors: No extra material required.

1.9 QUALITY ASSURANCE

A. Installer Qualifications:

1. Fire alarm contractor shall be a factory authorized service provider for the system furnished. Contractor shall maintain a spare parts stock at contractors place of business.
2. Fire alarm contractor shall demonstrate 5 years documented experience installing fire alarm systems similar in size and scope of the project.
3. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
4. Installation must be by personnel certified by NICET as fire-alarm Level II technician. Installation personnel must be supervised by a Level III technician. Certification of personnel must have occurred within the most recent 24 months (for Level II) or 26 months (for Level III).
5. Obtain certification by NRTL in accordance with NFPA 72.
6. Licensed or certified by authorities having jurisdiction.

1.10 FIELD CONDITIONS

A. Seismic Conditions: Unless otherwise indicated on Contract Documents, specified Work in this Section must withstand the seismic hazard design loads determined in accordance with ASCE/SEI 7 for installed elevation above or below grade.

1. The term "withstand" means "unit must remain in place without separation of parts from unit when subjected to specified seismic design loads and unit must be fully operational after seismic event."

1.11 WARRANTY AND MAINTENANCE CONTRACT

A. Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

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

- B. Maintenance Contract: Contractor agrees to maintain, test and, repair system in accordance with NFPA-72 "Guide for Testing Protection Signaling Systems".
 - 1. Include quote for unscheduled maintenance/repair including hourly rates for technicians trained on the equipment with travel costs included.
 - 2. Rates shall be valid for 2 years after expiration of warranty.

PART 2 - PRODUCTS

2.1 GENERAL

- A. OWNER-DESIGNATED EQUIPMENT SUPPLIER
 - 1. Refer to Section 011000 "Summary"
 - 2. Supplier: Johnson Controls
 - 3. Contacts:
 - a. Mary McMerty, mary.elizabeth.mcmerty@jci.com, 864-376-7491
 - b. Kevin Atkins - For new designs - 828 243 1130 - service sales
 - c. Jeff Kilpatrick - Contract Sales - 828-231-7542 jeffrey.kilpatrick@jci.com
 - 4. Supplier responsibilities
 - a. Submit equipment data sheets and shop drawings to Architect and Engineer for approval.
 - b. Submit equipment data sheets and shop drawings to Contractor for construction coordination.
 - c. Purchase equipment
 - d. Store equipment offsite.
 - e. Coordinate installation schedule with Contractor.
 - f. Deliver equipment to site.
 - g. Test equipment on site.
 - h. Manage equipment startup.
 - i. Warranty of equipment.
 - 5. Contractor Responsibilities - Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
 - a. Receive equipment on site.
 - b. Move equipment from receiving point to installation location.
 - c. Install equipment.
 - d. Connect and prepare for testing and energizing.
 - e. Energize equipment.
 - f. Warranty connection.

2.2 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Manufacturer: Subject to compliance with the specifications, furnish products and services by the following manufacturer
 - 1. Johnson Controls
- B. Description:

1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation.
- C. Performance Criteria:
1. Regulatory Requirements:
 - a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
 2. General Characteristics:
 - a. Automatic sensitivity control of certain smoke detectors.
 - b. Fire-alarm signal initiation must be by one or more of the following devices and systems:
 - 1) Manual pull stations.
 - 2) Heat detectors.
 - 3) Flame detectors.
 - 4) Smoke detectors.
 - 5) Duct smoke detectors.
 - 6) Air-sampling smoke-detection system.
 - 7) Carbon monoxide detectors.
 - 8) Combustible gas detectors.
 - 9) Automatic sprinkler system water flow.
 - 10) Preaction system.
 - 11) Fire-extinguishing system operation, including kitchen hood systems.
 - 12) Fire standpipe system.
 - 13) Dry system pressure flow switch.
 - 14) Fire pump running.
 - c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm and specific initiating device at FACU, connected network control panels, firefighters smoke control station, off-premises network control panels, and remote annunciators.
 - 3) Transmit alarm signal to remote alarm receiving station.
 - 4) Unlock electric door locks in designated egress paths.
 - 5) Override lighting fixtures on and full illumination.
 - 6) Override non-emergency audio systems off.
 - 7) Release fire and smoke doors held open by magnetic door holders.
 - 8) Activate alarm communication system.
 - 9) Switch HVAC equipment controls to fire-alarm mode.
 - 10) Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - 11) Activate stairwell and elevator-shaft pressurization systems.
 - 12) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 13) Activate preaction system.
 - 14) Recall elevators to primary or alternate recall floors.
 - 15) Activate elevator power shunt trip.
 - 16) Lighting Controls:
 - a) Activate emergency lighting control.

- b) Activate control override of normal lighting: turn lighting to on, full bright.
 - c) De-activate performance lighting
 - d) De-activate performance audio and visual presentations or broadcasts.
 - 17) Activate sprinkler system isolation valve in elevator hoistway or machine room.
 - 18) Activate emergency shutoffs for gas and fuel supplies, except for shutoffs serving legally required life-safety systems such as emergency generators and fire pumps.
 - 19) Record events in system memory.
 - 20) Record events by system printer.
 - 21) Indicate device in alarm on graphic annunciator.
- d. Supervisory signal initiation must be by one or more of the following devices and actions:
- 1) Valve supervisory switch.
 - 2) High- or low-air-pressure switch of dry-pipe or preaction sprinkler system.
 - 3) Alert and Action signals of air-sampling detector system.
 - 4) Elevator shunt-trip supervision.
 - 5) Independent fire-detection and -suppression systems.
 - 6) Fire pump is running.
 - 7) Fire pump has lost power.
 - 8) Power to fire pump has phase reversal.
 - 9) Zones or individual devices have been disabled.
 - 10) FACU has lost communication with network.
- e. System trouble signal initiation must 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 communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACU.
 - 5) Ground or single break in internal circuits of FACU.
 - 6) Abnormal ac voltage at FACU.
 - 7) Break in standby battery circuitry.
 - 8) Failure of battery charging.
 - 9) Abnormal position of switch at FACU or annunciator.
 - 10) Hose cabinet door open.
- f. System Supervisory Signal Actions:
- 1) Initiate notification appliances.
 - 2) Identify specific device initiating event at FACU, connected network control panels, off-premises network control panels, and remote annunciators.
 - 3) Record event on system printer.
 - 4) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
 - 5) Transmit system status to building management system.
 - 6) Display system status on graphic annunciator.
- g. Network Communications:

- 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
 - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
- a. System Printer:
- 1) Printer must be listed and labeled as integral part of fire-alarm system.
- b. Device Guards:
- 1) Description: Welded wire mesh of size and shape for manual station, smoke detector, gong, or other device requiring protection.
 - a) Factory fabricated and furnished by device manufacturer.
 - b) Finish: Paint of color to match protected device.
- c. Document Storage Cabinet:
- 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 - 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
 - 3) Color: Red powder-coat epoxy finish.
 - 4) Labeling: Permanently screened with 1 inch high lettering "FIRE ALARM SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - 5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.
 - 6) Contents
 - a) Operating instructions
 - b) Installation Manual
 - c) Closeout documents.
 - d) 11x14 floor plans.
 - e) USB memory with pdfs of closeout documents
 - f) USB memory with programming software.

2.3 FIRE-ALARM CONTROL UNIT (FACU)

- A. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.
- B. Performance Criteria:
1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
 2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
 - b. Include real-time clock for time annotation of events on event recorder and printer.
 - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.

- d. FACU must be listed for connection to central-station signaling system service.
- e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
- f. FACU Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, three line(s) of 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into system for control of smoke-detector sensitivity and other parameters.
- g. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
- h. Fire-Alarm Annunciator (FAA): Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- i. AHU Shutdown Defeat
 - 1) Install supervised switch at FACP or at FAA.
 - 2) Allows building occupants to continue HVAC operation should a trouble not be able to be cleared.
 - 3) Install engrave nameplate at location.
- j. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Signal Line Circuit: Signals (alarm, trouble, and supervisory) from addressable devices to be encoded onto a NFPA 72, Style 6 Class A with no "T" taps.
 - a) Capable of expansion to 198 addressable devices per SLC and 1980 initiating points. Include 20% spare capacity above required by project.
 - b) Install no more than 50 addressable devices on each signaling-line circuit.
 - 2) IDC Circuits: Wired NFPA 72, Class B.
 - 3) NAC: Wired NFPA 72, Class B with
 - a) Load NAC circuits to 75% current rating.
 - b) Include 20% spare capacity of NAC circuits.
 - 4) Pathway Survivability: Level 1.
 - 5) Install fault circuit isolation modules to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions,

whichever is more conservative. Include isolation modules at the following locations:

- a) At each end of the SLC loop, located at the FACP
- b) After every 20 initiating devices and control points.
- c) At the middle of the SLC loop.
- d) Where the SLC loop exits a building.
- e) At each FATC on each floor.

k. Serial Interfaces:

- 1) One dedicated RS 485 port for remote station operation using point ID DACT.
- 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
- 3) One USB port for PC configuration.
- 4) One RS 232 port for air-aspirating smoke detector connection.

l. Smoke-Alarm Verification:

- 1) Initiate audible and visible indication of "alarm-verification" signal at FACU.
- 2) Activate approved "alarm-verification" sequence at FACU and detector.
- 3) Record events by system printer.
- 4) Sound general alarm if alarm is verified.
- 5) Cancel FACU indication and system reset if alarm is not verified.

m. Notification-Appliance Circuit:

- 1) Audible appliances must sound in ANSI S3.41 three-pulse temporal pattern, as defined in NFPA 72.
- 2) Output sound level no less than 90dBA measured 10 feet from device. Maximum 110dBA.
- 3) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
- 4) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.
- 5) Voltage drop at EOL shall not exceed 14% of expected battery voltage or 3 VDC, whichever is less.

n. Elevator Recall: Initiate by one of the following alarm-initiating devices:

- 1) Elevator lobby detectors except lobby detector on designated floor.
- 2) Smoke detectors in elevator machine room.
- 3) Smoke detectors in elevator hoistway.

o. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.

p. Water-flow alarm connected to sprinkler in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.

- 1) Water-flow switch associated with sprinkler in elevator pit may have delay to allow elevators to move to designated floor.

- q. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.
- r. Remote Smoke-Detector Sensitivity Adjustment: Controls must 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 final adjusted values on system printer.
- s. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- t. Status Annunciator: Indicate status of various alarm zones and status of firefighters' two-way telephone communication zones.
- u. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- v. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from other printed indications. Also, print system reset event, including same information for device, location, date, and time. Commands initiate printing of list of existing alarm, supervisory, and trouble conditions in system and historical log of events.
- w. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, DACT and digital alarm radio transmitters must be powered by 24 V(dc) source.
- x. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
- y. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
- z. Batteries: Sealed gel-cell.
 - 1) 10-year life.
 - 2) Batteries sized to minimum 60 hours of power capacity plus 15 minutes of full alarm load.

C. Accessories:

- 1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions. Include NFPA 72 "Record of Completion". Store in Document Storage Cabinet.
- 2. Floor Plans: Computer printed 11x14 floor plan of each floor with fire alarm devices and address. Frame in aluminum frame with glass cover. Locate adjacent to the FACU
- 3. Preaction System Functionality:
 - a. Initiate Presignal Alarm: This function must cause audible and visual alarm and indication to be provided at FACU. Activation of initiation device connected as part of preaction system must be annunciated at FACU only, without activation of general evacuation alarm.

2.4 MANUAL PULL STATIONS

- A. General Requirements for Manual Pull Stations: Comply with UL 38. Pull Stations must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Dual-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
 2. Station Reset: Key-operated switch.
 3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm. Lifting cover actuates integral battery-powered audible horn intended to discourage false-alarm operation.
 4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at top to permit lifting for access to initiate alarm.
 5. Able to perform at up to 90 percent relative humidity at 90 deg F.

2.5 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:
1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
 - b. General Characteristics:
 - 1) Detectors must be two-wire type. Provide four wire type if needed for existing system compatibility.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
 - 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - 7) Operator at FACU, having designated access level, must 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.).
 - 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
 - 9) Color: White.

- 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
- 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F (8 or 11 deg C) per minute.
- 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F (57 or 68 deg C).
- 13) Multiple levels of detection sensitivity for each sensor.
- 14) Sensitivity levels based on time of day.

B. Ionization Smoke Detectors:

1. System Sensor
2. Performance Criteria:

a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 268.

b. General Characteristics:

- 1) Detectors must be two-wire type. Provide four wire type if needed for existing system compatibility.
- 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- 5) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- 7) Operator at FACU, having designated access level, must 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.).
- 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
- 9) Color: White.
- 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
- 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F (8 or 11 deg C) per minute.

- 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F (57 or 68 deg C).
- 13) Multiple levels of detection sensitivity for each sensor.
- 14) Sensitivity levels based on time of day.

2.6 DUCT SMOKE DETECTORS

A. System Sensor

B. Description: Photoelectric-type, duct-mounted smoke detector.

C. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 268A.

2. General Characteristics:

- a. Detectors must be two-wire type. Provide four wire type for existing systems or systems with four wire type integral.
- b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
- d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
- e. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
- f. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
- g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
- h. Each sensor must have multiple levels of detection sensitivity.
- i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- j. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.
- k. Remote Test and Annunciator Station
 - 1) Provide station compatible with duct smoke detectors.

2.7 REMOTE TEST AND ANNUNCIATOR STATION

- A. Description: Remote station paired with duct smoke detectors for status annunciation and testing. Also known as a RAIL.
- B. Performance Criteria
 - 1. Regulatory requirements
 - a. NFPA 72
- C. General characteristics:
 - 1. Mounting: Single gang outlet box.
 - 2. LED visual indication of detector Pilot, Trouble and Alarm Functions
 - 3. Selectable audible indication of Alarm, Trouble or both
 - 4. Buzzer Silence function, with silenced indication and "ringback" following condition correction
 - 5. Lamp/Buzzer test function
 - 6. Key-Operated detector Test and Reset functions
 - 7. Lever-operated "No-Tools" terminal block
 - 8. Green Pilot, Red Alarm and Yellow Trouble Visual LED Indication, Buzzer for Alarm/Trouble,
 - 9. Key-Operated Test/Reset, Silence Function with Ringback, and LED Test Function
 - 10. 24 VDC
- D. Environmental Requirements
 - 1. Operating Temperature 0 to 49°C
- E. Warranty: 3 years.

2.8 PROJECTED (LINEAR) BEAM SMOKE DETECTORS

- A. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. UL 268
 - b. NFPA 72.
 - 2. General Characteristics:
 - a. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.
 - b. Three calibrated sensitivity settings capable of maintaining sensitivity between 1.0% and 2.0% per meter obscuration at any operating distance between 30 and 300 feet (10 and 60 meters).
 - c. Include a calibration chart with Smoke Sensitivity versus Operating Distance for each sensitivity setting. Chart to show 3rd party listed sensitivity limits for the entire range of rated operating distances.
 - d. Rated for continuous operation up to 122 degrees F and 95% relative humidity.

- e. Compensating circuits to maintain normal sensitivity as environment conditions change and as dust builds up in lenses. Initiate trouble signal when limits of compensation are reached.
- f. Modulated IR beam. Abrupt, maintained blockage of IR beam to result in trouble signal to be initiated from within 10 to 60 seconds.
- g. Detector Address: Accessible from FACU and able to identify detector's location within system and its sensitivity setting.
- h. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).

2.9 CARBON MONOXIDE DETECTORS

- A. System Sensor
- B. Description: Carbon monoxide detector listed for connection to fire-alarm system.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72
 - b. NFPA 720.
 - c. UL 2075.
 - 2. General Characteristics:
 - a. Mounting: Adapter plate for outlet box mounting.
 - b. Testable by introducing test carbon monoxide into sensing cell.
 - c. Detector must provide alarm contacts and trouble contacts.
 - d. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - e. Locate, mount, and wire in accordance with manufacturer's written instructions.
 - f. Provide means for addressable connection to fire-alarm system.
 - g. Test button simulates alarm condition.

2.10 HEAT DETECTORS

- A. Combination-Type Heat Detectors:
 - 1. **System Sensor**
 - 2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.

- b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
 - c. Actuated by fixed temperature of 135 deg F (57 deg C) or rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
 - g. Color: White.
- B. Fixed-Temperature-Type Heat Detectors:
- 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Actuated by temperature that exceeds fixed temperature of 190 deg F (88 deg C).
 - 2) Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - 4) Detector must have functional humidity range of 10 to 90 percent.
 - 5) Color: White.

2.11 CONTINUOUS LINEAR HEAT-DETECTOR SYSTEM

- A. Performance Criteria:
- 1. Regulatory Requirements:
 - a. NFPA 72.
 - 2. General Characteristics:
 - a. Detector Cable: Rated detection temperature of 155 deg F (68 deg C). Listed for "regular" service and standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow cable twist pressure to short circuit wires at location of elevated temperature.
 - b. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for FACU.
 - c. Signals to FACU: Local system trouble must be reported to FACU as composite "trouble" signal. Alarms on each detection zone must be individually reported to central FACU as separately identified zones.
 - d. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.

2.12 MULTICRITERIA AND MULTISENSOR FIRE DETECTORS

- A. System Sensor
- B. Description: Fire-sensing detectors using multiple means of detection.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72.
 - 2. General Characteristics:
 - a. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - c. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. Detector must send trouble alarm if it is incapable of compensating for existing conditions.
 - d. Test button tests sensors in detector.
 - e. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present sensitivity selected.
 - 4) Sensor range (normal, dirty, etc.).
 - f. Detector must have functional humidity range within 10 to 90 percent relative humidity.
 - g. Color: White.
 - h. Comply with UL and FM Global requirements.
 - i. Sensors (Multisensor Type): Detector must be comprised of four sensing elements including smoke sensor, carbon monoxide sensor, infrared sensor, and heat sensor.
 - 1) Smoke sensor must be photoelectric type as described in "System Smoke Detectors" Article.
 - 2) Carbon monoxide sensor must be as described in "Carbon Monoxide Detectors" Article.
 - 3) Heat sensor must be as described in "Heat Detectors" Article.
 - 4) Each sensor must be separately listed in accordance with requirements for its detector type.

2.13 NONSYSTEM SMOKE DETECTORS

- A. Single-Station Smoke Detectors:
 - 1. System Sensor
 - 2. Performance Criteria:
 - a. Regulatory Requirements:

1) NFPA 72.

b. General Characteristics:

- 1) Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120 V(ac) with 9 V(dc) battery as secondary power source. Provide with "low" or "missing" battery chirping-sound device.
- 2) Auxiliary Relays: One Form C, rated at 0.5 A.
- 3) Audible Notification Appliance: Piezoelectric sounder rated at 90 dB(A-weighted) at 10 ft. (3 m) in accordance with UL 464.
- 4) Visible Notification Appliance: 177 cd strobe.
- 5) Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
- 6) Test Switch: Push to test; simulates smoke at rated obscuration.
- 7) Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector must actuate notification on connected detectors.
- 8) Plug-in Arrangement: Detector and associated electronic components must be mounted in plug-in module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
- 9) Self-Restoring: Detectors must not require resetting or readjustment after actuation to restore them to normal operation.
- 10) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

B. Single-Station Duct Smoke Detectors:

1. System Sensor
2. Performance Criteria:

a. Regulatory Requirements:

- 1) NFPA 72.
- 2) UL 268A.

b. General Characteristics:

- 1) Sensor: LED or infrared light source with matching silicon-cell receiver.
- 2) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Fixed base must be designed for mounting directly to air duct. Provide terminals in fixed base for connection to building wiring.
 - a) Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; listed for use with supplied detector.
- 3) Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
- 4) Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.14 AIR-SAMPLING SMOKE DETECTORS

A. Manufacturers

1. Fike Xtralis Vesda

2. Honeywell FFAST

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL 1887.

2. General Characteristics:

- a. Air-sampling smoke detector must be laser based using piping system and fan to transport particles of combustion to detector.
- b. Provide two levels of alarm from each zone covered by detector and two supervisory levels of alarm from each detector.
- c. Air being sampled must pass through filters to remove dust particulates greater than 20 microns before entering detection chamber.
- d. Detectors must have capability via RS 485 to connect up to 100 detectors in network.
- e. Detectors must communicate with FACU via addressable, monitored dry contact closures, RS 485, and interface modules. Provide minimum of six relays, individually programmable remotely for any function.
- f. Pipe airflow balancing calculations must be performed using approved calculation software.
- g. Detector, Filter, Aspirator, and Relays: Housed in mounting box and arranged such that air is drawn from detection area and sample passes through dual-stage filter and detector by aspirator.
- h. Obscuration Sensitivity Range: 0.08% to 4% percent obs/ft.
- i. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and programmable scan time delay. Threshold set points must be programmable.

1) Four alarm thresholds may be used as follows:

- a) Alarm Level 1 (Alert): Activate visual and audible supervisory alarm.
- b) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate visual and audible supervisory alarm.
- c) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
- d) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.

2) Final Detection System Settings: Approved by Engineer.

3) Initial Detection Alarm Settings:

- a) Alarm Level 1 (Alert): 0.08 percent obs/ft.
- b) Alarm Level 2 (Action): 1.0 percent obs/ft.
- c) Alarm Level 3 (Fire 1): 2.0 percent obs/ft.
- d) Alarm Level 4 (Fire 2): 4.0 percent obs/ft.

j. Power Supply:

- 1) Regulated 24 V(dc), monitored by FACU, with battery backup.
- 2) Battery backup must provide 24 hours' standby, followed by 30 minutes at maximum connected load.

- k. Detector must also transmit the following faults:
 - 1) Detector.
 - 2) Airflow.
 - 3) Filter.
 - 4) System.
 - 5) Zone.
 - 6) Network.
 - 7) Power.
 - l. Provide four in-line sample pipe inlets that must contain flow sensor for each pipe inlet. Detector must be capable of identifying pipe from which smoke was detected.
 - m. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to **650 ft. (200 m)** in total, (four pipe runs per detector) with transport time of less than 120 seconds from farthest sample port.
 - n. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in trouble alarm.
 - o. Provide software-programmable relays rated at 2 A at 30 V(dc) for alarm and fault conditions.
 - p. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) must be capable of storing up to 18,000 events.
 - q. Urgent and Minor Faults. Minor faults must be designated as trouble alarms. Urgent faults, which indicate unit may not be able to detect smoke, must be designated as supervisory alarms.
3. Displays:
- a. Include display module within each detector.
 - b. Each display must include the following features:
 - 1) Bar-graph display.
 - 2) Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to four alarm thresholds of indicated sector.
 - 3) Alarm threshold indicators for Alert, Action, and Fire 1.
 - 4) LED indication that first alarm sector is established.
 - 5) Detector fault and airflow fault indicators.
 - 6) LED indicators must be provided for faults originating in particular zone (Zone Fault), faults produced by overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
 - 7) Minor and urgent LED fault indicators.
4. Sampling Tubes:
- a. Smooth bore with nominal **1 inch (25 mm)** OD and **7/8 inch (21 mm)** ID. Sampling pipe with between **5/8 and 1 inch (15 and 25 mm)** ID can be used in specifically approved locations when recommended by manufacturer.
 - b. Pipe Material: CPVC and complying with UL 1887.
 - c. Joints in sampling pipe must be airtight. Use solvent cement approved by pipe manufacturer on joints except at entry to detector. Cap ends.
 - d. Make 45 and 90 degree bends with bending tool, not fittings.
 - e. Identify piping with labels reading:
 - 1) Sampling detector pipe: "Smoke Detecting Sampling Tube - Do Not Paint or Disturb" along its entire length at 20-ft intervals in accordance with NFPA 72.
 - f. Support pipes at not more than **60 inch (1.5 m)** centers.

- g. Fit end of each trunk or branch pipe with end cap and drilled with hole appropriately sized to achieve performance as specified and as calculated by system design.
- 5. Sampling Holes:
 - a. Sampling holes of **5/64 inch (2 mm)**, or other sized holes per manufacturer's written instructions, must be separated by not more than maximum distance allowable for conventional smoke detectors. Intervals may vary in accordance with calculations.
 - b. Follow manufacturer's written instructions to determine number and spacing of sampling points and distance from sampling points to ceiling or roof structure and to forced ventilation systems.
 - c. Each sampling point must be identified:
 - 1) Sampling Points: "Fire Detection System Do Not Paint"
 - 2) Farthest sampling port: "Test Point".

2.15 FIRE-ALARM NOTIFICATION APPLIANCES

A. Fire-Alarm Audible Notification Appliances:

- 1. System Sensor
- 2. Description: Horns, bells, or other notification devices that cannot output voice messages.
- 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - b. General Characteristics:
 - 1) Individually addressed, connected to signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.
 - 2) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 3) Chimes, High-Level Output: Vibrating type, 81 dB(A-weighted) minimum rated output.
 - 4) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
 - 5) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.
 - 6) ANSI S3.41 ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted) at 24 V.
 - 7) ANSI S3.41 ISO Temporal 3 Alert Tone: 95 plus or minus 5 dB(A-weighted) at 24 V.
 - 8) AS2220 Evacuation Tone: 93 plus or minus 4 dB(A-weighted) at 24 V.
 - 9) AS2220 Alert Tone: 93 plus or minus 5 dB(A-weighted) at 24 V.
 - 10) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured **10 ft.** from horn, using coded signal prescribed in UL 464 test protocol.

- 11) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

B. Fire-Alarm Visible Notification Appliances:

1. System Sensor
2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:
 - 1) Rated Light Output:
 - a) Candela value indicated on drawings.
 - b) 15/30/75/110 cd, selectable in field.
 - c) Exterior units: 100cd double flash.
 - 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
 - a) Exterior: Clear lens, weatherproof housing.
 - 3) Mounting: Wall mounted unless otherwise indicated.
 - 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
 - 5) Flashing must be in temporal pattern, synchronized with other units.
 - 6) Strobe Leads: Factory connected to screw terminals.
 - 7) Mounting Faceplate: Factory finished, red or white. Submit to Architect for approval.

C. Fire-Alarm Sounder Base, Low Frequency

1. Addressable Low frequency sounder base to meet NFPA 72 sleeping space requirements to produce a frequency of 520 Hz +/-10% with a square wave.
2. Performance Criteria
 - a. Regulatory Requirements
 - 1) NFPA 72
 - 2) UL 464 for Audible Signaling Devices.
 - b. General Characteristics
 - 1) Does not require SLC Loop address – uses sub point address feature.
 - 2) Support class A, Class X and Class B wiring.
 - 3) 24 VDC power connection supervised internally – no external supervision relay required.
 - 4) Uses both a SLC circuit and an external 24VDC circuit.
 - 5) Terminals accept 18 to 12 AWG size wires.
 - 6) 16-33 VDC
 - 7) External power standby current: 4.1 mA
 - 8) External power active current:
 - a) 33VDC: 86.7 mA
 - b) 24 VDC: 96.5 mA
 - c) 16 VDC: 156.6 mA
 - 9) SLC Operating voltage: 24VDC
 - 10) SLC Standby Current: 200 uA
 - 11) Installation temperature: 32 to 120 degrees F.

- 12) Operating relative humidity range: 0 to 93% non-condensing
- 13) Sound Pressure Level: 85dBA minimum.
- 14) Startup time: Max. 1 sec.
- 15) Maximum number of devices per zone: 127
- 16) Color: eggshell white.
- 17) Mounting: Ceiling or wall.
 - a) Flush: 4-in x 2-1/8" deep square box
 - b) Surface: Factory back-box, red finish.

2.16 EXIT-MARKING AUDIBLE NOTIFICATION APPLIANCES

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Provide exit-marking audible notification appliances at entrance to building exits.
- b. Provide exit-marking audible notification appliances at entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.17 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

- A. Description: Dedicated, two-way, supervised, telephone voice communication links between FACU and remote firefighters' telephone stations. Supervised telephone lines must be connected to talk circuits by controls in control module.

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Common-talk type for firefighter use only.
- b. Selective-talk type for use by firefighters and fire wardens.
- c. Controls to disconnect phones from talk circuits if too many phones are in use simultaneously. Indicator lamp must flash if phone is disconnected from talk circuits.
- d. Addressable firefighters' phone modules to monitor and control loop of firefighter phones. Module must be capable of differentiating between normal, off-hook, and trouble conditions.
- e. Audible Pulse and Tone Generator, and High-Intensity Lamp: When remote telephone is taken off hook, it causes audible signal to sound and high-intensity lamp to flash at FACU.
- f. Selector panel controls to provide for simultaneous operation of up to six telephones in selected zones. Indicate ground faults and open or shorted telephone lines on panel front by individual LEDs.
- g. Display: Graphic to indicate location of caller.

- h. Remote Telephone Cabinet: Flush- or surface-mounted cabinet as indicated; factory-standard red finish; with handset.
 - 1) Install one-piece handset to cabinet with vandal-resistant armored cord. Silk-screened or engraved label on cabinet door, designating "Fire Emergency Phone."
 - 2) With "break-glass" door access lock.
- i. Remote Telephone Jack Stations: Single-gang, stainless steel-plate mounted plug, engraved "Fire Emergency Phone."

2.18 EMERGENCY RESPONDER RADIO COVERAGE SYSTEM

- A. System is Add Alternate 3.
- B. Manufacturer: Westell or approved equal.
- C. Description: Emergency responder radio coverage systems use a combination of bidirectional amplifiers and distributed antenna systems to boost signals for sustaining two-way radio communications throughout a facility, including stairwells, underground tunnels, parking garages, and other challenging areas.
- D. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. In accordance with NFPA 72, emergency responder radio coverage systems must be designed, installed, and maintained in accordance with NFPA 1221.
 - 2. General Characteristics:
 - a. Where emergency responder radio coverage system is used in lieu of two-way in-building wired emergency communications system, it must have pathway survivability of Level 1, 2, or 3 as defined in NFPA 72.
 - b. Where leaky feeder cable is used as antenna, it must neither be required to be installed in metal raceway nor meet survivability requirements.
 - c. Feeder and riser coaxial cables must be rated as plenum cables.
 - d. Feeder coaxial cables must be connected to riser coaxial cables using hybrid coupler devices of value determined by overall design.
 - e. Where emergency responder radio coverage system is used in lieu of two-way in-building wired emergency communications system, design of system must be approved by authorities having jurisdiction. Riser coaxial cables must be rated as riser cables and routed through 2-hour-rated enclosure.
 - f. Connection between riser and feeder coaxial cables must be made within 2-hour-rated enclosure, and passage of feeder cable in and out of 2-hour-rated enclosure must be firestopped to 2-hour ratings.

2.19 FIREFIGHTERS' SMOKE-CONTROL SYSTEM

- A. Performance Criteria:
 - 1. Regulatory Requirements:

- a. NFPA 72.
 - b. UL 864
2. General Characteristics:
- a. Initiate Smoke-Management Sequence of Operation:
 - 1) Comply with sequence of operation as described in Section 230993.11 "Sequence of Operations for HVAC DDC" or on Drawings.
 - 2) Fire-alarm system must provide interfaces and control points required to properly activate smoke-management systems.
 - 3) First fire-alarm system initiating device to go into alarm condition must activate smoke-control functions.
 - 4) Subsequent devices going into alarm condition must have no effect on smoke-control mode.
 - b. Addressable Relay Modules:
 - 1) Provide address-setting means on module. Store internal identifying code for control panel use to identify module type.
 - 2) Allow control panel to switch relay contacts on command.
 - 3) Have minimum of two normally open and two normally closed contacts available for field wiring.
 - 4) Listed for controlling HVAC fan motor controllers.

2.20 FIRE-ALARM GRAPHIC ANNUNCIATORS

A. Performance Criteria:

- 1. Regulatory Requirements:
 - a. NFPA 72.
- 2. General Characteristics:
 - a. Graphic Annunciator Panel: Mounted in aluminum frame with nonglare, minimum **3/16 inch (4.76 mm)** thick, clear acrylic cover over graphic representation of facility. Detector locations must be represented by red LED lamps. Normal system operation must be indicated by lighted, green LED. Trouble and supervisory alarms must be represented by amber LED.
 - 1) Comply with UL 864.
 - 2) Operating voltage must be 24 V(dc) provided by local 24 V power supply provided with annunciator.
 - 3) Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and lamp test switch.
 - 4) Semiflush mounted in NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
 - 5) Graphic representation of facility must be CAD drawing and each detector must be represented by LED in its actual location. CAD drawing must be at **(1:100)** scale or larger.
 - 6) LED representing detector must flash two times per second while detector is in alarm.

- b. Graphic Annunciator Workstation: PC-based, with fire-alarm annunciator software with historical logging, report generation, and graphic interface showing alarm points in system. PC with operating system software, minimum 32GB hard drive, 17 inch digital display monitor, with wireless keyboard and mouse.

2.21 FIREFIGHTERS SMOKE CONTROL STATION (FSCS)

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. UL864

2. General Characteristics:

- a. Control and annunciation station for smoke evacuation functions of standalone or integrated HVAC fan systems.
 - 1) Mounting: Surface cabinet, NEMA 250, Type 1.
 - 2) Graphical representation of floor plan with smoke zones.
 - 3) Hand-Off-Auto switches for fan control, located next to graphic of zone controlled.
 - 4) Illuminated indicating lights to show status of fans
 - a) Stopped
 - b) Running
 - c) Fault.
- b. Connected by RS485 with the capability of connecting 10 FCSSs on a loop.
- c. See additional requirements in the Drawings.

2.22 FIRE-ALARM REMOTE ANNUNCIATORS

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.
 - 1) Mounting: Surface cabinet, NEMA 250, Type 1.

- b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.
- c. Connected by RS485 with the capability of connecting 10 annunciators on a loop.

2.23 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. Include address-setting means on module.
- b. Store internal identifying code for control panel use to identify module type.
- c. Listed for controlling HVAC fan motor controllers.
- d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
 - 1) Flow Switch, Fire Protection (Sprinkler): Monitor module shall have an alarm transmission delay from 0-60 seconds. Initial settings 30-45 seconds. Locate minimum 12 inches from flow switch. Division 21 shall provide flow switch. Division 28 shall provide monitor modules and connect to flow switch.
 - 2) Tamper Switch, Fire Protection, Sprinkler Valves: mount in position not to interfere with valve wheel. Adjust to operate within two revolutions toward the closed position or when the stem has moved no more than 1/5th of the distance from its original position.
- e. Relay Module: Capable of providing direct signal to elevator controller to initiate elevator recall, or to circuit-breaker shunt trip for power shutdown.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
- f. Control Module:
 - 1) Operate notification devices.
 - 2) Operate solenoids for use in sprinkler service.

2.24 DIGITAL ALARM COMMUNICATOR TRANSMITTERS (DACTs)

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.

2. General Characteristics:

- a. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
- b. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically capture two telephone line(s) and dial preset number for remote central station. When contact is made with central station(s), signals must be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of telephone line to remote alarm receiving station over remaining line. Transmitter must automatically report telephone service restoration to central station. If service is lost on both telephone lines, transmitter must initiate local trouble signal.
- c. Local functions and display at DACT must include the following:
 - 1) Verification that both telephone lines are available.
 - 2) Programming device.
 - 3) LED display.
 - 4) Manual test report function and manual transmission clear indication.
 - 5) Communications failure with central station or FACU.
- d. Digital data transmission must include the following:
 - 1) Address of alarm-initiating device.
 - 2) Address of supervisory signal.
 - 3) Address of trouble-initiating device.
 - 4) Loss of ac supply.
 - 5) Loss of power.
 - 6) Low battery.
 - 7) Abnormal test signal.
 - 8) Communication bus failure.
- e. Secondary Power: Integral rechargeable battery and automatic charger.
- f. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.25 FIRE-ALARM RADIO TRANSMITTERS

A. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. NFPA 1221.
- c. 47 CFR 90.

2. General Characteristics:

- a. Must be factory assembled, wired, and tested; ready for installation and operation.
- b. Packaging: Single, modular, NEMA 250, Type 1 metal enclosure with tamper-resistant flush tumbler lock.
- c. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of established remote alarm receiving station designated by Owner.
- d. Normal Power Input: 120 V(ac).

- e. Secondary Power: Integral-sealed, rechargeable, 12 V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - 1) Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports must withstand 100 mph (160 km/h) with gust factor of 1.3 without failure.
 - 2) Antenna Cable: Coaxial cable with impedance matched to transmitter output impedance.
 - 3) Antenna-Cable Connectors: Weatherproof.
 - 4) Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to transmitter, matching fire-alarm and other system outputs to message-generating inputs of transmitter that produce required message transmissions.
- f. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU or from its own internal sensors or controls and must automatically transmit signal along with unique code that identifies transmitting station to remote alarm receiving station. Transmitted messages must correspond to standard designations for fire-reporting system to which signal is being transmitted and must include separately designated messages in response to the following events or conditions:
 - 1) Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - 2) System Test Message: Initiated manually by test switch within transmitter cabinet, or automatically at optionally preselected time, once every 24 hours, with transmission time controlled by programmed timing device integral to transmitter controls.
 - 3) Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of transmitter normal power source, derangement of wiring of transmitter, or alarm input interface circuit or device connected to it.
 - 4) Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause trouble signal to be indicated on building system.
 - 5) Local Fire-Alarm-System Alarm Message: Actuated when building system goes into alarm state. Identifies device that initiated alarm.
 - 6) Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when building alarm system indicates supervisory alarm.

2.26 FIRE ALARM TERMINAL CABINETS

- A. Manufacturers: Space Age Electronics, Point Integration Cabinet
- B. Description:
 - 1. Enclosed cabinet with door and interior wire terminals for a central location of multiple fire alarm circuits.
- C. Regulatory Requirements
 - 1. UL Listed 864, OUXX.S2580
 - 2. SAE TTS
- D. Performance Criteria
 - 1. Enclosure
 - a. NEMA 1

- b. Dimensions:
 - 1) 16-point: 6.5 x 8.5 x 2.25 inch
 - 2) 18-point: 2.5 x 8.5 x 6.6 inch
 - 3) 32-point : 14 x 14 x 3.25 inch.
 - 4) 64-point : 23.5 x 13 x 5.5 inch
 - 5) 128 point: 23.5 x 23.5 x 5.5 inch
 - c. Material: Steel, 16 gauge
 - d. Cover: Continuous hinge, CAT 30 keyed lock, removable with machine retaining bolt.
 - e. Backplate: Galvanized, removable, ½-in standoff cabinet back.
 - f. Conduit entry electrical trade sizes: ½, ¾, 1.5, and 2-in conduit.
 - g. Finish: Red
 - h. Identification: White lettering, 1-in (16 and 18 point) or 2-inch (32 64 128 point) "FIRE ALARM TERMINAL CABINET".
 - i. Directory: Paper adhered to back of cover for field identification of cables and conductors.
2. Terminal Strips
- a. Quantity of terminals needed for splices or as noted.
 - b. Rated 12 gauge wire and 20A 250V per terminal (Class B/UL)
 - c. SAE TTS Tool-less wire release
 - d. TTS Test Probe test ports.

2.27 VIDEO SMOKE DETECTION

A. [Firevu](#)

B. Performance Criteria:

1. Regulatory Requirements:

- a. NFPA 72.
- b. NFPA 1221.
- c. 47 CFR 90.

2. General Characteristics:

- a. Unit dedicated to task of video fire detection running no additional software that can compromise detection.
- b. Views can be monitored by modern PC or Mac that uses viewing software.
- c. Camera viewing must use graphic user interface with independent video codecs to provide continuous analysis of video images; i.e., field of view covered by number of standard CCTV cameras. Unit must allow zones to be placed anywhere within camera view to enable source of fire to be identified in shortest time possible while alerting operator to presence of fire, by means of viewing software by computer on monitor screen.
- d. Smoke must be detected by monitoring of small areas of change within image and passing these pixel changes to processor for analysis. Series of filters within algorithm must be employed to seek particular characteristics associated with smoke. Further analysis must then be carried out on relationship between filtered characteristics to determine whether conditions have been met for system to confidently detect presence of fire.
- e. To cater for situations where background smoke is present, system must provide facility to vary quantity of smoke and duration smoke needs to exist before alarm condition is raised. Unit must also have facility to alarm only if smoke is present in one or more zones.

- f. Capacity: Unit must employ algorithms to process video information from up to four cameras simultaneously.
- g. Frame Rate: Unit must achieve 25 Hz-frame rate for each of four channels.
- h. Outputs: Minimum of 16 alarm outputs that may be individually assigned to combination of zones or sectors. These outputs must not be linked to any particular camera, allowing for zonal and image association. Through output logic matrix, operator must have ability to customize systems output to alarm conditions and, therefore, allow easy integration within "house" fire-alarm system.
- i. Hardware: Cameras or cabling chosen for integration with video smoke detection unit must be verified by manufacturer. System must be capable of viewing with standard camera that is capable of producing clear image in lighting conditions that are envisaged for application.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before other trades have completed cleanup must be replaced.
 - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of building.
 2. Connect new equipment to existing monitoring equipment at supervising station.
 3. Expand, modify, and supplement existing control and/or monitoring equipment as necessary to extend existing control and/or monitoring functions to new points. New components must be capable of merging with existing configuration without degrading performance of either system.
- C. Install wall-mounted equipment, with tops of cabinets not more than **78 inch (1980 mm)** above finished floor.
1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."
- D. Manual Pull Stations:
1. Install manual pull station in normal path of egress within **60 inch (1520 mm)** of exit doorway.
 2. Mount manual pull station on background of contrasting color.
 3. Operable part of pull station must be between **42 and 48 inch (1060 and 1220 mm)** above floor level. Devices must be mounted at same height unless otherwise indicated.
- E. Smoke- and Heat-Detector Spacing:
1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed **30 ft. (9 m)**.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
 5. HVAC: Locate detectors not closer than **36 inch (910 mm)** from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than **12 inch (300 mm)** from lighting fixture and not directly above pendant mounted or indirect lighting.
- F. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- G. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than **36 inch (9100 mm)** long must be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
 2. Provide Remote Annunciator and Test Station in nearest corridor or public area.
 3. Provide 12 x 12 in hinged access door for access to air sampling tubes or smoke detectors.
 4. Indicate air flow direction on duct using stencil or decal.
 5. Air sampling tubes: extend full width of ducts. Support every 3 feet.

- H. Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.
- I. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.
- J. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.
- K. Remote Test And Annunciator Station: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- L. Audible Alarm-Indicating Devices: Install not less than 6 inch (150 mm) below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- M. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch (150 mm) below ceiling. Install devices at same height unless otherwise indicated.
- N. Device Location-Indicating Lights: Locate in public space near device they monitor.
- O. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists wind load of 100 mph (160 km/h) with gust factor of 1.3 without damage.

3.4 SMOKE CONTROL SYSTEM

- A. Smoke Control Sequence of Operation
 1. This is a dedicated smoke control system, meaning that the equipment is installed for the sole purpose of providing smoke control. This equipment includes the supply air fan SC-1, the exhaust air fan SC-2, outdoor air intake and exhaust air dampers.
 2. The fire alarm / smoke control system shall override the Building Automation System (BAS) control of the air handlers AHU-B1, AHU-B2, CU-2, and general exhaust fan EF-B. These units shall be de-energized when the smoke control system is in operation. The outside air intake damper for SC-1 and the smoke exhaust damper for SC-2 are controlled only by the smoke control system. The BAS shall monitor and trend the status of the smoke control fans and each component.
 3. The FSCS and the fire alarm components shall be UL 864 listed for smoke control capabilities.
- B. SMOKE CONTROL SEQUENCE:
 1. The system shall be placed in a smoke control mode and an alarm condition displayed at the FSCS whenever any of the following occurs:
 2. Products of combustion are detected by the area smoke detectors in the Basement Level detention area or
 3. Sprinkler water flow in Basement Level detention area or
 4. The fire alarm system receives notification of a general fire alarm situation in a specific zone (the Basement Level detention area) from the central fire alarm system through a fire alarm control module or
 5. Upon an operator command from the FSCS.
 6. Upon an alarm being transmitted, the sequence of operations shall be as follows:

C. AUTOMATIC CONTROL

1. If products of combustion are detected by any smoke detector in the Basement Level detention area or sprinkler water flow is detected in the Basement Level detention area, then the smoke control system will be automatically activated. The following actions shall occur:

- Evacuation signal shall sound
- AHU-B1, AHU-B2, CU-B2, and EF-B shall shut down
- The smoke damper in the general exhaust duct shall be closed
- The outside air intake damper shall open for SC-1
- Make-up supply air fan SC-1 shall run
- The exhaust air damper shall open for SC-2
- Exhaust fan SC-2 shall run

D. MANUAL CONTROL

1. The FSCS shall have total "EVAC / AUTO / OFF" manual smoke control which overrides the automatic fire alarm control and the BAS. The normal operating position of the selector switch shall be **AUTO**, during which the BAS shall control the function of AHU-B1, AHU-B2, CU-B2, and EF-B, and in the event of an alarm the fire alarm / smoke control system shall override the BAS and automatically control AHU-B1, AHU-B2, CU-B2, and EF-B, smoke damper, intake and exhaust dampers, and fans as described above. Once the alarm condition has been reset, the system will automatically resume normal operation.
2. When the FSCS selector switch is manually placed in the "**EVAC**" position, the smoke control system shall be activated as described above under "Automatic Control".
3. When the FSCS selector switch is placed in the "**OFF**" position the smoke control system shall be deactivated, and the dampers shall return to their normal positions.

3.5 ELECTRICAL CONDUCTORS AND CABLES**A. Connect wiring in accordance with Section 260120 "Conductors and Cables."**

1. SLC circuit shall be FPL/FPLR/FPLP fire alarm cable 18 AWG minimum. Cable shield drain wires to be terminated to ground at FACP only. Shield to be spliced at device outlets and insulated from ground.
 - a. Manufacturers:
 - 1) Atlas 228-18-1-1STP
 - 2) BSCC S1802s19 (ECC 7806LC
 - 3) West Penn D975 D991 (AWG16) D995(AWG14)
 - b. Color: Red jacket with black and red insulated conductors.
 - c. Underground: Type TC or PLTC
2. Conductors
 - a. AWG 14, minimum, THHN/THWN stranded copper in metal conduit.
 - 1) Initiating circuit, general: Red (+) / White (-)
 - 2) Initiating circuit, smoke: Violet (+) / Gray (-)
 - 3) Signal Line Circuit cable: Red jacket with Red (+) / Black (-)
 - 4) Notification Appliance Circuits: Blue (+) / Black (-)
 - 5) AHU Shutdown Circuits: Yellow (+) / Brown (-)
 - 6) Door Control Circuits: Orange
 - 7) Elevator Capture Circuits: Brown
 - 8) One-way Voice/Alarm and Two-way
 - a) Digital audio circuits: UTP, 18 AWG, jacketed or optical fiber
 - b) Analog audio: STP 18 AWG copper: Belden 8970, West Penn293

- c) Gray with Red (+) and Black (-) Shield terminated at amplifier and sliced at devices but insulated from ground.
 - B. Ground equipment in accordance with Section 260510 "Grounding and Bonding"
 - C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- 3.6 PATHWAYS
- A. Pathways must be installed in EMT.
 - B. Exposed EMT shall be factory painted red enamel. Boxes shall be factory painted red enamel.
 - C. Route SLC loops in two separate vertical risers.
 - D. Smoke Control power and control conductors and cables to be routed underground or in 2-hour circuit protective systems.
 - E. ERRCS cabling to be routed vertically in 2-hour rated riser shaft from basement to roof.
- 3.7 CONNECTIONS
- A. Install control and electrical power wiring to field-mounted control devices.
 - B. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
 - C. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
 - D. Make addressable connections with monitor or relay modules to the following devices and systems. Install interface device less than 36 inch (910 mm) from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - 1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
 - 2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
 - 3. Smoke dampers in air ducts of designated HVAC duct systems.
 - 4. Magnetically held-open doors.
 - 5. Electronically locked doors and access gates.
 - 6. Alarm-initiating connection to elevator recall system and components.
 - 7. Alarm-initiating connection to activate emergency lighting control.
 - 8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 9. Supervisory connections at valve supervisory switches.
 - 10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
 - 11. Supervisory connections at elevator shunt-trip breaker.
 - 12. Data communication circuits for connection to building management system.

13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals.
- B. Install framed instructions in location visible from FACU.
- C. AHU Shutdown Defeat: Engrave nameplate with "AHU Shutdown Defeat" adjacent to switch.
- D. Electrical Power Source: Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 1. Nameplate must be laminated acrylic or melamine plastic signs with black background and engraved white letters at least **1/2 inch (13 mm)** high.
 2. Engraved nameplate
 - a. "PANELBOARD", "PANELBOARD LOCATION", "BRANCH CIRCUIT NUMBER"
- E. Branch circuits in panelboards serving fire alarms systems: Painted with a red ¼-in dot with a red locking handle accessory.
- F. Addressable Devices:
 1. Printed adhesive label, clear with black lettering. Hand-written not acceptable.
 2. Unique address number assigned to each device.
 3. Adhere to device base, readable from floor. Adhere to cover of device if base is not visible.

3.9 GROUNDING

- A. Ground FACU and associated circuits in accordance with Section 260510 "Grounding and Bonding"
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Engineer.
- B. Adminstrant for Tests and Inspections:
 1. Administer and perform tests and inspections. Test shall be conducted with the following personnel present:
 - a. Contractor
 - b. Manufacturers' Authorized Installer
 - c. FACU programmer.
 - d. Engineer.
- C. Pre-Final Inspection
 1. Conduct a system test to ensure system functionality prior Final Inspection.

D. Final Inspection:

1. Conduct 100% performance test for every initiating device.
2. System shall have been operational for 48 hours before test.
3. Notify Engineer and Owner 7 days before test.
4. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
5. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
6. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
7. Test audible appliances for private operating mode in accordance with manufacturer's written instructions.
8. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
9. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances. Test to be in accordance with NFPA 72 14.1 and Annex A 14.4.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. 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. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION AND TRAINING

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Provide video recording of training to Owner. Allow Owner to record training.
1. Minimum 8-hour on site time.
 2. Additional 1 hour training for personnel on 2nd and 3rd shift, to be conducted during that shift.
 3. Training schedule to be approved by owner.

4. Topics:
 - a. Preventative maintenance service techniques and schedules. Including historical data trending of alarm and trouble records.
 - b. Overall system concepts, capabilities and functions.
 - c. Explanation of all control functions including training on the use of programming software.
 - d. Methods of troubleshooting and replacement of field wiring devices.
 - e. Methods of troubleshooting the main FACU and peripheral devices.
5. Hands on Training: Training shall include a hands-on training event for the physical replacement of smoke detectors.
 - a. Three dirty smoke detectors will be installed in 3 separate locations.
 - b. A sensitivity report will be printed and the FACU.
 - c. The trainees will find the dirty smoke detectors.
 - d. The three smoke detectors shall be taken off line at the FACU.
 - e. The three smoke detectors shall be removed from the bases and replaced with new detectors.
 - f. The detectors will be addressed and programmed at the FACU and placed into service.
 - g. A separate scenario will be conducted with a ground fault isolation problem.
 - h. The trainees will be trained on the use of an NFPA 72 "Record of Completion" document for the services.

3.12 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 284621.11

SECTION 23 09 23
DDC SYSTEM FOR HVAC**PART 1 - GENERAL**

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. All work of this Division shall comply with the requirements of the Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions and Division 01 Specification Sections.
- B. Section 23 05 30 – Electrical Provisions for Mechanical Work
- C. Division 26 – Electrical
- D. Division 27 - Communications

1.2 DESCRIPTION

- A. Furnish and install a web-based Energy Monitoring and Control System (EMCS), with point and click graphics, using Direct Digital Controls described herein. Furnish all labor, materials, equipment, and service necessary for a complete and fully operational system. Drawings are diagrammatic only. The system shall be complete in all respects including all devices to provide the function described herein, regardless of whether specifically mentioned or not. This shall include HVAC control, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related for normal building operations as indicated on the drawings or elsewhere in this specification.
- B. The Owner has designated the equipment supplier for the building automation system to be Johnson Controls. Refer to Specification Section "011000 – Summary" for point of contact for Johnson Controls.
- C. Contractor shall coordinate with the Owner's designated equipment sources for delivery, installation requirements, connections, startup, testing, commissioning and warranty requirements associated with the Owner-designated equipment. Contractor shall include all labor, materials, accessories, connections and coordination necessary for a complete installation.
- D. Alternate proposals or substitutions, where provided, must conform to plans or specifications in detail, and any deviation, no matter how minor, must be included in the list of deviations submitted with the bid. Any proposed system with deviations which, in the opinion of the Owner and/or the Engineer, alter the basic intent of the specifications will not be accepted.
- E. The EMCS shall be stand-alone with a building control unit, BAS LAN and one (1) ethernet connection to the owner's wide area network. The system shall use the owner's Ethernet Network for data communication between the building and the Web Server.
- F. Provide the following electrical work as work of this section, complying with requirements of Section 23 05 30, Division 26, and Division 27 sections:
 - 1. Control wiring between field-installed controls, sensors, relays, transducers, indicating devices, and unit control panels.
 - 2. Interlock wiring between electrically-operated equipment units and between equipment and field-installed control devices.

1.3 WORK INCLUDED

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- A. The following work is specifically included without limiting the generality implied by these specifications and drawings.
1. Installation of a microprocessor based direct digital control (DDC) system to control HVAC equipment and systems for space conditioning, night setback, demand limiting, etc. All new controls shall be electronic.
 2. Cutting and patching as required for the introduction of work as shown on the plans and as specified in this Division. This includes wall repair and painting of locations where existing thermostats are removed and re-insulation of pipe and duct where control devices are installed.
 3. Providing all internal and external wiring for the Direct Digital Control System.
 4. Furnishing for installation by others, sensor wells and sockets, control valves, damper motors and other items of equipment indicated on the Drawings.
 5. Demolition of existing control devices, tubing, wiring, and equipment no longer in use.
 6. Provide all needed equipment and wiring to install the local area network within the building and provide the capability of accessing the system locally by connecting through laptop computers, monitoring remotely via web browser, and remote interface via mobile applications for Android and iOS platforms.
 7. Provide all software, hardware, programming, cables, wiring, devices, etc. for a complete and operational project.
 8. Provide start-up and testing of the system.
 9. Provide owner training on system operation, programming, and maintenance.

1.4 SHOP DRAWINGS

- A. Submit for approval apparatus bulletins and data sheets for all control components, valves, damper and room schedules showing size, configuration, capacity and location of all equipment. Include complete control diagrams with system description, wiring diagrams and installation and maintenance instructions.
- B. All control wires on the line side of relay, starter or contactor coils, pilot lamps or other utilization components shall be color coded and labeled. All control wires on the neutral side of utilization components shall be white.

1.5 ELECTRICAL WIRING

- A. Refer to Section 23 05 30 for wiring required under this Section.
- B. All wiring shall be done in accordance with the latest edition of the National Electric Code, Division 26, Division 27, and the North Carolina State Building Code.
- C. All wiring associated with the direct digital control system shall be by this Division.
- D. Wiring methods:
1. All line voltage wiring shall be in conduit.
 2. All low voltage control and signal wiring shall be in conduit in walls, mechanical rooms and where exposed.
 3. To the extent feasible, all sensor drops in existing walls shall be fished in the wall, routed down in closets, or otherwise concealed, or pulled through existing conduit.
 4. All wiring in finished areas shall be in surface raceway with the color to match the existing finish but only used where specifically approved.
 5. All penetrations of rated walls and floors shall be fire stopped in accordance with the NC Building Code, drawing notes, and UL details indicated on the drawings.
 6. Plenum cable shall only be used in concealed locations above ceilings and shall be neatly routed on J-hooks.

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1.6 GUARANTEE

- A. Control system specified herein shall be guaranteed free from original defects in material and workmanship for a period of two years of normal use and service after final inspection and acceptance of the project. Same-day service on warranty issues shall be guaranteed if a service call, from the Owner to Contractor, is placed before 12:00 noon. Except in the case of an emergency, warranty items will be addressed during normal working hours.
- B. The contractor shall provide one (1) year of maintenance service for the HVAC controls system to begin concurrently with the first year of warranty. Service shall include inspection and adjustment of all operating controls and components during the alternate season from when it was installed (ie. if installed in summer, adjust in winter). A service report shall be provided to the owner.
- C. The control system manufacturer shall state that equipment compatible with that being bid will be available for at least three years after acceptance of this work. Support and stock shall be available for at least five years.
- D. The manufacturer shall provide, free of cost, any upgrades to the software for a period of three years from acceptance of this work.

1.7 QUALIFICATION FOR MICROPROCESSOR BASED ENERGY MANAGEMENT EQUIPMENT SUPPLIER

- A. If the system is not installed by the manufacturer, the installing contractor's primary business shall be the installation of Temperature Control and Direct Digital Control Systems, and he shall have a minimum of ten (10) years' experience in the installation and service of microprocessor-based systems. The installer shall be approved by the manufacturer for both installation and maintenance of building systems and equipment. Upon request, the contractor should be able to provide a list of at least three other installations where he has installed a system of similar size and scope. Failure to show at least three successful installations will disqualify the contractor.
- B. The contractor shall have a local office within a 75-mile radius of the job, staffed with factory trained engineers capable of providing instruction, routine maintenance, and emergency maintenance service. The local office shall also maintain an adequate stock of spare parts needed for normal servicing and repairs.
- C. Make: Control system shall be by a company licensed to work on and install Controls system and capable of meeting all required operations and functions. Subject to compliance with requirements, provide products by the following:

1. Johnson Controls Incorporated. Refer to Specification Section 011000 – Summary.

1.8 INTERNET ACCESS

- A. All information exchanged over the Internet shall be encrypted and secure via SSL (provided by owner).
- B. Access to the web interface shall be password protected. Provide all necessary security software to create a minimum of three levels and sufficient firewall protection. Read only command privileges shall be set by the system administrator.
- C. Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics shall be available to users via a web browser.
- D. The web-based interface shall provide the following functionality to users, based on their access and

privilege rights.

1. Logon Screen: allows the user to enter their username, password, and Domain name for logging into the web server. Access to be limited based on security level.
 2. Alarm Display: a display of current alarms to which the user has access will be displayed. Users will be able to acknowledge and reset active alarms, and link to additional alarm information including alarm messages and informational and memo text.
- E. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature. The Ethernet communication protocols of the ~~new~~ system must be fully compatible with **this project's** Ethernet communication specifications. The contractor shall coordinate with **the owner's** IT Project Manager to obtain written approval to operate on the campus-wide network.
- F. The **Owner** will provide LAN access points for the system's internet access.

PART 2 - PRODUCTS

2.1 MICROPROCESSOR BASED CONTROL SYSTEM FOR ENERGY MANAGEMENT

- A. General Requirements: Furnish and install a networking microprocessor-based Energy Management System (MPS) for the monitoring and control of the mechanical and electrical equipment designated. It is the intent of this specification to describe the performance requirements of the MPS. Therefore, these specifications describe the operational functions of the system and present minimal requirements for equipment to accomplish these functions. The MPS shall be comprised of the hardware and the software required to perform all designated tasks as described hereinafter. The installation may consist of one or more individual MPS panels. The term MPS refers to each individual panel as well as the entire installation. An MPS shall be able to communicate with other MPS by local network through a twisted pair or shielded wire. A local network may be comprised of more than thirty (30) MPS. The local network shall be able to interface through the Web via an Ethernet port. The MPS system shall be a true distributive processing system and each MPS shall be a self-contained programmable control and monitoring system. Each MPS shall be able to perform its control, energy management and alarm functions independently from other units. The MPS shall consist of one or more logic panels depending upon control strategy and number of points controlled and/or monitored. The MPS shall not be dependent upon a master unit or CPU for control logic or data. The failure of one MPS shall not adversely affect the operation of other MPS of the distributed network.
- B. Hardware:
1. Each MPS controller shall be UL listed or shall comply with UL 916 standard for Energy Management. Power Supply to the panel shall be isolated with UL labeled Class II transformer. The primary side of the transformer shall be protected by overcurrent protection, and the secondary side shall have fused disconnect. Circuit breaker type disconnect at the secondary side will not be acceptable. Primary side protection shall not be required on small Application Specific Controllers (ASC's) used to control small individual pieces of equipment (exhaust fans, fan coil units, etc.) The MPS shall be provided as a networking stand-alone energy management system enclosed in one or more sturdy metal enclosures containing a microcomputer, separate peripheral ports for connecting a laptop, a network communications port, power supplies, battery backup, and input/output control boards. Each MPS shall be able to gather information and/or update a minimum of four (4) times a second. All stand-alone units shall be accessible via the network through peripheral ports on the network units following proper password access code entry. All peripheral communication as well as global data transfer between network units shall be accomplished through the local network. For owner-operator independence, the microcomputer shall be completely field-programmable through integral keyboard entries or

through the maintenance department's laptop computers.

- C. Status Indication: Annunciator light for each load, indicating controlled equipment operation. The MPS shall include a 24-hour time-of-day clock with standard calendar and full battery backup maintaining clock, building operating program and RAM memory for a minimum of thirty hours. A built-in charging circuit shall maintain battery at a full charge. All network units in the local network shall synchronize their time-of-day clocks every 24 hours. Each network port on the network shall allow access and programming to each of the other MPS units. A separate access code is to be maintained for each MPS unit. All system memory shall be programmable through these network ports and data entered into memory shall be recalled and displayed for operator review. Additions or deletions shall be made when the system is on-line. Systems requiring shutdown of any part shall not be acceptable. The programs and data sets, once entered into the MPS shall be capable of being stored on an external storage device (e.g. USB storage drive) through an on-site memory dump process and therefore be available to the operator for reloading as needed. The MPS supplier shall provide the necessary parts and external storage devices needed for this purpose. Check sum verification shall insure data integrity during loading operation. The MPS input/output hardware shall be compatible with electronic HVAC control systems for total building optimization, energy management and facilities management, such as abnormal condition alarm reporting. The MPS shall be capable of communication through the internet via an Ethernet link provided in the building. The MPS shall be furnished with a user programmable language and sufficient internal memory to provide at least the following software capabilities:
1. electric demand limiting
 2. time programmed commands to include two state and setpoint control
 3. duty cycle control
 4. optimum start-up control
 5. holiday scheduling
 6. time of day
 7. password entry
 8. direct digital control with P.I.D
 9. any other programs specified in the Input/Output schedule.
- D. Surge and Lightning Protection Line Voltage Protection: The DDC system control panels shall be powered by 120 VAC circuits provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall be a TE/100 manufactured by Advanced Protection Technologies or an approved equal. Line voltage protection shall not be required on small Application Specific Controllers (ASC's) used to control small individual pieces of equipment (exhaust fans, fan coil units, etc.).

2.2 NETWORK PROVISIONS

- A. Virtual Local Area Network (VLAN): Provide a minimum 100 MB/second Ethernet VLAN capable of connecting a local control system server, operator workstations, and multiple Java Application Control Engines (JACE's). The VLAN shall support XML internet protocol, Hypertext Transfer Protocol (HTTP), Simple Object Access Protocol (SOAP), Java, BACnet and LonWorks.
- B. Local Area Network (LAN): Provide a minimum 100 MB/second Ethernet LAN which shall comply with IEEE Standard 802.3 and use 100 Base-TX, UTP-8 wire, Category 5 (Cat 5) cabling.
- C. Remote Access: The VLAN shall be accessible without proprietary software by commonly available web browsers (i.e. Microsoft Edge, Google Chrome, Mozilla Firefox and Apple Safari) with tiered username and password security access.

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1. Internet Access: The Owner shall provide high-speed internet connection for access to the VLAN. The Owner shall provide temporary secured access, for the duration of the project through the one-year walk-through, to the VLAN users.

2.3 MOBILE DEVICE APPLICATIONS

- A. EMCS shall provide the capability of remote interface via mobile applications for Android and iOS platforms. The application for mobile platforms shall provide real-time access to monitored inputs, setpoints, modes, values, statuses, and outputs.
 1. Operator interface shall consist of:
 - a. An icon-based, interactive application for Android and iOS devices.
 - b. Standard Android and iOS navigation methods shall be used to access, edit, and modify controller functions and shall be used to navigate through menus, select options and icons, and change parameters.
 2. Operator interface shall, at a minimum, have the following functions:
 - a. Points: The operator interface shall provide points list menus to view the inputs, setpoints, and output values such as hardware inputs/outputs, analog values, binary values, and multistate values.
 - 1) The points lists menus shall allow the operator to monitor, set, and override controller points and values.
 - 2) A color-code shall be used to indicate the conditions and statuses of points displayed in the points list menus.
 - b. Alarms: The operator interface shall provide a controller's alarms menu to view details of an alarm, to acknowledge the alarm, and to view the alarm history.
 - 1) The alarm menu shall allow the operator to view the following type of alarms: active not acknowledged, active acknowledged, and inactive not acknowledged.
 - 2) The combination of an icon and its color state shall notify the operator of an alarm condition.
 - 3) The operator shall be able to select a single point in alarm to view further details such as the alarm to/from status, current status, event date and time, alarm event threshold, and alarm event value.
 - c. Overrides: The operator interface shall provide an overrides menu to view a list of the controller's overridden points such as hardware input, hardware output, value, constant, or variable. The menu shall allow the operator to select an overridden point and to modify or release the override on the selected point.
 - d. PID loops: The operator interface shall provide a PID Loops menu to view, configure, and adjust the PID parameters. The interface shall also provide visual PID tuning with live system response graphing (live-trend).
 - e. Favorites: The operator interface shall allow access to a list of bookmarked points.
 - f. Weather: The operator interface shall provide a weather menu to view the current weather conditions with a weather status icon. The units shall be configured to be displayed in either metric or US units.
 - g. Password Protected: The controller operator interface shall provide multi-level password protection, with user-defined, alphanumeric, name/password combinations. The operator interface shall return to lock mode after a user- defined log-off delay. A

password icon shall indicate the lock mode state.

- h. Settings: The operator interface shall provide a settings menu to view and configure date and time parameters such as the current time, time zone, and daylight savings time.

2.4 GENERAL APPLICATION PROGRAMS

- A. Each stand-alone networking unit shall be programmable through the integral keyboard or peripheral terminal. Software architecture shall allow both standard setups of point types, EMS Programs, loops or related parameters as well as custom program linking with math and logic. In addition, the MPS shall allow the building operators a means of interrogating input/output sensor conditions, such as interrogating the values of analog sensor input upon request, or the status of control via the standard keyboard and display unit. The MPS shall not be dependent upon a master control unit or CPU for control logic or data. The system access shall be restricted by at least three levels of password security. As a minimum, the system shall be programmed for six users each with designated three letter Operator ID and four- character password.
- B. Each of the MPS units on the network shall be able to access global information. Such information as outside air temperature, demand shed commands, and enthalpy changeover etc. routines can be shared by all units on the Network.
- C. Network data shall be capable of being trended from each MPS on the network for printout and alarm through locally connected printers on the network.
- D. Local Network status shall monitor all communication in the network. Loss of any data transfer will trigger alarms as well as default sequences to maintain system integrity. MPS will execute a pre-defined mode of operation if the system fails.
- E. Building alarm monitoring and reporting shall be generated based upon the presence of abnormal alarm conditions such as high/low temperature input or abnormal change of state such as freeze stats, fire stats, filter alarm switches, etc. Printed report upon alarm condition shall be generated and reported to designated terminal via Local Network System.

2.5 SPECIFIC APPLICATION PROGRAMS

- A. Electric Demand Limiting (EDL): The MPS shall contain a sliding window program and shall be programmed to reduce the peak demand for consumption and demand as user definable target values are approached. The MPS shall have the capability to do this although no electric demand sequences are included in this project.
- B. The EDL program shall automatically shed non-critical deferrable loads, on the network, such as electric heating coils, lights, battery chargers, HVAC systems, motors, etc., as outlined in the schedule, during high electrical usage periods. This sequence shall automatically restore the loads after a critical demand period has passed. The program should also have the capability of restoring loads based on any other data. This data could consist of time of day, outdoor or space temperatures, etc. The operator shall have the ability to select either the rolling (first off, first on) or the sequential (last off, first on) load shed tables for load assignment. Each load shall have its own minimum on, maximum off and minimum off time.
- C. The EDL program shall be capable of providing proportional voltage outputs which will change setpoints of HVAC control systems, and/or reset hot water or limit the number of operating compressors. Target demand limits shall be user definable.
- D. The EDL program shall be provided with a minimum of three times of day shifts, each containing unique KW target setpoints. These times of day target shifts will allow the target to be changed in

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accordance with the utility time of day metering schedule, such that during off hours EDL will allow a higher KW demand, if required, without being penalized for additional demand charges. The time of start and finish for each of the three times of day target values shall be user definable. Trend log may be programmed to store for future recall, the peak demand value, the day of month of occurrence and the time of day of occurrence.

2.6 TIME PROGRAMMED COMMANDS (TPC)

- A. The MPS system shall provide automatic start-up and/or shutdown of selected remote equipment and automatic adjustment of setpoint data according to pre-set schedules stored in the computer. All remote fans, pumps, motors, lights, HVAC systems, boilers, chillers, etc. or any device which operates on a preset time basis can be assigned to this program.
- B. TPC shall operate in accordance with a yearly calendar with automatic adjustment for daylight savings time and leap year.
- C. TPC shall incorporate holiday schedules capability which will automatically bring up predefined holiday schedules of operation. Holidays can be scheduled up to one year in advance and shall be capable of any number of holidays per year. The technique for scheduling holiday operation shall be to specify the date of the beginning day of the holiday and the date of the ending day of the holiday. For each of those days specified as a holiday, the time clock will follow its unique holiday schedule.
- D. TPC shall provide time dependent programmable two state control. This time program shall contain unique schedules which may be defined with appropriate start/stop times for each piece of controlled equipment. There should not be any limitation of number of schedules or number of start/stop per schedule. In addition to the time dependent two state control, TPC shall also provide time dependent setpoint control. This control provides the capability of outputting proportional setpoint values of a pre-determined, pre-defined setting in accordance with the time of day and day of week. This program shall be used to accomplish night setback, morning warm-up, and normal daily operating setpoints of all control system loops, controlled by the MPS.
- E. As with the two-state control, time dependent setpoint control shall be subject to the holiday schedule. The setpoints desired shall be user definable. The operator shall be capable of reading and/or altering all stored data pertaining to time of day, day of week, on/off times, setpoint values, and holiday designation.

2.7 OPTIMUM START PROGRAM (OS)

- A. The optimum start-up time of assigned equipment shall be determined based on a software calculation which takes into consideration outdoor air conditions, space conditions, and building R factor. Any or all zones and their associated loop control shall be capable of being optimized by the optimum start program. The software program shall be capable of precisely determining the ideal start-up time in the heating and cooling system. Each zone being optimized may have its own unique set of variables, such as temperature and occupancy time.
- B. The optimum start program shall control the start-up of the HVAC cooling and heating equipment to achieve the target occupancy space temperature at the precise time of building occupancy. By use of a local terminal device, i.e. laptop, the operator shall have the ability to program the occupancy time and target temperature for each zone to be optimized. A unique built-in "learning" technique shall allow the MPS to automatically adjust itself to the most effective time to start equipment in order to achieve the desired occupancy target temperature. Each zone being optimized shall have its own learning curve.

2.8 CUSTOM CONTROL

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- A. The MPS shall utilize real-time calendar year time functions. The processor shall be able to evaluate seconds, minutes, hours, days of week, days of month, and years. The MPS shall make an automatic adjustment for leap years. The battery back-up shall accurately maintain all time functions in the event of power loss. The MPS software shall allow individual programmability of each load as well as coordinated control of loads within one MPS, as well as between different MPS. The MPS software must be of a user programmable type which will permit the user/operator easy communication with the processor. The MPS software shall provide an editing feature so that the user can enter control programs as well as alter, delete, or add to control programs. The MPS software shall provide a control simulation feature thereby allowing the user to pre-test the system software prior to, or while external wiring connections are being made to the system. The system shall have the ability to perform the following pre-tested control algorithms:
1. Two-position control
 2. Proportional control
 3. Proportional plus integral control
 4. Proportional, integral, plus derivative control
 5. Automatic loop tuning
- B. The MPS software must make available elapsed seconds and minute timers for use in control software. Such timers will provide for the elimination of equipment short cycling.
- C. The MPS software must be structured in such a manner as to allow the user to develop his own user programs to fit the energy management and control strategy needs of the specific installation at hand. The MPS software must use a straightforward English format. The MPS software must have the capability of performing program control strategies based upon any or all analog and digital inputs and/or outputs within the specific MPS, or via the intercommunications lines, any or all analog and digital inputs and/or outputs from different MPS units. The MPS must have a programmable Daylight Savings Time feature which is user definable.
- D. The MPS shall allow the user to input full English identifications of all digital inputs, analog inputs, digital outputs, analog outputs, and counters. When the printout of data is requested, the full English identification will be printed with the data. The user shall be able to directly identify equipment status, system operation, digital and analog input data, without the need to reference tables or wiring diagrams.
- E. The MPS shall be able to perform special priority actions and strategies upon return of power after a power loss at the facility.
- F. The MPS software shall have the capability to execute control strategies based upon Boolean logic statements. The MPS software shall execute full addition, subtraction, multiplication, division, greater-than, less-than, and equals-to statements. The MPS shall also be able to process "and", "or", and "else" logic functions in the determination of control sequences.
- G. The MPS shall support an expanded math area where the user may input numeric values, decimal and negative numbers, and mathematical expressions. The MPS shall therefore allow the user to input user defined formulas for proportional, integral and derivative control including combinations of these controls. The MPS shall be able to utilize stored number values and the calculated values of user-defined formulas in the execution of the control strategies. The conversion of analog and digital information to customer-defined engineering units shall include, and not be limited to, KWH, %RH, GPM, CFM, etc.
- H. The MPS software shall be capable of performing special control strategies and alarming based upon occurrence of one or more emergency conditions such as equipment failure and temperature, pressure, flow or humidity readings which are determined by the processor to be out of a pre-determined range. The user must have the ability to adjust the emergency conditions at any time.

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- I. The MPS software shall be capable of scheduling hours of occupancy for a full year in advance. The software must have the capability of scheduling 20 or more holiday schedules and vacation periods. Such events must be user-adjustable. The user shall have the capability of adjusting such events at any time.
- J. The MPS software shall employ internal machine diagnostics and parity checks to detect hardware or software faults. Upon itemization of such failure, the MPS shall shut down in a fail-safe manner as described hereinafter.
- K. Alarming Requirements:
 - 1. All alarms shall be immediately displayed.
 - 2. The networking microprocessor-based Energy Management System, hereinafter referred to as MPS, shall have the capability of storing and configuring alarms from a particular building or panel to be displayed when a particular user logs into the system at the laptop computer, or via the web browser.
 - 3. The MPS shall have the capability to initiate an alert to service personnel.
 - 4. The sending of the alarm report may be activated by user-defined "out of limits" conditions as determined by the input and output data to the MPS.
 - 5. The alarm report shall be user-definable and will include the facility identification, the specific MPS identification, time of alarm activation and the alarm condition. Each MPS shall maintain up to 16 different alarm reports.
 - 6. The MPS shall also store the time of alarm activation and the time at which the alarm is cleared in its data file.
 - 7. Each MPS of the distributed processing network shall have the capability to activate the sending of an alarm report.
 - 8. The operator shall have the capability of deciding the alarm levels that shall be automatically printed.
- L. Control Points:
 - 1. Output: As required to perform control function outlined in the system description hereinafter. The processor shall be capable of expanding the output control points as required for future growth.

2.9 DIRECT DIGITAL CONTROL (DDC)

- A. Direct control capability using a custom control program, manual command, or time program-initiated commands shall be provided as a standard feature of this system. The Digital Output board shall be used for two state commands to loads, such as stop/start, day/night, open/close, etc. The digital output board shall provide a normally closed or open dry contact output with a minimum contact rating of 1 amp at 24 volts. The Digital Input board shall accept an input voltage of 0 to 2V for OFF and 10 to 24V for an ON, which can represent status or alarm signals from monitored devices or can count pulses from an energy demand generator. The Analog Input board shall accept 1 to 11 volts or 4 to 20 ma dc. Analog inputs shall be scaled to readout in engineering units, as appropriate. The Analog Output board shall be used for varying outputs (4-20 mA, 0-20 VDC, etc.) used for controlling modulating valves, dampers, etc.
- B. Inclusion above does not constitute automatic pre-qualification. Suppliers still must prove that they meet the specifications.

2.10 SENSORS AND TRANSMITTERS

- A. Space Temperature Sensors shall be electronic type. Accuracy of the transmitter shall be plus or minus 0.5 deg. F, at ambient temperature 77 deg. F. Sensors shall have a temperature range of -40 to 160 deg. F. Sensors shall have setpoint adjustment, manual override switch, display, and

communication port allowing access to the entire network.

- B. Outdoor Air Temperature Sensor shall be mounted in the outdoors on the north side of the building where natural air flow occurs, away from any artificial affect from mechanical sources. The temperature range shall be - 40 to 220 deg. F. A sun shield and weatherproof assembly for mounting to 1/2-inch rigid conduit must be provided.
- C. Outdoor Air Humidity Sensor shall be mounted in the outdoors on the north side of the building where natural air flow occurs, away from any artificial affect from mechanical sources. Outdoor air humidity sensors shall have a sensing range of 20%-100% RH and shall be suitable for ambient conditions of 40°C-75°C (40°F-170°F). Humidity sensors shall not drift more than 1% of full scale annually.
- D. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 0 to 90% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 140 degrees F (0 to 60 degrees C). Sensors shall be selected for wall, duct or outdoor type installation as appropriate.
- E. Differential Liquid Pressure Switches shall be piped in parallel across all water circuits for positive indication of flow. Snap action SPDT switches shall operate from a neoprene slack diaphragm, corrosion-resistant stainless-steel diaphragm, or copper diaphragm capable of being adjusted through the total pressure range.
- F. Duct Temperature Sensors shall have an insertion measuring probe 6 inches long with a temperature range of -40 to 250 deg. F. The sensor shall include a utility box and gasket to prevent leakage and vibration noise. For all mixed air and preheat air applications, install bendable averaging duct sensors with a minimum 5-foot-long sensor element.
- G. Water Temperature Sensors shall have a temperature range of -40 to 250 deg. F. Provide brass or stainless steel thermowells and install sensor probe with heat conductive grease. Probe and sensor shall be removable without breaking fluid seal. Install sensors in top of pipe for horizontal runs to prevent condensation from flowing to sensor head.
- H. Differential Air Pressure Switches shall be piped in parallel across fans for positive indication of flow. Static pressure sensing tips shall be used for both high & low inputs. Pressure range shall be adjustable between .07 and 1.0" W.C. Snap acting contact shall be rated at 300 VA at 120 VAC.
- I. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 mA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within 2% of full scale.
- J. Pressure Switches: Pressure switches shall have a repetitive accuracy of $\pm 2\%$ of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap- acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.
- K. Space CO2 Sensor: The wall mounted Carbon Dioxide (CO2) sensor shall be contained in a decorative housing. The CO2 sensor shall use non-dispersive infrared (NDIR) technology and shall have integral programming to perform automatic baseline calibration without user interface. Sensor to be gold-plated. The recommended manual recalibration period shall not be less than five years. The CO2 range shall be 0-2000 PPM $\pm 5\%$ and ± 50 PPM, with analog outputs of 4-20 ma or 0-10 v. The power source shall be 18-30VAC, 50/60 Hz. The accuracy shall be ± 30 PPM + 2% of reading. Operating temperature 32-122F. Operating humidity 0% to 95% RH noncondensing. Sensor shall be located as shown on the plans and mounted approximately 60" above the floor.

2.11 CONTROL AND COMPUTER INTERFACE RELAYS

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- A. Relays shall be plug-in type with blade type terminals (not pin type). Relays shall be furnished with separate relay base for ease of serving. Relays shall be furnished with SPDT, DPDT, 3PDT or 4PDT configuration as may be required. Relays shall have a minimal contact rating of 10 amps at 240 volts. Relay mechanical life expectancy shall be rated for 50,000,000 or more operations.
- B. Coil resistance shall be low VA type.

2.12 ELECTRIC DAMPER AND VALVE ACTUATORS

- A. Size electric actuators to operate their appropriate dampers or valves with sufficient reserve power to provide smooth modulating action or two-position action as specified. Where two or more actuators are to be operated in sequence to each other, provide position feedback positive positioners with adjustable start point and operating range.
- B. Stall Protection. Mechanical or electronic stall protection shall prevent actuator damage throughout the actuator's rotation.
- C. Spring-Return Mechanism. Actuators used for power-failure and safety applications shall have an internal mechanical spring-return mechanism or an uninterruptible power supply (UPS).
- D. Signal and Range. Proportional actuators shall accept a 0-10 Vdc or a 0-20 mA control signal and shall have a 2-10 Vdc or 4-20 mA operating range.
- E. Wiring. 24 Vac and 24 Vdc actuators shall operate on Class 2 wiring.
- F. Manual Positioning. Operators shall be able to manually position each actuator when the actuator is not powered. Non-spring-return actuators shall have an external manual gear release. Spring-return actuators with more than 7 N·m (60 in.-lb) torque capacity shall have a manual crank.
- G. Operator bodies shall be metal.

2.13 CONTROL DAMPERS (Where dampers are not an integral part of the equipment and are furnished by DDC Contractor)

- A. Type. Control dampers shall have linear flow characteristics and shall be parallel- or opposed-blade type as specified below or as scheduled on drawings.
 - 1. Outdoor and return air mixing dampers and face-and-bypass dampers shall be opposed-blade and shall direct airstreams toward each other.
 - 2. Other modulating dampers shall be opposed-blade.
 - 3. Two-position shutoff dampers shall be parallel- or opposed-blade with blade and side seals.
- B. Frame. Damper frames shall be 2.38 mm (13 gauge) galvanized steel channel or 3.175 mm (1/8 in.) extruded aluminum with reinforced corner bracing.
- C. Blades. Damper blades shall not exceed 20 cm (8 in.) in width or 125 cm (48 in.) in length. Blades shall be suitable for medium velocity (10 m/s [2000 fpm]) performance. Blades shall be not less than 1.5875 mm (16 gauge).
- D. Shaft Bearings. Damper shaft bearings shall be as recommended by manufacturer for application, oil impregnated sintered bronze, or better.
- E. Seals. Blade edges and frame top and bottom shall have replaceable seals of butyl rubber or neoprene. Side seals shall be spring-loaded stainless steel. Blade seals shall leak no more than

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50 L/s·m² (10 cfm per ft²) at 1000 Pa (4 in. w.g.) differential pressure. Blades shall be airfoil type suitable for wide-open face velocity of 7.5 m/s (1500 fpm).

- F. Sections. Damper sections shall not exceed 125 cm - 150 cm (48 in. - 60 in.). Each section shall have at least one damper actuator.
- G. Linkages. Dampers shall have exposed linkages. The shaft to which the actuator is coupled shall be square or hexagonal or round with one side flattened.

2.14 CONTROL VALVES

- A. Factory fabricated type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- B. Type. Provide two- or three-way control valves for two-position or modulating service as shown.
- C. The manufacturer shall warrant all components for a period of 5 years from the date of production, with the first two years unconditional.
- D. Characterized Control Valves
 - 1. NPS 2" and Smaller: Nickle-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 a TEFZEL flow characterizing disc. (NPS ¾" and smaller for Terminal Units: Nickle plated forged brass body rated at no less than 600 psi, chrome plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL 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 1 psi.
 - b. Three-Way Modulating: Twice the load pressure drop, but not more than 5 psig.
 - 4. Close-Off Pressure Rating: 100 PSI. (NPS ¾" and Smaller for Terminal Units: 200 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.
- E. Fail Position. Water valves shall fail normally open or closed as follows unless otherwise specified.
 - 1. Water zone valves: normally open.
 - 2. Heating coils in air handlers: normally open.
 - 3. Chilled water control valves: normally closed.

2.15 ENCLOSURE

- A. The MPS shall be in a NEMA 1, 16-gauge steel cabinet. The cabinet door shall include a key lock latch and shall be made of steel with welded seams and corners. The cabinet shall contain sufficient terminal strips for input/output wiring and an enclosed block for connection of 120 volts, 60 Hz power. The I/O terminal shall be designed for easy installation of field cables. Terminal strips shall be clearly marked for ease of installation. The field breakdown of the panel must be possible without the need to disconnect the field wiring.

2.16 LABELS AND TAGS

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- A. Provide labels for all field devices including sensors, meters, transmitters, and relays. Labels shall be plastic laminate and located adjacent to the device.
- B. Labels of field devices shall be associated with their respective air handler, pump, VAV box, etc.
- C. Junction box covers shall be painted blue and labeled "DDC".
- D. VAV box label locations indicated on ceilings shall be printed on plastics acetate with adhesive backing.

PART 3 - EXECUTION

3.1 STARTUP

- A. Calibrate and adjust all control equipment and place systems into operation. All instrument calibrations shall be traceable to NIST. This shall include a systematic point-by-point checkout and operational check of all control devices with particular attention to the following:
 - 1. Tag all equipment involved with this contract with permanent bakelite lamichord tags. Stick-on type labels will not be acceptable.
 - 2. Check calibration of all sensing devices.
 - 3. Verify that all devices are wired properly and sensing or controlling as desired.
 - 4. Check out sequence of all equipment in all operating modes.
 - 5. Set clock for proper operation.
 - 6. Program the system with initial schedules and setpoints after discussions with the Owner.

3.2 SYSTEM TESTING

- A. The contractor shall perform the following on-site testing once installation is complete. The contractor shall provide a report on all discrepancies/errors that were uncovered and corrected during the system testing to designer prior to final acceptance.
- B. A 100% field calibration of all sensors and equipment.
- C. Verification of each control point by comparing the control command and the field device.
- D. Temperature Sensors: Measure temperature with calibrated thermometer or temperature sensor. Touch or otherwise disturb the sensor to verify the sensor being measured is connected to the correct point. Verify operation of the manual override and manual adjustment where applicable.
- E. Pressure Sensors and Transducers: Verify offset and gain calibration of every device.
- F. Verify output operation of all relays and verify they are connected to the correct point.
- G. Valve and damper strokes: Verify valve and damper stroke as compared to as-builts. Verify software stroke data corresponds with actual valve and damper strokes.
- H. Provide graphical trends of all setpoint control, both PID, two position, and floating. Verify PID loops have been "loop tuned".
- I. Verify each Sequence of Operation using simulation mode. If simulation is not possible, provide trends of all points associated with each equipment system and trends of all global data to sufficiently and properly verify system operation.

3.3 SYSTEM DEMONSTRATION

- A. The controls contractor shall demonstrate that controls are installed, adjusted and operate as required by the drawings and specifications. This demonstration shall be documented and shall be conducted in conjunction with the Owner's personnel training. The documentation shall identify the item, the person performing the demonstration, the date, and the signature of the Owner's representative. The representative will select the items to be demonstrated. Items shall be demonstrated as follows:
1. Disconnect one DDC from the building network to demonstrate that a single device failure will not disrupt peer-to-peer communication.
 2. Manually generate alarms at 10% of the installed alarmed points and demonstrate that the alarms are received.
 3. Provide documentation that calibration has been performed on 100% of the sensors.
 4. Provide point-to-point verification of 25% of all points. Include labeling of all points.
 5. Demonstrate the complete sequence of operation for air handling systems.
 6. Demonstrate the complete sequence of operation of the HVAC controls system during a fire alarm.
 7. Demonstrate the complete sequence of operation for 25% of VAV terminal units.
 8. Demonstrate graphics system is functional and the layout is consistent with field conditions.
 9. Demonstrate response to upset conditions and change of setpoint for all major systems for items 5 and 6 listed above.

3.4 TRAINING

- A. The manufacturer and the controls contractor shall provide on-site training in the maintenance and operation of the installed system for up to six (6) personnel. The training shall be documented and a syllabus and O&M manuals shall be submitted and approved by designer two (2) weeks prior to the training. The training shall include the following:
1. HVAC systems layout including the locations of chiller, boiler, air handler, DDC controllers, VAV boxes, pumps, etc. This will include a walk-thru of the building.
 2. Sequence of Operation for each control loop.
 3. Accessing the control system including:
 - a. Logon procedure.
 - b. Use of graphic and DDC pages.
 - c. Password requirements.
 4. Operation and troubleshooting including:
 - a. Modification of setpoints and schedules.
 - b. Overview of graphics and text pages.
 - c. Trending of points.
 - d. Calibration and adjustment.
 - e. Hands on training in troubleshooting and replacement of components including sensors, transmitters, control valves and actuators. Contractor shall have examples of each component and demonstrate measurement of input and output signals, and any operator adjustments available.
 - f. DDC controller functions and operation.
- B. The controls contractor shall provide an additional on-site training session nine (9) months after project completion. The purpose of the session will be to review any operation problems that have developed. In addition, the contractor will lead Owner's personnel through a comprehensive annual preventative maintenance of the controls system. This shall be scheduled at least one (1) month in advance.

3.5 GENERAL REQUIREMENTS

A. Control Wiring:

1. Control wiring shall be minimum 18 gauge.
2. All line voltage control wiring shall be in conduit. All low voltage control wiring shall be in conduit in walls, mechanical rooms and where exposed. Conduit shall be run parallel or perpendicular to wall and building lines. Junction box covers shall be painted blue and labeled "DDC".
3. Wires shall be labeled with mechanically prepared labels at their connection point to each apparatus point of connection.
4. Wiring shall not use voice/data wire way/conduit systems as pathways.
5. Plenum cable shall only be used in concealed locations above ceilings and shall be neatly routed on J-hooks.

B. Install temperature sensors and manual overrides at locations shown on the drawings. All sensors and control devices intended to be adjusted by building occupants shall be mounted with their top located at 48" AFF.

C. Manual overrides shall switch systems from unoccupied mode to occupied mode for a programmable length of time. Activation of the manual override for a particular system shall automatically bring on and control all other equipment needed by the system. This will include all needed hot water generators, chillers, pumps, etc.

D. Provide alarms and trend logs as detailed in the Input / Output Schedules shown on plans. The points shown in the Input / Output Schedule are the minimum points to be provided. The Contractor shall provide additional Input / Output points, as required, to provide the performance described in this section and sequences of operation shown on plans.

E. In the event of an MPS failure, all systems controlled by the particular MPS panel shall fail in the occupied mode of operation.

F. Equipment serving a specific building zone shall be run according to the zone's own occupancy schedule. The Owner shall provide initial occupancy schedules for each zone to the Contractor. The Contractor shall include each specific zone schedule in the initial programming of the MPS. The Owner shall have the capability of modifying these schedules whenever desired.

G. Laminate one copy of the panel layout and install in pouch in each control panel.

H. Provide graphical programming of the system, including automatically updating graphic screens that demonstrate building conditions and the operation of each piece of equipment and system.

I. Upon startup of the system, the maintenance personnel of the Owner shall be provided with four (4) hours of a planned and progressively advanced on-site training by a factory trained manufacturer's representative on the operation and maintenance of the DDC Control System. System startup time shall not apply toward this training time.

3.6 SEQUENCE OF OPERATION

A. The Contractor shall examine the Sequence of Operation in the contract documents and advise the Engineer of any anticipated problems in programming the sequence and submit specific recommendations for modifying the sequence. The Contractor shall participate in discussions with the Owner and Engineer to develop the final Sequence of Operation. It shall be the contractor's responsibility to program the sequence and make any necessary changes for proper and optimal system performance. The Contractor shall use controllers that are capable of providing the full final sequence of operation for each particular application. Any installed controllers that are demonstrated

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not to have that full capability shall be replaced by the Contractor with the appropriate controllers.

- B. A meeting shall be scheduled prior to installation and programming of the DDC system between the controls subcontractor, engineer, and owner to refine control strategies and determine zoning and scheduling.

END OF SECTION

SECTION 23 64 23

AIR COOLED SCROLL WATER CHILLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS AND RELATED WORK SPECIFIED ELSEWHERE:

A. Related Documents

Drawings, Standard General Conditions of the Construction Contract, including Supplementary General Conditions, Division-01 Specification sections and other Division 23 specification sections, Division 26 specifications apply to work of this section.

1.2 SECTION INCLUDES

- A. Chiller package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Starters.
- F. Electrical power connections.

1.3 REFERENCES

- A. ANSI/ARI 590 - Positive Displacement Compressor Water - Chilling Packages.
- B. ANSI/ARI 550 - Centrifugal or Rotary Water - Chilling Packages.
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.
- E. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code
- F. ANSI/NEMA MG 1, 2, 3, 10 and 11: Standards for High Efficiency Motors.
- G. ANSI/UL 465 - Central Cooling Air Conditioners.
- H. ANSI/UL 984 - Safety Standard for Hermetic Motor Compressors.
- I. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings. Bearings must have life of not less than L10 200,000 hours.
- J. ASTM B117 - Standard Method of Salt Spray (Fog) Testing

- K. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- L. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
- M. UL 1995 – Heating and Cooling Equipment
- N. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

1.4 SUBMITTALS

- A. Submittals of shop drawings and manufacturer's data, etc. shall be provided to the Designers electronically in PDF format.
- B. Submit drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate accessories where required for complete system.
- C. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- D. Summary of all auxiliary utility requirements such as electricity, water, etc. Summary shall indicate quality and quantity of each required utility.
- E. Single line schematic drawing of the field power hookup requirements, indicating all items that are furnished.
- F. Schematic diagram of control system indicating points for field interface/connection. Diagram shall fully delineate field and factory wiring.
- G. Submit manufacturer's installation instructions and qualifications of factory start up service person.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation data.
- B. Include start-up instructions, maintenance data, controls, and accessories.
- C. Submit maintenance data.

1.6 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ARI 590 Standard for testing and rating of Positive Displacement Compressor Water - Chilling Packages or conform to ANSI/ARI 550 Standard for testing and rating of Centrifugal and Rotary Screw Water - Chilling Packages.
- B. Conform to ANSI/UL 465 or UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at his expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative. Alternatively, the chiller may be ETL listed.

- C. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.
- D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.

1.7 STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.
- C. Unit controls shall be capable of withstanding 203 Deg F (95 Deg C) storage temperatures in the control compartment for an indefinite period of time.

1.8 WARRANTY

- A. The refrigeration equipment manufacturer's guarantee shall be for a period of one year from date of equipment start-up but not more than 18 months from shipment. The guarantee shall provide for repair or replacement due to failure by material and workmanship that prove defective within the above period, excluding refrigerant.
- B. 1st Year Labor Warranty: Entire unit.
- C. Extended Compressor Warranty: Four (4) years extended compressor warranty, parts, and labor.
- D. Refrigerant Warranty: One (1) year R-32 refrigerant.
- E. Delay Warranty Start: If Substantial Completion of the installation of the chiller is later than 12 months after shipment, the warranty shall start 12 months after shipment.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SUMMARY

- A. The Contractor shall provide an air-cooled water chiller as described in the schedule on the drawings and throughout this specification section.
- B. **Furnish Carrier scroll compressor chiller. Carrier is the Owner's designated equipment supplier. Refer to specification Section 011000 – Summary.**
- C. Unit must be run tested at the factory to confirm proper operation. Documentation of factory run test Certification is to be a final part of the submittal process.

2.2 GENERAL UNIT DESCRIPTION

- A. Provide factory assembled and tested outdoor air-cooled liquid chillers consisting of helical scroll compressors, condenser, evaporator, thermal or electronic expansion valve, refrigeration accessories, starter and microprocessor-based control panel. Construction and ratings shall be in accordance with ANSI/ARI 550 or ANSI/ARI 590. Unit shall have single point power connection.

2.3 COMPRESSORS

A. Compressor/Compressor Assembly:

- 1. The compressors shall be sealed hermetic, scroll type with crankcase oil heater and suction strainer. The compressor motor shall be refrigerant gas cooled, high torque, hermetic induction type, two-pole, with inherent thermal protection on all three phases and shall be mounted on RIS vibration isolator pads. The compressors shall be equipped with an internal module providing compressor protection and communication capability.

2.4 EVAPORATOR – EITHER TYPE IS ALLOWED

A. SHELL AND TUBE

- 1. Provide factory insulated shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally finned copper tubes, roller expanded into tube sheets.
- 2. Design, test, and stamp refrigerant side for 300 psig (2068 kPa) working pressure and water side for 215 psig (1482 kPa) working pressure, in accordance with ANSI/ASME SEC 8.
- 3. Insulate with 0.75 inch (20 mm) minimum thick flexible elastomeric rubber closed cell insulation with maximum K value of [0.28]. Provide heat tape to protect evaporator to -10 degrees F (-19 degrees C).
- 4. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
- 5. Water connections shall be welded. Evaporator shall have only one entering and one leaving connection.

B. BRAZED PLATE-TO-PLATE

- 1. The evaporator shall be a compact, high efficiency, dual circuit, brazed plate-to-plate type heat exchanger consisting of parallel stainless-steel plates. Vent and drain connections shall be provided in the inlet and outlet chilled water piping by the installing contractor.
- 2. The evaporator shall be protected with an external, electric resistance heater plate. The evaporator and suction piping to the compressors shall be insulated with 3/4" (19 mm) thick CFC and HCFC-free closed-cell flexible elastomeric foam insulation material with 100% adhesive coverage. The insulation shall have an additional outer protective layer of 3mm thick PE embossed film to provide superior damage resistance. Insulation without the protective outer film shall not be acceptable. UV resistance level shall meet or exceed a rating of 'Good'

in accordance with the UNI ISO 4892 - 2/94 testing method. This combination of a heater plate and insulation shall provide freeze protection down to -20°F (-29°C) ambient air temperature.

3. The water-side maximum design pressure shall be rated at a minimum of 435 psig (3000 kPa). Evaporators shall be designed and constructed according to, and listed by Underwriters Laboratories (UL).

2.5 CONDENSER AND FANS

- A. Chiller shall be able to operate in ambient conditions down to 36 deg. F.
- B. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Alternatively, a micro channel coil may be used. Provide sub-cooling circuits. Air test under water to 506 psig (3488 kPa).
- C. Provide factory painted and mounted louvered coil guards. Coil guards shall cover the condenser coils.
- D. Provide vertical discharge direct driven condenser fans with fan guard on discharge. Entire fan assembly shall be statically, and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Provide variable speed control on all, or not less than one, of the condenser fans.
- E. The variable speed drives for condenser fans shall include a DC link reactor.
- F. Fans shall be protected by coated steel wire safety guards.

2.6 ENCLOSURES

- A. House components in heavy gauge galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.
- B. Unit panels, louvered panels, and control panels shall be finished with a baked-on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.
- C. Mount starters and disconnects in weatherproof panel provided with full opening access doors. Provide lockable through-the-door disconnect operating handle external to panel and clearly visible from outside of unit indicating if power is on or off.
- D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the unscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be

identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

2.7 REFRIGERANT CIRCUIT

- A. All units shall have a minimum of 2 refrigeration circuits, each with one or two (manifolded) compressors on each circuit.
- B. Provide for each refrigerant circuit:
 - 1. Liquid line shutoff valve.
 - 2. Filter dryer (replaceable core type).
 - 3. Liquid line sight glass and moisture indicator.
 - 4. Electronic expansion valve sized for maximum operating pressure.
 - 5. Charging valve.
 - 6. Discharge and oil line check valves.
 - 7. Compressor suction and discharge service valves.
 - 8. High side pressure relief valve.
 - 9. Full operating charge of R-32 and oil.
 - 10. Unit factory leak tested at 200 psig.

2.8 CONTROLS

- A. The chiller(s) shall be controlled by a stand-alone direct digital control (DDC) system. A dedicated Unit Control Module (UCM) is to be supplied with each chiller by the chiller manufacturer. The controller shall provide chiller capacity control in response to the leaving chilled water temperature.
- B. On chiller, mount weatherproof control panel containing starters and power and control wiring. Provide single point power connection on units with MCA less than 500 amps. Provide primary and secondary fused control power transformer and a single 115-volt single phase connection for evaporator heat tape.
- C. For each compressor, provide across-the-line starter on 460V applications or star-delta starter on 200-230V.
- D. Provide the following safety controls with indicating lights or diagnostic readouts.
 - 1. Low chilled water temperature protection.
 - 2. High refrigerant pressure.
 - 3. Low oil flow protection.
 - 4. Loss of chilled water flow.

5. Contact for remote emergency shutdown.
6. Motor current overload.
7. Phase reversal/unbalance/single phasing.
8. Failure of water temperature sensor used by controller.
9. Compressor status (on or off).

E. Safeties:

1. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
 - a. Reverse rotation.
 - b. Low chilled fluid temperature.
 - c. Motor overtemperature.
 - d. High pressure.
 - e. Electrical overload.
 - f. Loss of phase.
 - g. Loss of chilled water flow.
2. Condenser-fan motors shall have internal overcurrent protection.

F. Provide the following operating controls:

1. Number of steps for leaving chilled water temperature control shall equal or exceed the number of compressors.
2. Five-minute solid state anti-recycle timer to prevent compressor from short cycling. If a greater than 5-minute solid state anti-recycle timer is provided, hot gas bypass shall be provided to insure accurate temperature control in light load applications.
3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip-outs.
4. High ambient unloader pressure stat that unloads compressors to keep head pressure under control and help prevent high pressure nuisance tripouts on days when outside ambient is above design.
5. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip-outs.
6. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function, then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
7. Low ambient lockout control with adjustable setpoint.
8. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

- G. Provide digital display of pressures/ temperatures on microprocessor.
- H. Provide ammeters for each compressor or digital display of % RLA on microprocessor.
- I. Manufacturer shall provide flow switches.
- J. Provide ability for building DDC system to provide start stop and chilled water reset. Chiller to output a start stop signal to the chilled water pump. This will be relayed by the DDC system to start the pump.
- K. Maximum Sound Generation Levels
 - 1. A-Weighted Sound Pressure Levels (dB re 20 micropascals) calculated based upon a 30' horizontal distance, at full load, receiver at 3' above ground shall not exceed 68.5 dBA.
 - 2. Notes: (1) Measurements performed in accordance with AHRI Standard 370-2015 for air cooled Chillers. Distance 30'.
- L. Additional Features:
 - 1. Variable Speed Condenser Fans:

One or more fans on the unit shall have variable speed fan motors to provide higher part load efficiency and reduced acoustic levels. Each such fan circuit shall have a factory-installed, independent variable speed drive with display. Variable speed drives shall have rated IP-55 enclosures and be UL Listed. Variable speed condenser fans also allow the chiller to operate at ambient temperatures as high as 125.6°F (52°C).
 - 2. Unit-Mounted Non-Fused Disconnect:

Unit shall be supplied with factory-installed, lockable, non-fused electrical disconnect for main power supply.
 - 3. Energy Management Module:

A factory installed module shall provide the following energy management capabilities: 4 to 20 mA signals for leaving fluid temperature reset, cooling set point reset or demand limit control; 2-step demand limit control (from 0% to 100%) activated by a remote contact closure.
 - 4. Condenser Coil Trim Panels:

Unit shall be supplied with factory-installed or field-installed hail guard coil covers.
 - 5. BACnet¹/Modbus² Translator Control:

Unit shall be supplied with factory or field-installed interface between the chiller and a BACnet Local Area Network (LAN, i.e., MS/TP EIA-485). Field programming shall be required.
 - 6. Isolation Valve Option:

Unit shall be supplied with factory-installed isolation valve which provides a means of isolating the compressors from the evaporator vessel, which is beneficial in servicing the chiller.

7. Suction Line Insulation:

Unit shall be supplied with suction line insulation. Insulation shall be tubular closed-cell insulation. This option shall be required with applications with leaving fluid temperatures below 30°F (-1.1°C) and for areas of high dewpoints where condensation may be a concern.

8. Control Transformer:

Unit shall be supplied with a factory-installed transformer that will allow supply control circuit power from the main unit power supply.

9. GFI Convenience Outlet:

Shall be factory mounted and wired with easily accessible 115-v female receptacle. Shall include 4-amp GFI (ground fault interrupt) receptacle.

10. Hail Guards:

Unit shall be equipped with a factory-installed option consisting of louvered panels on the end and sides of the machine to cover and protect the condenser fins. These coverings shall firmly fasten to the machine frame.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Contractor shall install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on elastomeric vibration isolators per manufacturer's recommendations.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning for shell and tube models.
- G. Install flow switches in chilled water piping properly interlocked to ensure that unit can operate only when water flow is established.
- H. Furnish and install taps for thermometers and pressure gauges in water piping adjacent to inlet and outlet connections of unit.
- I. Provide and install drain valves to drain the chiller.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Contractor shall supply the services of factory trained representatives to test and start-up chiller. Test controls and demonstrate to engineer compliance with requirements. Replace damaged, or malfunctioning controls and equipment and retest. Do not place chillers in sustained operation prior to initial balancing of mechanical systems which interface with the chillers.
- B. Contractor shall supply factory trained representative to provide two hours of instruction on operation and maintenance of the chiller to Owner. This shall not include time spent on chiller startup.
- C. Contractor shall supply initial charge of refrigerant and oil.

3.3 MAINTENANCE MANUALS

- A. Maintenance Manuals shall be submitted in three (3) hard copies in vinyl 3-ring binders, and three (3) copies in electronic format as PDF files on disks. Each manual shall have the following:
- B. Service telephone number of the installing company, including an emergency number.
- C. Contact person, phone number, and address of manufacturer or distributor where equipment was purchased.
- D. The manufacturing company's operating and maintenance manuals for each piece of equipment.
- E. Copies of all approved shop drawings.
- F. Copies of warranties with their start dates.

3.4 Training:

- A. Provide 2 one-day Training Seminars at the site for the County facilities staff. The seminars shall cover operation, maintenance and servicing of the chiller.

END OF SECTION