

North Florida College
BID-NFC-04-2024
Building 8 HVAC Replacement



Project Manual Part II



BID NUMBER: NFC-BID-04-2024

BID NAME: Building 8 HVAC Replacement

BID SPECIFICATIONS: This Project Manual II prescribes the administrative, quality, and technical requirements for the project and accompanies the Project Drawings.

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BID RESPONSE DEADLINE: November 15, 2024, 2:00 PM EST

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**SECTION 01 1000
SUMMARY**

PART 1 GENERAL

1.1 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is shown on drawings and specified in Section 02 4100.
- B. Scope of alterations work is indicated on drawings.
- C. The purpose of the project is to replace the existing HVAC systems with a new variable refrigerant flow (VRF) system with a packaged dedicated outside air system (DOAS).
- D. The existing equipment and heating/chilled water piping associated with the existing hydronic system shall be removed.
- E. Perform electrical and plumbing work in support of demolition of existing HVAC and plumbing and installation of new HVAC and plumbing systems.
- F. Project lay-down area will be limited, and will be coordinated with North Florida College. Provide fencing and protect trees. Restore lay-down area upon completion of project.
- G. Protect existing floors, finishes and building during the HVAC upgrades.
- H. Provide new finishes in finished spaces to match existing where specified.
- I. Make other improvements as noted on the Drawings.

1.2 PROJECT SCHEDULE - IMPORTANT DATES

- A. Installation shall be complete, including Test and Balance by August 16, 2024.

1.3 OWNER OCCUPANCY

- A. Cooperate with the Owner to minimize conflict and to facilitate the Owner's operations.
- B. Schedule the Work to accommodate the Owner occupancy.
- C. The Owner will vacate the building for construction.

1.4 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: Limited to areas noted on Drawings.
- B. Arrange use of site and premises to allow:
 - 1. the Owner occupancy of the adjacent building.
 - 2. Work by Others.
 - 3. Work by the Owner.
 - 4. Use of site parking and adjacent building by the public.

- C. Existing building spaces may not be used for storage.
- D. Time Restrictions:
 - 1. Limit conduct of especially noisy exterior work to the adjacent building's regular building un-occupied hours in evening or over weekends.
 - 2. Limit interruption of utility services in classroom areas to regular building un-occupied hours in the evenings of 10 PM to 7 AM or over weekends.
- E. Do not permit construction traffic over unprotected floor surfaces.
- F. Limit disruption of utility services to hours the building is unoccupied.
 - 1. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days' notice to the Owner and authorities having jurisdiction.
 - 2. HVAC:
 - a. Refer to Time Restrictions above.
 - b. The building's HVAC system cooling shall remain in service throughout the entire construction period; unless otherwise noted.
 - c. The Contractor shall not allow the building's relative humidity to exceed 55%.
 - d. When work is required at the riser connections, the HVAC system may be disrupted when the building is unoccupied, the duration of the disruption to not exceed four hours; each occurrence.
 - e. The Contractor shall use the HVAC supply to condition the work area during construction and control building humidity during construction.
 - f. When dust producing operations are in progress, the contractor shall protect the return air openings with construction filters during the entire construction period. Change the filters weekly.

**SECTION 01 3000
ADMINISTRATIVE REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preconstruction meeting.
- B. Progress meetings.
- C. Construction progress schedule.
- D. Submittals for review, information, and project closeout.
- E. Number of copies of submittals.
- F. Submittal procedures.

1.2 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements: Additional coordination requirements.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 PRECONSTRUCTION MEETING

- A. the Owner will schedule a meeting after Notice of Award.
- B. Attendance Required:
 - 1. the Owner.
 - 2. the Design Professional.
 - 3. the Contractor.
 - 4. The Building User.
- C. Agenda:
 - 1. Distribution of Contract Documents.
 - 2. Submission of list of Subcontractors, list of Products, and schedule of values.
 - 3. Designation of personnel representing the parties to Contract and .
 - 4. Submission of the project safety plan.
 - 5. Designation of personnel representing the parties in Contract and the Design Professional.

6. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 7. Submit preliminary progress schedule indicating Scheduling of Work.
 8. Joint examination of existing facilities and preparation of schedule documenting any existing damage to remain.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to the Design Professional, the Owner, participants, and those affected by decisions made.

3.2 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum bi-monthly intervals.
- B. Attendance Required: Job superintendent, major Subcontractors and suppliers, the Owner, the Design Professional, as appropriate to agenda topics for each meeting.
- C. Agenda:
1. Review minutes of previous meetings.
 2. Review of Work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Maintenance of progress schedule.
 7. Corrective measures to regain projected schedules.
 8. Planned progress during succeeding work period.
 9. Maintenance of quality and work standards.
 10. Effect of proposed changes on progress schedule and coordination.
 11. Other business relating to Work.
- D. Record minutes and distribute copies within two days after meeting to participants, with two copies to the Design Professional, the Owner, participants, and those affected by decisions made.

3.3 CONSTRUCTION PROGRESS SCHEDULE - SEE SECTION 01 3216

- A. Within 10 days after date established in Notice to Proceed, submit preliminary schedule defining planned operations for the first 60 days of Work, with a general outline for remainder of Work.

- B. Present preliminary schedule at the Preconstruction meeting.
- C. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- D. Within 20 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
- E. Within 10 days after joint review, submit complete schedule.
- F. Submit updated schedule with each Application for Payment.

3.4 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 - 1. Product data.
 - 2. Shop drawings.
- B. Submit to the Design Professional for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- C. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 7800 - Closeout Submittals.

3.5 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 - 1. Design data.
 - 2. Certificates.
 - 3. Test reports.
 - 4. Inspection reports.
 - 5. Manufacturer's instructions.
 - 6. Manufacturer's field reports.
 - 7. Other types indicated.
- B. Submit for the Design Professional's knowledge as contract administrator or for the Owner. No action will be taken.

3.6 SUBMITTALS FOR PROJECT CLOSEOUT

- A. When the following are specified in individual sections, submit them at project closeout:
 - 1. Closing submittals as required in the General Conditions.

2. Project record documents.
3. Operation and maintenance data.
4. Warranties.
5. Bonds.
6. Other types as indicated.

3.7 NUMBER OF COPIES OF SUBMITTALS

- A. Documents for Review:
 1. Small Size Sheets, Not Larger Than 8-1/2 x 11 inches: Submit the number of copies that the Contractor requires, plus two copies that will be retained by the Design Professional.
- B. Documents for Information: Submit two copies.
- C. Documents for Project Closeout: Make reproduction of submittal originally reviewed. Submit extra of submittals for inclusion with maintenance manuals.

3.8 SUBMITTAL PROCEDURES

- A. Shop Drawing Procedures:
 1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting the Contract Documents and coordinating related Work.
 2. Generic, non-project specific information submitted as shop drawings do not meet the requirements for shop drawings.
- B. Transmit each submittal with a copy of approved submittal form.
- C. Transmit each submittal with approved form.
- D. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
- E. Identify Project, the Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate on each copy.
- F. Apply the Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- G. Assemble the submittal data for major Contractors in complete sets in hard back three-ring binders, separated by trade, (HVAC, Plumbing, and Electrical), and bound with numbered index sheets and tabs. Submittal data shall be submitted at one time unless unavailable data such as control submittal would delay project progress. Data shall include capacities, complete installation instructions, dimensional data and electrical data, BHP, motor HP, operating weights and load distribution at mounting points.

- H. Deliver submittals to the Design Professional at business address.
- I. Schedule submittals to expedite the Project, and coordinate submission of related items.
- J. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor.
- K. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
- L. Provide space for the Contractor and the Design Professional review stamps.
- M. When revised for resubmission, identify all changes made since previous submission.
- N. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.
- O. Submittals not requested will not be recognized or processed.

END OF SECTION

**SECTION 01 4000
QUALITY REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Contractor Minimum Qualifications.
- B. Control of installation.
- C. Tolerances.
- D. Manufacturers' field services.

1.2 REFERENCES AND STANDARDS - SEE SECTION 01 4219

1.3 SUBMITTALS

- A. Submit the completed form in 1.4 below with the Bid.

1.4 CONTRACTOR'S MINIMUM HVAC QUALIFICATIONS

Firm Name _____

Firm Address _____

Firm Telephone no. _____

Firm Point of Contact _____

Name of Full Time Project Manager _____

Name of Full Time Superintendent _____

Has the Firm been in operation under the present name for a minimum of 4 years? _____

Has the Firm been declared in default on any construction contract in that time? _____

Does the firm have a current State of Florida License for the mechanical work described within these documents? _____ Number: _____

List three projects involving mechanical construction involving hydronic systems and air distribution of at least \$275,000 in total construction cost. Provide a contact reference for each.

Project Name and Date of Completion	Reference Contact Name and Title

The project superintendent shall have at least 4 years' experience on projects of similar scope and complexity as this project. List three similar projects and provide a contact reference for each.

Project Name and Date of Completion	Reference Contact Name and Title

The project manager shall have at least 2 years' experience on projects of similar scope and complexity as this project. List three similar projects and provide a contact reference for each.

Project Name and Date of Completion	Reference Contact Name and Title

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from the Design Professional before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Have Work performed by persons qualified to produce required and specified quality.
- F. Verify all dimensions, elevations, grades and pitch by taking measurements at the building before ordering material or doing work which is dependent upon coordination with building conditions.
- G. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- H. No consideration will be given to any claim based on differences between the actual dimensions and those indicated on the drawings.
- I. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.2 CONTROL OF WORKER'S ATTIRE, VEHICLES, AND LANGUAGE:

- A. the Contractor's regularly scheduled project meetings shall include reinforcement of the prohibition of improper attire and language.
- B. Worker's clothing shall be appropriate for the tasks being performed and shall not include wording or other adornments other than the Company's name and logo, if any. Shirts and trousers shall be worn at all times on the Owner's property.
- C. Vehicles on the Owner's property shall not possess or exhibit signs, stickers, posters, etc. portraying or including inappropriate pictures or language.
- D. Complaints regarding violations of these requirements shall be immediately conveyed to the Project Superintendent, and the Design Professional simultaneously, with confirmation with specifics provided in writing within one workday.

3.3 INDOOR AIR QUALITY

- A. Portions of the building will be in use and occupied during construction.
- B. the Contractor shall schedule work and provide temporary ventilation and/or isolation to insure that fumes from welding, other construction tasks, and out-gassing from construction materials do not migrate to occupied areas.

3.4 TOLERANCES

- A. Before ordering material or doing work which is dependent upon coordination with building conditions, the Contractor shall verify all dimensions, elevations, grades and pitch by taking measurements at the building and shall be responsible for the correctness of same.
- B. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- C. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from the Design Professional before proceeding.
- D. Adjust products to appropriate dimensions; position before securing products in place.

3.5 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment, and _____ as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

END OF SECTION

**SECTION 01 5000
TEMPORARY FACILITIES AND CONTROLS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Temporary sanitary facilities.
- B. Temporary Controls: Barriers, enclosures, and fencing.
- C. Security requirements.
- D. Waste removal facilities and services.

1.2 RELATED REQUIREMENTS

- A. Section 01 7000 - Execution and Closeout Requirements - Progress Cleaning.

1.3 TEMPORARY SANITARY FACILITIES

- A. The Contractor will be allowed the use of an existing designated toilet in the building for use of workmen on the job. the Owner shall designate toilet to be utilized. No workmen shall be allowed to use other toilets.
- B. Maintain daily in clean and sanitary condition.

1.4 STORAGE AREAS:

- A. Space for materials storage at the site is limited.
- B. Materials and equipment may be stored within the mechanical equipment rooms at the site.
- C. All materials not used at the end of the day shall be returned to the designated storage areas.
- D. The project site is located in the center of the campus, with student traffic around all sides, and formal gardens are adjacent to the site. Material shall not be stacked to hinder student traffic. No material shall be allowed in areas where work is not being performed.
- E. At completion of the project, material and debris shall be removed.

1.5 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.6 FENCING

- A. Construction: Commercial grade chain link fence with privacy slats and with no openings.
- B. Provide 6 foot high fence around construction site; equip with vehicular and pedestrian gates with locks.

1.7 INTERIOR ENCLOSURES

- A. Provide temporary partitions as indicated to separate work areas from the Owner-occupied areas, to prevent penetration of dust and moisture into the Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces:

1.8 MAINTENANCE OF ACCESS

- A. Use Protective rubber mats provided by Valdosta State University to protect existing hardscape(pavers and paving) and return in good condition.
- B. Limit size of construction vehicles to sizes that will not damage the existing hardscape. Refer to 1.10.

1.9 SECURITY

- A. the Owner will furnish access to the building for use by the Contractor.
- B. The Contractor shall be responsible for keeping the mechanical rooms locked and secured, and for keeping the building locked and secured when not occupied by the Owner.

1.10 CONSTRUCTION VEHICLES, VEHICULAR ACCESS AND PARKING - SEE SECTION 01 5500

- A. Coordinate access and haul routes with governing authorities and the Owner DPO.
- B. Ingress and egress shall be limited to the most direct access to the work areas, mechanical rooms, and equipment.
- C. Limit size of construction vehicles to protect existing hardscape.
- D. Use rubber mats provided by the University to protect the hardscape and return in good working order.
- E. No parking outside the work site will be available on the Owner premises for private vehicle operated by employees of the Contractor.
- F. No vehicles or material shall be located , even temporarily, so as to hinder normal school functions.
- G. Provide and maintain access to fire hydrants, free of obstructions.
- H. Provide means of removing mud from vehicle wheels before entering streets.

- I. Any debris dropped or tracked outside of areas in which work is being done shall be immediately cleaned up.
- J. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.
- K. Do not allow vehicle parking on existing pavement.

1.11 WASTE REMOVAL

- A. See Section 7000 - Execution and Closeout Requirements - Progress cleaning for additional requirements.
- B. Provide waste removal facilities and services as required to maintain the building and site in clean and orderly condition.
- C. Provide containers with lids. Remove trash from site daily.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.
- F. All building material and trash shall be disposed off the campus.
- G. Burning of material on the site will not be permitted.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

**SECTION 01 6000
PRODUCT REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Transportation, handling, storage and protection.
- B. Product option requirements.
- C. Maintenance materials, including extra materials, spare parts, tools, and software.
- D. Section 01 6116 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

PART 2 PRODUCTS

2.1 NEW PRODUCTS

- A. Provide new products unless specifically required or permitted by the Contract Documents.
- B. Do not use products having any of the following characteristics:
- C. Where all other criteria are met, the Contractor shall give preference to products that:
 - 1. If used on interior, have lower emissions, as defined in Section 01 6116.
 - 2. If wet-applied, have lower VOC content, as defined in Section 01 6116.
 - 3. Have a published GreenScreen Chemical Hazard Analysis.
- D. Motors: Refer to Section 23 0513 - MOTORS FOR HVAC EQUIPMENT, NEMA MG 1 Type. Specific motor type is specified in individual specification sections.

2.2 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.3 MATERIAL SAFETY DATA SHEETS (MSDS):

- A. MSDS data sheets for all products to be utilized on the project shall be submitted to the Owner prior to performing the work.
- B. These sheets could include, but not be limited to, cleaning chemicals, caulks, lubricants, concrete, paint, etc.

- C. MSD sheets shall be submitted and approved by the Owner prior to the corresponding material being brought on to the Project Site.

2.4 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.1 SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify time restrictions for submitting requests for substitutions during the bidding period. Comply with requirements specified in this section.
- B. Substitutions may be considered when a product becomes unavailable through no fault of the Contractor.
- C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D. A request for substitution constitutes a representation that the submitter:
 - 1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 - 2. Will provide the same warranty for the substitution as for the specified product.
 - 3. Will coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to the Owner.
 - 4. Waives claims for additional costs or time extension that may subsequently become apparent.
- E. Substitution Submittal Procedure:
 - 1. Submit three copies of request for substitution for consideration. Limit each request to one proposed substitution.
 - 2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
 - 3. The Architect will notify the Contractor in writing of decision to accept or reject request.

3.2 TRANSPORTATION AND HANDLING

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.

- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.3 STORAGE AND PROTECTION

- A. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
- B. Store and protect products in accordance with manufacturers' instructions.
- C. Store with seals and labels intact and legible.
- D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- E. For exterior storage of fabricated products, place on sloped supports above ground.
- F. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- G. Comply with manufacturer's warranty conditions, if any.
- H. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- I. Prevent contact with material that may cause corrosion, discoloration, or staining.
- J. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- K. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

**SECTION 01 7000
EXECUTION AND CLOSEOUT REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Examination, preparation, and general installation procedures.
- B. Cutting and patching.
- C. Cleaning and protection.
- D. Closeout procedures, except payment procedures.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.

1.3 COORDINATION

- A. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Notify affected utility companies and comply with their requirements.
- C. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- D. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- E. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- F. Coordinate completion and clean-up of work of separate sections.
- G. After the Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of the Owner's activities.

PART 2 PRODUCTS

2.1 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.

- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.
- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 6000.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.

3.4 CUTTING AND PATCHING

- A. Whenever possible, execute the work by methods that avoid cutting or patching.
- B. Perform whatever cutting and patching is necessary to:
 - 1. Complete the work.
 - 2. Fit products together to integrate with other work.
 - 3. Provide openings for penetration of mechanical, electrical, and other services.
 - 4. Match work that has been cut to adjacent work.
 - 5. Repair areas adjacent to cuts to required condition.
 - 6. Repair new work damaged by subsequent work.
 - 7. Remove samples of installed work for testing when requested.
 - 8. Remove and replace defective and non-conforming work.
- C. Execute cutting and patching including excavation and fill to complete the work, to uncover work in order to install improperly sequenced work, to remove and replace defective or non-conforming work, to remove samples of installed work for testing when requested, to provide openings in the work for penetration of mechanical and electrical work, to execute patching to complement adjacent work, and to fit products together to integrate with other work.
- D. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.
- F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
- G. Restore work with new products in accordance with requirements of Contract Documents.
- H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- I. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 8400, to full thickness of the penetrated element.
- J. Patching:
 - 1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
 - 2. Match color, texture, and appearance.

- 3. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.
- K. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
- L. Make neat transitions. Patch work to match adjacent work in texture and appearance. Where new work abuts or aligns with existing, perform a smooth and even transition.

3.5 PROGRESS CLEANING - DAILY

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Vacuum clean interior areas daily after completion of the day's work and prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically daily and dispose off-site; do not burn or bury.

3.6 PROTECTION OF INSTALLED WORK

- A. Protect installed work from damage by construction operations.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Remove protective coverings when no longer needed; reuse or recycle plastic coverings if possible.

3.7 SAFETY

- A. Contractor shall obtain welding/cutting permit prior to performing any welding or cutting with a torch on the project.
- B. Two (2) 15 lb. CO2 fire extinguishers shall be located at each permitted area.

3.8 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

3.9 FINAL CLEANING

- A. Use cleaning materials that are nonhazardous.
- B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- C. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- D. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- E. All materials, equipment and mechanical rooms shall be cleaned prior to Substantial Completion.
- F. Wash down and scrub clean all mechanical room floors, walls, equipment bases and equipment.
- G. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- H. All air handling equipment shall be cleaned internally prior to Substantial Completion. Clean unit casing externally and internally. Seal/replace all damaged duct liner.
- I. Chipped or scraped paint shall be retouched to match original finish.
- J. All dents and sags in ductwork and equipment casings shall be straightened.
- K. All ductwork, insulation, equipment, pipe, pipe fittings and appurtenances shall be free of dust, rust and stains prior to Substantial Completion.
- L. Clean filters of operating equipment.
- M. Clean debris from roofs, gutters, downspouts, and drainage systems.
- N. Clean site; sweep paved areas, rake clean landscaped surfaces.
- O. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.10 CLOSEOUT PROCEDURES

- A. Make submittals that are required by governing or other authorities.
- B. Notify the Design Professional when work is considered ready for Final Observation.

- C. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for the Design Professional's review.
- D. Correct items of work listed in the Final Observation Report and comply with requirements for access to the Owner-occupied areas.
- E. Notify the Design Professional when work is considered finally complete.

END OF SECTION

**SECTION 03 3000
CAST-IN-PLACE CONCRETE**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete formwork.
- B. Concrete curing.

1.2 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
- B. ACI 301 - Specifications for Structural Concrete; 2010 (Errata 2012).
- C. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000.
- D. ACI 308R - Guide to Curing Concrete; 2001 (Reapproved 2008).
- E. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2013.
- F. ASTM C150/C150M - Standard Specification for Portland Cement; 2015.
- G. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2014.
- H. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2015.
- I. ASTM C1240 - Standard Specification for Silica Fume Used in Cementitious Mixtures; 2014.

PART 2 PRODUCTS

2.1 FORMWORK

- A. Form Materials: the Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.
 - 1. Form Facing for Exposed Finish Concrete: the Contractor's choice of materials that will provide smooth, stain-free final appearance.
 - 2. Form Coating: Release agent that will not adversely affect concrete or interfere with application of coatings.
 - 3. Form Ties: Cone snap type that will leave no metal within 1-1/2 inches of concrete surface.

2.2 REINFORCEMENT

- A. Reinforcement Accessories:

2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I - Normal Portland type. Provide _____ manufactured by _____ .
- B. Fine and Coarse Aggregates: ASTM C 33.
- C. Lightweight Aggregate: ASTM C330/C330M.
- D. Fly Ash: ASTM C618, Class C or F.
- E. Calcined Pozzolan: ASTM C618, Class N.
- F. Silica Fume: ASTM C1240, proportioned in accordance with ACI 211.1.
- G. Water: Clean and not detrimental to concrete.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.

3.4 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.

3.5 CURING AND PROTECTION

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

3.6 DEFECTIVE CONCRETE

3.7 SCHEDULE - CONCRETE TYPES AND FINISHES

- A. Equipment Pads and Bases: 3,000 pounds per square inch 28 day concrete, air entrained, smooth rubbed finish. Refer to Section 23 0548 for additional requirements.

END OF SECTION

**SECTION 07 8400
FIRESTOPPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Firestopping systems.
- B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies , whether indicated on drawings or not , and other openings indicated.

1.2 REFERENCE STANDARDS

- A. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2015.
- B. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2013a.
- C. ITS (DIR) - Directory of Listed Products; current edition.
- D. FM 4991 - Approval Standard for Firestop Contractors; 2013.
- E. FM P7825 - Approval Guide; Factory Mutual; current edition.
- F. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition.

1.3 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on product characteristics.
- C. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Fire Testing: Provide firestopping assemblies of designs that provide the specified fire ratings when tested in accordance with methods indicated.
 - 1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
 - 2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
 - 3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
- B. Installer Qualifications: Company specializing in performing the work of this section and:

1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors .

1.5 FIELD CONDITIONS

- A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.
- B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.1 FIRESTOPPING - GENERAL REQUIREMENTS

- A. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.2 MATERIALS

- A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
- B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant; conforming to the following:
- C. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers; conforming to the following:
 1. Durability and Longevity: Permanent.
 2. Color: Dark grey.
 3. Manufacturers:
 - a. A/DFire Protection Systems Inc: www.adfire.com.
 - b. USG: www.usg.com.
- D. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening; conforming to the following:
 1. Durability and Longevity: Permanent.
 2. Manufacturers:
 - a. A/DFire Protection Systems Inc: www.adfire.com.
 - b. Pecora Corporation: www.pecora.com.
 - c. Thermafiber, Inc: www.thermafiber.com.
 3. Durability and Longevity: Permanent ; suitable for pedestrian traffic.

- E. Intumescent Putty: Compound that expands on exposure to surface heat gain; conforming to the following:
 - 1. Potential Expansion: Minimum 1000 percent.
 - 2. Durability and Longevity: Permanent.
 - 3. Color: Black, dark gray, or red.
 - 4. Manufacturers:
 - a. RectorSeal: www.rectorseal.com.
 - b. 3M Fire Protection Products: www.3m.com/firestop.
 - c. Hilti, Inc: www.us.hilti.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.

- F. Reusable Firestopping: Removable intumescent compressible shapes, pillows, or blocks specifically tested in removable configuration; conforming to the following:
 - 1. Durability and Longevity: Permanent.
 - 2. Manufacturers:
 - a. RectorSeal: www.rectorseal.com.
 - b. Hilti, Inc: www.us.hilti.com.
 - c. Nelson FireStop Products: www.nelsonfirestop.com.
 - d. Specified Technologies, Inc: www.stifirestop.com.

- G. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive the work of this section.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
- B. Remove incompatible materials that could adversely affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.3 INSTALLATION

- A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
- B. Do not cover installed firestopping until inspected by authority having jurisdiction.
- C. Install labeling required by code.

3.4 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

3.5 PROTECTION

- A. Protect adjacent surfaces from damage by material installation.

END OF SECTION

**SECTION 07 9200
JOINT SEALANTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Joint backings and accessories.

1.2 REFERENCE STANDARDS

- A. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2013.

1.3 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective work within a one year period after Date of Substantial Completion.
- C. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal , exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Non-Sag Sealants: Permits application in joints on vertical surfaces without sagging or slumping.
 - 1. Adhesives Technology Corporation: www.atcepoxy.com/#sle.
 - 2. BASF Construction Chemicals-Building Systems: www.buildingsystems.basf.com.
 - 3. Bostik Inc: www.bostik-us.com.
 - 4. Dow Corning Corporation: www.dowcorning.com/construction/#sle.
 - 5. Franklin International, Inc: www.titebond.com/#sle.
 - 6. Hilti, Inc.: www.us.hilti.com/#sle.
 - 7. Momentive Performance Materials, Inc (formerly GE Silicones): www.momentive.com.
 - 8. QUIKRETE Companies: www.quikrete.com/#sle.
 - 9. Sherwin-Williams Company: www.sherwin-williams.com/#sle.
 - 10. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
 - 11. Substitutions: See Section 01 6000 - Product Requirements.

2.2 JOINT SEALANT APPLICATIONS

- A. Scope:

1. Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.
 - a. Wall expansion and control joints.
 - b. Joints between door, window, and other frames and adjacent construction.
 - c. Joints between different exposed materials.
 - d. Openings below ledge angles in masonry.
 - e. Other joints indicated below.
 2. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.
 - a. Joints between door, window, and other frames and adjacent construction.
 - b. Other joints indicated below.
 3. Do not seal the following types of joints.
 - a. Intentional weepholes in masonry.
 - b. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.
 - c. Joints where sealant is specified to be provided by manufacturer of product to be sealed.
 - d. Joints where installation of sealant is specified in another section.
 - e. Joints between suspended panel ceilings/grid and walls.
- B. Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, and food processing areas; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, and other similar items.

2.3 JOINT SEALANTS - GENERAL

- A. Colors: Match surrounding finishes or clear.

2.4 ACCESSORIES

- A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.

- C. Joint Cleaner: Non-corrosive and non-staining type, type recommended by sealant manufacturer; compatible with joint forming materials.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.2 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.3 INSTALLATION

- A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Perform installation in accordance with ASTM C1193.
- C. Install bond breaker backing tape where backer rod cannot be used.
- D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- E. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- F. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements for additional requirements.
- B. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

3.5 POST-OCCUPANCY

- A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at the low temperature in the thermal cycle. Report failures immediately and repair.

END OF SECTION

**SECTION 09 5100
ACOUSTICAL CEILINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.2 REFERENCE STANDARDS

- A. ASTM C635/C635M - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2013a.
- B. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2014.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is under HVAC control, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate grid layout and related dimensioning and mechanical and electrical items installed in the ceiling.
- C. Product Data: Provide data on suspension system components, acoustical units, and acoustical insulation.
- D. Manufacturer's Installation Instructions: Indicate special procedures.
- E. Maintenance Materials: Furnish the following for the Owner's use in maintenance of project.
 - 1. Extra Acoustical Units: 100 tiles in unopened cartons.

1.5 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.1 ACOUSTICAL UNITS

- A. Manufacturers:
 - 1. Armstrong; Product 1728A

2. Substitutions: Not permitted.
- B. Acoustical Units - General: ASTM E1264, Class A.
- C. Acoustical Tile: Painted mineral fiber, ASTM Type: III, Form: 2, Pattern: C E with to the following characteristics:
1. VOC Content: Certified as Low Emission by one of the following :
 - a. GreenGuard Children and Schools; www.greenguard.org.
 2. Size: 24 x 24 inches.
 3. Thickness: 5/8 inches.
 4. Composition: Water felted.
 5. Light Reflectance: 87 percent, determined as specified in ASTM E1264.
 6. NRC: 0.55
 7. Ceiling Attenuation Class (CAC): 33, determined as specified in ASTM E1264.
 8. Edge: Square layin.
 9. Surface Color: White, except where noted to be painted matte black in Air Traffic Control Labs. Shall be factory painted.
 10. Surface Pattern: Lightly Textured.

2.2 SUSPENSION SYSTEM(S)

- A. Manufacturers:
1. Same as for acoustical units.
 2. USG.; Product USG DX/DXL 15/16" Exposed Tee: www.usg.com.
 3. Substitutions: Not permitted.
- B. Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required. White painted.
- C. Exposed Steel Suspension System: Formed hot dipped galvanized steel, commercial quality cold rolled; intermediate-duty.
1. Profile: Tee; 15/16 inch wide face.
 2. Construction: Double web.
 3. Finish: White painted, except where noted on drawings as painted black in Air Traffic Control Simulation Labs. Shall be factory painted.

2.3 ACCESSORIES

- A. Perimeter Moldings: Same material and finish as grid.
 - 1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.
- B. Acoustical Insulation: Specified in Section 07 2100.
 - 1. Thickness: 2 inch.
 - 2. Size: To fit acoustical suspension system.
- C. Acoustical Sealant For Perimeter Moldings: Non-hardening, non-skinning, for use in conjunction with suspended ceiling system.
- D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that layout of hangers will not interfere with other work.

3.2 INSTALLATION - SUSPENSION SYSTEM

- A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- B. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size.
- C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
- D. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
- E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- F. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- G. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- H. Do not eccentrically load system or induce rotation of runners.
- I. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.

1. Use longest practical lengths.
 2. Overlap and rivet corners.
- J. The project includes reinstalling existing light fixtures in the exact same location as in the original ceiling layout. The new ceiling grid shall be measured, planned, and installed so that the existing light fixtures can be set in the new grid without any electrical re-wiring. Refer to Sheets A2.01 and A2.02. The fixtures shall be removed from the existing ceiling and suspended from the structure during the ductwork installation. Provide new 18 ga wire to support light fixtures. The existing fixtures shall not be electrically disconnected. Refer to Electrical Drawings.

3.3 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install units after above-ceiling work is complete.
- E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- F. Cutting Acoustical Units:
 1. Make field cut edges of same profile as factory edges.
- G. Where round obstructions occur, provide preformed closures to match perimeter molding.

3.4 WARRANTY

- A. 30 year manufacturer warranty.

3.5 SCHEDULE

- A. All other spaces: Ceiling Type 2

**SECTION 09 9000
PAINTING AND COATING**

PART 2 PRODUCTS

1.1 MANUFACTURERS

- A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
 - 1. Base Manufacturer: Sherwin Williams Company.
 - 2. Duron, Inc: www.duron.com/#sle.
 - 3. PPG Paints: www.ppgpaints.com/#sle.
 - 4. Pratt & Lambert Paints: www.prattandlambert.com/#sle.
 - 5. Sherwin-Williams Company: www.sherwin-williams.com/#sle.

1.2 PAINTS AND COATINGS - GENERAL

- A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
 - 1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
 - 2. Supply each coating material in quantity required to complete entire project's work from a single production run.
 - 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: As follows unless other primer is required or recommended by manufacturer of top coats; where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Volatile Organic Compound (VOC) Content:
 - 1. Provide coatings that comply with the most stringent requirements specified in the following:
 - a. 40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
 - 2. Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

1.3 PAINT SYSTEMS - INTERIOR

- A. Paint MI-OP-3A - Ferrous Metals, Unprimed, Alkyd, 3 Coat:

1. One coat of alkyd primer.
- B. Paint MI-OP-2A - Ferrous Metals, Primed, Alkyd, 2 Coat:
1. Touch-up with alkyd primer.
- C. Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:
1. One coat of alkyd primer sealer.

1.4 ACCESSORY MATERIALS

- A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
- B. Patching Material: Latex filler.
- C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

2.1 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to coating application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
- D. Seal surfaces that might cause bleed through or staining of topcoat.
- E. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

2.2 APPLICATION

- A. Apply products in accordance with manufacturer's instructions.
- B. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
- C. Apply each coat to uniform appearance.
- D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.
- E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

END OF SECTION

**SECTION 23 0510
GENERAL MECHANICAL REQUIREMENTS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions.
- B. Quality Assurance Requirements and Installer Qualifications.
- C. General Product Delivery and Storage.
- D. Installer Warranty.
- E. Submittal Procedures Supplementing Section 01 3000.
- F. Operating and Maintenance Manuals.
- G. Execution Requirements common to Division 23 systems.
- H. Existing HVAC Equipment.
- I. Pipe Sleeves within building.
- J. Pipe Sleeves in footings and foundations.
- K. Space Conditioning during Construction.
- L. Piping Pressure Tests.
- M. Equipment backboards.
- N. Starting equipment and Systems-General Requirements.
- O. Training Requirements.
- P. Cleaning Requirements.
- Q. Finishing Requirements.

1.2 RELATED SECTIONS

- A. Section 01 3300 - Submittal Procedures, for submittal procedures.
- B. Section 01 7000 - Execution Requirements, for additional submittal and warranty requirements.
- C. Section 03 3000 - Cast-in-Place Concrete.
- D. Section 07 8413 - Penetration Firestopping.
- E. Section 9200 - Joint Sealants.
- F. Section 09900 - Painting and Coatings.

1.3 DEFINITIONS

- A. Manufacturer's Representatives: Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. Concealed: Where the word concealed is used in this Division, it shall mean items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. Finished Spaces or Areas: Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. Provide: Furnish and install.
- E. Control and Interlock Wiring: All wiring, both line voltage and low voltage, other than power wiring from an electrical distribution panel, through the primary control device, to the item of equipment.
- F. Primary Control Device: That ONE device for any item of equipment which interrupts power flow during normal operation. Where magnetic starters are provided, they are the primary control. For items not switches by starters, the primary control device will be that ONE thermostat, time clock, manual switch, aquastat, P.E. switch, or relay performing the primary switching.
- G. Diagrammatic: A drawing that shows arrangement and relations (as of parts).i.e: A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.
- H. Readily Accessible: Items requiring maintenance shall be available for close approach for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling through an access point by maintenance staff safely standing on a ladder no taller than the ceiling.
- I. Noted, Indicated or Shown: Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- J. Detail: Where reference is made to a Detail, the Detail shall be on the plans unless otherwise noted.
- K. Specifications: Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- L. Notification by the Contractor, and Instructions to the Contractor: Where reference is made in these specifications to notification by or instructions given to the Contractor, it shall be inferred that the Design Professional shall be the instructor or shall be notified, as the case exists.
- M. Division or Section Reference: Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.

- N. Flow Diagram: A single-line, two-dimension, non-scaled drawing depicting arrangement and sequence of equipment, valves, controls, thermometers, gauges, and other specialty devices in a pipe or duct system.

1.4 REGULATORY REQUIREMENTS

- A. Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.
- B. Materials and equipment included in Underwriters Label Service shall bear that label. Electrical equipment shall be U.L. approved as installed.
- C. Permits and Codes: Refer to the General Conditions.
- D. Fire Prevention Precautions in Cutting and Welding Areas: Conform to Article 2605 Fire Prevention Precautions, International Fire Code, 2018 Edition, for all work involving cutting and welding.
- E. HVAC: Conform to the International Mechanical Code, 2018 Edition.
- F. Energy: Conform to the International Energy Conservation Code, 2018 Edition.
- G. Electrical: Refer to Division 26. Conform to the National Electrical Code, NFPA 70, 2017 Edition and the National Electrical Safety Code.
- H. Building Code: Conform to the Florida State Building Code, 7th Edition, 2020.

1.5 SUBMITTALS

- A. Supplementing Division 1 Administrative Requirements; the Contractor shall:
 - 1. Identify all submittals by a cover sheet showing project name, specification section, drawing or detail number, room number, date, revision date, contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and Preparer's phone number.
 - 2. Prepare a master list of submittal proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format of the master list shall contain a Specification Section, Section Title, Item Description, Item Status and any comment.
 - 3. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by the Design Professional are not Change Orders. The purpose of submittals is to demonstrate that the Contractor understands the design concept of the project by indicating the equipment and materials he intends to furnish and install, and by detailing the installation he intends to achieve.

- b. The Contractor shall conform to the requirements of the Contract Documents unless a change order is issued. The Contractor shall identify on each submittal that the submittal contains no deviations or the Contractor shall identify any proposed deviations.
 - c. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked "Revise and Resubmit" (the contractor acknowledges this by the submission), and the Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.
 - d. Failure of the Contractor to provide this information during the shop drawing phase shall make the Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
4. Provide a Letter from the HVAC Contractor stating that they have checked all submittals for compliance with specifications.
5. Product Data:
 - a. Provide data specific to the product proposed indicating capacity data, all standard and optional features to be supplied and all accessories and options available for that product.
 - b. Manufacturers' standard drawings shall be modified by deletions or additions to show only items applicable to this project.
- B. Deliver submittals to the Design Professional at the business address.
- C. Digital Delivery of Submittals:
 1. Submittal data may be posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and a password.
 2. Prepare the submittals as described above. Take steps to reduce submittal file size.
 3. Do not scan in color or high resolution unless required for clarity.
 4. Optimize any scans to help control file size.
 5. Ensure any reproductions are legible.
 6. Organize Submittal files individually by specification section with file name format as Follows; "CS/Section# - Section Title - any further identifier required such as *control drawings*"
 7. Send an email to submittal@nbpengineers.com with a copy to the HVAC Design Professional and any Architectural Design Professional identified during the preconstruction phase.

8. Identify the submittal using the official project title, specification section and submitted item. i.e. Project No. G-xxx, Addition to Administrative Building-Section 230548-Vibration and Seismic Controls. Include drawing or detail number, room number, date, revision date(s), contractor and subcontractor's organization as applicable
 9. Include the project manager's and manufacturers' representative's, salesman's (or a preparer who can answer questions) contact information, email and phone number.
 10. Identify the submittal in the email subject line using the same information listed above.
 11. Provide a submittal index.
 12. Ensure any submittal posted to NBP's or other FTP site has the same identification.
 13. NBP Design Professionals will not process or react to submittals which are not properly transmitted, indexed, and identified.
- D. Tabulation of Power Wiring Requirements: Within 60 Days of the Notice to Proceed, provide a Tabulation of Power Wiring Requirements of all proposed equipment, including H.P., amps, voltage, phase and KW, tabulated on a separate sheet. A copy of the tabulation shall be transmitted independently to the Contractor, the Design Professional and to all affected trades. (Refer to Electrical Drawings for electrical provisions for equipment.)
- E. Warranty: Submit the HVAC installer's warranty letter addressed to the Owner stating the correct project name and number, if applicable, the warranty period and ensure that form has the correct date of the Material Completion.

1.6 OPERATING AND MAINTENANCE MANUALS

- A. Operating and Maintenance Manuals shall be prepared by the Contractor for all equipment and be submitted for review a minimum of prior to the request for Material Completion.
- B. Digital delivery of Operating and Maintenance Manuals:
1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
 2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
 3. Do not scan in color or high resolution unless required for clarity.
 4. Ensure any reproductions are legible.
 5. Send an email to submittal@nbpengineers.com with a copy to the HVAC Design Professional and the Architectural Design Professional identified during the preconstruction phase.
 6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.

7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
 8. Ensure the manuals posted to the FTP site has the same identification.
 9. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.
- C. Each Manual shall contain the following information, data and drawings:
1. Copies of submittals (with Design Professional's review comments and stamp), equipment and materials.
 2. Manufacturer's installation, operating and maintenance instructions for each item of equipment with moving parts including recommended frequency of inspections and maintenance for one year of facility operation.
 3. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
 4. Control diagrams, electrical interlock diagrams, and control valve lists.
 5. Copies of as-built shop drawings showing layouts and construction details.
 6. Copies of Test and Balance Reports including list of instruments and description of methods employed.

1.7 QUALITY ASSURANCE

A. HVAC Installer Qualifications:

1. Wherever the word "company" or "firm" is used in these subparagraphs, it shall mean the contractor/subcontractor of record for the installations used for proficiency qualification.
2. Refer to the individual sections within this division for additional installer qualification requirements.
3. The Contractor expressly warrants that the company performing the installation of the air conditioning systems has demonstrated proficiency in the installation, start-up and adjustment of such systems by the successful performance of work of the nature specified herein on at least three commercial or institutional buildings, each containing minimum of 200 tons capacity or greater with ducted air distribution and chilled water, PTAC or wall hung units excluded.
4. The Contractor further warrants that the aforesaid subcontractor, if any, has trained personnel, instruments, tools, and equipment to perform the installation, start-up, instruction and maintenance service specified.
5. The Contractor also warrants that the aforesaid installer, if any, has been in business performing services of the nature specified herein for at least five years.

B. Testing and Balancing Qualifications: Refer to Section 23 0593.

1.8 WARRANTY

- A. Refer to Section 01 7000 - Contract Closeout, for additional warranty requirements.
- B. Submit manufacturers' warranties prior to final inspection. Refer to the General Conditions.
- C. Correct any defective Work within a one year period after Date of Material Completion. Provide HVAC Installer's warranty letter dated the date of the Material Completion
- D. Where warranties beyond the Contractor's one (1) year warranty are specified, the additional warranty time shall start on the same date as the Contractor's warranty.

PART 2 PRODUCTS-NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Hazardous Materials:
 - 1. Design Professional's Responsibility: Plans and specifications have been prepared by the A/E for the Owner without the Design Professional having conducted investigation as to the presence of asbestos or hazardous waste on the project. Not being a part of this contract, the Design Professional has not charged any fees and has not and will not advise the Owner with regard to the detection and/or removal of asbestos or hazardous waste. the Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of the Owner.
 - 2. If the Contractor observes the existence of a friable material which must be disturbed during the course of his work, the Contractor shall promptly notify the Owner and the Design Professional. the Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. the Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from the Owner through the Design Professional.
 - 3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.
- B. Refer to the specifications and Architectural and Structural drawings for additional requirements pertaining to work under this discipline. Notify the Design Professional for clarification in the event of conflict.
- C. All materials of systems installation exposed in hollow spaces that are used as ducts or plenums shall have a flame spread rating of 25 or less and a smoke development rating of 50 or less.

3.2 PREPARATION

- A. Drawings are diagrammatic and show the general proximity of the equipment, ducts, and pipes, etc., are not to be scaled, and do not include all required changes in direction or offsets necessary in coordinating the installation of various materials either between trades or within

the same trade. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at the Contractor's risk. Refer to Architectural plans for exact building dimensions and details.

B. Space Conditions:

1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.
2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to the Owner and shall be subject to approval.
3. All equipment requiring service shall be made accessible. Coordinate piping and ductwork installation to avoid conflict with other trades.

3.3 HVAC DEMOLITION

- A. The HVAC demolition plans have been prepared to assist the Contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. the Contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.
- B. All existing material removed from the facility shall be the property of the Contractor, unless otherwise noted, and shall be removed from the facility as required by the Contract provisions concerning trash removal.
- C. All existing equipment removed from the facility shall be the property of the Contractor, unless otherwise noted, and shall be removed from the facility as required by the Contract provisions concerning trash removal.
- D. Material and equipment which has been removed shall not be used in the new work, except as noted.
- E. Where the Documents indicate an equipment item to be removed. Remove all associated material including hangers, supports, wiring, controls conduit, etc. Do not leave abandoned items.
- F. Dispose of any material to be discarded in accordance with all laws and regulations.

3.4 INSTALLATION

- A. Clearance above and in front of electrical switchgear, electrical power panels or control panels shall be maintained by mechanical systems so that no mechanical ducts, pipes, vents or equipment is routed above or across the space directly above this equipment in conformance with the National Electrical Code.
- B. All equipment shall be installed in accordance with manufacturers' published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturers' instructions, no work shall be performed until additional instructions are received.

- C. Install and connect all appliances, equipment, and appurtenances as specified, indicated or required in accordance with the manufacturer's instructions and recommendations. Furnish and install complete auxiliary piping, water seals, valves, electric connections, and similar items, recommended by the manufacturer or as required for proper operation.
- D. Equipment, valves and other items installed under this division requiring service shall be installed to be readily accessible. Refer to definitions in this section.
- E. Coordinate with the Contractor and monitor the progress of the work so that other trades do not obstruct items requiring access for service.
- F. After final balancing, equipment with belt drives shall have their belts operating in the mid-80% position of the adjustable sheave.
- G. Provide equipment belt and coupling guards shielding the perimeter and face of all new belt drives, shafts and couplings. Provide openings opposite drive and driven shafts to permit use of revolution counter. Guards for fans shall be supported from the fan and mounting base, independent of the floor or housekeeping pad.
- H. Route piping and ductwork to avoid skylights, translucent, and transparent ceilings.
- I. Pipe Sleeves in Slabs, Masonry Walls and Partitions:
 - 1. Provide sleeves in all slabs and walls/partitions unless otherwise noted.
 - 2. Omit sleeves on cast iron pipe through slabs on grade.
 - 3. Elevated Slabs: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a slab.
 - 4. Masonry Partitions: Schedule 40 black steel pipe: Sleeves shall be sized to include the insulation with minimum gap around insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated masonry wall/partition.
 - 5. Omit sleeves in openings core drilled in masonry partitions.
 - 6. Rated Drywall Partitions: Twenty gage galvanized steel. Sleeves shall be sized to include the insulation with minimum gap around the insulation. Install, without developing a break in the pipe insulation, according to the fire sealant manufacturer's installation instructions for a U.L. Listed assembly for a rated pipe penetration through a rated drywall wall/partition.
 - 7. Non-Rated Drywall Partitions: Omit sleeves.
- J. Pipe sleeves in footings and foundation walls:
 - 1. Schedule 40 black steel pipe.

2. Chilled water, heating water, condenser water, refrigerant, or process piping passing under a footing or through a foundation wall shall be installed in a pipe sleeve, two pipe sizes larger than the pipe passing through.
 3. Sleeves in walls to spaces below grade shall be provided with 10 gauge leak plates.
- K. Seal sleeves and openings in mechanical room walls, fire rated partitions, and floors above grade vaportight, watertight, or for smoke/fire protection as applicable. Refer to Section 07 8400
- L. Seal sleeves and openings in exterior walls vaportight or watertight as applicable. Refer to Section 07 9000.
- M. Equipment and pipe support upper attachments shall be 3" x 3" x 1/4" steel angles, minimum, spanning structural members unless noted otherwise. Provide inserts and bolts for supporting pipes and equipment from structural members.
- N. Saw cut or core drill openings in existing work for the installation of the mechanical system. Patching shall be performed by the trade whose work is cut. Contractor shall lay out and install his work ahead of the work of other trades wherever possible.

3.5 SPACE CONDITIONING DURING CONSTRUCTION

- A. Coordinate with the Contractor regarding the limits of space conditions specified or requested by other trade sections.
- B. Assist the Contractor in the preparation of the construction schedule and determine to what extent the project's HVAC system can be operated within the restrictions listed below to help maintain those conditions.
- C. Ducted air handling systems shall not be placed into operation for testing or for temporary space conditioning until all walls in areas served by the system have been prepared for painting and the building is broom clean.
- D. The building's HVAC system shall be kept clean during the entire construction process. Protect equipment, motor, ducts, pipes from dirt and debris.
- E. Filters during construction:
1. Provide and maintain filters on all air handling equipment and terminal units used for space conditioning during construction.
 2. Provide and maintain filters on all return air grilles once ceilings are installed when air handling equipment or terminal units are used for space conditioning during construction.
 3. Provide filters with a minimum MERV rating of 8.
- F. Heating Terminal units such as unit heaters, cabinet heaters and finned radiation may be used for temporary heat during construction. Clean to new condition.

3.6 PIPING PRESSURE TESTS

A. General:

1. Provide 48 hours notification to the Design Professional in advance of any test.
2. Complete tests prior to insulating.
3. Leaks shall be repaired, defective materials replaced, and system shall be retested.
4. Strike all joints in copper and steel piping under a pressure test.
5. Conduct tests prior to connecting to equipment or isolate equipment from system.
6. No water pressure test shall be conducted in freezing weather where subject to freezing.
7. Test shall be maintained at conditions specified until approved but, in no event, for less than eight (8) hours minimum duration, unless otherwise noted.
8. Hydrostatic pressure tests shall maintain pressure without change, except that due to temperature change.

B. Refrigerant Piping: Refer to Section 23 2300.

3.7 EQUIPMENT BASES AND HOUSEKEEPING PADS

- A. Provide housekeeping and equipment bases as shown or listed below. Rough up slab under bases before pouring concrete.
- B. Materials: Refer to Section 03 3000 - Cast-in-Place Concrete. Omit test cylinders for concrete poured under this section.
- C. Bases/Pads shall be rectangular with vertical sides 4-inches from centerline of anchor bolts or 2 inches from edges of equipment supports, whichever provides the larger dimension, side of equipment or base edge, unless otherwise noted.
- D. Height:
1. Dedicated Outside Air Units: 8 inches, minimum, unless noted otherwise on Drawings. Increase pad height for unit furnished to provide space for condensate drain trap, refer to trap detail on drawings.
 2. Housekeeping Pads for Other Equipment: 4-inches or as shown on plans.
 3. Condensing Unit (7 Tons and Smaller): Concrete pad, refer to detail.
- E. Chamfer: 3/4-inch on edges and corners.
- F. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.8 EQUIPMENT BACKBOARDS

- A. General: Provide wood backboards for installation of surface mounted control panels, enclosed motor controllers, variable frequency controllers, and where shown.

- B. Type: 3/4-inch thick grade 1 fire retardant treated plywood supported by 3/4" x 3/4" x 1/8" aluminum angle frame attached to wall with 1/4-inch toggle bolts for hollow masonry, expansion shields for solid masonry.
- C. Finish: Frame and board with two coats light gray enamel paint.

3.9 STARTING EQUIPMENT AND SYSTEMS

- A. Adjust equipment for proper operation within manufacturers' published tolerances.
- B. Demonstrate proper operation of systems and equipment to the Owner 's designated representative.

3.10 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. A manufacturer's service representative shall provide the instructions for each piece of equipment on system when specified in other Sections of this Division. A manufacturer's sales representative is not acceptable. (The instructor shall not be a sales person, but shall have service experience on a continuing basis and be knowledgeable about the subject equipment.)

3.11 CLEANING AND PROTECTION

- A. All materials, equipment and mechanical rooms shall be cleaned prior to Material Completion.
- B. Wash down and scrub clean all mechanical room floors, walls, equipment bases and equipment.
- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish.
- D. All air handling equipment shall be cleaned internally prior to Material Completion. Clean unit casing externally and internally. Seal/replace all damaged duct liner.
- E. Chipped or scraped paint shall be retouched to match original finish.
- F. Clean and polish all equipment nameplates. All nameplate information shall be legible.
- G. All dents and sags in ductwork and equipment casings shall be straightened.
- H. All ductwork, insulation, equipment, pipe, pipe fittings and appurtenances shall be free of dust, rust and stains prior to Material Completion.

3.12 FINISHING EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint shop-primed equipment.
- C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- D. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

- E. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- F. Paint all exposed un-insulated ferrous metals, flat black.
- G. Paint interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.

END OF SECTION

**SECTION 23 0513
MOTORS FOR HVAC EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single phase electric motors.
- B. Three phase electric motors.

1.2 RELATED REQUIREMENTS

- A. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015.
- B. IEEE 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; 2004.
- C. NEMA MG 1 - Motors and Generators; 2014.
- D. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.

1.4 QUALITY ASSURANCE

- A. Conform to NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Baldor, Century, Lincoln, Marathon, Magnetec, Toshiba

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Electrical Service:
 - 1. Motors 1/2 HP and Smaller: 115 volts, single phase, 60 Hz.
 - 2. Motors 1/2 HP and larger: three phase 60 Hz.
 - a. 200 volt motors on 208 volt systems.
 - 3. Refer to Electrical drawings for voltage and phase required.

- B. Overload Protection: Single phase motors shall be furnished with built-in automatic reset overload protection.
- C. Efficiency: Motors 1 HP and larger shall be premium efficiency motors and have minimum full load efficiencies not less than listed in the Energy Code.
- D. Brake Horsepower: All motors shall have rated horsepower at least 10 percent above the indicated brake horsepower of equipment including belt losses and inlet vane losses.
- E. Construction:
 - 1. Open drip-proof type except where specifically noted otherwise.
 - 2. Design for continuous operation in 40 degrees C environment.
 - 3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 4. All copper windings and leads.
 - 5. Motors for belt driven equipment and base mounted pumps shall have cast iron yoke and bearing housings.
- F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- G. Motors serviced by Variable Frequency Controllers:
 - 1. Motors shall be Definite Purpose Inverter-Fed Motors complying with NEMA MG1-Part 31. Stator laminations shall be vacuum-pressure impregnated with varnish for reduction of audible motor noise.
 - 2. Motors shall be equipped with factory installed grounding rings to electrically ground the motor shaft to prevent eddy current damage to bearings, AEGIS-SCR.
- H. Wiring Terminations:
 - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
 - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.

2.3 APPLICATIONS

- A. Exception: Motors less than 250 watts, for intermittent service may be the equipment manufacturer's standard and need not conform to these specifications.
- B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.
- C. Single phase motors for fans and pumps: Capacitor start, capacitor run type.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.
- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.
- E. Insulation System: NEMA Class B or better.
- F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.
- G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000

hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- I. Sound Power Levels: To NEMA MG 1.
- J. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION

SECTION 23 0548
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vibration isolators.

1.2 REFERENCE STANDARDS

- A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; 2015.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements, for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's product literature documenting compliance with PART 2 PRODUCTS.
- C. Shop Drawings:
 - 1. Provide schedule of vibration isolator type with location and load on each.
- D. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

1.4 QUALITY ASSURANCE

- A. Comply with applicable building code.
- B. Perform design and installation in accordance with applicable codes.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Amber Booth: www.amberbooth.com.
- B. Isolation Technology, Inc.: www.isolationtech.com
- C. Kinetics Noise Control, Inc: www.kineticsnoise.com.
- D. Korfund Dynamics: www.thevmcgroup.com.
- E. Mason Industries: www.mason-ind.com.
- F. Vibration Eliminator Company, Inc; _____: www.veco-nyc.com/#sle.

G. Vibration Mounting and Control: www.vmc-kdc.com.

H. Vibro-Acoustics: <http://www.vibro-acoustics.com>.

2.2 PERFORMANCE REQUIREMENTS

A. General:

1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
2. Steel springs to function without undue stress or overloading.

2.3 VIBRATION ISOLATORS

A. Non-Seismic Type:

1. Neoprene Pad Isolators:
 - a. Rubber or neoprene waffle pads.
 - 1) Hardness: 30 durometer.
 - 2) Thickness: Minimum 1/2 inch.
 - 3) Maximum Loading: 50 psi.
 - 4) Rib Height: Maximum 0.7 times width.
 - b. Configuration: Single layer.
 - c. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 SCHEDULE

A. Equipment Isolation Schedule.

1. Air Cooled Condensing Units, 7-1/2 tons capacity and less. Refer to Detail on Drawings.
 - a. Isolator Type: Neoprene Pad.
 - b. Isolator Deflection: 0.25 inches.

END OF SECTION

**SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. ASME A13.1 - Scheme for the Identification of Piping Systems; 2007.

1.2 SUBMITTALS

- A. Refer to Section 23 0510- General HVAC Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.
- B. Size: 1/2 inch high letters unless otherwise noted.
- C. Size when located on ceiling grid: 3/8 inch high letters unless otherwise noted.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Identify dedicated OA systems, air cooled condensers, VRF cassettes, ductless split systems and terminal heat transfer equipment with plastic nameplates.
- B. Where equipment is located above ceilings, in addition to the nameplate provided for the device; Apply a separate nameplate to ceiling grid adjacent to panel to be removed for access for equipment located above accessible ceilings or to access panel for non-accessible ceilings.
- C. Identify control panels and major control components outside panels with plastic nameplates.
- D. Tag automatic controls, instruments, and relays. Key to control schematic.

END OF SECTION

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct Liner

1.2 REFERENCE STANDARDS

- A. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2014.
- B. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2012.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- D. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2014.
- E. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association 2007.
- F. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.4 QUALITY ASSURANCE

- A. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 DUCT LINER - GLASS FIBER

- A. Manufacturers: Certainteed Toughguard2, Owens-Corning QuietR Textile Duct Liner, JohnsManville Permacote Linacoustic HP.
- B. Insulation: Incombustible glass fiber complying with ASTM C 1071; flexible blanket; impregnated surface and edges coated with acrylic polymer shown to be fungus and bacteria resistant by testing to ASTM G 21.
 - 1. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 2. Service Temperature: Up to 250 degrees F.
 - 3. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 - 4. Density: 1.5 pcf.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
 - b. 2 inch Thickness: 0.70.
- C. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- D. Liner Fasteners: Galvanized steel, welded with press-on head.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that ducts have been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Provide insulation with vapor barrier jackets.
- D. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- E. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, duct lined with duct liner, heating coil return bends at terminal units, and expansion joints.

F. Fiber Glass, Flexible:

1. Do not pull insulation tight around ducts.
2. Lap transverse joints 2 inch, minimum and secure with staples 18 inches on center.
3. Wrap insulation with Tie Wire 18 inches on center, maximum.
4. Install mechanical fasteners not more than 18 inches on center on ducts over 24 inches wide.
5. Provide 24 inch length, minimum, of rigid glass fiber insulation on bottom of ducts supported from trapeze hangers.

G. Weld mechanical fasteners to duct. No glue or stick on allowed.

H. Duct Accessories, Duct Mounted Meters and Gages Instruments and Duct Mounted Instrumentation and Other Control Devices:

1. In conditioned spaces devices shall be left exposed and/or accessible above the insulation vapor barrier jacket for access. Seal to vapor barrier jacket.
2. In non-conditioned spaces devices shall be insulated within the insulation vapor barrier jacket with the insulation and jacket arranged to provide access.
3. Accessible devices to include:
 - a. Duct mounted Instrumentation,
 - b. Airflow Measuring Station pressure ports,
 - c. Input/Output Sensors,
 - d. Duct access door handles,
 - e. Volume Control damper handles(MVD),
4. Damper operators shall be left exposed and/or accessible above the insulation vapor barrier jacket for access. Seal to vapor barrier jacket.

I. Duct Liner Locations:

1. Line supply, return, and mixed air ducts where noted on drawings with 1 inch liner.
2. Provide 2 inch liner at field fabricated mixing plenums.
3. Do not install liner in duct within six feet downstream of a cooling coil or outside air intake.

J. Duct and Plenum Liner Application: (Glass Fiber Liner)

1. Install liner in accordance with manufacturer's Published Installation Instructions and SMACNA Installation Standards including Figure No. 7-11 and 7-12.
2. Adhere insulation with adhesive for 90 percent coverage.

3. Secure insulation with mechanical liner fasteners, type 3 or 4 located in accordance with SMACNA Figure 7-11. Refer to SMACNA (DCS) Standards for spacing.
4. Install with longitudinal and transverse joints under compression.
5. Seal and smooth all longitudinal and transverse joints, field cuts exposed edges and any minor surface damage with edge coat.
6. Seal liner surface penetrations with edge coat.
7. Provide 26 gauge metal nosing on leading edge at fan discharges and at any interval of lined duct proceeded by unlined duct.
8. Terminate liner at duct mounted accessories such as turning vanes and dampers. Provide sheet metal "hat" section build out in accordance with SMACNA Figure 7-13.
9. Duct dimensions indicated are net metal inside dimensions required for air flow. Do not increase duct size to allow for insulation thickness.
10. Provide protection for surfaces that may be subject to damage by tradesmen installing electrical, controls or other work.

3.3 CLEANING

- A. Clean adjacent surfaces, valves, valve handles, etc. of jacketing materials.

3.4 SCHEDULES

A. Outside Air Intake Ducts:

1. Glass Fiber, Flexible; 2 inch thick.

B. Plenums:

1. Glass Fiber, Flexible; 2 inch thick.

C. Supply Ducts:

1. Concealed and exposed in Mechanical Rooms and Non Conditioned Interior Spaces:
Glass Fiber, Flexible; 2 inch thick.
2. Exposed Supply Ducts in Conditioned Spaces: Do Not Insulate.

END OF SECTION

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.

1.2 REFERENCE STANDARDS

- A. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2014.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- C. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association 2007.
- D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 23 0510 - General HVAC Requirements for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.4 QUALITY ASSURANCE

- A. All insulation, mastics, coatings, sealants, and adhesives shall be certified by the manufacturer to be Asbestos-free.
- B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum Three years of experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E 84, NFPA 255, or UL 723.

2.2 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc.; Aerocel: www.aeroflexusa.com/#sle.
 - 2. Armacell LLC: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; Insul-Tube: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible closed-cell elastomeric rubber insulation complying with ASTM C 534 Grade 1; use molded tubular material. Split tube installation is prohibited.
 - 1. 'K' ('Ksi') value: 0.25 at 75 degrees F (0.04 at 24 degrees C).
 - 2. Maximum Moisture Absorption: < 1.0 percent (pipe) by volume, when tested in accordance with ASTM C 209.
 - 3. Water Vapor Permeability: 0.05 perm-inches, when tested in accordance with ASTM E 96.
 - 4. Minimum Service Temperature: Minus 40 degrees F.
 - 5. Maximum Service Temperature: 220 degrees F.
 - 6. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.3 STAPLES, BANDS, AND WIRES

- A. Staples shall be outward clinching type of type 304 or 316 stainless steel, or monel.
- B. Bands shall be galvanized steel, aluminum, brass, or nickel copper alloy, of 3/4 inch nominal width. The band thickness exclusive of coating shall be not less than 30 gauge for steel and nickel copper alloy.
- C. Wire shall be 18-gauge stainless steel.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.

- C. Exposed Piping: Locate insulation and cover seams in least visible locations. Exterior of insulation shall be uniform in appearance.
- D. Insulation jacket shall fit snug to insulation.
- E. Valves and fittings:
 - 1. Insulate pipe and all valves and fittings including valve bonnets on A.C. condensate drain and refrigerant suction piping. Leave only valve stems, open ends of wells and gauge cocks exposed.
 - 2. All Other Piping: Insulate pipe and fittings, but omit insulation on unions and valves. Taper insulation ends and cover with jacket material.
- F. Insulation at Hangers: Hangers for horizontal, A.C. condensate drain, refrigerant suction, and trapeze supports shall be outside of insulation with saddles as specified herein.
- G. Saddles:
 - 1. Provide galvanized steel saddles at each point where pipe insulation passes through a hanger or rests on a support.
 - 2. Saddles shall be 180 arc for horizontal piping, 360 arch for vertical piping.
 - 3. Center saddle on pipe hanger.
 - 4. Length and gauge of saddle shall be as follows:
 - a. 2 inch pipe size and smaller: 18 Gauge saddle, 8 inch long, minimum.
 - b. 2-1/2 & 3 inch pipe size: 18 Gauge saddle, 12 inch long, minimum.
 - c. 4 inch pipe size: 16 Gauge saddle, 16 inch long, minimum.
 - d. 6 inch pipe size and larger: 16 Gauge saddle, 24 inch long, minimum.
- H. Flexible elastomeric cellular rubber insulation: Install without splitting and under compression during pipe fabrication. Seal Joints with adhesive. Paint exposed insulation with two coats of vinyl insulation paint after adhesive has dried for twelve hours, minimum. Allow two hours, minimum, between coats.

3.3 CLEANING

- A. Clean adjacent surfaces, valves, valve handles, etc. of jacketing materials.

3.4 SCHEDULES

- A. DX Cooling Systems:
 - 1. Refrigerant Piping: 3/4 inch thick preformed flexible elastomeric cellular rubber insulation.

- B. Condensate Drains from Cooling Coils: 3/4 inch thick preformed flexible elastomeric cellular rubber insulation.

END OF SECTION

**SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Input/Output Sensors:
- B. Control panels.
- C. Input/Output Sensors.
- D. Miscellaneous accessories.
- E. Section 23 0994 - HVAC Sequence of Operation.
- F. Section 26 0519 - Low-Voltage Electrical Power and Conductors & Cables.

1.2 REFERENCE STANDARDS

- A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2008.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.

1.3 SUBMITTALS

- A. Refer to Section 23 0510- General HVAC Requirements for submittal procedures.
- B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
- D. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years' experience employed directly by the digital equipment manufacturer.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.1 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.2 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with hinged, lockable face panel.
- C. Finish: Baked enamel factory finish.
- D. Provide common keying for all panels with two keys per control panel.
- E. Nameplates:
 - 1. Use device identification and number from control drawings.
 - 2. Identify panel with permanent label mounted on panel face. Nameplate shall be bakelite with white letters, 3/8 inch minimum height.
 - 3. Identify all panel mounted devices with permanent label mounted adjacent to device. Nameplates shall be bakelite with white letters, 1/8 inch minimum height.
- F. Door mounted devices: Refer to the Sequence of Operation for devices specified to be door mounted.
- G. Wiring:
 - 1. Power supply of capacity required with disconnect switch, surge protection, fuse holder with fuses or circuit breaker, 120 VAC service receptacle.
 - 2. Conductors color coded with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.
 - 3. Connections and junctions to terminal strips and devices only.
 - 4. Route wiring parallel to cabinet side in wiring troughs or laced with nylon ties.
 - 5. Wiring and devices that derive power from other sources shall be located in a separate compartment and be provide with separate terminal strips.
 - 6. Cover all line voltage terminations in panel.
- H. Indicator lights: 24 VAC light emitting diode. 100,000 hour lamp life. Provide single "Press-To-Test" button for all lights in panel.

2.3 INPUT/OUTPUT SENSORS

- A. Temperature Sensors:
 - 1. Platinum resistance temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.

2. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
 3. Provide 3 lead wires and shield for input bridge circuit.
 4. Use insertion elements in ducts not affected by temperature stratification and smaller than 9 square feet. Use averaging elements where larger or prone to stratification. Sensor length 8 feet or 16 feet as required.
 5. Use sensor holder with mounting plate and conduit enclosure with cover plate for elements mounted on ducts. Provide extension between plate and enclosure on insulated ducts.
 6. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches. Provide lagging extensions on insulated pipes.
 7. Room digital thermostats: Sensor with setpoint adjustment marked warmer/cooler, built-in override button, terminal block wiring connection and I/O communication port for portable monitoring device. Locking cover. blank cover in all public spaces
 8. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.
- B. Humidity Sensors:
1. Elements: Accurate within 5 percent full range with linear output.
 2. Room Sensors: With locking cover matching pneumatic thermostats used, span of 10 to 60 percent relative humidity.
 3. Duct and Outside Air Sensors: With element guard and mounting plate, range of 0 - 100 percent relative humidity.
- C. Equipment Operation Sensors:
1. Status Inputs for Electric Motors:
 - a. U.L. Listed current sensing relay with split core current transformer, 1 amp @ 30 VAC adjustable setpoint output switch, adjustable mounting bracket, power and trip LED indication.
 - b. Constant speed fans and pumps: Output switch trip setpoint at 10% below the normal motor operating speed and current draw.
 - c. Variable speed fans and pumps: Output switch trip setpoint at 5% below the lowest motor operating speed and current draw as determined in the commissioning process, typically 20%.
 - d. Product: Veris Industries Hawkeye H-900, Kele D-150, Veris Industries.

2.4 SWITCHING DEVICES

- A. Duct Mounted Smoke Detector: NFPA 72, photoelectric type with auxiliary SPDT relay contact, key-operated NORMAL-RESET-TEST switch, duct sampling tubes extending width of duct, and

visual indication of detector actuation, in duct-mounted housing. Provide two-wire detector with common power supply and signal circuits.

B. Electric Relays:

1. Heavy duty, isolated, cabinet mounted, blade plug-in type with base.
2. Rating: 10 amps, minimum at 125 VAC:

2.5 THERMOSTATS

A. Fire Thermostats(Firestats):

1. UL labeled, factory set in accordance with NFPA 90A.
2. Normally closed contacts, adjustable setpoint, manual reset, dust cover and adjustable duct mounting flange with extension for mounting on insulated duct.
3. Set point range: 100-250 Degree F.
4. Initial Setpoint: 195 Degree F

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that systems are ready to receive work.
- C. Beginning of installation means installer accepts existing conditions.
- D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F. Ensure installation of components is complementary to installation of similar components.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Locate all control devices except for sensors and devices integral to equipment within control panels, unless otherwise noted.
- C. Install control devices in a readily accessible location. Refer to definitions in Section 23 0510.
- D. Coordinate with the Contractor and monitor the work so that other trades do not obstruct control devices or other items requiring access for service.
- E. Device mounting:

1. All devices shall be permanently mounted and secured in place.
2. Mount control panels on backboards adjacent to associated equipment on vibration free walls or free standing angle iron supports. Refer to Section 23 0510 for backboards.
3. Panel mounted controls: Secure to panel backs with non-ferrous sheet metal screws.
4. Gypsum Board and Plaster walls: Moly-bolt type anchor. No adhesive or plastic insert anchors.
5. Concrete Walls: Non-ferrous screws and expansion shields.
6. Concrete masonry units: Mount to recessed box or secure with moly-bolt type anchor.
7. Provide accessory wall adapter plates where required to cover block or wall opening edges.
8. Pipe and duct mounted devices: Secure to well or mounting flange. Provide well and flange extensions on insulated duct and pipe to clear insulation thickness.

F. Identification:

1. Nameplates: Identify all sensors mounted in mechanical rooms using device ID and number from control drawings with permanent label mounted adjacent to device. Nameplates shall be engraved plastic laminate with uppercase black letters on a white field, 1/4 inch minimum height.
 - a. Include sensor type, normal setpoints information on nameplate.
 - b. Mounting: Attach nameplates with epoxy cement or non-ferrous screws after final painting.
2. Color code conductors with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.

G. Electrical wiring:

1. All control and interlock wiring shall be provided under this section.
2. No splices between field devices and control panels are permitted.
3. All Wiring materials and methods shall comply with Division 26 except:
 - a. Minimum wire size shall be 14 AWG(copper) for line voltages.
 - b. Minimum wire size shall be 18 AWG(copper) for signal.
4. Fire Alarm System Interface: Signal for fan shutdown shall be obtained from fire alarm output relay located in mechanical room adjacent to the starter/motor control center, unless otherwise noted.

- H. Check and verify location of thermostats and exposed control sensors with plans and room details before construction of wall assemblies. Locate between 42 to 48 inches above finished

floor. Mount at common elevation within same space. Align with lighting switches. Refer to Section 26 0537.

- I. Mount in center of 8x8 inch block face with recessed mounting box and accessory wall adapter plate covering block opening where mounted in concrete masonry units.
- J. Use a single sensor for outside air temperature.
- K. Mount outdoor thermostats and outdoor sensors indoors, with sensing elements outdoors on north side of building or in shaded location. Mount with sun shield.
- L. Mount outdoor thermostats and outdoor sensors away from building discharge openings or doors where conditioned air from building will effect signal. Do not mount on positive pressurized HVAC devices where conditioned air can leak thru opening effecting signal.
- M. Provide separable sockets for liquid elements. Mount sockets as specified in Section 23 2113. Cut element to length for full insertion into well and provide conducting compound.
- N. Provide mounting flanges for air bulb elements with extensions as required on insulated ducts to clear insulation.
- O. Install current sensing relays in starter enclosure for equipment served.
- P. Install damper operators in accessible locations.

END OF SECTION

**SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System Description
- B. Controllers
- C. Power Supplies and Line Filtering
- D. Controller Software
- E. HVAC Control Programs
- F. Digital control equipment
- G. Software set-up and application programming
- H. Owner demonstration and training

1.2 RELATED REQUIREMENTS

- A. Section 23 0800 - HVAC Commissioning Requirements.
- B. Section 23 0913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC.
- C. Section 23 0994 - HVAC Sequence of Operation.
- D. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2012.
- B. BTL - BACnet Testing Laboratories.
- C. NFPA 70 - National Electrical Code; 2020 Edition.

1.4 SUMMARY

- A. The Building Automation System (BAS) shall be comprised of a distributed peer-to-peer network of DDC controllers and a web-based operator interface. Network control system complete with all necessary hardware and software including all programming and a complete system of direct digital automatic temperature controls (DDC).
- B. The BAS shall be capable of total integration of the facility infrastructure systems with user access to all system data both locally over a secure Intranet within the building and by remote access by a standard Web Browser over the Internet. This shall include HVAC controls, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to building operations as indicated on the drawings or in this specification.

- C. System shall use the BACnet protocol for communication to the operator workstation or web server and for communication between control modules.

1.5 SYSTEM DESCRIPTION

- A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units. All devices down to field level controllers shall communicate using BACnet protocol.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on BACnet protocol network, with central and remote hardware, software, and interconnecting wire and conduit. Provide Building Controllers (BC), Advanced Application Controllers (AAC), and Application Specific Controllers (ASC) as required to achieve specified sequences and performance. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in ANSI/ASHRAE 135, BACnet Annex L.
- C. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to ANSI/ASHRAE Standard 135-BACnet, and have a BTL label for compliance and interoperability.
- D. The BAS shall be a Web based system communicating over the campus Local Area Network (LAN). Contractor shall be responsible for coordination with the University IT department to ensure that the building automation system will perform in the data network environment without disruption to any of other activities taking place on that LAN. TCP/IP connections and addresses will be provided by the University for interface with the network. The BAS shall operate via a single IP address for the building.
- E. The BAS shall support standard Web browser access via Intranet/Internet, supporting a minimum of 5 concurrent users.
- F. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- G. Provide HVAC control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- H. The Contractor shall be responsible for all equipment, cables, installation, and programming to implement the required interface with the campus network.
- I. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.6 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:

1. Table of Contents listing sheet titles and sheet numbers.
2. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
3. Provide drawing legend and list of abbreviations.
4. System architecture: Provide a drawing of the proposed system architecture showing configuration and locations for DDC controllers, packaged HVAC equipment, connection to the campus IT network, terminal unit controllers, power and control wiring for each device, and hardware and wiring for connections to networks external to the building.
5. DDC system data: Proposed system manufacturer's data sheets on DDC controllers, sensors, meters, relays, actuators, motors, terminal unit controllers, protection devices, and other devices specified herein. Include data on system software packages to be installed and illustrations of proposed graphics displays.
6. Diagrams: Separate field wiring diagrams for each system, motor starting and interlock wiring, ladder diagrams, control wiring, interior electrical circuits of control instruments with terminal and control device designations, actuators and motors, colors of wires, locations of instruments and remote elements, interfaces with communications equipment provided with equipment specified in other Sections, and normal position of relays. Each diagram shall have terminals labeled as they will be marked on the installed equipment. Electrical wiring diagrams shall include diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which is existing, factory-installed and portions to be field-installed.
7. The control submittal is to include schematic control drawings showing the configuration of the equipment, the location of all sensors, monitoring inputs, and controlled devices and any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
8. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). Provide a full points list with the following included for each point:
 - a. Controlled system
 - b. Point abbreviation/acronym
 - c. Point description
 - d. Engineering unit to be displayed with the point
 - e. Control point or set-point (Yes / No)
 - f. Monitoring point (Yes / No)

- g. Intermediate point (Yes / No)
 - h. Calculated point (Yes / No)
 - 9. Proposed Graphics: Submittal shall include all proposed displays as required by the project documents and specifications.
 - 10. Sequences of Operation: Complete detailed sequences of operation, including a narrative of the system operation and interactions and interlocks with other systems; notations indicating whether interlock or interaction is accomplished through software or hard-wired connections; detailed delineation of control between packaged controls and the DDC system; and sequences of operation for packaged controlled equipment that interfaces with the DDC system describing what points the DDC system monitors only and what points are control points and are adjustable. Sequence shall include:
 - a. Equipment start-up sequences.
 - b. Warm-up mode sequences.
 - c. Normal operating mode sequences.
 - d. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, capacity control, staging, optimization, etc.
 - e. Temperature and pressure control: setbacks, setups, resets, etc.
 - f. Shutdown sequences.
 - g. Unoccupied mode sequences.
 - h. Sequences for all alarms and emergency shut downs.
 - i. Effects of power or equipment failure with all standby component functions.
 - j. Seasonal operational differences and recommendations.
 - k. Initial and recommended values for all adjustable settings, set-points and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.
 - l. Schedules, if known.
 - m. All sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered
- 11. BACnet Systems:
 - a. BACnet object description, object ID, and device ID, for each I/O point.

- b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
 - c. Submit PICS indicating the BACnet functionality and configuration of each controller.
12. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.
- a. Drawings and Diagrams: Schematic flow diagrams and system architecture diagrams shall be provided on electronic media as AutoCAD 2005 or later version drawing files. Other drawings and diagrams may be provided as either AutoCAD files or PDF files, as most appropriate.
 - b. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format.
- D. Project Record Documents: Submit full set of "As-Built" control drawings, reflecting all changes made during the construction, checkout, and commissioning process. The "As-Built" drawings shall include:
- 1. Accurate scaled floor plans showing the locations of all installed control equipment, sensors, monitoring points, and equipment connected to the DDC control system. Floor plans shall locate any electrical panels that provide power to the system or that are monitored or controlled by it. Space sensors shall be located on these floor plans. Equipment shall be identified on these floor plans by its control system designation.
 - 2. A control schematic showing the location of all sensors, monitoring devices, and control outputs, an accurate Materials Schedule identifying the installed equipment, and floor plans showing the installed locations of all control equipment and the locations of electrical panels supplying power to control equipment.
 - 3. Full as-built sequence of operations for each piece of equipment, reflecting any changes made to achieve the required system performance.
 - 4. Points List - An updated points list, identifying all points, actual and virtual, installed in the system. Provide the following information for each point: Point type, Point identifier, Point address.
 - 5. A listing of all terminal controllers, with the following information for each device:
 - a. Associated air handler unit ID and air terminal unit tag ID.
 - b. Floor, room number, and room name where located and reference drawing number showing location.
 - c. Terminal unit tag identification, as implemented in the installed control system.
 - d. Heating and/or cooling valve tag identification.
 - e. Minimum cfm.

- f. Maximum cfm.
 - g. Calibrated flow coefficient.
6. Valve Schedule reflecting the actual equipment installed, with the following information for each device:
 - a. Floor, room number, and room name where located and reference drawing number showing location.
 - b. Associated coil served and heating and/or cooling valve tag ID.
 - c. Normal position (Normally open/Normally closed).
 - d. Maximum gpm.
 - e. Valve flow coefficient (Cv).
 - f. Expected pressure drop at design flow.
 - g. Associated valve actuator.
7. Damper Schedule, reflecting the actual equipment installed with the following information for each device:
 - a. Floor, room number, and room name where located and reference drawing number showing location.
 - b. Associated equipment served and device tag ID.
 - c. Normal position (Normally open/Normally closed).
 - d. Maximum cfm.
 - e. Valve flow coefficient (Cv).
 - f. Expected pressure drop at design flow.
 - g. Associated damper actuator.
8. Controller/module data shall include specific instructions on how to perform and apply functions, features, and modes specified herein and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included. Provide hardcopy and electronic copy on DVD or thumb-drive.
9. Control Equipment Data: The data of this section shall include a separate table of contents and/or index to document the information provided.
 - a. Control equipment data should include the manufacturer's maintenance, set-up, testing, calibration, operation, and repair data sheets on all DDC controllers, sensors, meters, relays, actuators, motors, terminal unit controllers, protection devices, and

other devices provided as a part of the installed DDC system. This data must include specific step by step instructions on how to perform all routine servicing and maintenance procedures recommended by the device manufacturer. Provide specific sensor calibration procedures and recommended calibration intervals for each device used in the installed system.

- b. Data must include the detailed technical manual for programming and customizing control loops and algorithms. Specific procedures and instructions for applying all functions, features, modes, etc. of the equipment are required.
- c. In addition, include data on system software packages provided, documenting all functions and providing guidance on their use.
- d. Thermostats, sensors, switches, and timers, including maintenance instructions and sensor calibration requirements and methods by sensor type.
- e. Full as-built documentation of software programming to include fully commented software program with English language comments describing the operation of the controller programming. Documentation shall include all schedules, set points, and alarm limits established during the commissioning and acceptance testing of the system. Provide an electronic copy of programming and database information for this facility, sufficient to restore the facility to full operation.

E. Operation and Maintenance Data:

1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Provide maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
5. Provide BAS User's Guides (Operating Manuals) for each controller type and for all workstation hardware and software and workstation peripherals.
6. Provide BAS advanced Programming Manuals for each controller type and for all workstation software.
7. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Divisions 1 and 23.
8. Provide as-built network architecture drawings showing all BACnet nodes including a description field with specific controller identification, description and location information.

9. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
 10. Provide record system architecture riser diagram showing the location of all controllers.
 11. Complete original issue diskettes for all software provided, including operating systems, programming language, backup copy of programming code for the controllers in the project, operator workstation software and graphics software.
 12. Licenses, guarantees, and warranty documents for all equipment and systems.
 13. Maintain project record documents throughout the construction period and submit final documents at Material Completion.
- F. Observation by the Design Professional: Provide an affidavit to the Design Professional stating the Controls Systems are performing in accordance with the contract documents prior to Request for Material Completion.
- G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in the Owner's name and registered with manufacturer.
- H. Certificate: Provide Manufacturer's Certificate complying with the requirements of the General Conditions.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 70.
- B. Personnel: Mechanics and electricians performing this work shall be regularly engaged in the installation of automatic temperature controls and be in the direct employ of the installing company and shall have a copy of the approved submittal data in immediate possession when performing work.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 WARRANTY

- A. See Section 01 7700 - Closeout Procedures, for additional warranty requirements.
- B. All components, system software, and parts furnished and installed by the BAS contractor shall be guaranteed against defects in materials and workmanship for one year from date of Material Completion. Project-specific software, database software, and firmware updates which resolve known software deficiencies as identified by the BAS Contractor shall be provided to the Owner at no charge during the warranty period. All corrective software modifications made during warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
- C. At Material Completion, the BAS contractor shall upgrade all control software and firmware packages to the latest release available from the vendor.

- D. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.9 PROTECTION OF SOFTWARE RIGHTS AND LICENSES

- A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software. All project developed software and documentation shall become the property of the owner. These include, but are not limited to:
1. Project graphic images
 2. Record drawings
 3. Project network database
 4. Project-specific application programming code
 5. All documentation.
- B. The Contractor shall provide additional software licensing as follows:
1. Provide or upgrade all licensing for all software packages at all required workstations. Building automation system licensing shall allow unlimited simultaneous users for access to all aspects of the system including system access, workstations, points, programming, database management, graphics etc. No restrictions shall be placed on the licensing. All operator interfaces, programming environment, networking, database management and any other software used by the Contractor to install the system or needed to operate the system to its full capabilities shall be licensed and provided to the Owner.
 2. All software should be available on all Operator Workstations or servers provided, and on all Portable Operator Terminals. Hardware and software keys to provide all rights shall be installed on all workstations. At least 2 sets of CDs shall be provided with backup software for all software provided, so that the Owner may reinstall any software as necessary. Include all licensing for workstation operating systems, and all required third-party software licenses.
 3. Provide licensing and original software copies for each Operator Workstation or server.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Andover Controls by Facility Automation Solutions.

2.2 BACNET™ COMMUNICATION

- A. Control products, communication media, connectors, repeaters, hubs, and routers shall comprise a BACnet internetwork. Controller and operator interface communication shall conform to the latest edition of ANSI/ASHRAE Standard 135, BACnet.

- B. Each controller shall have a communication port for temporary connection to a laptop computer or other operator interface. Connection shall support memory downloads and other commissioning and troubleshooting operations.
- C. Controllers with real-time clocks shall use the BACnet Time Synchronization service. The system shall automatically synchronize system clocks daily from an operator-designated controller via the internetwork. If applicable, system shall automatically adjust for daylight saving and standard time.
- D. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in ANSI/ASHRAE 135, BACnet Annex J.

2.3 BUILDING CONTROL UNITS

- A. Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment. The BC(s) shall provide fully distributed control independent of the operational status of operator work stations or web-servers. All necessary calculations required to achieve control shall be executed within the BC independent of any other device. All control strategies performed by the BC(s) shall be both operator definable and modifiable through the Operator Interfaces. Each BC shall provide intelligent, standalone control of HVAC functions. Each BC may be capable of standalone direct digital operation utilizing its own processor, non-volatile memory, input/output, wiring terminal strips, A/D converters, real-time clock/calendar and voltage transient and lightning protection devices.
- B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.
- C. All local controller operating parameters, setpoints, and schedules shall be stored in non-volatile EEPROM memory.
- D. Arrange Unit and Unit I/O so that control unit functions continue if communications over network are lost.
- E. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both data base and control functions simultaneously.

6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Automatic Temperature Control.
 - c. Event initiated control.
 - d. Calculated point.
 - e. Scanning and alarm processing.
 - f. Full direct digital control.
 - g. Trend logging.
 - h. Global communications.
- F. Global Communications:
 1. Broadcast point data onto network, making that information available to all other system control units.
 2. Transmit any or all input/output points onto network for use by other control units and utilize data from other control units.
- G. Input/Output Capability:
 1. Discrete/digital input (contact status) isolated, either N.O. or N.C. as specified.
 2. Discrete/digital output: Isolated relay contacts with built-in HOA switch rated for 1 amp at 24 VAC, minimum.
 3. Analog input: Compatible with sensors specified in Instruments and Control Elements.
 4. Analog Output: Supervised Analog output compatible with operator(0-10VDC, 4-20mA) with built-in HOA and manual positioner, 8 bit minimum.
 5. Pulse input (5 pulses/second).
 6. Pulse output (0-655 seconds in duration with 0.01 second resolution).
- H. Provide transient protection on all I/O signals where cable or device is external to building.
- I. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse inputs, pulse outputs and discrete inputs/outputs, as required. Each building controller shall be provided with a minimum of one spare digital and analog output points, and two universal input points.
- J. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.

- K. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds over voice grade phone lines.
- L. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
 - 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from work station.
 - 2. Control output points but change only data base state or value; leave external field hardware unchanged.
 - 3. Enable control actions on output points but change only data base state or value.
- M. Each DDC controller and associated input/output modules shall be configured and installed with a minimum of 10% spare input and output points of each type required, but no less than one point of each type.

2.4 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:

- 1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
- 2. Limit connected loads to 80 percent of rated capacity.
- 3. Match DC power supply to current output and voltage requirements.
- 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
- 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
- 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
- 7. Operational Ambient Conditions: 32 to 120 degrees F.
- 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
- 9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:

- 1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers. Suppressors shall be solid state, operate bi-directionally, and have a turn-on and turn-off time of less than one nanosecond, and all shall provide the

protection specified herein, either as an internal part of the DDC controllers or as a separate component.

2. Communication of Signal Conductor Transient Suppressors shall require the following:
 - a. Maximum single impulse current conductor-to-conductor or conductor-to-ground: 10000 amperes, 8x20 microsecond waveform.
 - b. Pulse life rating: 3000 amperes, 8x20 microsecond waveform, 2000 occurrences.
 - c. Maximum clamping voltage at 10000 amperes, 8x20 microsecond waveform, with the peak current not to exceed the normal applied voltage by 200%.

2.5 LOCAL AREA NETWORK (LAN)

- A. Provide communication between control units and operator station(s) over local area network (LAN).
- B. The BAS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.
- C. BACnet Router: Communication between the campus server(s) and the controllers shall be BACnet/IP. A router shall be provided to interface the BACnet/IP and the data network installed between the controllers.
- D. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- E. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- F. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.6 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability From Operator Station:
 1. Request display of current values or status in tabular or graphic format.
 2. Command selected equipment to specified state.
 3. Initiate logs and reports.
 4. Change analog limits.
 5. Add, delete, or change points within each control unit or application routine.
 6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.

7. Add new control units to system.
 8. Modify and set up maintenance scheduling parameters.
 9. Develop, modify, delete or display full range of color graphic displays.
 10. Automatically archive select data even when running third party software.
 11. Provide capability to sort and extract data from archived files and to generate custom reports.
 12. Support printer operations.
 - a. Print alarms, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off.
 - b. Print reports, page prints, and data base prints.
- B. Web Based Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.
- C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
1. Add and delete points.
 2. Modify any point parameter.
 3. Change, add, or delete English language descriptors.
 4. Add, modify, or delete alarm limits.
 5. Add, modify, or delete points in start/stop programs, trend logs, etc.
 6. Create custom relationship between points.
 7. Create or modify DDC loops and parameters.
 8. Create or modify override parameters.
 9. Add, modify, and delete any applications program.
 10. Add, delete, develop, or modify dynamic color graphic displays.
- D. Dynamic Color Graphic Displays:
1. Utilizes custom symbols or system supported library of symbols.
 2. Sixteen (16) colors, minimum.
 3. Sixty (60) outputs of real time, live dynamic data per graphic.
 4. Dynamic graphic data.

5. 1,000 separate graphic pages, minimum.
 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- E. Web Server or Existing Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
 2. Interrogate LAN for updated point data when requested.
 3. Allow operator command of devices.
 4. Allow operator to place specific control units in or out of service.
 5. Allow parameter editing of control units.
 6. Store duplicate data base for every control unit and allow down loading while system is on line.
 7. Control or modify specific programs.
 8. Develop, store and modify dynamic color graphics.
 9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.
- F. Alarm Processing:
1. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states, and alarm reactions for each system object. Configure and enable alarm points as specified in Sequences of Operation and as designated by the User. Additional alarms can be added to all system points in the future without additional software, hardware or wiring, Alarms shall be BACnet alarm objects and shall use BACnet alarm services.
 2. Alarm Messages
 - a. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location, and nature.
 3. Alarm Reactions
 - a. Operator shall be able to configure (by object) the actions that workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail and page notification, and audibly annunciate. The send e-mail alarm action should be able to run a report and attach it to the e-mail. The e-mail shall use SSL to secure the communications between the system server and the mail server.
 - b. Operator shall also be able to set the following conditions for an alarm action:

- 1) Run the alarm action only when the alarm source generates an alarm or when it returns to normal.
 - 2) Wait a specified amount of time, then run the alarm action if the alarm has not been acknowledged or has not returned to normal.
 - 3) Run if the alarm occurs during the occupied hours defined for a schedule group, or run if the alarm occurs during the group's unoccupied hours.
4. Alarm Maintenance
- a. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms, and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.
- I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 2. Compose, change, or delete any message.
 3. Display or log any message at any time.
 4. Assign any message to any event.
- J. Reports:
1. Manually requested with time and date.
 2. Long term data archiving to hard disk.
 3. Automatic directives to download to transportable media such as floppy diskettes for storage.
 4. Data selection methods to include data base search and manipulation.
 5. Data extraction with mathematical manipulation.
 6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
 7. Generating reports either normally at operator direction, or automatically under work station direction.

8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
 9. Include capability for statistical data manipulation and extraction.
 10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.
- K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.
- L. Data Collection:
1. The supplied system must incorporate the ability to access all data using browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) compliant web-server database is required for all system database parameter storage to allow all historical data to be easily imported into any ODBC compliant software (i.e. Microsoft ACCESS, EXCEL, etc.) This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs shall not be acceptable.
 2. Automatically collect and store in disk files.
 3. Daily electrical energy consumption for building electrical meters and submeters.
 4. Daily gas consumption for building gas meter and submeters.
 5. Daily water consumption for building domestic water flow meter.
 6. Provide archiving of stored data for use with system supplied custom reports.
- M. Trends:
1. The contractor shall build graphic trends for the following for each HVAC system, with multiple trend points:
 - a. Analog outputs trend with output value, control input variable, setpoint value, reset value, modes, one trend per control loop.
 - b. Analog input trend with all input variables for a system.
 - c. Digital input/output trend with all digital variables for a system.
 2. Operator shall be able to configure trend sample or change of value (COV) interval, start time, and stop time for each system data object. Controller shall sample and store trend data and shall be able to archive data to the existing web-server. Owner shall be able to add additional trend points, intranet and internet viewable, and build trend graphs to display without additional hardware or software. Authorized operators shall have the capability of viewing trends from any workstation that is connected to the web.
- N. Graphic Display: Support graphic development on work station with software features:
1. Page linking.

2. Generate, store, and retrieve library symbols.
 3. Single or double height characters.
 4. Sixty (60) dynamic points of data per graphic page.
 5. Pixel level resolution.
 6. Animated graphics for discrete points.
 7. Analog bar graphs.
 8. Display real time value of each input or output line diagram fashion.
- O. Maintenance Management:
1. Run time monitoring, per point.
- P. Advisories:
1. Summary which contains status of points in locked out condition.
 2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
 3. Report of power failure detection, time and date.
 4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.7 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and SI (metric) units of measurement.
- B. Automatic Time Scheduling:
1. Self-contained programs for automatic Start/Stop/scheduling of Building HVAC loads.
 2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
 3. Special days schedule shall support up to 30 unique date/duration combinations.
 4. Any number of loads assigned to any time program; each load can have individual time program.
 5. Each load assigned at least 16 control actions per day with 1 minute resolution.
 6. Sequence starting of equipment with motors 3 KW or larger with adjustable time delay.
 7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
 8. Create temporary schedules.

9. Broadcast temporary "special day" date and duration.
- C. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- D. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
 1. Employ arithmetic, algebraic, Boolean, and special function operations.
 2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.
- E. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
 1. Define time interval between each control action between 0 to 3600 seconds.
 2. Output may be analog value.
 3. Provide for "skip" logic.
 4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.
- F. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
 1. Control loops: Defined using "modules" that are analogous to standard control devices.
 2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
 3. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Lo signal selector.
 - f. Single pole double throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.

4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
 5. Display: Value or state of each of the lines which interconnect DDC modules.
- G. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
 - a. Control loop being tuned
 - b. Input (process) variable
 - c. Output (control) variable
 - d. Setpoint of loop
 - e. Proportional band
 - f. Integral (reset) Interval
 - g. Derivative (rate) Interval
 2. Except from a start-up, maximum allowable variance from setpoint during functional testing for controlled variables shall be as follows:
 - a. Air temperature $\pm 1^{\circ}\text{F}$
 - b. Air humidity $\pm 5\% \text{ RH}$
 - c. Space temperature $\pm 0.5^{\circ}\text{F}$
 3. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" vs "variable".
- H. Trend logging:
1. Each control unit will store samples of control unit's data points.
 2. Update file continuously at discretely assignable intervals.
 3. Automatically initiate upload request and then store data on hard disk.
 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 5. Co-ordinate sampling with on/off state of specified point.
 6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.
 7. The contractor shall assist the Owner in setting up the HVAC system trending functions during training. The specifications for the trends shall be defined by the Owner for identification by name, and recall by that name.

2.8 HVAC CONTROL PROGRAMS

A. General:

1. Support Inch-pounds and SI (metric) units of measurement.
2. Identify each HVAC Control system.

2.9 PROGRAMMING APPLICATION FEATURES

A. Trend Point:

1. Sample up to 6 points, real or computed, with each point capable of collecting samples at intervals specified in minutes, hours, days, or month.
2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:

1. Allow definition of minimum of 50 messages, each having minimum length of 180 characters for each individual message.
2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
3. Output assigned alarm with "message requiring acknowledgments".
4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:

1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
2. Provide program times for each day of week, per point, with one minute resolution.
3. Automatically generate alarm output for points not responding to command.
4. Provide for holidays, minimum of 100 consecutive holidays.
5. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:

1. Permit events to occur, based on changing condition of one or more associated master points.

2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that conditioned power supply is available to the control units and to the operator work station.
- C. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.2 PROGRAMING

- A. Include operating system programming of software capability specified to provide:
 1. Set-up of system I/O capability, operator access as defined by the User, database creation and support.
 2. DDC system shall be installed and programmed to accomplish the sequence of operation as defined on the project documents. Programming shall be arranged to allow the "stand-alone" operation of mechanical systems and to minimize the impact of failures of individual controllers and/or communication links.
 3. Programming shall be configured such that ALL setpoints, high/low limits, decision points, and other variables in the programming are variables that can be adjusted by an operator with the appropriate access authority through the use of graphic displays.
 4. Equipment responses to fire alarm system signals, as defined by the project documents, shall be independent of the DDC controller and its output. As defined by the project documents, secondary responses to these signals or responses of other associated equipment may be accomplished through the DDC system and programming
 5. Graphic Display-Levels: Provide graphic display leveling scheme for building site, floor plans, and system diagrams as follows:
 - a. Level 1: Identify location of building on the site.
 - b. Level 2: Show each floor plan of the building.
 - c. Level 3: Show each mechanical room and equipment layout.
 - d. Level 4: Show each individual system such as chilled water loop, heating water loop, air handling units, exhaust systems, terminal units, etc.
 6. Graphic Display-Systems:
 - a. Provide and generate dynamic color graphics providing menu-generated flow charting of each building process using background graphics, standard and user defined symbols and dynamic variables.

- b. Provide flow charting for each system indicating all available points.
 - c. Indicate setpoint condition status by changing color, flashing. Provide flow charting for each system indicating all available points.
 - d. Dynamic updates: All graphic I/O object values shall update with change of value, or by operator selected discrete intervals.
 7. Graphic Displays- Floor Plans:
 - a. Provide building floor plan graphics with thermographics or temperature readouts and a change in color during alarms.
 - b. Show actual locations of equipment, and thermostats on the graphics.
 8. Graphic Trends: - Each HVAC System:
 - a. Analog outputs trend with output value, control input variable, setpoint value, reset value, modes, one trend per control loop.
 - b. Analog input trend with all input variables for a system.
 - c. Digital input/output trend will all digital variables for a system.
 9. Sequences of Operation:
 - a. Provide a graphic screen displaying the written out full sequence of operation for each piece of HVAC equipment.
 - b. Provide a link to the sequence of operation displays on their respective equipment graphics.
 10. Equipment Runtime monitoring.
- B. Include HVAC programming of software to provide:
 1. System and equipment operating to specified Sequence of Operation.
 2. Night set-up/set-back of temperature set-points as directed by the User.
- C. Include Application system programming of software capability specified to provide:
 1. Trend logging:
 - a. Logging, reporting and graphing of user defined system trends on disk file and printer as directed by user.
 - b. Organize data in each trend logs to facilitate documenting system operation in compliance with Sequence of Operation.
 2. Alarms: Logging, reporting and printing of user defined system alarms on disk file and printer as directed by user.
 3. Owner Occupancy Scheduling:

- a. Program user defined system scheduling of HVAC systems as directed by the University Facilities Management.
- b. Implement optimized starting and stopping for building warm-up/cool-down before occupancy.

3.3 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where accessible for inspection, maintenance and repair and not subject to excessive vibration.
- B. Install software in control units and in campus server(s). Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0993.
- C. Identification:
 1. Nameplates: Identify all sensors mounted in mechanical rooms using device ID and number from control drawings with permanent label mounted adjacent to device. Nameplates shall be engraved plastic laminate with uppercase black letters on a white field, 1/4 inch minimum height.
 - a. Mounting: Attach nameplates with epoxy cement or non-ferrous screws after final painting.
 2. Conduit/Cable Markers:
 - a. Color coded, sunlight resistant cable ties.
 - b. Location: Install on all conduit and raceways exposed or above ceilings in a visible location at:
 - 1) Connections to junction, pull boxes, or manholes. Label box cover with nominal system voltage, circuit number and panel identification legibly written with permanent marker.
 - 2) Connections to equipment.
 - 3) Each side of a wall, roof or floor penetration.
 - 4) Along straight runs at 50 feet intervals.
 - 5) At changes of direction.
 - 6) Parallel Conduits: Group markers on each conduit in-line with the adjacent marker.
 - c. Color: Baby Blue.
 3. Color code cable with both ends identified with manufactured alpha-numeric self-adhesive vinyl tags, 3 mils thick, minimum, keyed to termination points.
- D. Communication Wiring:

1. All wiring shall be in accordance with National Electrical Codes and Division 26 of this specification. Communication wiring shall be provided in a customized color jacketing material. Material color shall be as submitted and approved. In addition all wiring jackets shall be labeled "BAS" in 3 foot or fewer intervals along the length of the jacket material.
2. Contractor shall supply all communication wiring between Controllers, Routers, and other devices.
3. Control LAN For any portions of this network required under this section of the specification, contractor shall use Category 5 or better cable as specified in TIA-568B. Media shall be Class 2 plenum rated and installed in accordance with manufacturer's recommendations. Network shall be run with no splices and separate from any wiring over thirty (30) volts.

E. Signal Wiring:

1. Contractor shall run all signal wiring in accordance with National Electric Codes and Division 26 of this Specification.
2. Signal wiring to all field devices, including, but not limited to, all sensors, transducers, transmitters, switches, etc. shall be twisted, 100% shielded pair, minimum 18-gauge wire with PVC cover, Class 2 plenum rated. Signal wiring shall be run with no splices and separate from any wiring above thirty (30) volts.
3. Signal wiring shield shall be grounded at controller end only unless otherwise recommended by the controller manufacturer.

F. Low Voltage Analog Output Wiring:

1. Contractor shall run all low voltage control wiring in accordance with National Electric Codes and Division 26 of this Specification.
2. Low voltage control wiring shall be minimum 18-gauge, twisted pair, 100% shielded, with PVC cover, Class 2 plenum-rated. Low voltage control wiring shall be run with no splices separate from any wiring above thirty (30) volts.

G. Electrical Wiring Installation:

1. All terminations of field wiring shall be to terminal strips.
2. Power wiring to control units shown on drawings is provided under Division 26. Provide conduit and conductors and power supplies and transformers to extend power to all supplemental control units.
3. Wiring System: Install complete wiring system for electric control systems. Conceal wiring except in mechanical rooms and areas where other conduit and piping are exposed. Installation of wiring shall generally follow building lines. Install in accordance with National Electrical Code and Division 26 of this Specification. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.

4. Control Wiring Conductors: Install control wiring conductors, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code and Division 26 of this Specification.
5. Communication wiring, signal wiring and low voltage control wiring shall be installed separate from any wiring over thirty (30) volts. Signal wiring shield shall be grounded at controller end only, unless otherwise recommended by the controller manufacturer.
6. All control network wiring shield shall be terminated as recommended by controller manufacturer. All control network wiring shall be labeled with a network number, NodeID at each termination and shall correspond with the network architecture and floor plan submittals.
7. Install all control wiring external to panels in electric metallic tubing or raceway. Installation of wiring shall generally follow building lines. Provide compression type connectors. Provide rigid conduit at all exterior locations and where subjected to moisture. All conduits penetrating partitions, walls or floors shall be sealed with an approved material to prevent migration of air through the conduit system and maintain the required firestopping performance. Communication wiring, signal wiring and low voltage control wiring may be run without conduit using plenum rated cable in concealed, accessible locations if noise immunity is ensured. Contractor will be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance. Accessible locations are defined as areas inside mechanical equipment enclosures, such as heating and cooling units, instrument panels etc.; in accessible pipe chases with easy access, or suspended ceilings with easy access. Installation of wiring shall generally follow building lines. Run in a neat and orderly fashion, bundled where applicable, and completely suspended (strapped to rigid elements or routed through wiring rings) away from areas of normal access. Tie and support conductors neatly with suitable nylon ties. Conductors shall not be supported by the ceiling system or ceiling support system. Conductors shall be pulled tight and be installed as high as practically possible in ceiling cavities. Wiring shall not be supported by piping, conduit, the ceiling or ductwork. Conductors shall not be installed between the top cord of a joist or beam and the bottom of roof decking. Contractor shall be fully responsible for noise immunity and rewire in conduit if electrical or RF noise affects performance.

H. DDC Panel Installation:

1. Power wiring to control units shown on drawings is provided under Division 26. Provide conduit and conductors and power supplies and transformers to extend power to all supplemental control units.
2. Wire controllers, relays, switches, and controls in the control panel to a terminal block. Line voltage and low voltage shall be separated on different terminal blocks with labels indicating voltage. Each sensor or other electrical device shall be wired back to the terminal block in the control panel. Devices in series shall be individually terminated at the terminal block, such that each side of each device is available at the control panel for troubleshooting. In addition to number markings on each conductor, conductor color shall be the same throughout each wiring run.

3. Wiring shall be neatly and tied and routed in the control panel. Shielded wiring shall be terminated neatly, with heat shrink tubing placed over the bare end of the shield. Ground conductors over 4" long shall be insulated with tubing.
4. DDC panel installation shall include 120V duplex convenience outlet wired from the same circuit as the DDC controller.
5. Each item in the panel shall be labeled with the nameplates or tags bearing the functional designations shown on approved control diagrams. Each control panel shall be labeled to identify the system or equipment served and to identify the location and circuit designation of the electrical power source.
6. Panels shall be located to avoid conflicts with ductwork, piping, equipment, the work of other trades, and building conditions. Panel locations indicated on the Drawings shall be coordinated prior to installation and adjusted to avoid conflict.
7. All Wiring materials and methods shall comply with Division 26 except:
 - a. Minimum wire size shall be 14 AWG(copper) for line voltages.
 - b. Minimum wire size shall be 18 AWG(copper) for signal.
- I. Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.4 MANUFACTURER'S FIELD SERVICES

- A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B. Provide the services of control technicians at start-up to check-out the system, verify and calibrate sensors and outputs, input data supplied by the Owner and place the system in operation. Verify proper operation of each item in the sequence of operation, including hardware and software.
- C. Check-out each system for control function through the entire sequence. Check actuator travel on dampers and valves for action and extent. Verify that control dampers and valves open and close completely. Check calibration of instruments. Calculate and verify instrument setpoints.
- D. Calibration and testing: Calibrate sensors and monitoring inputs and verify proper operation of outputs before the system is placed on-line. Check each point within the system by making a comparison between the operator console and field device. DDC control loops, failure modes, interlocks, sequences, energy management programs, and alarm shall be debugged, tested and stable operation verified. Control loop parameters and tuning constants shall be adjusted to produce accurate, stable control system operation. Before obtaining permission to schedule the functional test, provide written documentation of system calibration and certification that the installed complete system has been calibrated, verified, and is ready to begin testing.
- E. Provide start-up certificate in the format prescribed by the General Conditions.

3.5 DEMONSTRATION, TRAINING AND INSTRUCTIONS

- A. Demonstrate a complete and operating system to the Columbus State-FMD operating staff.
- B. Provide services of the BAS vendor technical personnel to instruct the Columbus State-FMD personnel in operation and maintenance of the control system. Instruction shall be in classroom setting at the project site.
- C. All training sessions may be attended by the Commissioning Agent.
- D. The standard operating manual for the control system and any special training manuals shall be provided for each trainee. Manuals shall include detailed descriptions of the subject matter for each training session. The manuals shall include system control sequences with a definitions index that fully describes relevant terms used in the manuals and in software displays.
- E. The training sessions shall include course material for System Operation Training as developed to meet the specific needs of the User.
- F. The BAS vendor designated training personnel shall meet with the Owner's representative, and the Commissioning Agent for the purpose of discussing and fine-tuning the training agenda prior to the first training session. The training plan shall be submitted 30 days prior to the scheduled training sessions.
- G. Training shall occur after the functional testing for the systems has been completed.
- H. Training shall be provided for up to 8 individuals.
- I. The Training Agenda shall include the following:
 - 1. Session 1:
 - a. Brief walk-through of building, including identification of all controlled equipment and condensed demonstration of portable and built-in operator interface devices and display capabilities.
 - b. Brief overview of the various parts of the O&M manual, including hardware and software programming and operating publications, catalog data, controls installation drawings, and DDC programming documentation.
 - c. Demonstration of workstation login/logout procedures, password setup, and exception reporting.
 - d. Demonstration of workstation menu penetration and broad overview of the various workstation features.
 - 2. Session 2:
 - a. General Review of sequence of operation, control unit programming, standalone modes, fail modes and graphic workstation screen for each HVAC subsystem.
 - b. Demonstration and set-up of alarm feature.

- c. Demonstration and set-up of diagnostics features.
 - d. Demonstration of workstation graphic screens and functions.
 - e. Demonstration and set-up of trend feature.
 - f. Demonstration and set-up of workstation reports
 - g. Fail modes and procedures to take in the event of and following a power outage.
 - h. Standalone modes and procedures to take in the event of and following various communication failures.
 - i. Question and answer period.
3. Session 3:
- a. Review of previous sessions.
 - b. Introduction to programming (utilize typical site specific programs) for all control unit types.
 - c. Demonstration of Control Unit features, diagnostics, program upload/download.
 - d. Demonstration of I/O hardware testing, calibration, and replacement.
 - e. Review of sequence of operation, control unit programming, standalone modes, fail modes and graphic workstation screen for each HVAC subsystem.
 - f. Demonstration of workstation diagnostics features, program upload/download capabilities and software backup concepts.
 - g. Question and answer period.
4. Session 4:
- a. Review of previous sessions.
 - b. Review of alarm, diagnostics, trends, graphics, and report features.
 - c. Review of fail modes and standalone modes and corresponding procedures to follow.
 - d. Review of I/O hardware testing, calibration, and replacement.
 - e. Start-up, Setpoint Adjustment, Scheduling and Shutdown Procedures for each system.
 - f. Demonstration of setpoint optimization and fine-tuning concepts.
 - g. Demonstration of control unit features, diagnostics, program upload /download.
 - h. Question and answer period.
5. Session 5:

- a. Review of previous sessions.
 - b. Review of all remaining miscellaneous workstation features.
 - c. Review of setpoint optimization and fine-tuning concepts.
 - d. Programming examples (utilize typical site specific programs) for all control unit types.
 - e. Demonstration of workstation diagnostics features, program upload/download capabilities and software backup concepts.
 - f. Question and answer period.
- J. Deferred Training, Testing, and Programming:
1. This session shall be conducted on-site approximately six months after occupancy for a minimum of 8 hours. Follow-up training shall be scheduled and structured to address specific topics and review questions concerning operation of the building automation system.
 2. Contractor shall provide 8 hours of control technician on-site support to verify programming and control loop tuning during off-season testing.
 3. Contractor shall provide 8 hours of control technician on-site support for reprogramming as directed by the Owner.

3.6 COMMISSIONING SUPPORT REQUIREMENTS:

- A. The Construction Manager shall attend a preliminary commissioning scoping meeting and other commissioning coordination meetings during the construction process as necessary to facilitate the commissioning process. Construction Manager shall keep the Commissioning Authority (CxA) and mechanical Commissioning Supervisor informed of progress with the Project and of changes to the proposed installation, programming and test plan.
- B. The Construction Manager shall provide assistance to the Commissioning Authority for scheduling and witnessing of testing. Review the Prefunctional and Functional test procedures to ensure feasibility, safety, and equipment protection.
- C. Preparation of a written start-up and initial checkout plan indicating in a step-by-step manner the procedures that will be followed to test, check-out, and adjust the control system prior to beginning functional testing. Submit the proposed plan to the Commissioning Authority and mechanical Commissioning Supervisor for review and approval prior to startup. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
 1. Step-by-step procedures for testing each type controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to load controllers and verifying that they are addressed correctly.

- c. Process of verifying proper hardware and wiring installation.
 - d. Process of performing operational checks of each controlled component.
 - e. Plan and process for calibrating valve and damper actuators and sensors.
 - f. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - g. A copy of the log and field check-out sheets that will document the process. This log shall include a place for initial and final values read during calibration of each point and clearly indicate when a sensor or controller has passed and is operating within the contract parameters. Notification of any equipment failures shall be documented.
 - h. A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - i. A description of the instrumentation required for testing, including a certification of calibration for each test instrument.
 - j. Identify which tests and systems should be completed prior to using the control system for test, adjustment, and balance work.
 - k. The Commissioning Agent may request further documentation necessary for the commissioning process.
2. Provide the Commissioning Authority and mechanical Commissioning Supervisor complete system logic diagrams, describing the proposed system programming, with programmed attributes shown. These diagrams shall be updated with field modifications from the start-up, check-out, and pre-functional testing prior to the beginning of the functional testing of the DDC system. Provide a copy of each proposed graphical interface screen with interface points shown for the entire system. Provide assistance to the Commissioning Authority in preparing the specific functional performance test procedures required, to include normal cut sheets and shop drawing submittals of commissioned equipment and any additional requested documentation, prior to normal O&M manual submittals. Review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the tests.
 3. Pre-functional tests: Provide skilled technicians to execute startup of equipment and to execute the pre-initial checkout as described by the approved plan. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem solving. Verify and document the proper installation, addressing, calibration, programming, operation, and failure mode of DDC control points, sequences, and equipment and provide a copy to the commissioning authority. Provide a signed and dated certification to the Commissioning Authority and Commissioning Supervisor upon completion of the check-out of each controlled device, equipment, and system that installation, set-up, adjustment, calibration, and system programming is complete and as indicated on the Drawings, except functional testing. Completed pre-functional documentation of the system verification shall be submitted to the Commissioning Authority and Commissioning Supervisor for review and approval prior to the functional testing of the DDC control system or its being used in the

testing of other equipment or systems, or other purposes. Copies of final field check-out sheets and trend logs shall be provided to the Commissioning Authority and Commissioning Supervisor for inclusion in the Commissioning Report.

4. Meet with the testing, adjusting, and balancing contractor prior to beginning the test, adjustment, and balance process and review the test, adjusting, and balancing plan to determine the capabilities and requirements of the control system in completing the testing, adjusting, and balancing process. For a given area, have all required pre-functional checklists, calibrations, startup and selected functional tests of the system completed and approved by the Commissioning Authority prior to beginning the testing, adjusting, and balancing effort. Provide the testing, adjusting, and balancing contractor with the appropriate software and any needed unique instruments for setting terminal units and instruct the testing, adjusting, and balancing contractor personnel in their use. Assist and cooperate with the testing, adjusting, and balancing contractor by providing a qualified technician to operate the controls as required to assist the testing, adjusting, and balancing contractor in performing his work, or alternatively, provide sufficient training for the testing, adjusting, and balancing contractor to operate the system without assistance. Verify the proper operation of affected controls at the completion of the test, adjustment, and balance procedure.
5. Address current Design Professional punch list items before functional testing. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the control systems for the respective air- or water-related systems.
6. Functional tests: Conduct and document a functional test under the direction of the Commissioning Authority of the complete installed DDC control system. Functional testing is intended to begin upon completion of a system but may be conducted in phases or sections, as defined by the requirements of the Functional Test, or as approved by the Commissioning Authority. The DDC system, or applicable portions of the system, shall have completed pre-functional testing and be approved by the Commissioning Authority and Commissioning Supervisor before being used for other purposes, such as test and balance measurements, or in support of the functional testing of other systems.
 - a. Provide technicians and or knowledgeable programming personnel as required to conduct the required functional testing. Assist the Commissioning Authority in resolving issues found during the functional testing process.
 - b. Assist in the functional testing of equipment and systems by implementing trend logs and equipment monitoring as specified in the contract documents. The monitoring and data logging capabilities of the DDC system shall be available for use in the commissioning process. Assist the Commissioning Authority in the testing and documentation process by using the data logging and trending capability of the DDC system in monitoring the testing effort and recording the performance of systems and interpreting the monitoring data, as necessary.
 - c. The controls contractor shall coordinate with the University Facilities personnel and provide and set up a temporary testing operator station to allow full operator station interface with the system during the entire functional testing process. This temporary operator station shall provide all functions required of the system at the operator station, including real time graphic displays and report generation.

7. Correct deficiencies (differences between specified and observed performance) as interpreted by the Commissioning Authority and retest the equipment.

D. Seasonal Adjustment:

1. Assist the Commissioning Authority and Commissioning Supervisor with the seasonal adjustment process. During this effort the Commissioning Authority and Commissioning Supervisor will:
 - a. Check and verify the calibration of temperature control devices and thermostats.
 - b. Test and verify control sequences for proper operation for the season.
 - c. Where deficient operation or defective equipment is discovered, provide corrective measures as required by the warranty provisions specified herein.

END OF SECTION

**SECTION 23 0994
HVAC SEQUENCE OF OPERATION**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Listing of required monitor points.
- B. Sequence of operation for HVAC systems.
 - 1. Packaged Dedicated Outside Air Unit.

1.2 RELATED SECTIONS

- A. Section 23 0800 - HVAC Commissioning Requirements.
- B. Section 23 0913 - Instrumentation and Control Devices for HVAC.
- C. Section 23 0923 - Direct-Digital Control System for HVAC.
- D. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 SYSTEM DESCRIPTION

- A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits.
 - 2. Include written description of control sequence.
 - 3. Include flow diagrams for each control system, graphically depicting control logic.
- C. Review controls with and obtain approval of chiller manufacturer. Mark control diagrams "Approved" by chiller manufacturer.
- D. Review controls with and obtain approval of boiler manufacturer. Mark control diagrams "Approved" by boiler manufacturer.
- E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL

- A. All operators shall be in NORMAL position when each system is OFF.
- B. Provide smoke detector in supply air stream on all air systems over 2000 CFM. .
- C. Provide control power circuits to operate damper actuators in ductwork and dampers serving air handling systems.
- D. All temperatures are Fahrenheit.
- E. Sequences specified herein indicate the functional intent of the systems operation and may not fully detail every aspect of the programming that may be required to obtain the indicated operation. Contractor shall provide all programming necessary to obtain the sequences/system operation indicated.
- F. When an air handling unit is not in operation, control devices shall remain in their "off" positions. "Off" positions may differ from the "normal" (meaning failed) position. Except as specified otherwise, "off" and "normal" positions of control devices shall be as follows:
 - 1. Heating Coil Valves:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Open.
 - 2. Cooling Coil Valves:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.
 - 3. Outside Air Damper:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.
 - 4. Return Air Damper:
 - a. "Off" Position: Open.
 - b. "Normal" Position: Open.
 - 5. Exhaust/Relief Air Damper:
 - a. "Off" Position: Closed.
 - b. "Normal" Position: Closed.

6. Variable Frequency Drive:
 - a. "Off" Position: Off.
 - b. "Normal" Position: Off.

- G. Except as specified otherwise, throttling ranges, proportional bands, and cycle differentials shall be centered on the associated setpoint. All modulating feedback control loops shall include the capability of having proportional, integral, and derivative action. Unless the loop is specified "proportional only" or "P+I", Contractor shall apply appropriate elements of integral and derivative gain to each control loop which shall result in stable operation, minimum settling time, and shall maintain the primary variable within the specified maximum allowable variance.

- H. Where any sequence or occupancy schedule calls for more than one motorized unit to start simultaneously, the DDC System start commands shall be staggered by 5 second (adj.) intervals to minimize inrush current.

- I. Alarm messages specified throughout the sequences shall be assigned to discrete priority levels. Priority levels dictate the handling and destination of alarm reports.

- J. Wherever a value is indicated as adjustable (adj.), it shall be modifiable, with the proper password level, from the operator interface or via a function block menu. For these points, it is unacceptable to have to modify programming statements to change the setpoint.

- K. When a power failure is detected in any phase, the DDC System start commands shall be retracted immediately from all electrically powered units served by the failed power source. If the associated primary control panel (ACP) is powered by normal or emergency power, it may monitor its own power source as an indication of power status. If the ACP is powered by uninterruptable power supply (UPS), or if ACP is not capable of monitoring its own power for use in sequences, Contractor shall provide at least one voltage monitor (three phase when applicable). When the DDC System detects that power has been restored, all equipment for which the DDC System start command had been retracted shall be automatically restarted on staggered 5 second intervals to minimize inrush current. When loss of equipment status coincides with a power failure, system shall not alarm individual equipment failures. Instead, only a single alarm shall be enunciated as follows:
 1. **BUILDING POWER FAILURE:** Acknowledge alarm when power is restored.

- L. Where reset action is specified in a sequence of operation, but a reset schedule is not indicated on the drawings, the contractor shall determine a fixed reset schedule that shall result in stable operation and shall maintain the primary variable within the specified maximum allowable variance one of the following methods shall be employed. Obtain approval of reset schedule from the Design Professional. All parameters of reset schedule shall be adjustable without programming statement modifications.

- M. Wherever a value is indicated to be dependent on another value (i.e.: setpoint plus 5°F) the DDC System shall use that equation to determine the value. Simply providing a virtual point that the operator must set is unacceptable. In this case three virtual points shall be provided. One to store the parameter (5°F), one to store the setpoint, and one to store the value which is the result of the equation.

3.2 MONITOR POINTS

- A. Arrangement: Locate all control points for a system within one DDC panel within the mechanical equipment room containing the majority of the equipment for that system.
- B. Each DDC controller including associated input/output modules, shall be provided with a minimum of three spare input and output points of each type installed.
- C. Monitoring: In addition to the temperature, pressure, digital or flow sensor points required to implement the sequences of operation, the points provided shall include as a minimum:
- D. Temperatures:
 - 1. Outside air.
 - 2. Supply air : DOAS-1.

3.3 DEDICATED OUTSIDE AIR UNIT

- A. Sequences: DOAS-1
- B. Supply Fan Start-Stop:
 - 1. The DDC time of day programming shall provide a signal to start-stop the unit in accordance with the building occupied/unoccupied programmed schedules.
 - 2. The OA damper shall open when the unit is operating.
 - 3. The digital output relay stops the fan.
- C. Safety Controls to Stop Supply Fan:
 - 1. Normally closed fire alarm output relay.
- D. Supply Air Dehumidification/Temperature Control: Unit operates on built-in controls to cycle compressors, modulate hot gas reheat coil and stage electric heating coil to dehumidify the outside air and maintain supply air temperature at 56 degrees dewpoint (or less). At no time shall the supply dewpoint rise above 56 degrees F. The supply air DB temperature shall be controlled to maintain supply setpoint of 65 degrees F to 70 degrees F (adj.).

END OF SECTION

**SECTION 23 2300
REFRIGERANT PIPING**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 0719 - HVAC PIPING INSULATION.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2013.
- B. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- D. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2013.
- E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.
- F. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- G. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings.
- B. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.
- C. Provide hard drawn copper refrigerant piping where piping is exposed.
- D. Concealed refrigerant piping may be preinsulated soft copper line sets. Insulation shall comply with Section 230719.
- E. Provide pipe hangers and supports in accordance with ASME B31.5 unless indicated otherwise.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.

- B. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- C. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

1.6 QUALITY ASSURANCE

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers with dry nitrogen, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.1 PIPING

- A. Copper Tube: ASTM B 280, H58 hard drawn
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy;6% minimum silver content (typical:Dynaflow or silphos).
- B. Pipe Supports and Anchors:
 - 1. Conform to ASME B31.5.
 - 2. Upper attachments shall not attached to roof or floor decks. Upper attachments shall be attached to structural members
 - 3. Attachments to joists shall be from top chord only.
 - 4. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 - 5. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

PART 3 EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.

- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 3. Place hangers within 12 inches of each horizontal elbow.
 - 4. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 5. Provide copper plated hangers and supports for copper piping.
 - 6. Upper attachments:
 - a. Provide attachment to upper cord of bar joist or to flanges of steel beams. Attach with beam clamps or other listed devices for this purpose.
 - b. Do not support from roof deck.
 - c. Weights of 15 Lbs. or less may be supported from floor decks.
 - d. Unless otherwise noted, connect pipe supports to structural members only. Where structural members do not occur above piping, provide supports spanning between members. Supports shall be sized for weight to be supported.
- G. Arrange piping to return oil to compressor. Provide traps and loops in piping as recommended by manufacturer or as detailed. Slope horizontal piping 0.40 percent in direction of flow.
- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Flood piping system with nitrogen when brazing.

- J. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- K. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- L. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.
- C. Pressure test for 6 hours minimum duration.
- D. Vacuum test; 500 microns; 15 minutes minimum duration.
- E. Break vacuum with dry nitrogen and re-evacuate to 500 microns a second time.
- F. Break vacuum with dry nitrogen and re-evacuate to 500 microns a third time.
- G. Break vacuum with refrigerant charge.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Metal ductwork.
- B. Flexible Ducts.
- C. Ductwork Fabrication.

1.2 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 09 9123 - Interior Painting: Weld priming, paint or coating.
- C. Section 23 0510 - Mechanical General
- D. Section 23 0713 - DUCT INSULATION: External insulation and duct liner.
- E. Section 23 3300 - AIR DUCT ACCESSORIES.
- F. Section 23 3700 - AIR OUTLETS AND INLETS.
- G. Section 23 0593 - TESTING, ADJUSTING AND BALANCING FOR HVAC.

1.3 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2015b.
- C. ASTM A276/A276M - Standard Specification for Stainless Steel Bars and Shapes; 2016.
- D. ASTM A480/A480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip; 2015.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2015.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2015.
- G. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2014.
- H. ASTM C443M - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric); 2011.

- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.
- J. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association; 1985, First Edition.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- L. SMACNA Round Industrial Duct Construction Standards; 1999, 2nd Edition.
- M. SMACNA - Duct Cleanliness for New Construction Guidelines., 2000.
- N. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

1.4 DEFINITIONS

- A. Low Pressure Duct: Duct having Pressure Class of 2-inches or less.
- B. Medium or High pressure Duct: Duct having Pressure Class over 2-inches.

1.5 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data for :
 - 1. Flexible ducts.
 - 2. Duct take-off fittings.
 - 3. Manufactured metal ductwork and fittings.
 - 4. Transverse Duct Connection System.
- C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.
- D. Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

1.8 DELIVERY, STORAGE, AND PROTECTION(REFER TO DUCT CLEANLINESS LEVEL SPECIFIED IN INSTALLATION)

- A. Store in clean dry place and protect from weather and construction traffic.
- B. Exercise care during construction to prevent the accumulation of dust, dirt, and refuse in the supply and return ductwork.
- C. All openings shall be tightly closed with 8-mil polyethylene when work creating dust and debris is in progress.
- D. Exposed Spiral Duct in finished spaces:
 - 1. Accept products on site in protective wrapping. Inspect for damage.
 - 2. Protect surface and finish from damaged(dings), grease or other contaminants affecting duct finish.
 - 3. "Nested" shipment for exposed duct shall not be acceptable.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
- B. Provide Paint-Grip finish on exposed galvanized ducts for field painting.
- C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 316.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid, non-fibrated, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. VOC Content: Not more than 50g/L, excluding water.
 - 3. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E84.
 - 4. Products:
 - a. Manufacturers (water based): Ductmate Proseal, Hardcast IronGrip 601, Marathon 460, Foster 32-19; Childers CP-146; DuroDyne SAS.

- E. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCTWORK FABRICATION

- A. General: Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- C. All dimensions are net inside metal measurements in inches unless otherwise shown.
- D. Duct sizes shown include allowance for liner thickness unless otherwise noted, except sizes shown for lined double-wall round spiral and double-wall rectangular duct are sizes of perforated inner liner.
- E. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
- F. Low Pressure Duct- Supply, Return, and Exhaust (2" Class or less):
 - 1. Longitudinal Seams:
 - a. Corner Seams: Fig. 2-2, Type L1 (Pittsburgh Lock).
 - 1) Corner seams for ducts less than 18 inch, L-2 (Button Punch Snap Lock) is acceptable.
 - b. Fig. 2-2, Type L-3 for seams other than corner.
 - 2. Transitions:
 - a. Changes in duct sizes shall be made by transitions.
 - b. Refer to Fig. 4-7, CONCENTRIC TRANSITION, unless otherwise noted.
 - c. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - d. Transitions shall be provided between equipment and duct where sizes are not the same.
 - 3. Rectangular Duct:
 - a. Elbows:
 - 1) Mitered with turning vanes. Type RE 2, Figure 4-2, unless otherwise noted.
 - b. Turning Vanes:

- 1) Turning vanes shall be in accordance with Figs 4-3 and 4-4, unless otherwise noted.
- 2) Provide single wall vanes for ducts 18" width or less.
- 3) Provide double wall vanes for ducts over 18" width.
- c. Splits and Tees:
 - 1) Fig. 4-5, Type 1, Type 2 (with stationary splitter), 4A, or 4B only.
 - 2) Use of Square Throat Elbow with Turning Vanes is acceptable, unless otherwise noted.
 - (a) Provide volume control damper in each branch.
 - 3) Omit volume control damper in Return and Exhaust duct unless otherwise noted.
- d. Where acoustical lining is indicated, provide acoustical turning vanes of perforated metal with glass fiber insulation.
4. Round Duct Manufactured Spiral Duct:
 - a. Elbows: Radius elbow with radius not less than 1-1/2 times width of duct on centerline.
5. Branch and Runout Connections:
 - a. Entry fittings for Return and Exhaust: Construct for a 45 degree entry angle to ease the turbulence created by converging airstreams. Increase the minimum length shown in Fig. 4-6, 45 DEGREE ENTRY, from 4 inch to 6 inch.
 - b. Rectangular Branch or Runout from Rectangular Duct:
 - 1) Fig. 4-6, 45 DEGREE ENTRY, with flange and gasket for connection to trunk with a minimum of six screws.
 - c. Round Branch or Runout from Rectangular Duct:
 - 1) Fig. 4-6, 45 DEGREE LEAD IN, with flange and gasket for connection to trunk with a minimum of six screws.
 - 2) Provide volume control damper with locking quadrant at branch or runout connection unless over inaccessible ceiling (Refer to Grille Schedule on Drawings for neck mounted volume dampers).
 - d. Round Branch or Runout from Round Duct:
 - 1) Fig. 3-5, 45 DEGREE ENTRY TEE fitting with oval to round tap.
 - 2) Fig. 3-6, CONICAL TEE fitting.

- e. Rectangular Runout to Sidewall Grille/Register:
 - 1) Fig. 4-6, 45 DEGREE ENTRY, with flange and gasket for connection to trunk with a minimum of six screws.
- 6. Offsets: Fig. 4-7, Type 1 and Type 3 only, unless otherwise indicated.
- 7. Dampers: Fig. 7-4, SINGLE BLADE TYPE, or 7-5, MULTIBLADE TYPE.
- 8. Reinforcement:
 - a. Tie Rod Reinforcement is NOT acceptable.
- G. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- H. Ducts Connecting to Wall Louvers:
 - 1. Provide sheet metal plenum sealing louver area and connecting duct.
 - 2. Fabricate in accordance with Fig. 6-1.
 - 3. Fabricate plenum using same material and pressure class as connecting duct.
 - 4. Paint exterior side of plenum flat black.

2.3 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Flexible Ducts: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound spring steel wire.
 - 1. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 2. Insulation thickness shall be 1 inch thick, minimum; 3/4 lbs./cu ft, minimum.
 - 3. Maximum Velocity: 4000 fpm.
 - 4. Temperature Range: -20 degrees F to 210 degrees F.
 - 5. Manufacturers:
 - a. Atco Rubber Products, Inc; Model UPC-037: www.atcoflex.com.
 - b. Flexible Technologies Group-Thermafex, Inc; Model M-KE: www.thermafex.net
 - c. Flexmaster USA; Model Type 3M: www.flexmasterusa.com.
 - d. Wiremold, Inc; Model WK: www.wiremold.com.

- C. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Duct sizes for lined duct are net metal and include allowance for liner. For unlined duct, sizes are inside clear dimensions.
- E. Duct sizes for runouts to Air Terminals and grilles, registers and diffusers shall match the size of the device unless otherwise noted.
- F. Duct Cleanliness level: Intermediate Level in accordance with SMACNA Duct Cleanliness for New Construction Guidelines.
- G. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Seal all transverse joints in metal new supply, exhaust and return ducts.
 - 1. Class A seal for pressure class 4 in. wg and higher.
- K. Supply duct run-out to inlet of terminal unit shall be the same size as the terminal unit connection unless indicated otherwise on the Drawings.
- L. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- M. Connect diffusers to concealed low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with metal strap or clamp.
- N. Secure flexible ducts to metal ducts with draw bands. and metal strap or clamp.
- O. Patch Plates/ Duct Cap: Provide where openings in existing ducts are closed. Plate shall be same material as duct being patched and one gauge heavier than scheduled for the duct size and pressure class at the patched location. Secure with sheet metal screws 6 inches maximum on center with a minimum of two screws for each side.

- P. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

3.2 SCHEDULES

A. Ductwork Material:

1. Low Pressure Supply: Galvanized Steel.
2. Return and Relief: Galvanized Steel.
3. Outside Air Intake: Galvanized Steel.
4. Louver Plenums: Galvanized Steel.

B. Ductwork Pressure Class:

1. Supply System: 2 inch.
2. Outside Air Intake: 2 inch negative.

END OF SECTION

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct access doors.
- B. Fire dampers.
- C. Flexible duct connections.
- D. Volume control dampers.

1.2 RELATED REQUIREMENTS

- A. Section 23 3100 - d HVAC DUCTS AND CASINGS.
- B. Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2015.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.
- C. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- D. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Provide instructions for fire dampers.
- D. Maintenance Materials: Furnish the following for the Owner's use in maintenance of project.
 - 1. Extra Fusible Links: One of each type and size.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.1 DUCT ACCESS DOORS(AP)

- A. Manufacturer: Cesco Model *AD.
- B. Other acceptable manufacturers offering equivalent products: Airstream, Flexmaster Inspector Series, Nailor Industries Model 0800, National Controlled Air ADR, Prefco, Ruskin, Ventlok, Pottorff.
- C. Fabrication:
 - 1. Factory fabricated in accordance with SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible, Figures 7-2, 7-3 and as indicated.
 - 2. Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices.
 - 3. Install minimum 1 inch thick insulation with sheet metal cover for insulated ducts.
 - 4. Access doors up to 2 inch pressure class:
 - a. Less Than 12 inches Square: Secure with sash locks.
 - b. Up to 18 inches Square: Provide two hinges and two sash locks.
 - c. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
 - d. Larger Sizes: Provide an additional hinge.
 - 5. Fabricate access doors over 2 inch pressure class in accordance with Figure 7-2.
- D. Access doors with sheet metal screw fasteners are not acceptable.

2.2 FIRE DAMPERS(FD)

- A. Manufacturer: Ruskin.
- B. Other acceptable manufacturers offering equivalent products: Advanced Air, Inc., Air Balance, Air Control Products, Airstream, American Warming and Ventilating, Cesco, Greenheck, Louvers and Dampers, Nailor Industries, National Controlled Air, Pacific Air Products, Phillips, Safe-Aire, Shipman, United, Ventco, Pottorff.
- C. Fabricate in accordance with NFPA 90A and UL 555 for dynamic systems, and as indicated.
- D. Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations.
- E. Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.

- F. Dampers shall be Type 'A' with breakaway connections, same size as duct unless otherwise noted. Net damper opening of low resistance type 'B' dampers in retracted position shall not be less than 90% of cross sectional area of attached duct.
- G. Dampers in medium pressure ducts shall be Type 'C' with non-breakaway connections and sleeve gauge listed for application .
- H. Multiple Fire Damper Assemblies (Vertical Installations; Allowed Only for Sizes Exceeding 48 inches in Length or Width): Fire dampers assembled together to form protection for a single opening shall be provided with steel mullion(s) meeting the requirements of UL 555 Standard for Safety Fire Dampers and Ceiling Dampers.

2.3 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible, Figures 7-8 and 7-9, and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
- C. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
 - 1. Net Fabric Width: Approximately 2 inches wide.
 - 2. Metal: 3 inches wide, 24 gage, 0.0239 inch thick galvanized steel.

2.4 VOLUME CONTROL DAMPERS (MVD).

- A. Manufacturer: Ruskin MD35.
- B. Other acceptable manufacturers offering equivalent products: Airstream, Arrow, Greenheck, Nailor Industries, National Controlled Air, Prefco, Pottorff.
- C. Single Blade Dampers: Figure 7-4. Fabricate for duct sizes up to 6 x 30 inch.
- D. Multi-Blade Damper: Figure 7-5. Fabricate of opposed blade pattern with maximum blade sizes 8 x 48 inch long. Assemble center and edge crimped blades in galvanized channel frame with suitable hardware; 16 gauge, minimum, steel channel frame with blade stops top and bottom; 16 gauge steel blades with formed edge groove to have 3/8 inch interlock between adjacent blades, with 1/2 inch diameter cadmium plated shaft extended 6 inches beyond frame and blade linkage.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings.
- F. Quadrants:
 - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Duct Access Doors:
 - 1. Provide duct access doors for inspection and cleaning before fire dampers and elsewhere as indicated for service access or cleaning access.
 - 2. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.
- C. Label access doors as required by NFPA 90A.
- D. Provide fire dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Demonstrate re-setting of fire dampers to the Owner's representative.
- F. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Refer to Section 23 0548.
 - 1. Do not install on air handling units with factory flexible connections on fan.
- G. Volume Control Dampers:
 - 1. Install where shown on drawings or required by details.
 - 2. Lock all volume control dampers in the full open position for adjustment by the TAB agency.

END OF SECTION

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Registers/grilles
- B. Louvers

1.2 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.1 NARROW BLADE WALL EXHAUST AND RETURN REGISTERS/GRILLES(NBW)

- A. Manufacturer: Titus Model 1700L.
- B. Other acceptable manufacturers offering equivalent products:
 - 1. Anemostat 2250.
 - 2. Carnes 6700.
 - 3. Price 42CD.
 - 4. Krueger AL5815-FR820.
 - 5. MetalAire 42CD.
 - 6. Tuttle & Bailey GHA.
- C. Type: Streamlined narrow blade core with fixed blades in removable core, 3/4 inch minimum depth, 5/16 inch maximum blade spacing, with device to set cores in one of four air pattern deflections, horizontal face. Model Numbers listed are for supply registers. Return grilles/registers shall have matching core without indents.
- D. Frame: 1 inch ,minimum, margin with countersunk screw mounting.
- E. Fabrication: Steel frames and blades, with factory finish as scheduled on Drawings.
- F. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where scheduled.

2.2 LOUVERS-ALUMINUM-DRAINABLE BLADE STYLE

- A. Manufacturer: Ruskin Model ELF-6375DX.

- B. Other acceptable manufacturers offering equivalent products:
 - 1. American Warming & Ventilating LE-33.
 - 2. Air Balance .
 - 3. Arrow EA-615-D.
 - 4. Dowco DW-6.
 - 5. Greenheck ESD-603.
 - 6. Industrial Louvers 653.
 - 7. Louvers & Dampers IEL-6.
 - 8. Shipman LE-33.
 - 9. Tuttle & Bailey DB-645.
- C. Type: 6 inch deep with blades on 45 degree slope, drainable blade with gutter, heavy channel frame, 19 gauge birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.
- D. Fabrication: 12 gage thick extruded aluminum, welded assembly, with factory baked enamel finish color to be selected.
- E. Mullions: Provide hidden or exposed mullions to support blades as shown on architectural elevations.
- F. Mounting: Furnish with masonry strap anchors for installation.

PART 3 EXECUTION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

3.2 AIR OUTLET AND INLET SCHEDULE

- A. Refer to Schedule on Drawings.

END OF SECTION

**SECTION 23 4000
HVAC AIR CLEANING DEVICES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disposable, extended area panel filters.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General HVAC Requirements - Space Conditioning during construction and building flushout.
- B. Section 23 0519 - Gages and Meters - Filter Gages.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2012, with 2015 amendments.
- B. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.
- C. Maintenance Materials: Furnish the following for the Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Provide filters whenever any system is operated during construction. Refer to Section 23 0510.
 - 3. For every system requiring filters;
 - a. Provide and install one set of new disposable panel filters at Material Completion.
 - b. Provide one set of spare disposable panel filters at Material Completion.

PART 2 PRODUCTS

2.1 DISPOSABLE, EXTENDED AREA PANEL FILTERS(EAPF)

- A. Manufacturers: American Air Filter AM-AIR, Air Guard, CamFil-Farr 30/30,Purolator.
- B. Media: UL 900 Class 2, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
 - 1. Frame: Cardboard.

2. Nominal size: 24 x 24 inches.
 3. Nominal thickness: 2 inches.
- C. Minimum Efficiency Reporting Value (MERV): 8, when tested in accordance with ASHRAE Std 52.2.
 - D. Initial resistance at 500 FPM face velocity: 0.20 inch WG.
 - E. Recommended final resistance: 0.9 inch WG.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

3.2 SCHEDULES

- A. Provide filter media for Packaged Dedicated OA Unit specified in section 23 7425.

END OF SECTION

**SECTION 23 7425
PACKAGED DEDICATED OUTSIDE AIR UNITS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Split System Dedicated Outside Air System - Indoor Unit
- B. Air Cooled Condenser.
- C. Unit Controls.

1.2 RELATED REQUIREMENTS

- A. Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B. Section 23 0913 - Instrumentation and Control Devices for HVAC
- C. Section 23 0994 - HVAC Sequence of Operation
- D. Section 23 3100 - HVAC Ducts and Casings
- E. Section 23 4000 - HVAC Air Cleaning Devices: Filters.
- F. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air Conditioning and Air-Source Heat Pump Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- B. AHRI 270 - Sound Rating of Outdoor Unitary Equipment; Air-Conditioning, Heating, and Refrigeration Institute; 2008.
- C. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; Air-Conditioning, Heating, and Refrigeration Institute; 2004.
- D. ASHRAE Std 23 - Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2005.
- E. ASHRAE Std 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2007. (ANSI/ASHRAE/IESNA Std 90.1).
- F. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2009, Revision 1 - 2010.
- G. NFPA 70 - National Electrical Code; National Fire Protection Association ; 2020.

1.4 SUBMITTALS

- A. Refer to Section 23 0510 - General Mechanical Requirements for submittal procedures.

- B. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, gas piping service and connection requirements, and duct connections.
- C. Controls Data:
 - 1. The control submittal is to include schematic control drawings showing the configuration of new units, the location of all sensors, monitoring inputs, and controlled devices and any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - 2. Sequences of Operation: Include a narrative of the system operation, and the sequences of operation for packaged controlled equipment, and what points are control points and are adjustable.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements and include start-up instructions.
- E. Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data and parts listing.
- F. Warranty: Submit manufacturer's warranty and ensure that all forms have been filled out in the Owner's name and registered with the manufacturer.
- G. Certificate: Provide Manufacturer's Certificate in accordance with the requirements of the General Conditions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND PROTECTION

- A. Protect units from physical damage by storing until concrete support pad is in place and ready for immediate installation.
- B. Store unit under cover and elevated above grade.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Provide five-year manufacturer warranty to include coverage for refrigeration compressors.

1.8 EXTRA MATERIALS

- A. Provide one set of disposable panel filters at Material Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Layout Basis: United Cool Air.
- B. Other Acceptable Manufacturers:
 - 1. Aaon, Inc.
 - 2. Venmar.

2.2 DESCRIPTION

- A. Split System, single zone outside air unit, assembled in a housing and suspended with horizontal discharge duct arrangement with the following:
 - 1. Centrifugal blower fan section.
 - 2. DX cooling/dehumidification coil.
 - 3. Hot gas reheat coil.
 - 4. Electric heat coil.
 - 5. Filter section.
 - 6. Air intake section.
 - 7. Compressor section.
 - 8. Refrigeration and temperature controls.
- B. Air Cooled Condenser.
- C. Units shall have Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than prescribed by ASHRAE Std 90.1.

2.3 FABRICATION

- A. Inside unit shall be completely factory assembled, piped and wired and shipped in one section.
- B. Cabinets shall be double wall construction of G90 galvanized steel with the exterior constructed of min. 22 gauge, interior panels of minimum 22 gauge.
- C. Cabinet shall be entirely double-wall construction with foam injected or fiberglass insulation, minimum 2-in. thick panels. There shall be no exposed insulation in the airstream.
- D. Unit specific color coded wiring diagrams shall match the unit color coded wiring and will be provided in both point-to-point and ladder form.
- E. Diagrams shall also be laminated in plastic and permanently affixed inside the control compartment.

- F. Access to filters, fans, coils, heating section, and other items needing periodic checking or maintenance shall be through access panels.
- G. All access doors shall be double wall insulated similar to cabinet wall construction.
- H. Unit shall have decals and tags to indicate unit lifting and rigging, service areas and caution areas. Installation and maintenance manuals shall be supplied with each unit.

2.4 SUPPLY FANS:

- A. Type: V-Belt driven with permanently lubricated bearings, double width, double inlet, forward curved centrifugal fan.
- B. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
- C. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- D. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Provide access to fan sections through access panels
- E. Blowers, drives and motors shall be dynamically balanced.
- F. Provide a factory installed variable frequency drive (VFD).
- G. Motors shall be thermally protected and premium efficiency.

2.5 FILTERS:

- A. Supply Air: EAPF - 2" thick fiberglass pleated, MERV-8.

2.6 EVAPORATOR COIL AND HOT GAS REHEAT COIL:

- A. Coils shall be copper tube with aluminum fins mechanically bonded to the tubes.
- B. Coils shall have galvanized end casings.
- C. Coils shall have equalizing type vertical tube headers.
- D. Coils shall be furnished with a thermostatic expansion valve.
- E. Coils shall be furnished with a double sloped stainless steel drain pan for the positive drainage of condensate.
- F. Provide minimum of 6-in. separation between the evaporator coil and HGR coil.
- G. Electro-Coil Coating: Evaporator finned tubed coil shall be protected with a flexible cationic epoxy electrocoat uniformly applied to all coil surface areas without material bridging between fins.

2.7 REFRIGERATION SYSTEM:

- A. Compressors shall be hermetic digital scroll type with internal thermal overload protection and mounted on the compressor manufacturer's recommended rubber vibration isolators. Each compressor shall have independent refrigerant circuits.
- B. System shall be equipped with thermostatic expansion valve type refrigerant flow control, located at air handling unit.
- C. System shall be equipped with head pressure control, and automatic reset low pressure and manual reset high-pressure refrigerant controls.
- D. Unit shall be equipped with Schrader type service fittings on both the high side and low-pressure sides of the system.
- E. Unit shall be equipped with refrigerant liquid line driers.
- F. Unit shall have holding charge of refrigerant, R-410A.
- G. The following features shall be provided:
 - 1. Each compressor shall be individually staged for capacity control.
 - 2. All circuits shall be equipped with liquid line sight glasses.
 - 3. Unit shall be provided with a hot gas reheat coil with modulating hot gas reheat control valve.
 - 4. Unit shall be equipped with a 5 minute anti-short cycle delay timer for each stage.
 - 5. Each compressor shall be equipped with suction and discharge service valves.

2.8 ELECTRIC HEAT SECTION:

- A. Unit shall include an electric heating section complete with fuses, and a resettable high temperature limit switch with capacity as scheduled.
- B. Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in terminal block mounted in a heater control box with integral fusing, control circuit transformer and fuse, airflow proving device, and toggle switch (pilot duty). Provide SCR heater controller.

2.9 OUTDOOR AIR COOLED CONDENSER

- A. Cabinet shall be unpainted and constructed of galvanized steel.
- B. The condenser coil shall be configured for draw-thru airflow for uniform air distribution across the coil face. Coil shall be made with continuous plate type aluminum fin with copper tubes. All coils shall be factory leak checked under pressure.
- C. Corrosion protection: Provide electro-coil coating on condenser coil.
- D. Condenser fans shall be incorporate fully drawn fan venturi with vertical air discharge.

- E. Fan motor shall be totally enclosed (TEFC) type.

2.10 OPERATING CONTROLS

- A. General: Unit control system shall be a factory-supplied, direct digital electronic integrated system with equipment manufacturer solely responsible.
- B. Automatic control and monitoring and system using factory installed programmable micro-processor based units installed in the air unit.
- C. Provide BACnet interface for connection to BAS.
- D. Locate controls in a NEMA ICS 6 weatherproof steel control cabinet separated from power wiring and other components. Provide an LED or LCD display indicating the status of all serial communication, error messages, power status, and all digital output and analog input points.
- E. Provide control systems consisting of sensors, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems and to perform functions specified.
- F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- G. Unit Start-Stop: Interlock to operate when range exhaust fan is ON.
- H. Supply Air Dehumidification/Temperature Control: Unit operates on built-in controls to cycle compressors, modulate hot gas reheat coil and stage electric heater to dehumidify the outside air and maintain space temperature setpoint. At no time shall supply dewpoint rise above 56°F.
- I. Built-In Controls: Additional built-in controls shall include power phase/voltage protection, smoke detector, surge capacitor, safety controls, control transformer, and contact for fire alarm relay shutdown.

2.11 POWER WIRING

- A. Provide electrical access for both main power and control power connections.
- B. Provide factory wired units with a single point of electrical connection.
- C. Provide across-the-line starter, non-recycling compressor overload, starter relay for each compressor. Provide manual reset current overload protection.
- D. Provide starter relay for each condenser fan and motor with built-in overload protection
- E. Provide a surge capacitor in starter cabinet for protection from power surges due to lightning and switching transients.
- F. Ground shall be #6 A.W.G. Provide separate driven ground for grade mounted units.
- G. Provide motor protector.
- H. Control Power Transformers: 120 volt secondary. 45 VA minimum. Provide fused primary, secondary, and bond unfused leg of secondary to enclosure.

- I. Disconnect Switch: Factory mount disconnect switch on power cabinet. Switch shall be accessible without the use of tools.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that area on site is ready for installation of unit for mounting on a concrete pad.
- B. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 90A.
- C. Route copper evaporator condensate piping, full size, thru trap as detailed on Drawings to drywell. Refer to mechanical floorplan drawings.
- D. Provide level concrete pad for air cooled condenser as indicated.
- E. Auxiliary Drain Pan: Provide 22 gauge, G90 galvanized steel, auxiliary drain pan, 2 inches deep and extending beyond unit 3 inches on all sides, on units in locations other than in mechanical equipment rooms located on grade with floor drains. Mount factory condensate overflow switch in auxiliary drain pan and wire to unit.
- F. Install flexible connections specified in Section 23 3300 between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and unit while running.
- G. Electric Duct Coils: Wire in accordance with NFPA 70. Refer to Section 26 2717.
- H. Check and verify location of thermostats with plans and room details before construction of wall assemblies. Locate between 42 to 48 inches above finished floor. Mount at common elevation within same space. Align with lighting switches [<>].

3.3 STARTING EQUIPMENT

- A. Provide manufacturer's field representative to prepare and start equipment.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Provide start-up certificate in accordance with the General Conditions.

3.4 CLOSEOUT ACTIVITIES

- A. Refer to Section 23 0510 - Demonstration, Training and Instructions for additional requirements.
- B. Demonstrate proper operation and maintenance of equipment to the Owner's designated representatives.

- C. Provide the services of the manufacturer's field representative to conduct training.

3.5 SCHEDULES

- A. Capacities shall not be less than scheduled at 95 F ODT.
- B. Total cooling and heating capacities shown are the minimum.
- C. Refer to the Schedule on Project Drawings.

END OF SECTION

**SECTION 23 8129
VARIABLE REFRIGERANT FLOW HVAC SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Variable refrigerant volume HVAC system includes:
 - 1. Outdoor/condensing unit(s).
 - 2. Indoor/evaporator units.
 - 3. Refrigerant piping.
 - 4. Control panels.
 - 5. Control wiring.

1.2 RELATED REQUIREMENTS

- A. Section 23 2300 - REFRIGERANT PIPING: Additional requirements for refrigerant piping system.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code; 2020 Edition.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings shown in the contract documents:
 - 1. Outdoor/Central Units:
 - a. Refrigerant Type and Size of Charge.
 - b. Cooling Capacity: Btu/h.
 - c. Heating Capacity: Btu/h.
 - d. Cooling Input Power: Btu/h.
 - e. Heating Input Power: Btu/h.
 - f. Operating Temperature Range, Cooling and Heating.
 - g. Air Flow: Cubic feet per minute.
 - h. Fan Curves.

- i. External Static Pressure (ESP): Inches WG.
 - j. Sound Pressure Level: dB(A).
 - k. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).
 - 3) Maximum Starting Current (MSC).
 - 4) Full Load Amps (FLA).
 - 5) Total Over Current Amps (TOCA).
 - 6) Fan Motor: HP.
 - l. Weight and Dimensions.
 - m. Maximum number of indoor units that can be served.
 - n. Maximum refrigerant piping run from outdoor/condenser unit to indoor/evaporator unit.
 - o. Maximum height difference between outdoor/condenser unit to indoor/evaporator unit, both above and below.
 - p. Control Options.
2. Indoor/Evaporator Units:
- a. Cooling Capacity: Btu/h.
 - b. Heating Capacity: Btu/h.
 - c. Cooling Input Power: Btu/h.
 - d. Heating Input Power: Btu/h.
 - e. Air Flow: Cubic feet per minute.
 - f. Fan Curves.
 - g. External Static Pressure (ESP): Inches WG.
 - h. Sound Pressure level: dB(A).
 - i. Electrical Data:
 - 1) Maximum Circuit Amps (MCA).
 - 2) Maximum Fuse Amps (MFA).
 - 3) Maximum Starting Current (MSC).

- 4) Full Load Amps (FLA).
- 5) Total Over Current Amps (TOCA).
- 6) Fan Motor: HP.
- j. Maximum Lift of Built-in Condensate Pump.
- k. Weight and Dimensions.
- l. Control Options.
3. Control Panels: Complete description of options, control points, zones/groups.
- C. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
 1. Detailed piping diagrams, with branch balancing devices.
 2. Condensate piping routing, size, and pump connections.
 3. Detailed power wiring diagrams.
 4. Detailed control wiring diagrams.
 5. Locations of required access through fixed construction.
 6. Drawings required by manufacturer.
- D. Operating and Maintenance Data:
 1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 3. Identification of replaceable parts and local source of supply.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
 2. Company that provides system design software to installers.
- B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.7 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it shall be repaired or replaced at the discretion of Daikin AC (Americas), Inc. according to Daikin's terms and conditions. All warranty service work shall be preformed by a Daikin factory trained service professional.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Toshiba/Carrier.
- B. Other Manufacturers: Daikin, Hitachi, Trane.

2.2 HVAC SYSTEM DESIGN

- A. System Operation: Heating or cooling, selected at system level.
 - 1. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
 - 2. Conditioned spaces are shown on drawings.
 - 3. Required equipment unit capacities are shown on the drawings.
 - 4. Refrigerant piping sizes are not shown on drawings.
 - 5. Connect equipment to condensate piping provided by others; condensate piping is shown on drawings.
- B. Energy Design Wind Speed: 25 mph.
- C. Operating Temperature Ranges:
 - 1. Cooling Mode Operating Range: 23 degrees F to 110 degrees F dry bulb.
- D. Refrigerant Piping Lengths: Provide equipment capable of serving system with following piping lengths without any oil traps:
 - 1. Minimum Piping Length from Outdoor/Central Unit(s) to Furthest Terminal Unit: 540 feet, actual; 620 feet, equivalent.
 - 2. Total Combined Liquid Line Length: 3280 feet, minimum.

3. Minimum Piping Length Between Indoor Units: 49 feet.

E. Control Wiring Lengths:

1. Between Outdoor/Condenser Unit and Indoor/Evaporator Unit: 6,665 feet, minimum.
2. Between Outdoor/Condenser Unit and Central Controller: 3,330 feet, minimum.
3. Between Indoor/Evaporator Unit and Remote Controller: 1,665 feet.

F. Controls: Provide the following control interfaces:

2.3 EQUIPMENT

A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.

1. Refrigerant: R-410A.
2. Performance Certification: AHRI Certified; www.ahrinet.org.
3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL, listed in ITS (DIR), and bearing the certification label.
4. Provide outdoor/condensing units capable of serving indoor unit capacity up to 200 percent of the capacity of the outdoor/condensing unit.
5. Provide units capable of serving the zones indicated.
6. Thermal Performance: Provide heating and cooling capacity as indicated, based on the following nominal operating conditions:
7. Energy Efficiency: Report EER and COP based on tests conducted at "full load" in accordance with AHRI 210/240 or alternate test method approved by U.S. Department of Energy.

B. Electrical Characteristics:

1. Power - Indoor Units: 208 to 230 Volts, single phase, 60 Hz.
2. 208-230 Voltage Range: 187 to 253 volts.

C. Refrigerant Piping:

1. Insulate each refrigerant line individually between the condensing and indoor units.

2.4 OUTDOOR/CONDENSING UNITS

A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.

1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.

2. Refrigerant: Factory charged.
 3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
 4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
 5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
 6. Sound Pressure Level: As specified, measured at 3 feet from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
 7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
 8. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
 9. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
 10. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
 11. Controls: Provide contacts for electrical demand shedding.
- B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
1. Designed to allow side-by-side installation with minimum spacing.
- C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
1. Provide minimum of 2 fans for each condensing unit.
 2. External Static Pressure: Factory set at 0.12 in WG, minimum.
 3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG, minimum; provide for mounting of field-installed ducts.
 4. Fan Airflow: As indicated for specific equipment.
 5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.

- D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.
- E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
 - 1. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours.
 - 2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
 - 3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
 - 4. Provide oil separators and intelligent oil management system.
 - 5. Provide spring mounted vibration isolators.

2.5 INDOOR/EVAPORATOR UNITS

- A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
 - 1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
 - 2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
 - 3. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
 - a. Provide thermistor on liquid and gas lines.
 - 4. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
 - 5. Return Air Filter: Washable long-life net filter with mildew proof resin, unless otherwise indicated.
 - 6. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
 - 7. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.2 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform system startup.
- B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- C. Adjust equipment for proper operation within manufacturer's published tolerances.
- D. Provide start-up certificate in accordance with the General Conditions.

END OF SECTION

**SECTION 23 8130
DUCTLESS SPLIT SYSTEM AIR CONDITIONERS(DAC-* & DCU-*)**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior Unit.
- B. Exterior Unit.
- C. Controls.

1.2 RELATED SECTIONS

- A. Section 23 0510 - General HVAC Requirements - Warranty.
- B. Section 23 0513 - Motors for HVAC Equipment: Evaporator and condenser fan motors.
- C. Section 23 2300 - Refrigerant Piping and Specialties.

1.3 SUBMITTALS

- A. Refer to Section 23 0510 - General HVAC Requirements for submittal procedures.
- B. Product Data: Provide data for manufactured products and assemblies. Indicate water, drain, thermostatic valves, and electrical rough-in connections with electrical characteristics and connection requirements.
- C. Refrigerant Piping: Obtain manufacturer's recommendations for piping and piping appurtenances for the equipment supplied and incorporated into the refrigerant piping specified in Section 23 2300.
- D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in the Owner's name and registered with manufacturer.

1.4 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. See Section 23 0510 - General HVAC Requirements, for additional Warranty requirements.
- C. Provide a five year warranty to include coverage for compressor including materials only.

1.5 EXTRA MATERIALS

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Vertiv Leibert SRC.

- B. Carrier.
- C. Daikin.
- D. Hitachi.
- E. Johnson Controls.
- F. Mitsubishi .

2.2 AIR CONDITIONING UNITS

- A. Description: Packaged, ductless split air conditioning system consisting of interior evaporator with a variable speed inverter driven compressor located in a remote condensing unit. The system shall consist of a single phase outdoor condensing unit, a matched capacity indoor evaporator unit, and a wired wall-mounted controller.

2.3 INTERIOR UNIT

- A. Cabinet
 - 1. Cabinet shall be manufactured of high strength molded thermoplastic polymer and high impact polystyrene with smooth finish with access to filter through front panel.
- B. Evaporator fan
 - 1. Fan: Direct drive fan assembly with multi-speed motor.
 - 2. Motor: high efficiency, with permanently lubricated bearings.
- C. Evaporator coil
 - 1. Direct expansion coiling coil of seamless copper tubes expanded into aluminum fins.
- D. Air filters
 - 1. Half-inch thick, aluminum, washable filter with service access from the front of the evaporator cabinet.

2.4 EXTERIOR UNIT

- A. Casing
 - 1. House components in galvanized steel panels with weather resistant, baked enamel finish.
 - 2. Mount contactors and controls in weatherproof panel provided with full opening access doors.
 - 3. Provide removable access doors or panels with quick fasteners .
 - 4. Wind Baffle: 20 gauge painted sheet metal.
- B. Compressor

1. Compressor: twin-rotor rotary compressor with variable speed inverter.

C. Condenser coils

1. Coils: Aluminum fins mechanically bonded to seamless copper tubing or all aluminum fins and tube. Air test under water to 600 psig, and vacuum dehydrate. Seal with holding charge of refrigerant.
2. Coil Guard: Louvered or PVC coat steel wire .

D. Fans and motors

1. Direct driven propeller type condenser fans with fan guard on discharge.
2. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor with permanent lubricated ball bearings and built in thermal overload protection.

E. Refrigerant: Charge with R-410A.

F. Refrigerant circuit

1. For each refrigerant circuit, provide:
 - a. Suction accumulator.
 - b. Suction and liquid line service valves and gage ports.
 - c. Charging valve.
 - d. Condenser pressure relief mechanism.
 - e. Electronic thermal expansion valve.

G. Controls

1. Factory wired with single point power connection.
2. Factory wired controls shall include contactor, high and low pressure cutouts, internal winding thermostat for compressor, control circuit transformer, non-cycling reset relay.
3. Provide a surge capacitor and lightning arrestor in unit cabinet for protection from power surges due to lightning and switching transients.
4. Provide controls to permit operation down to 0 degrees F ambient temperature to include:
 - a. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
 - b. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.

2.5 CONDENSATE PUMP

- A. Manufacturer: Little Giant EC-400

- B. Field installed, fully automatic, two-piece condensate pump with self-priming pump and separate reservoir.
- C. Pump:
 - 1. Self-priming
 - 2. Automatic start/stop and overflow detection.
 - 3. Thermally protected motor.
- D. Reservoir:
 - 1. Float-sensor

2.6 CONTROLS

- A. Factory wired, microprocessor-based control system.
- B. Wall mounted remote controller:
 - 1. LCD display with built-in weekly schedule with multiple event settings per day.
 - 2. Incorporate the following:
 - a. Setpoint/program control
 - b. Temperature setpoint adjustment
 - c. Fan speed selection
 - d. Unit operation mode.
 - e. Temperature display shall be in Fahrenheit or Celsius.
- C. Unit Controls:
 - 1. Short cycle protection.
 - 2. System auto restart: system shall provide automatic restart with programmable time delay up start up after power failure.
 - 3. Alarms: Control system shall monitor unit operation and activate a visual alarm in the event of any factory preset alarm conditions.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
- B. Verify that proper power supply is available and in correct location.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide level housekeeping pad or base as indicated.
- C. Pipe refrigerant piping from interior unit to exterior unit; refer to section 23 2300.
- D. Check and verify location of wired remote controller with plans and room details before construction of wall assemblies. Locate between 42 to 48 inches above finished floor.
- E. Infrastructure for connection to building data network provided under Div 26. Coordinate with IT Staff for IP addresses and access to network.

3.3 STARTING EQUIPMENT

- A. Provide manufacturer's field representative to prepare and start equipment.
- B. Adjust for proper operation within manufacturer's published tolerances.
- C. Demonstrate proper operation of equipment to the Owner's designated representative.
- D. Provide start-up certificate in accordance with the General Conditions.

END OF SECTION

SECTION 26 0510
GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Definitions
- B. Quality Assurance Requirements and Installer Qualifications.
- C. Submittal Procedures
- D. Execution Requirements common to Division 26 systems
- E. Equipment bases and housekeeping pads

1.2 DEFINITIONS

- A. Manufacturer's Representatives: Wherever MANUFACTURER'S REPRESENTATIVE is referred to in this division, said representative shall be regularly employed by the manufacturer to perform similar activities to those called for herein, which indicates his competence in that field of work.
- B. Concealed: Where the word concealed is used in this Division, it shall mean items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in cabinet work, and under counters or equipment so as to be not visible from an elevation of 5 feet at a horizontal distance of 10 feet.
- C. Finished Spaces or Areas: Where finished spaces or areas are referred to in this Division, it shall mean all spaces except concealed spaces, mechanical rooms, or boiler rooms unless otherwise noted.
- D. Provide: Where the word provide is used, it shall mean to furnish and install the item(s) in accordance with plans, specifications or manufacturer's instructions.
- E. Control and Interlock Wiring: All wiring, both line voltage and low voltage, other than power wiring from an electrical distribution panel, through the primary control device, to the equipment.
- F. Primary Control Device: That ONE device for any item of equipment which interrupts power flow during normal operation. Where magnetic starters are provided, they are the primary control. For items not switched by starters, the primary control device will be the ONE thermostat, manual switch, aquastat, P.E. switch, or relay performing the primary switching.
- G. Diagrammatic: A drawing that shows arrangement and relations (as of parts).i.e.: A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and is not necessarily to scale. Arrangement, location, and sizes shown are firm.
- H. Readily Accessible: Equipment, valves and other items requiring service shall be installed to be readily accessible. These items shall be available for maintenance or use in a space, through an access door from floor elevation, or above a lay-in ceiling by maintenance staff standing on a ladder no taller than the ceiling.

- I. Noted, Indicated or Shown: Where the terms "Noted", "Indicated" or "Shown" are used in these specifications, the words "in the specifications or on the plans" shall be inferred.
- J. Detail: Details referenced shall pertain to plans unless otherwise noted.
- K. Specifications: Where reference is made to these specifications, it shall be inferred in this Division of specifications.
- L. Notification by the Contractor, and Instructions to the Contractor: Where reference is made in these specifications to notification by or instructions given to the Contractor, it shall be inferred that the Design Professional shall be the notifier or the instructor as the case exists.
- M. Submittal Data, Equipment Cuts, Shop Drawings: Wherever these terms are used in the plans or specifications, the information is to be submitted for review as part of the packaged submittal specified under "SUBMITTALS".
- N. Conduit of Duct Bank: Two or more, 2-inch or larger conduits with a common point of origin and a common point of termination routed parallel, and as specifically designated on plans.
- O. See Article 100 of the 2017 National Electrical Code with all Georgia State Amendments.
- P. Division or Section Reference: Where reference is made to another Division or Section within this Division, refer to specifications table of contents for Division, Section, or Page Number.
- Q. Diagrammatic: A drawing that shows arrangement and relations (as of parts). A diagrammatic drawing uses symbols rather than pictorial representation of pipes, ducts, conduit and other items shown and are not necessarily to scale. Arrangement, location and sizes shown are firm.
- R. Horizontal Cabling: A data cabling term indicating the cable from the work area back to the patch panel. Commonly used in the description "conduit for horizontal cabling shall be 1" minimum in size".

1.3 REGULATORY REQUIREMENTS

- A. General: Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications.
- B. Materials and equipment included in Underwriters Label Service shall bear that label. Electrical equipment shall be U.L. Listed or Labeled.
- C. Jurisdiction: Where codes or guides refer jurisdiction to local governing code officials, such official in this procedure shall be the State Fire Marshal.
- D. Permits: Permits and licenses of a temporary nature necessary for the prosecution of the work shall be obtained and paid for by the Contractor. Neither the Contractor nor any sub-contractor will be required to pay Municipal or County building permit fees. The Contractor and/or any subcontractor will be required to pay any Municipal and/or County building license taxes or fees, if any.
- E. Energy: Conform to the International Energy Conservation Code, 2018 Edition
- F. Fire Prevention: Conform to International Fire Code 2018 Edition.

- G. Building Code: Conform to the Florida State Building Code, 7th Edition, 2020.
- H. Electrical: Conform to the National Electrical Code (NEC), NFPA 70, 2017 Edition and the National Electrical Safety Code.
- I. Fire Alarm: Conform to the 2018 Edition of NFPA 72 - National Fire Alarm Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Requirements specified herein are minimum. All equipment, when installed, shall perform equal to or exceed specified requirements.

1.5 SUBMITTALS

- A. Refer to Section 01 7800 - Closeout submittals, for general submittal procedures.
- B. In general, the design professional is allocated 14 calendar days to review a submittal. On large items such as gear, panel, and lighting submittals, our office will require this same amount of time, and should receive copies of these submittals at the same time as the design professional. Special circumstances may require faster turnaround times, and may be discussed at the onset of the submittal process.
- C. Supplementing Division 1 requirements; the Contractor shall:
 - 1. Review the submittal data and check to ensure compliance with specifications prior to submitting.
 - a. The Contractor agrees that submittals of equipment and material and shop drawings of equipment and material layouts required under provisions of these specifications and processed by the Design Professional are not Change Orders.
 - b. The purpose of submittals is to demonstrate that the Contractor understands the design concept of the project by indicating the equipment and materials he intends to furnish and install, and by detailing the installation he intends to achieve. The review by the Design Professional shall NOT be construed to be for the purpose of "approving" equipment or drawings. The plans and specifications alone are the contract document. The contractor has agreed to follow the contract document, regardless of the results of the submittal submission.
 - c. The Contractor shall conform to the requirements of the Contract Documents unless a change order or a specific letter of clarification is issued. The Contractor shall identify on each submittal and in letter form to the Design Professional any and all deviations from the Contract Documents.
 - d. Any submittal or shop drawing not conforming to the Contract Documents without this identification and notification shall be assumed to be marked "Revise and Resubmit" (the Contractor acknowledges this by the submission), and the Contractor shall promptly resubmit said submittal so as to be in full compliance with the Contract Documents.

- e. Failure of the Contractor to provide this information during the shop drawing phase shall make the Contractor responsible for all changes to achieve compliance with the Contract Documents without additional compensation.
2. Assemble the submittal data in complete sets in hard back three-ring binders, separated by trade, (Electrical), and bound with numbered index sheets and tabs. Submittal data shall be submitted at one time unless unavailable data such as control submittal would delay project progress. Submittal data for Fire Alarm System, Security System, Telecommunications System, and Intercom System shall include the following:
 - a. Devices and panels data sheets.
 - b. Typical devices wiring diagrams.
 - c. Plans showing devices, zone of each device, & interconnecting conductor/conduit.
 - d. System operation description.
 3. Identify all submittals by a cover sheet showing project name, specification sections, drawing or detail number, room number, date, revision date, the Contractor and subcontractor's organization and project manager with phone number, the model, style and size of item being submitted with manufacturers' representative, salesman (or a preparer who can answer questions), and preparer's phone number.
 4. Manufacturers' standard drawings shall be modified by deletions or additions to show only items applicable to this project.
 5. Prepare a master list of submittals proposed to be submitted on the project. This list shall be updated for each submission and shall be the first sheet(s) of the submission in the quantity that is submitted for review. The information and general format shall contain an Tab number, Item Description, Item Status and any comment. Items that require quicker submittal review because of material lead times should be indicated in this list.
 6. Provide a Letter stating that all submittals have been checked for compliance with specifications.
 7. Deliver submittals to the Design Professional at the business address.
 8. Paperless Delivery of Submittal:
 - a. Submittal data may be posted to NBP's FTP site when agreed upon by the Design Professional and the Owner during preconstruction. The Contractor will be provided with a project folder and password.
 - b. Prepare the submittals as described above. Take steps to reduce submittal file size.
 - c. Do not scan in color or high resolution unless needed for clarity.
 - d. Ensure any reproduction are legible.

- e. Send an email to submittal@nbpengineers.com with a copy to the Electrical Design Professional and the Architectural Design Professional identified during the preconstruction phase.
 - f. Identify the submittal in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administration Building Section 26 0534- Conduit.
 - g. Ensure the submittal posted to the FTP site has the same identification.
 - h. NBP Design Professionals will not process or react to submittals not properly sent or identified.
- D. Power Wiring Requirements: The Contractor shall submit a letter acknowledging receipt and review of the Tabulated List of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of the Specifications. Failure to submit this letter will require the Contractor to assume responsibility for any required changes to the electrical design attributed to mechanical equipment. Include a copy of the Tabulated List of Power Wiring Requirements with the letter. The electrical requirements for the mechanical equipment is based on the best information available at the time of design. The Contractor is responsible for coordinating with the purchased equipment. Power Wiring letters are required for the following equipment:
1. Mechanical
- E. Service Voltage Verification: The Contractor shall provide a letter verifying that existing voltages match voltages indicated on plans. The letter shall be included in the submittal data. No electrical equipment shall be released for fabrication until such verification has been made.

1.6 OPERATING AND MAINTENANCE MANUALS

- A. Each Manual shall be compiled as follows:
1. Data shall be bound in smooth surface hard back commercial quality three-ring notebooks with project identification shown on the front cover and binding back. Identification labels shall be typed and adhered with waterproof glue.
 2. Notebooks shall have 9-1/2-inch by 11-1/2-inch covers with back width to permit the covers to lie parallel or to converge, and have not less than 1-1/2-inch back width.
 3. Index divider sheets of heavy Manila paper shall be inserted between each section of the Manual with a 2-inch x 1/3-inch ready-cut shield tab attached to each sheet for identification of sections.
 4. Data sheets and diagrams shall be 8-1/2-inch x 11-inch or be mounted on 8-1/2-inch x 11-inch sheets of 16-pound paper if smaller, with reinforced 11-inch mechanically perforated edges. Drawings and diagrams larger than 8-1/2-inch by 11-inch shall be folded up from the bottom to form a height of 11-inches and folded to the left to form a width of 8-1/2-inches.
 5. Table of Contents(Index) sheets shall be provided in the order listed with identifications typed in capital letters.

B. Digital delivery of Operating and Maintenance Manuals:

1. Operating and Maintenance Manuals may be delivered digitally and posted to the NBP Engineers FTP site when agreed upon by the Design Professional and the Owner during the preconstruction phase. The Contractor will be provided with a project folder and password.
2. Prepare the Operating and Maintenance Manuals as described above. Take steps to reduce submittal file size.
3. Do not scan in color or high resolution unless required for clarity.
4. Ensure any reproductions are legible.
5. Send an email to submittal@nbpengineers.com with a copy to the Electrical Design Professional and the Architectural Design Professional (if applicable) identified during the preconstruction phase.
6. Identify the manuals in the email subject line using the official project title, specification section and submitted item. I.E. Project No. G-xxx, Addition to Administrative Building.
7. Table of Contents(Index) sheets shall be included in the order listed with identifications typed in capital letters.
8. Ensure the manuals posted to the FTP site has the same identification.
9. NBP Design Professionals will not process or react to manuals which are not properly transmitted, indexed, and identified.

C. Each Manual shall contain the following information, data and drawings:

1. Copies of approved submittals (with Design Professional's review comments and stamp), equipment and materials.
2. Manufacturer's installation, operating and maintenance instructions for each item of equipment.
3. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
4. Control diagrams.
5. Wiring diagrams and color codes for fire alarm system. Refer to fire alarm specifications.
6. Copies of shop drawings showing layouts and construction details. Shop drawings are required for the following systems:
 - a. Lighting control (occupancy sensor and relay panels)
 - b. Fire Alarm system
 - c. Security system (CCTV, Card Access)

- d. Low voltage system (voice/data/catv)
- e. Card Access system
7. Testing Results: Infrared Scan, Coordination Study, final settings on all adjustable breakers.
8. Provide a copy of the riser diagram, no smaller than printed on 11X17, with lengths of feeders shown (handwritten is acceptable).
9. Maintenance schedules.
10. Warranty Information.
11. Sign in sheets for all owner training sessions.

1.7 QUALITY ASSURANCE

A. Electrical Installer's Qualifications:

1. General: Wherever the word "Sub-Contractor" or "Firm" is used in these subparagraphs, it shall mean the Contractor/sub-contractor of record for the installations used for proficiency qualification.
2. Warranty of Contractor: The Contractor shall warrant that the Firm(s) selected by him are reputable, skilled, reliable, competent, qualified in the trade or field in which they are to perform on the project, and thoroughly familiar with applicable codes and standards.
3. Location: The firm which performs the installation of the work under this section shall be one who maintains an established, experienced organization with a permanent, manned office. See General Conditions.
4. Experience: The firm's proficiency in the installation and adjustment of Electrical systems shall have been demonstrated by the successful performance of work as specified herein on at least three commercial, hospital or institutional buildings with a minimum floor area of 10000 square feet, 480 volt, 800 amps, 3 phase service entrance.
5. The firm shall have been in business performing services as specified herein for at least 3 years.

B. Substitutions:

1. All costs incurred by acceptance of substitutions shall be borne by the Contractor. Should any proposed substitute equipment require services in addition to or in excess of services provided in the Contract Documents, these services shall be provided at no extra cost to the Owner.
2. Request for approval of a proposed product (substitution) shall be accompanied by the schedule setting forth in which respects the materials or equipment submitted for consideration differ from the materials or equipment designated in the Contract Documents and from the design intent. If there are no deviations or changes required to the design, the submittal shall be accompanied by the following statement: "The proposed

material or equipment submitted for approval requires no changes to the Contract Documents to achieve the design intent." Lack of the schedule or statement will result in automatic disapproval of the request.

3. Facsimile (Fax) Requests for prior approval will not be considered due to the inability of the sender being able to assure that information sent was information received and possible poor clarity of the fax, and the short time period for review and response.

1.8 WARRANTY

- A. Refer to Section 01 7000 - Project Closeout, for additional warranty requirements.
- B. See General Conditions.
- C. Where extended warranties beyond the Contractor's one (1) year warranty are specified, the additional warranty time shall start at the end of the Contractor's warranty.
- D. Correct defective Work within a one year period after Date of Material Completion.

1.9 NOTIFICATION TO THE OWNER WHEN THE CONTRACTOR VISITS SITE AFTER FINAL INSPECTION

- A. When the Contractor's representative visits the job after the final inspection to perform specific work such as maintenance service, seasonal balance, or to correct a deficiency, the Contractor shall notify the Owner not less than 48 hours prior to the date on which they will visit the site, except under an emergency condition.
- B. The Contractor shall visit the designated office of the Owner to notify the Owner that the Contractor is on the site prior to visiting the site, thereby enabling the Owner's representative to accompany the Contractor, should they so desire while the Contractor is on the project site.
- C. A carbon copy of the notification shall be provided to the Design Professional with the intent of the site visit. After the Contractor has completed the site visit, the Contractor shall give a written report of the action taken and any incomplete work yet to be performed to the Design Professional, within five (5) days.

1.10 ABBREVIATIONS - ELECTRICAL

AIC	AVAILABLE INTERRUPTING CAPACITY
AFF	ABOVE FINISHED FLOOR
AL	ALUMINUM
ANT	ANTENNA
AWG	AMERICAN WIRE GAUGE
BE	BOTTOM ELEVATION
BG	BELOW FINISHED GRADE
BRKR	BREAKER

C	CONDUIT
CAT	CATALOG
CH	CEILING HEIGHT
CLG	CEILING
CO	CONVENIENCE OUTLET
COND	CONDUCTOR(S)
CR	CONTROL RELAY
CU	COPPER
D	DIAMETER
EMER	EMERGENCY
EMT	ELECTRICAL METALLIC TUBING
FO	FIBER OPTIC
FAP	FIRE ALARM PANEL
FUT	FUTURE
GND	GROUND
HOA	HAND-OFF-AUTO
HPS	HIGH PRESSURE SODIUM
HTR	HEATER
IAW	IN ACCORDANCE WITH
IC	INTERCOM MASTER STATION
IMC	INTERMEDIATE METALLIC CONDUIT
MB	MAIN BREAKER
MC	MASTER CLOCK
MFGR	MANUFACTURER
MLO	MAIN LUGS ONLY
MTD	MOUNTED
MTG	MOUNTING
MV	MERCURY VAPOR

NEC	NATIONAL ELECTRICAL CODE (2017)
NFDS	NON FUSED DISCONNECT SWITCH
NIC	NOT IN CONTRACT
NMC	NON METALLIC CONDUIT
NO.	NUMBER
PB	PUSHBUTTON
PLCS	PLACES
PVC	POLYVINYL CHLORIDE
R	RADIUS
RGS	RIGID STEEL CONDUIT
SCHED	SCHEDULE
SEC	SECTION
SMR	SURFACE METAL RACEWAY
SURF	SURFACE
SYM	SYMMETRICAL
TEL	TELEPHONE
TR	TIME RELAY
TYP	TYPICAL
W/	WITH
WP	WEATHERPROOF
XFMR	TRANSFORMER
20A/3P	20 AMP / 3 POLE TYPICAL

PART 2 PRODUCTS

PART 3 EXECUTION

3.1 EXAMINATION

A. Hazardous Materials:

1. A/E's Responsibility: Plans and specifications have been prepared by the A/E for the Owner without the A/E having conducted investigation as to the presence of asbestos or hazardous waste on the project. Not being a part of this contract, the A/E has not charged

any fees and has not and will not advise the Owner with regard to the detection and/or removal of asbestos or hazardous waste. The Owner is aware that asbestos or hazardous waste could be present and will make all decisions with regard to its removal. The removal of all hazardous materials and encapsulation of remaining surfaces is the sole responsibility of the Owner.

2. If the Contractor observes the existence of a friable material which must be disturbed during the course of his work, the Contractor shall promptly notify the Owner and the Design Professional. The Owner shall make all arrangements regarding testing and removal or encapsulation of asbestos material if present. The Contractor shall not perform any work pertinent to the friable material prior to receipt of special instructions from the Owner through the Design Professional.
3. "Friable Material" is any material which can be crumbled, pulverized or reduced to a powder by hand pressure when dry.

B. Asbestos (ACBM)

1. Specifications written for equipment and materials in this division of the specifications are intended to eliminate any asbestos containing substance. The Contractor and his suppliers are hereby notified that NO ASBESTOS CONTAINING PRODUCT IS PERMITTED. If a product is listed in these specifications which contains asbestos, the Contractor and his supplier shall so inform the Design Professional immediately and shall not deliver such product to the project site until additional written instructions are received.
2. Upon completion of construction, and prior to final inspection, the Contractor for work performed under this division of the specifications shall be required to provide a certificate to the Design Professional in the following form:

CERTIFICATION FOR ASBESTOS CONTAINMENT

I/we _____ (Sub-Contractor), certify that there is no asbestos contained in materials provided and/or installed by us in _____ (Project/Building).

WITNESS _____ (Notary Public) DATE: _____

CONTRACTOR: _____

BY: _____

TITLE: _____

3.2 PREPARATION

- A. Drawings are diagrammatic and show the general location of the equipment, raceway, and equipment, but are not to be scaled. All dimensions shall be verified at the building site. Prefabrication and/or installation of work from drawings shall be at the Contractor's risk. Confirm exact building dimensions and details on site.
- B. Space Conditions:
 - 1. All apparatus shall fit into the available spaces in the building and must be introduced into the building so as not to cause damage to the structure. Equipment larger than access to equipment spaces shall be disassembled into sub-assemblies for installation.
 - 2. Where deviations from the plans are required in order to conform to the space limitations, such changes shall be made at no additional cost to the Owner and shall be subject to approval.
 - 3. All equipment requiring service shall be made accessible.
- C. Where new work is specified or shown connected to old work and materials are different from existing, the Contractor shall request a clarification from the Design Professional prior to performing the work.
- D. The demolition plan has been prepared to assist the Contractor in determining the scope of demolition work and should not be construed to be all of the demolition required. The Contractor shall visit job site (after carefully reviewing the contract documents) and determine exact areas and quantities of existing materials to be removed to accomplish new construction.

3.3 INSTALLATION

- A. All equipment shall be installed in accordance with manufacturer's published installation instructions shipped with the equipment. In the event there is a discrepancy between these specifications or Drawings and the manufacturer's instructions, no work shall be performed until additional instructions are received.
- B. Route conduits and cable trays to avoid skylights, translucent, and transparent ceilings.
- C. Cutting and patching in connection with the installation shall be done by the trade whose work is to be cut. The Contractor shall lay out and install his work ahead of the work of other trades wherever possible.
- D. Where penetrations are made in fire rated partitions, walls, floors or ceilings during the course of electrical installation, these penetrations shall be restored to their intended fire ratings by the use of fittings or materials as approved by Underwriter's Laboratories for this purpose.
- E. See General Conditions.
- F. Fire Prevention Precautions in Cutting and Welding Areas: Conform to International Fire Code.

- G. Seal sleeves and openings in exterior walls and mechanical room walls vaportight, watertight, or for smoke/fire protection as applicable.
- H. Seal exterior openings to make watertight with Oleo-Resinous architectural grade sealant for interior and exterior use without painting, gun consistency, off-white color, unless otherwise noted. Gibson-Homan's Eternaflex, DAP Flexi-Seal, Pecora's Synthcalk GC-9, or Sonneborn's Sonolastic.
- I. Seal other openings for fire protection with foam or putty type sealant, U.L. Classified, for penetration seal maintaining fire rating of barrier penetrated, having a flame spread rating of 20 in accordance with ASTM E-84-84, and capable of withstanding 450 F temperatures without softening, unless otherwise noted. [Material shall comply with Federal Spec TTS-230-C Type II Class B for sealants.] Dow Corning 2001 Fire Stop foam and Dow Corning 2000 caulk, Semco PR 855, 3M Products Fire Barrier Caulk CP 25 N/S (no sag) and Putty 303 (no filler sheets allowed), Metacaulk 835, Hilti CS 240 caulk. Provide submittal data including installation instructions for penetrations in project.
- J. Continuity of Building Services:
 - 1. Conform to staging as described under Division 01.
 - 2. Schedule work so existing building systems will not be interrupted when they are required for normal usage of the existing building.
 - 3. Perform work to provide minimum inconvenience to the Owner and as approved by the Design Professional. No allowance will be made for lack of knowledge of existing conditions.
- K. Record Drawings:
 - 1. After completion, any changes in the location of conduits, the connections of circuits, or any other changes from the contract documents shall be noted on a clean set of blue line white prints and delivered to the Design Professional before final acceptance of work.
- L. Condition of Work Upon Project Completion:
 - 1. The condition of equipment and work upon project completion shall be NEW and UNDAMAGED. For example, broken fixture lenses and dented or scratched housings shall be replaced. Painted-over wiring devices shall be cleaned or replaced. Do not use tape or other adhesive for temporary labels, as they leave residue. All circuit breaker factory-printed data/information shall be legible and undamaged. Panelboards and transformers shall be free of scratches, dents, and rust. Any equipment or work deemed by the design professional as not meeting the requirement of NEW and UNDAMAGED shall be replaced by the Contractor at no cost to the Owner.

3.4 INTERFACE WITH OTHER WORK

- A. General: No roughing shall be done until roughing drawings and exact electrical demand of equipment is obtained. Notify the Design Professional of any discrepancies.
- B. Mechanical:

1. Review Tabulated List of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of the specifications. Conduit, conductor and breaker sizes shown for mechanical equipment are based upon the best available information on the equipment specified. The Contractor shall be allowed to provide electrical circuits compatible with the proposed mechanical equipment where the mechanical equipment conforms to Division 26 of the specifications, but does not conform to the electrical criteria of these contract documents. The Contractor shall submit the proposed electrical modifications to the Design Professional for review prior to roughing. No additional costs to the contract will be allowed for these modifications.
 2. Provide control, program and interlock wiring as shown on Mechanical and/or Electrical drawings.
 3. Provide conduit, wiring, boxes, adaptors for equipment terminations and disconnect switches. Provide power wiring through primary control device.
 4. Starters, push-button stations, contactors, relays, limit and safety devices, and control items are specified in Division 26 of the specifications (except as shown in Motor Control Center). Unless otherwise noted, all starters shall be mounted between 24" and 80" above finished floor. Push-button stations shall be mounted at switch height except as noted.
- C. Site Utilities: The information shown on the plans is based upon the best information available. Before performing any work on the site, the Contractor shall contact the utility company(s) serving the facility and stake out all underground services. Notify the Design Professional of any discrepancies.

3.5 EQUIPMENT BASES AND HOUSEKEEPING PADS

- A. Provide housekeeping and equipment pads where penetrations occur through any slab in the electrical and data rooms. Conduit that penetrates the slab and is exposed in the space shall be wrapped in a housekeeping pad. These include under electrical panels and conduit sleeves through data room slabs. All electrical items that sit on the slab shall have housekeeping pads below. Rough up slab under bases before pouring concrete.
- B. Bases/Pads shall be rectangular with vertical sides 4 inches from centerline of anchor bolts or 2 inches from edges of equipment supports, whichever provides the larger dimension, side of equipment or base edge, unless otherwise noted. Housekeeping pads shall be minimum 4 inches thick.
- C. Chamfer: 3/4 inch on edges and corners.
- D. Reinforcing: 6"x 6" 10/10 WWF at mid-depth of slab. (4 inch thick pads.)

3.6 STARTING EQUIPMENT AND SYSTEMS

- A. Adjust equipment for proper operation within manufacturers' published tolerances.
- B. Demonstrate proper operation of systems and equipment to the Owner's designated representative.

3.7 DEMONSTRATION, TRAINING AND INSTRUCTIONS

A. Completion of Work:

1. At final observation a test shall be made and the entire system shall be shown to be in working condition. The following shall be made available to personnel conducting the test:
 - a. Electrician with hand tools.
 - b. Accurate Voltmeter.
 - c. Clamp on Ammeter.
 - d. Test Lamp.
 - e. Phase Rotation Indicator.
 - f. Complete Electrical Specifications and Drawings with all addenda and revisions.
 - g. Pre-final Punch List indicating disposition of all items with initials of person confirming completion.
2. Before final observation or at final observation, the Contractor shall present the following to the Design Professional:
 - a. Finalized and corrected maintenance manuals.
 - b. Special systems certificates.
 - c. Record marked-up drawings.
 - d. Required test results.

3.8 CLEANING AND PROTECTION

- A. All materials, equipment and electrical/telecommunications rooms shall be cleaned prior to Final Observation.
- B. Remove any stored materials. Vacuum interiors of all panelboards, switchboards, switchgear, transformers and any other electrical equipment.
- C. Paint equipment where finish has been damaged requiring retouching of finish to match factory finish. Equipment which has been damaged beyond the point of retouching or has been retouched not to match shall be repainted to match factory finish.
- D. Chipped or scraped paint shall be retouched to match original finish.
- E. All equipment shall be free of dust, rust and stains prior to material completion.
- F. During Construction: Conduit openings shall be closed with caps or plugs. All equipment shall be covered and protected against water, dirt and chemical or mechanical injury. All equipment and material shall be stored in accordance with manufacturer's recommendations.

3.9 FINISHING ELECTRICAL EQUIPMENT AND MATERIAL

- A. Use paint systems specified in Division 9 for the substrates to be finished.
- B. Paint conduit and electrical equipment in exposed, public areas per the Design Professional's instructions.
- C. All ferrous fasteners and hanger supports not having a corrosion resistant plated finish shall be painted to prevent rust.
- D. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.

END OF SECTION

SECTION 26 0519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wire and cable for 600 volts and less.
- C. Wiring connectors.
- D. Electrical tape.
- E. Heat shrink tubing.
- F. Wire pulling lubricant.
- G. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).
- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- G. NEMA WC 70 - Nonshielded Power Cable 2000 V or Less for the Distribution of Electrical Energy; 2009.
- H. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- I. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

- J. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- K. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- L. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- M. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- N. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide for each cable assembly type.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Underground feeder and branch-circuit cable is not permitted.
- E. Service entrance cable is not permitted.
- F. Armored cable is not permitted.
- G. Metal-clad cable is not permitted.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- D. Comply with NEMA WC 70.
- E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

- F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- G. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
- H. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- I. Minimum Conductor Size:
 - 1. Branch Circuits: 10AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 2) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
- J. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- K. Conductor Color Coding:
 - 1. Color code conductors as indicated. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.

- 4) Neutral/Grounded: White.
- c. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
 - 1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation; _____: www.generalcable.com/#sle.
 - d. Southwire Company: www.southwire.com/#sle.
- B. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.

2.4 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 0526.
- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- D. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.

3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. NSI Industries LLC: www.nsiindustries.com/#sle.
- H. Mechanical Connectors: Provide bolted type or set-screw type.
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.

2.5 WIRING ACCESSORIES

- A. Electrical Tape:
1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 2. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 3. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 4. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.
 5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
- C. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that raceway installation is complete and supported.
- E. Verify that field measurements are as shown on the drawings.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.
- B. Verify that interior of building has been protected from weather.

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
 - 6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:

- a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
8. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Installation in Raceway:
1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 2. Pull all conductors and cables together into raceway at same time.
 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
- G. Install conductors with a minimum of 12 inches of slack at each outlet.
- H. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- I. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- J. Make wiring connections using specified wiring connectors.
1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 3. Do not remove conductor strands to facilitate insertion into connector.

4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- K. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 3. Wet Locations: Use heat shrink tubing.
- L. Insulate ends of spare conductors using vinyl insulating electrical tape.
- M. Color Code Legend: Provide identification label identifying color code for ungrounded conductors at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- P. Install wire and cable securely, in a neat and workmanlike manner, as specified in NECA-1.
- Q. Route wire and cable as required to meet project conditions.
1. Wire and cable routing indicated is approximate unless dimensioned.

2. Include circuit of lengths required to install connected devices within 10 ft of location shown.

R. Use wiring methods indicated.

END OF SECTION

**SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Grounding and bonding components.

1.2 RELATED REQUIREMENTS

- A. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NETA STD ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems; International Electrical Testing Association; 2007.
- C. NFPA 70 - National Electrical Code, 2020; National Fire Protection Association.
- D. NFPA 99 - Health Care Facilities Code; 2015.
- E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled by Underwriter's Laboratories, Inc. (UL) as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify existing conditions prior to beginning work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Identify grounding and bonding system components in accordance with Section 26 0553.

- D. Bond all conduits and/or other conductor enclosures.
- E. Bond all panelboards, safety switches and non-current carrying, metal enclosures of fixed equipment.
- F. Install additional rod electrodes as required to achieve specified resistance to ground.
- G. Provide grounding electrode conductor and connect to reinforcing steel in foundation footing where indicated. Bond steel together.
- H. Provide bonding to meet requirements described in Quality Assurance.
- I. Bond together reinforcing steel and metal accessories in pool and fountain structures.
- J. Provide a separate grounding conductor in all flexible conduit.
- K. Where a building ground network is provided, connect the neutral point on all dry type transformers to the nearest grounding plate/bus.
- L. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
 - 1. Bond to all metal boxes that the conductors pass through, including, but not limited to, pull boxes, junction boxes, and outlet boxes. The means of connection shall be through a grounding screw or other listed grounding device that is used for no other purpose.

END OF SECTION

**SECTION 26 0529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.2 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2013.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's catalog data for fastening systems.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 70.
- B. Comply with applicable building code.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 1. Comply with MFMA-4.
- E. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
- F. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

2.2 MATERIALS

- A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
- B. Supports: Fabricated of structural steel or formed steel members; galvanized or painted. All ferrous fasteners exposed to outside conditions and refrigerated spaces shall be coated with corrosion resistant, plated finish to prevent rust.
- C. Anchors and Fasteners:
 1. Concrete Structural Elements: Use precast inserts, expansion anchors, or preset inserts.
 2. Steel Structural Elements: Use beam clamps, steel spring clips, or welded fasteners.
 3. Concrete Surfaces: Use expansion anchors.
 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Use toggle bolts.

5. Solid Masonry Walls: Use expansion anchors or preset inserts.
 6. Sheet Metal: Use sheet metal screws.
 7. Wood Elements: Use wood screws.
- D. All ferrous fasteners exposed to outside conditions and refrigerated spaces shall be coated with corrosion resistant, plated finish to prevent rust.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by the Design Professional, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by the Design Professional, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Design Professional.
- G. Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

**SECTION 26 0533.13
CONDUIT FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Intermediate metal conduit (IMC).
- C. PVC-coated galvanized steel rigid metal conduit (RMC).
- D. Flexible metal conduit (FMC).
- E. Liquidtight flexible metal conduit (LFMC).
- F. Electrical metallic tubing (EMT).
- G. Rigid polyvinyl chloride (PVC) conduit.
- H. Conduit fittings.
- I. Conduit, fittings and conduit bodies.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems.
- D. Section 26 0533.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit (EIMC); 2005.
- B. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2003.
- C. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit; 2005.
- D. NEMA TC 14 (SERIES) - Reinforced Thermosetting Resin Conduit and Fittings Series; 2015.
- E. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- F. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.
- G. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- H. UL 360 - Liquid-Tight Flexible Steel Conduit; Current Edition, Including All Revisions.

- I. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- J. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- K. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- L. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.5 ABBREVIATIONS

- A. GRS indicates galvanized rigid steel conduit also termed rigid steel conduit .
- B. RGS indicates galvanized rigid steel conduit also termed rigid steel conduit .
- C. GRC indicates galvanized rigid steel conduit also termed rigid steel conduit .
- D. IMC indicates intermediate metal conduit whether made of galvanized steel or aluminum. See Part 2 for specification.
- E. EMT indicates Electrical Metallic Tubing whether made of galvanized steel or aluminum. See Part 2 for specification.
- F. PVC40 indicates PVC electrical conduit, schedule 40.
- G. PVC80 indicates PVC electrical conduit, schedule 80.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.
- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

- B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use intermediate metal conduit (IMC), PVC-coated galvanized steel rigid metal conduit, or rigid PVC conduit.
 - 2. Exterior, Direct-Buried: Use galvanized steel rigid metal conduit, intermediate metallic conduit (IMC), PVC-coated galvanized steel rigid metal conduit, rigid PVC conduit, or reinforced thermosetting resin conduit (RTRC).
 - 3. Where steel conduit is installed in direct contact with earth where soil has a resistivity of less than 2000 ohm-centimeters or is characterized as severely corrosive based on soils report or local experience, use corrosion protection tape to provide supplementary corrosion protection or use PVC-coated galvanized steel rigid metal conduit.
- D. Concealed Within Hollow Stud Walls: Use galvanized steel rigid metal conduit, intermediate metal conduit (IMC), or electrical metallic tubing (EMT).

2.2 CONDUIT REQUIREMENTS

- A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- B. Fittings:
 - 1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.

2.4 INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:

1. Non-Hazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless set screw and compression (gland) type fittings are not permitted.
- C. Conduit Size: Comply with NFPA 70.
1. Minimum Size: 1/2 inch unless otherwise specified.
 2. All conduits 1-1/2 inches and larger containing power conductors shall be rigid metal conduit.
- D. Underground Installations:
1. More than 5 Feet from Foundation Wall: Use PVC Schedule 40.
 2. Within 5 Feet from Foundation Wall: Use rigid metal conduit.
 3. In or Under Slab on Grade: Use rigid metal conduit. Coordinate all in slab work with Structural.
 4. In Slab on Grade: Rarely will conduit be routed within the slab on grade. Exceptions may be made with expressed written consent by the Structural Design Professional. If it is allowed, use rigid metal conduit. Coordinate all in slab work with Structural.
 5. Minimum size 1/2 inch.
 6. NOTE: Site data conduits are different. Data conduits shall transition from PVC within 5 feet of the building footer, to IMC. Provide IMC into the main data room from this point. No PVC shall pass under the building footer or penetrate the slab for data conduits.
- E. Outdoor Locations Above Grade: Use rigid metal conduit.
- F. In Slab Above Grade:
1. Use rigid metal conduit.
 2. Maximum Size Conduit in Slab: 3/4 inch (19 mm). No conduit shall cross in the slab unless specifically called for by the structural engineering drawings.
 3. Coordinate all in slab work with Structural.
- G. Wet and Damp Locations: Use rigid metal conduit.
- H. Dry Locations:
1. Concealed: Use electrical metallic tubing where rigid conduit is not required by Paragraph A above.
 2. Exposed: Use rigid metal conduit.

- I. Fire Alarm: Provide factory painted (RED) electrical metallic tubing.
- J. Exposed below 5 feet in Mechanical Rooms: Use rigid metal conduit.
- K. Intermediate Metal Conduit (IMC) may be substituted for Rigid Steel conduit as allowed by the National Electrical Code (NEC). All fittings shall be the same as for Rigid Steel conduit.
- L. Branch Circuits to Motors: Use rigid metal conduit for all branch circuits to motors. Isolate actual motor connection from conduit system and from building with flexible conduit (liquidtight if wet or damp location) not less than four diameters nor more than 24-inches in length.
- M. Telecommunications, Security, and Intercom: Use electrical metallic tubing. Rigid Metal Conduit shall be required for Telecommunications service entrance cables where demarcation point is located more than fifty (50) feet beyond conduit building entry point. Refer to the National Electrical Code.

2.5 METAL CONDUIT

- A. Rigid Metal Conduit.
- B. Fittings and Conduit Bodies: Material to match conduit. Fittings shall be malleable iron threaded.
- C. Intermediate Metal Conduit (IMC) may be substituted for Rigid Steel conduit as allowed by the National Electrical Code (NEC). All fittings shall be the same as for Rigid Steel conduit.

2.6 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil.
- C. PVC-Coated Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Non-Hazardous Locations: Use fittings listed and labeled as complying with UL 514B.
 - 3. Material: Use steel or malleable iron.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil.

2.7 FLEXIBLE METAL CONDUIT (FMC)

- A. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.
- B. Fittings:

1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
- C. Description: Interlocked steel construction.
- D. Connectors: Provide Zinc or cadmium plated steel. Fittings anchoring conduit by means of set screws are prohibited.
- E. B-X cable is prohibited.
- F. Provide separate grounding conductor inside flexible conduit.
- G. Flexible conduit shall be liquid-tight neoprene coated in damp & wet locations and for all motor connections.
- H. Flexible conduit shall be minimum 1/2-inch nominal.

2.8 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
- C. Description: Interlocked steel construction with PVC jacket.
- D. Fittings: NEMA FB 1.

2.9 ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- B. Fittings:
1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 2. Material: Use steel or malleable iron.
 3. Connectors and Couplings: Use compression (gland) or set-screw type.
 - a. Do not use indenter type connectors and couplings.
- C. Fittings and Conduit Bodies: Steel or malleable iron compression type.

2.10 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.
- B. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
- C. Description: Schedule 40 PVC.
- D. Fittings and Conduit Bodies: Material to match conduit.
 - 1. The conduit, fittings, elbows and cement shall be produced by the same manufacturer.
- E. Description: NFPA 70, Type RTRC reinforced thermosetting resin conduit complying with NEMA TC 14 (SERIES).
- F. Supports: Per manufacturer's recommendations.
- G. Fittings: Same type and manufacturer as conduit to be connected.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive conduits.
- C. Verify that conditions are satisfactory for installation prior to starting work.
- D. Verify routing and termination locations of conduit prior to rough-in.
- E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
- C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
- D. Install intermediate metal conduit (IMC) in accordance with NECA 101.
- E. Install PVC-coated galvanized steel rigid metal conduit (RMC) using only tools approved by the manufacturer.

- F. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
- G. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- H. Connections and Terminations:
 - 1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 - 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 - 3. Use suitable adapters where required to transition from one type of conduit to another.
 - 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 - 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 - 6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.
 - 7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.
- I. Penetrations:
 - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Design Professional.
 - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 - 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 - 4. Conceal bends for conduit risers emerging above ground.
 - 5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
 - 6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 - 7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and

maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.

8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
- J. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for reinforced thermosetting resin conduit (RTRC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- K. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
 1. Where conduits pass from outdoors into conditioned interior spaces.
 2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- L. Provide grounding and bonding in accordance with Section 26 0526.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Penetration of fire rated walls, partitions, floors and ceilings: The contractor shall seal around all raceway penetrating fire rated walls, partitions, floors, and ceilings. Contractor shall utilize UL Listed material and shall install per UL Testing.
- B. Install conduit to preserve fire resistance rating of partitions and other elements.
- C. Route conduit through roof openings for piping and ductwork whenever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified herein.

END OF SECTION

SECTION 26 0533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Wall and ceiling outlet boxes.

1.2 RELATED REQUIREMENTS

- A. Section 26 0529 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- B. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- C. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- D. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- E. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- F. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
 - 2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 - 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use suitable concrete type boxes where flush-mounted in concrete.
 4. Use suitable masonry type boxes where flush-mounted in masonry walls.
 5. Use raised covers suitable for the type of wall construction and device configuration where required.
 6. Use shallow boxes where required by the type of wall construction.
 7. Do not use "through-wall" boxes designed for access from both sides of wall.
 8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes.
 12. Wall Plates: Comply with Section 26 2726.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA 250 Environment Type, Unless Otherwise Indicated:
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.2 MANUFACTURERS

2.3 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.

1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
 - a. Boxes and covers shall not be less than 1/16 inch thick.
 - b. Box shall be anchored in place.
 - c. Unless otherwise specified, ceiling outlet boxes need not be provided with plaster rings and shall be minimum two inches (2") deep. Boxes shall be provided with blank covers.
 - d.
 2. Concrete Ceiling Boxes: Concrete type.
 3. Switch and wall receptacles outlet boxes in plaster walls shall be four inches (4") square.
 4. In exposed masonry or tile walls, four inch (4") square boxes with deep plaster covers shall be used.
- B. Cast Boxes: NEMA FB 1, Type FD, cast ferrous alloy. Provide gasketed cover by box manufacturer. Provide threaded hubs.
- C. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.4 PULL AND JUNCTION BOXES

- A. All pullboxes and junction boxes shall be sized in accordance with the National Electrical Code.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 2716.
- D. Surface Mounted Exposed Boxes: Boxes shall be corrosion resistant cast iron in wet locations. Use solid steel boxes with no knockouts in dry locations. Holes for raceways shall be drilled on the job.
- E. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
 1. Material: Galvanized cast iron.
 2. Cover: Furnish with ground flange, neoprene gasket, and galvanized steel cover/screws.
- F. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
 1. Material: Galvanized cast iron.
 2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on drawings.
- B. Verify that mounting surfaces are ready to receive boxes.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Box Supports:
 - 1. Secure and support boxes in accordance with NFPA 70 and Section 26 0529 using suitable supports and methods.
 - 2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
- E. Install boxes plumb and level.
- F. Flush-Mounted Boxes:
 - 1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
 - 2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
 - 3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
- G. Install boxes as required to preserve insulation integrity.
- H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.

- J. Close unused box openings.
- K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
- L. Provide grounding and bonding in accordance with Section 26 0526.
- M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
- N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
- O. No more than one box extension shall be installed on any outlet or pull box. Larger boxes shall be installed as required per NEC.
- P. Provide outlet boxes for lighting fixtures, wall switches, wall receptacles, telecommunications equipment, protection equipment, antenna, and all equipment.
- Q. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
- R. Unless otherwise indicated wall outlet boxes shall be placed with center lines at distances above the finished floor (except at casework) as follows:
 - 1. Convenience Outlets: 18"
 - 2. Switches: 42"
 - 3. Clocks: 8'-2" or 12" below ceiling. Conform to lowest mounting.
 - 4. Fire Alarm Pull Stations: 48" to the operable handle.
 - 5. Fire Alarm Visual or Horn/Visual: 80" or 6" below ceiling - conform to lowest mounting. Device shall never be mounted higher than 96". Note that these measurements are made so that the entire strobe lens is within the range specified.
 - 6. Television Outlets: 18 inches
 - 7. Telecommunications Outlets: 18 inches
 - 8. Wall Phone Outlets: Per ADA requirements.
 - 9. Drinking Fountain Outlets: As recommended by manufacturer.
- S. The approximate locations of outlets are shown on the plans. The exact locations shall be determined at the building. The right is reserved to change the exact location of any outlet a maximum of 10 feet before it is permanently installed without additional cost.
- T. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
- U. Maintain headroom and present neat mechanical appearance.
- V. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.

- W. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- X. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- Y. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- Z. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
- AA. Where outlets are shown above cabinets and casework, the outlets shall be mounted so the bottom of the device plates will be 1 to 3 inches above the backsplash.
 - 1. Where outlets of different levels are shown adjacent, they shall be installed in one vertical line. Outlets shown back to back on a common wall shall be offset a minimum of 10 inches to dampen sound transmission through the wall. On all walls with 1 hour or greater fire rating, "back to back" outlets shall be minimum 24 inches apart with a stud between outlets for gypboard constructed partition.
 - 2. Where the mounting height of an outlet is not shown on the plans or specifications, the contractor shall contact the Design Professional for exact mounting height requirements.
 - 3. At locations where two or more devices are shown adjacent and at the same mounting height, they shall be installed in one outlet box and covered with one face plate.
- BB. Where outlets are installed in unfinished block or tile partitions, they shall be installed at the points in the tile to permit the face plate to cover the rough opening. The horizontal and vertical locations indicated may be altered to permit doing this. However, contractor shall check the Architectural drawings to prevent conflicts when shifting location. Where outlets are shown back to back on a common wall, they shall be offset 10" to avoid sound transmission.
- CC. Outlets in Poured-in-Place Concrete: A six by six by three inch (6"X6"X3") deep wood box shall be placed in the form before the concrete is poured. This box shall be removed before waterproofing is applied. Install outlet and grout around the box. Boxes shall be set so that cover plates are flush.
- DD. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- EE. Use flush mounting outlet box in finished areas.
- FF. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
- GG. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- HH. Use stamped steel bridges to fasten flush mounting outlet box between studs.
- II. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- JJ. Use adjustable steel channel fasteners for hung ceiling outlet box.

- KK. Do not fasten boxes to ceiling support wires.
- LL. Support boxes independently of conduit. Provide threaded rods, screws, bolts, toggle bolts, etc. for support. Do not use clips or other hardware to attach boxes to ceiling grids.
- MM. Use gang box where more than one device is mounted together. Do not use sectional box.
- NN. Use two gang box with plaster ring for single device outlets.
- OO. Use cast outlet boxes in exterior locations exposed to the weather and wet locations.
- PP. Use cast outlet boxes for all surface mount box installations in Mechanical Rooms.
- QQ. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.

3.3 ADJUSTING

- A. Adjust flush-mounting outlets to make front flush with finished wall material.
- B. Install knockout closures in unused box openings.

3.4 CLEANING

- A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

END OF SECTION

**SECTION 26 0553
IDENTIFICATION FOR ELECTRICAL SYSTEMS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Voltage markers.
- D. Warning signs and labels.

1.2 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.

PART 2 PRODUCTS

2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Panelboards:
 - 1) Identify power source and circuit number. Include location when not within sight of equipment.
 - 2) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
 - 3) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- B. Identification for Conductors and Cables:
 - 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
 - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
- C. Identification for Boxes:
 - 1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Nameplates:

1. Materials:
2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.

B. Identification Labels:

1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.3 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:

1. Materials:
2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:

1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
3. Minimum Size: 2 by 4 inches unless otherwise indicated.

END OF SECTION

**SECTION 26 0583
WIRING CONNECTIONS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 0533.13 - Conduit for Electrical Systems.
- B. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
- C. Section 26 0533.16 - Boxes for Electrical Systems.
- D. Section 26 2726 - Wiring Devices.

1.3 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 COORDINATION

- A. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- B. Determine connection locations and requirements.
- C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- D. General: No roughing shall be done until roughing drawings and exact electrical demand of equipment is obtained. Notify Design Professional of any discrepancies.
 - 1. Mechanical:
 - a. Review tabulated sheet of Power Wiring Requirements of all Mechanical Equipment specified in Division 23 of Specifications. Conduit, conductor, and breaker sizes shown for mechanical equipment are based upon the best available information on the equipment specified. The Contractor shall be allowed to provide electrical circuits compatible with the proposed mechanical equipment where the mechanical equipment conforms to Division 23 of the specifications, but does not conform to the electrical criteria of these contract documents. The Contractor shall submit the proposed electrical modifications to the Design Professional for review prior to roughing. No additional costs to the contract will be allowed for these modifications.

- b. Provide 4" thick concrete housekeeping pad beneath any equipment free standing on concrete floor. Pad shall extend 2" on all sides of equipment and shall be beveled 1 inch on all sides.
 - c. Provide conduit, wiring, boxes, adaptors for equipment terminations and disconnect switches. Provide power wiring through primary control device.
 - d. Starters, push-button stations, contactors, relays, limit and safety devices, and control items are specified in DIVISION 23 except as shown in Motor Control Center. Unless otherwise noted, all starters shall be mounted between 24" and 80" above finished floor. Push-button stations shall be mounted at switch height except as noted.
- E. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Wiring Devices: As specified in Section 26 2726.
- B. Flexible Conduit: As specified in Section 26 0534. Final connection to all HVAC equipment shall be LFMC.
- C. Wire and Cable: As specified in Section 26 0519.
- D. Boxes: As specified in Section 26 0537.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.

- H. Install terminal block jumpers to complete equipment wiring requirements.

- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements. Pay close attention to the requirements of DCU's and DAC's.
The electrical contractor is responsible for interconnecting the wiring between these two pieces.

END OF SECTION

SECTION 26 2200
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General purpose transformers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0533.13 - Conduit for Electrical Systems: Flexible conduit connections.
- C. Section 26 0533.13 - Conduit for Electrical Systems: Flexible conduit connections.

1.3 REFERENCE STANDARDS

- A. 10 CFR 431, Subpart K - Energy Efficiency Program for Certain Commercial and Industrial Equipment - Distribution Transformers; Current Edition.
- B. IEEE C57.94 - IEEE Recommended Practice for Installation, Application, Operation, and Maintenance of Dry-Type General Purpose Distribution and Power Transformers; 1982 (R2006).
- C. IEEE C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers; 2013.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA 409 - Standard for Installing and Maintaining Dry-Type Transformers; 2009.
- F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- G. NEMA TP 1 - Guide for Determining Energy Efficiency for Distribution Transformers; National Electrical Manufacturers Association; 2002.
- H. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers; National Electrical Manufacturers Association; 2005.
- I. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency; National Electrical Manufacturers Association; 2000.
- J. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- K. UL 506 - Standard for Specialty Transformers; Current Edition, Including All Revisions.
- L. UL 1561 - Standard for Dry-Type General Purpose and Power Transformers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.

- B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
- C. Test Reports: Indicate loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual locations of transformers.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com.
- B. ABB - General Electric
- C. Schneider Electric; Square D Products: www.schneider-electric.us.
- D. Siemens Industry, Inc: www.usa.siemens.com.

2.2 TRANSFORMERS - GENERAL REQUIREMENTS

- A. Description: Factory-assembled, dry type transformers for 60 Hz operation designed and manufactured in accordance with NEMA ST 20 and listed, classified, and labeled as suitable for the purpose intended.
- B. Unless noted otherwise, transformer ratings indicated are for continuous loading according to IEEE C57.96 under the following service conditions:

1. Altitude: Less than 3,300 feet.
 2. Ambient Temperature:
 - a. Greater than 10 kVA: Not exceeding 104 degrees F.
 - b. Less than 10 kVA: Not exceeding 77 degrees F.
 3. Ambient Temperature: Not exceeding 86 degrees F average or 104 degrees F maximum measured during any 24 hour period.
- C. Core: High grade, non-aging silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Keep magnetic flux densities substantially below saturation point, even at 10 percent primary overvoltage. Tightly clamp core laminations to prevent plate movement and maintain consistent pressure throughout core length.
- D. Impregnate core and coil assembly with non-hydroscopic thermo-setting varnish to effectively seal out moisture and other contaminants.
- E. Basic Impulse Level: 10 kV.
- F. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- G. Isolate core and coil from enclosure using vibration-absorbing mounts.
- H. Nameplate: Include transformer connection data, ratings, wiring diagrams, and overload capacity based on rated winding temperature rise.

2.3 GENERAL PURPOSE TRANSFORMERS

- A. Description: Self-cooled, two winding transformers listed and labeled as complying with UL 506 or UL 1561; ratings as indicated on the drawings.
- B. Insulation System and Allowable Average Winding Temperature Rise:
1. Less than 15 kVA: Class 180 degrees C insulation system with 115 degrees C average winding temperature rise.
 2. 15 kVA and Larger: Class 220 degrees C insulation system with 150 degrees C average winding temperature rise.
- C. Coil Conductors: Continuous aluminum windings with terminations brazed or welded.
- D. Winding Taps:
1. Less than 3 kVA: None.
 2. 3 kVA through 15 kVA: Two 5 percent full capacity primary taps below rated voltage.
 3. 15 kVA through 300 kVA: Two 2.5 percent full capacity primary taps above and four 2.5 percent full capacity primary taps below rated voltage.

4. 500 kVA and Larger: Two 2.5 percent full capacity primary taps above and two 2.5 percent full capacity primary taps below rated voltage.
- E. Energy Efficiency: Comply with 10 CFR 431, Subpart K.
- F. Energy Efficiency: Standard efficiency complying with NEMA TP 1.
 1. Test efficiency according to NEMA TP 2.
 2. Label transformer according to NEMA TP 3.
- G. Sound Levels: Standard sound levels complying with NEMA ST 20
- H. Mounting Provisions:
 1. Less than 15 kVA: Suitable for wall mounting.
 2. 15 kVA through 75 kVA: Suitable for wall, floor, or trapeze mounting.
 3. Larger than 75 kVA: Suitable for floor mounting.
- I. Transformer Enclosure: Comply with NEMA ST 20.
 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 2. Construction: Steel.
 - a. Less than 15 kVA: Totally enclosed, non-ventilated.
 - b. 15 kVA and Larger: Ventilated.
 3. Finish: Manufacturer's standard grey, suitable for outdoor installations.
 4. Provide lifting eyes or brackets.
- J. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers , ratings as indicated.
- K. Primary Voltage: 480 volts, 3 phase.
- L. Secondary Voltage: 208Y/120 volts, 3 phase.
- M. Insulation system and average winding temperature rise for rated kVA as follows:
 1. 1-15 kVA: Class 185 with 115 degrees C rise.
 2. 16-500 kVA: Class 220 with 115 degrees C rise.
- N. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point at full load.
- O. Winding Taps:

1. Transformers Less than 15 kVA: Two 5 percent below rated voltage, full capacity taps on primary winding.
 2. Transformers 15 kVA and Larger: NEMA ST 20.
- P. Basic Impulse Level: 10 kV.
- Q. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- R. Coil Conductors: Continuous windings with terminations brazed or welded.
- S. Transformer coils shall be vacuum impregnated with non-hygroscopic, thermosetting varnish and shall have a final wrap of electric insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible are not acceptable.
- T. On units 500 kVA and smaller the vibration isolating system shall be so designed as to provide for continual securement of the core and coil unit to the enclosure.
- U. Sound isolating systems requiring the removal of all tie down facilities are not acceptable.
- V. Transformer Enclosure: NEMA ST 20.
1. Type 1.
 2. Ventilated.
 3. All ventilating openings shall be of the louvered type. Expanded metal coverings are not acceptable.
 4. The base of the transformer shall be constructed of minimum 12 gauge steel, with stamped openings for ventilation.
 5. Provide lifting eyes or brackets.
 6. The enclosure shall be degreased, cleaned and phosphatized with one coat of zinc chromate primer and one coat of baked enamel.
 7. The core and coil shall be visibly grounded to the frame of the transformer cubicle by means of a flexible strap.
 8. A maximum case temperature shall not exceed a 35 degree Celsius rise above ambient at its warmest point.
- W. Isolate core and coil from enclosure using vibration-absorbing mounts.
- X. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 SOURCE QUALITY CONTROL

- A. Factory test transformers according to NEMA ST 20.

- B. Production test each unit according to NEMA ST 20.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1.
- B. Install transformers in accordance with manufacturer's instructions.
- C. Install transformers in accordance with NECA 409 and IEEE C57.94.
- D. Use flexible conduit, under the provisions of Section 26 0533.13, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- E. Arrange equipment to provide minimum clearances as specified on transformer nameplate and in accordance with manufacturer's instructions and NFPA 70.
- F. Set transformers plumb and level.
- G. Use flexible conduit, under the provisions of Section 26 0534, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- H. Mount wall-mounted transformers using integral flanges or accessory brackets furnished by the manufacturer. Provide plywood backboard for mounting and reinforce wall as required to support the transformer.
- I. Mount floor-mounted transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
 - 1. Pads shall be rubber in shear type isolating pads under each transformer corner. Bolt the isolator to the transformer and to the floor or support.
- J. Mount trapeze-mounted transformers as indicated. See mounting detail on drawings.
- K. Provide seismic restraints.
- L. Provide grounding and bonding in accordance with Section 26 0526.
- M. Remove shipping braces and adjust bolts that attach the core and coil mounting bracket to the enclosure according to manufacturer's recommendations in order to reduce audible noise transmission.
- N. Where not factory-installed, install lugs sized as required for termination of conductors as shown on the drawings.
- O. Install transformer identification nameplate in accordance with Section 26 0553.
- P. Coordinate transformer suspension with Design Professional to minimize noise transmission. In each suspension rod, provide a spring hanger isolator.

3.2 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.
- C. Inspect and test in accordance with NETA STD ATS, except Section 4.

3.3 ADJUSTING

- A. Measure primary and secondary voltages and make appropriate tap adjustments.
- B. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

END OF SECTION

**SECTION 26 2416
PANELBOARDS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0529 - Hangers and Supports for Electrical Systems.
- D. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NECA 407 - Standard for Installing and Maintaining Panelboards; 2009.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- D. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- E. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- F. UL 67 - Panelboards; Current Edition, Including All Revisions.
- G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement and sizes.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- D. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- E. Maintenance Data: Include spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.6 MAINTENANCE MATERIALS

- A. See Section 01 6000 - Product Requirements, for additional provisions.
- B. Furnish two of each panelboard key.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ABB/GE; _____: www.electrification.us.abb.com/#sle.
- B. Eaton Electrical/Cutler-Hammer; Model _____: www.eatonelectrical.com.
- C. ABB - General Electric
- D. Square D; Model _____: www.squared.com.
- E. Siemens Industry, Inc; _____: www.usa.siemens.com/#sle.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
- D. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- E. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

- F. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- G. Conductor Terminations: Suitable for use with the conductors to be installed.
- H. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- I. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Aluminum.
 - 2. Ground Bus Material: Aluminum.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.

- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
- F. Manufacturers: Square D, General Electric, Cutler-Hammer, ITE/Siemens Allis.
- G. Description: NEMA PB 1, circuit breaker type, factory assembled.
- H. Panelboard Bus: Aluminum, ratings as indicated. Provide copper ground bus in each panelboard, bonded to panel enclosure.
- I. Bus Assembly Arrangement: Distribution phase sequence type vertically numbered so that odd numbered single poles and spaces are located on the left. No two single poles or spaces, vertically, shall be connected to the same phase. All current carrying parts shall be plated. See schedules for special arrangements.
- J. Minimum integrated short circuit rating:
 - 1. 208/240 Volt Panelboards: 22,000 amperes rms symmetrical.
 - 2. 480 Volt Panelboards: 42,000 amperes rms symmetrical.
 - 3. Series rating is not allowed.
- K. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse clips: Designed to accommodate Class R fuses.
- L. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR. All load side connections of the same breaker shall be in the same gutter for multi-pole breakers.
- M. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.
- N. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole: UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- O. Controllers: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower, with bimetal overload relay.
 - 1. Coil operating voltage: 120 volts, 60 Hz.
 - 2. Coil operating voltage: 120 volts, DC.
- P. Size as shown on Drawings.
 - 1. Provide unit mounted control power transformer, RED indicating light in front cover.

- Q. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.
- R. Enclosures shall be NEMA 1 unless otherwise noted. Dimensions of enclosure shall not exceed what is shown on the plans.
 - 1. Provide with code size side and end gutters, 4 inch minimum.
 - 2. Enclosure shall be constructed of galvanized code gauge steel.
 - 3. Boxes shall NOT be furnished with concentric knockouts pre-punched by the manufacturer.
- S. Cabinet Front: Surface type, fastened with adjustable, concealed trim clamps, hinged door with flush lock, metal directory frame, finished in rust inhibiting prime coat and manufacturer's standard gray enamel. Directory cover shall be glass or clear plastic. Front shall be constructed of code gauge steel.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Aluminum.
 - 3. Ground Bus Material: Aluminum.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Provide clear plastic circuit directory holder mounted on inside of door.
- F. Manufacturers: Square D, General Electric, Cutler-Hammer, ITE/Siemens Allis.
- G. Description: NEMA PB1, circuit breaker type, factory assembled lighting and appliance branch circuit panelboard.

- H. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard, bonded to panel enclosure; provide insulated ground bus where scheduled.
- I. Bus Assembly Arrangement: Distribution phase sequence type vertically numbered so that odd numbered single poles and spaces are located on the left. No two single poles or spaces, vertically, shall be connected to the same phase. All current carrying parts shall be plated. See schedules for special arrangements.
- J. Minimum Integrated Short Circuit Rating:
 - 1. 208/240 Volt Panelboards: 10,000 amperes rms symmetrical.
 - 2. 480 Volt Panelboards: 14,000 amperes rms symmetrical.
 - 3. Series rating is not allowed.
- K. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, quick-make, quick-break, ambient compensated with common trip handle for all poles; UL listed.
 - 1. Type SWD for lighting circuits.
 - 2. Type HACR for air conditioning equipment circuits.
 - 3. Class A ground fault interrupter circuit breakers where scheduled.
 - 4. Do not use tandem circuit breakers.
 - 5. All load side connections of the same breaker shall be in the same gutter for multi-pole breakers.
- L. Current Limiting Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole; UL listed. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.
- M. Enclosure: NEMA PB 1, Type 1.
 - 1. Provide with code size side and end gutters, 4 inch minimum.
 - 2. Enclosure shall be constructed of galvanized code gauge steel.
 - 3. Boxes shall NOT be furnished with concentric knockouts pre-punched by the manufacturer.
- N. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.
- O. Cabinet Front: ____ cabinet front with adjustable, concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Directory cover shall be glass or clear plastic. Finish with rust inhibiting prime coat and manufacturer's standard gray enamel.

2.5 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:

1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
5. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), NEMA PB 1.1, NECA 1 (general workmanship), NECA 407 (panelboards), NEMA PB 1.1, NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 0529.
- E. Install panelboards plumb.
- F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- H. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

- I. Provide grounding and bonding in accordance with Section 26 0526.
- J. Install all field-installed branch devices, components, and accessories.
- K. Install panelboards in accordance with NEMA PB 1.1 and the NECA Standard of Installation.
- L. Install panelboards plumb. Install recessed panelboards flush with wall finishes.
- M. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- N. Provide 4 inch high, 6 inch deep concrete housekeeping pad beneath each surface mounted panelboard. The concrete pad shall enclose all conduits feeding into the panelboard from the floor.
- O. Provide filler plates to cover unused spaces in panelboards.
- P. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.
- Q. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads. Directory shall contain complete equipment identification and space numbers of all spaces controlled by branch circuits.
- R. Provide identification nameplate for each panelboard in accordance with Section 26 0553.
- S. Provide arc flash warning labels in accordance with NFPA 70.
- T. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
 - 1. Minimum spare conduits: 3 empty 3/4 inch.
- U. Shunt Trip Circuit Breakers: Provide conduit and conductors to interlock control of shunt trip breakers.
- V. Ground and bond panelboard enclosure according to Section 26 0526.

3.2 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS, except Section 4.
- B. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
- C. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.3 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

- B. Adjust alignment of panelboard fronts.

END OF SECTION

**SECTION 26 2417
SURGE PROTECTIVE DEVICES (SPDS)**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low Voltage AC Surge Protection for Electrical Distribution Systems

1.2 RELATED SECTIONS

- A. Section 26 2416 - Panelboards

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code; National Fire Protection Association; 2020.
- B. ANSI/UL 1449 - Fourth Edition

1.4 DEFINITIONS

- A. Where items are shown as "lightning arrestor", "lightning suppressor", "surge arrestor", "arrestor", "suppressor", "transient voltage surge suppressor" (TVSS), or "surge suppressor", provide Surge Protective Device (SPD).

1.5 SUBMITTALS

- A. See Section 26 0510- General Electrical Requirements, for submittal procedures.
- B. Provide verification that the SPD complies with the required ANSI/UL 1449 4th Edition listing by Underwriters Laboratories (UL). Compliance may be in the form of a file number that can be verified on UL's website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (In).
- C. For sidemount mounting applications (SPD mounted external to electrical assembly), electrical/mechanical drawings showing unit dimensions, weights, installation instruction details, and wiring configuration.
- D. Product Data: Provide data sheets for each different component to be used.
 - 1. Provide a list of device locations with the corresponding device type proposed.
 - 2. Show that Surge Protective Devices (SPDs) and associated components are manufactured in the United States of America.
- E. Submit a copy of the written guarantee.
- F. Provide a letter stating that the manufacturer shall provide unit replacement within 48 hours of notification by the Owner with or without prior receipt of damaged parts.
- G. Operating & Maintenance Data:

1. Submit the service organization name and phone number.
2. Operation and maintenance manuals shall be provided with each SPD shipped.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
- B. SPD units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 4th Edition).

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of manufacturer's instructions shall be included with the equipment at time of shipment.

1.8 WARRANTY

- A. The manufacturer shall provide a full five (5) year warranty from the date of shipment against any SPD part failure when installed in compliance with manufacturer's written instructions and any applicable national or local code.
- B. Warranty shall begin upon the date of final building acceptance by the Owner.
- C. During the warranty period, the manufacturer shall provide new SPDs to arrive at the Owner's premises within 48 hours of the Owner's request.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. APT
- B. Liebert
- C. Square D
- D. ABB - General Electric
- E. Eaton
- F. Siemens
- G. Surge Suppression, Inc.

2.2 VOLTAGE SURGE SUPPRESSION - GENERAL

- A. Electrical Requirements:
 1. Unit Operating Voltage - Refer to drawings for operating voltage and unit configuration.
 2. Maximum Continuous Operating Voltage (MCOV) - The MCOV shall not be less than 125% of the nominal system operating voltage.

3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
 4. Protection Modes - The SPD must protect all modes of the electrical system being utilized. The required protection modes are:
 - a. Line-to-Neutral
 - b. Line-to-Ground
 - c. Line-to-Line
 - d. Neutral-to-Ground
 5. Nominal Discharge Current (In) - All SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an In less than 20kA shall be rejected.
 6. ANSI/UL 1449 4th Edition Voltage Protection Rating (VPR) - The maximum ANSI/UL 1449 4th Edition VPR for the device shall not exceed the following:
 - a. 480Y/277 Volts:
 - 1) L-N, L-G, N-G = 1200
 - 2) L-L = 2000
 - b. 208Y/120 Volts:
 - 1) L-N, L-G, N-G = 800
 - 2) L-L = 1200
- B. SPD Design:
1. Maintenance Free Design - The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 2. Balanced Suppression Platform - The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.
 3. Electrical Noise Filter - Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 30 dB from 10 kHz to 100 MHz

using the MIL-STD-220A insertion loss test method. Products unable able to meet this specification shall not be accepted.

4. Internal Connections - No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
5. Monitoring Diagnostics - Each SPD shall provide the following integral monitoring options:
 - a. Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.
 - 1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.
 - 2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.
 - 3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
 - b. Remote Status Monitor - The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.
 - c. Audible Alarm and Silence Button - The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.
 - d. Surge Counter - The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
 - 1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory

and displayed after power is restored. A backup battery may also be utilized in order to achieve this functionality.

6. Overcurrent Protection - The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.
7. Fully Integrated Component Design - All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules may be ganged together in order to achieve higher surge current ratings.
8. Safety Requirements:
 - a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. Replaceable modules are acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
 - b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.

2.3 SYSTEM APPLICATION

- A. The SPD applications covered under this section include distribution and branch panel locations, busway, motor control centers (MCC), switchgear, and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.
- B. Surge Current Capacity - The minimum surge current capacity the device is capable of withstanding (based on ANSI/IEEE C62.41 location category) shall be as follows:
 1. Category C (Service Entrance Locations - Switchboards, Switchgear, Motor Control Centers, Main Entrance):
 - a. Per Phase - 240 kA
 - b. Per Mode - 120 kA
 2. Category B (High Exposure Rooftop Locations - Distribution Panelboards):
 - a. Per Phase - 160 kA
 - b. Per Mode - 80 kA
 3. Category A (Branch Locations - Panelboards, MCCs, Busways):
 - a. Per Phase - 120 kA

b. Per Mode - 60 kA

- C. SPD Type - all SPDs installed on the line side of the service entrance disconnect shall be Type 1 SPDs. All SPDs installed on the load side of the service entrance disconnect shall be Type 1 or Type 2 SPDs.

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

- A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
 2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
 3. The panelboard shall be capable of re-energizing upon removal of the SPD.
 4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
 5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
 6. Sidemount Mounting Applications Installation (SPD mounted external to electrical assembly): Lead length between the breaker and suppressor shall be kept as short as possible to ensure optimum performance. Any excess conductor length shall be trimmed in order to minimize let-through voltage. The installer shall comply with the manufacturer's recommended installation and wiring practices.

2.5 ENCLOSURES

- A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings and as described below:
1. NEMA 1 - Constructed of a polymer (units integrated within electrical assemblies) or steel (sidemount units only), intended for indoor use to provide a degree of protection to personal access to hazardous parts and provide a degree of protection against the ingress of solid foreign objects (falling dirt).
 2. NEMA 4 - Constructed of steel intended for either indoor or outdoor use to provide a degree of protection against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (dirt and windblown dust); to provide a degree of protection with respect to the harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose

directed water); and that will be undamaged by the external formation of ice on the enclosure. (sidemount units only).

3. NEMA 4X - Constructed of stainless steel providing the same level of protection as the NEMA 4 enclosure with the addition of corrosion protection. (sidemount units only)

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Surface or Flush Mounted Panelboards with Exterior SPDs: Mount SPDs on the side or bottom of the panelboard, closest to the serving breaker. Make leads as short and straight as possible.
- C. Provide multi-pole, 30 Amp breaker as a dedicated disconnect for SPD unless otherwise indicated on drawings. Provide breakers for ALL SPDs.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality control testing:
 1. After installing the Surge Protection Device, but before electrical circuitry has been energized, test for compliance with requirements.
 2. Complete start-up checks and voltage verifications according to manufacturer's written instructions.
 3. Perform visual and mechanical inspection on each unit. Certify that units are installed per manufacturer's recommendations.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

END OF SECTION

**SECTION 26 2726
WIRING DEVICES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Receptacles.
- C. Wall plates.

1.2 RELATED REQUIREMENTS

- A. Section 26 0533.16 - Boxes for Electrical Systems.
- B. Section 26 0533.16 - Boxes for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- B. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- C. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- D. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- E. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- F. UL 943 - Ground-Fault Circuit-Interruptioners; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
 - 2. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
 - 3. Notify the Design Professional of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.

- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 GENERAL:

- A. Different type devices shall match in color. Receptacles, light switches, low voltage switches, wall mounted occupancy sensors, etc. shall be the same color with the same type of trim or cover. Provide submittals data indicating this color prior to purchasing.

2.2 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Unless noted otherwise, do not use combination switch/receptacle devices.

2.3 WIRING DEVICE FINISHES

- A. Provide wiring device finishes as described below unless otherwise indicated.
- B. Wiring Devices, Unless Otherwise Indicated: Ivory with stainless steel wall plate.
- C. Wiring Devices Installed in Wet or Damp Locations: Ivory with specified weatherproof cover.

2.4 WALL SWITCHES

- A. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable FS W-S-896; types as indicated on the drawings.
 - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
- B. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.

- C. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- D. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- E. Switch Types: Single pole, double pole, 3-way, 4-way, pilot gang, and key.
 - 1. Single Pole Switches:
 - a. Eaton AH1221
 - b. Hubbell HBL1221
 - c. Leviton 1221-2
 - d. P&S PS20AC1
 - 2. Double Pole Switches:
 - a. Eaton AH1222
 - b. Hubbell HBL1222
 - c. Leviton 1222-2
 - d. P&S PS20AC2
 - 3. 3-Way Switches:
 - a. Eaton AH1223
 - b. Hubbell HBL1223
 - c. Leviton 1223-2
 - d. P&S PS20AC3
 - 4. 4-Way Switches:
 - a. Eaton AH1224
 - b. Hubbell HBL1224
 - c. Leviton 1224-2
 - d. P&S PS20AC4
 - 5. Pilot Gang (provide for lighting control of all Janitor's closets, closets, and storage spaces where the switch is located outside the space):

- a. Eaton AH1221PL
 - b. Hubbell HBL1221PL
 - c. Leviton 1221-PL
 - d. P&S PS20AC1-RPL7
6. Key:
- a. Eaton AH1221L
 - b. Hubbell HBL1221L
 - c. Leviton 1221-2L
 - d. P&S PS20AC1-L

2.5 RECEPTACLES

- A. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
 2. NEMA configurations specified are according to NEMA WD 6.
- B. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
 2. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap; isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
 3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
 4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
 5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
- C. GFCI Receptacles:

1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.

D. Outlet Types:

1. Duplex Convenience Receptacles.
 - a. Eaton AH5362
 - b. Hubbell HBL5362
 - c. Leviton 5362
 - d. P&S 5362-A
2. GFCI Receptacles: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Devices shall be UL943 Compliant.
 - a. Eaton SGF20
 - b. Hubbell GFR5362
 - c. Leviton GFTR2-HFG
 - d. P&S PT2097

2.6 WALL PLATES

- A. Wall Plates: Comply with UL 514D.
1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
 2. Size: Standard.
 3. Screws: Metal with slotted heads finished to match wall plate finish.

- B. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- C. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- F. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
- C. Coordinate locations of outlet boxes provided under Section 26 0533.16 as required for installation of wiring devices provided under this section.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- I. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
- J. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
- K. Install in accordance with NECA "Standard of Installation."
- L. Install wiring devices plumb and level with mounting yoke held rigidly in place.
- M. Install wall switches with OFF position down.
- N. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- O. Do not share neutral conductor on branch circuits utilizing wall dimmers.
- P. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
- Q. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- R. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
- S. Install receptacles with grounding pole on bottom.
- T. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
- U. Install wall plates on switch, receptacle, and blank outlets.
- V. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- W. Connect wiring devices by wrapping conductor around screw terminal.
- X. Use jumbo size plates for outlets installed in masonry walls.
- Y. Install plates with all edges in contact with the finished wall.
- Z. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- AA. Mount all plates vertically unless otherwise noted.
- BB. Where two or more devices are shown adjacent, they shall be mounted in ganged boxes and covered with one faceplate.

- CC. Install protective rings on active flush cover service fittings.
- DD. Where outlets of different levels are shown adjacent, they shall be installed in one vertical line. Outlets shown back to back on a common wall shall be offset a minimum of 10 inches to dampen sound transmission through the wall.
- EE. On all walls with 1 hour or greater fire rating, "back to back" outlets shall be installed a minimum of 24 inches apart. Mount with stud between outlets for gypboard constructed partitions.
- FF. Where outlets are installed in unfinished block or tile partitions they shall be installed at the points in the tile to permit the face plate to cover the rough opening. The horizontal and vertical locations indicated may be altered to permit above installation. Contractor shall check the Architectural drawings to prevent conflicts when shifting locations.
- GG. Provide GFI receptacles where located within 6' of a water source, and as shown on plans.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under Section 26 0537 to obtain mounting heights specified.
- B. Where outlets are shown above cabinets or casework, install outlet 6 inches above backsplash of counter.
- C. Where the mounting height of an outlet is not shown on the plans or specifications, the contractor shall contact the Design Professional for exact mounting height requirements.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspect each wiring device for damage and defects.
- C. Operate each wall switch and wall dimmer with circuit energized to verify proper operation.
- D. Operate each wall switch with circuit energized and verify proper operation.
- E. Verify that each receptacle device is energized.
- F. Test each receptacle device for proper polarity prior to final inspection.
- G. Test each GFCI receptacle for proper tripping operation according to manufacturer's instructions.
- H. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.7 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION

**SECTION 26 2813
FUSES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.

1.2 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- B. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 MAINTENANCE MATERIALS

- A. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS: BUSSMAN, G.E., FERRAZ SHAWMUT, ECONOMY, CEFCO, CUTLER HAMMER.

2.2 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Use only fuses of voltage, amperage and class compatible with fuse holder or disconnect.
- F. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- G. Voltage: Rating suitable for circuit phase-to-phase voltage.
- H. Main Service Switches Larger than 600 amperes: Class L (time delay).

- I. Disconnect Switches: 208 or 240V system U.L. Class RK-5, 250 volt rating with minimum interrupting capacity of 200,000 symmetrical amperes.
- J. Disconnect Switches: 277/480V or 600V systems U.L. Class RK-5, 600 volt rating with minimum interrupting capacity of 200,000 symmetrical amperes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Provide fuses in all fused devices. This shall include equipment of other trades.
- C. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION

**SECTION 26 2816.13
ENCLOSED CIRCUIT BREAKERS**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed circuit breakers.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 0553 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2014.
- C. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- D. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.
- E. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- F. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements for submittal procedures.
- B. Product Data: Provide catalog sheets showing ratings, trip units, time current curves, dimensions, and enclosure details.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Perform Work in accordance with NECA Standard of Installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com/#sle.
- B. ABB - General Electric
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

2.2 ENCLOSED CIRCUIT BREAKERS

- A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between 23 degrees F and 104 degrees F.
- D. Short Circuit Current Rating:
 - 1. Provide enclosed circuit breakers with listed short circuit current rating not less than the short circuit rating of the next upstream overcurrent protection device..
- E. Conductor Terminations: Suitable for use with the conductors to be installed.
- F. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.
- G. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
- H. Provide externally operable handle with means for locking in the OFF position.

2.3 MOLDED CASE CIRCUIT BREAKERS

- A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489 and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
- B. Interrupting Capacity:
 - 1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:

2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- C. Conductor Terminations:
1. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
- D. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
- E. Circuit Breakers: NEMA AB 1.
1. Enclosure shall be NEMA 1 rated for indoor applications and NEMA 3R where exposed to weather.
 2. Provide with non-teasible, positive, quick-make, quick-break mechanisms.
 3. Minimum interrupting capacity (UL and NEMA) shall match that of the next panelboard upstream.

2.4 TRIP UNITS

- A. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time continuous current, short time pickup current setting for automatic operation. Range of Adjustment: ____ seconds.
- B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 200 amperes and larger with changeable trip units.
- C. Current Limiting Circuit Breaker: Provide circuit breaker as indicated with automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.
- D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with integral ground fault sensing; instantaneous trip.

2.5 ACCESSORIES

- A. Enclosures: NEMA AB 1, Type 1.
1. Fabricate enclosures from steel.
 2. Finish: Manufacturer's standard enamel finish, gray color.
- B. Undervoltage Trip Device: 120 volts, AC.
- C. Electrical Operator: 120 volts, AC.
- D. Handle Lock: Include provisions for padlocking.
- E. Provide mechanical trip device.
- F. Provide grounding lug in each enclosure.

- G. Provide products suitable for use as service entrance equipment where so applied.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.
- B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Install enclosed circuit breakers plumb. Provide supports in accordance with Section 26 0529.
- E. Install enclosed circuit breakers plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Maximum mounting height to operating handle shall be 6 feet (1.9 M).
- I. Provide identification nameplates for each enclosed circuit breaker in accordance with Section 26 0553.
- J. Provide arc flash warning labels in accordance with NFPA 70.

3.2 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Perform inspection, testing, and adjusting in accordance with Section 01 4000.
- C. Inspect and test in accordance with manufacturer's instructions and NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than _____ amperes. Tests listed as optional are not required.
- E. Correct deficiencies and replace damaged or defective enclosed circuit breakers.
- F. Inspect and test each circuit breaker to NEMA AB 1.
- G. Inspect each circuit breaker visually.
- H. Perform several mechanical ON-OFF operations on each circuit breaker.
- I. Verify circuit continuity on each pole in closed position.

- J. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.
- K. Include description of testing and results in test report.

3.3 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

END OF SECTION

**SECTION 26 2816.16
ENCLOSED SWITCHES**

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fusible switches.
- B. Nonfusible switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- B. Section 26 0529 - Hangers and Supports for Electrical Systems.
- C. Section 26 2813 - Fuses.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- B. NFPA 70 - National Electrical Code, 2020 Edition; National Fire Protection Association.

1.4 SUBMITTALS

- A. See Section 26 0510 - General Electrical Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

1.5 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation: www.eaton.com/#sle.
- B. ABB - General Electric
- C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- D. Siemens Industry, Inc: www.usa.siemens.com/#sle.

2.2 COMPONENTS

- A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch (H.P. Rated).

1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 2. Handle and switching mechanism integral with switch base, with easily recognizable position and lockable in OFF position.
 3. Visible blades.
 4. Non-teasible, positive, quick-make, quick-break mechanism.
 5. Line terminal shields.
 6. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.
- B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch (H.P. Rated).
1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
 2. Handle and switching mechanism integral with switch base, with easily recognizable position and lockable in OFF position.
 3. Visible blades.
 4. Non-teasible, positive, quick-make, quick-break mechanism.
 5. Line terminal shields.
- C. Enclosures: NEMA KS 1.
1. Interior Dry Locations: Type 1.
 2. Exterior locations: Type 3R

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches in accordance with manufacturer's instructions.
- B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required supports in accordance with Section 26 0529.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

- G. Provide grounding and bonding in accordance with Section 26 0526.
- H. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
- I. Provide arc flash warning labels in accordance with NFPA 70.
- J. Install fuses in fusible disconnect switches.
- K. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

END OF SECTION