SECTION 00 01 07 – SEALS PAGE

Professional Certification: I hereby certify that these documents were prepared or approved by me and that I am a duly registered Professional Engineer in the State of Washington. My stamp only applies to the sections listed below.

Name	Sections	Stamp
Benjamin Roush, PE (Mechanical & Fire Protection), LEED AP BD+C, CCP, ASHRAE BEMP and BEAP, CEPE License No. 45144	23 05 00 23 05 05 23 05 11 23 09 13 23 09 23 23 09 34	 1/23/25
Arthur Stokes, PE License No. 34736	26 05 00 26 05 01 26 05 33.13	 1/23/25

END OF SECTION 00 01 07

SECTION 23 05 00 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.

1.02 SCOPE OF WORK – GENERAL

A. This section specifies general requirements for HVAC installations and includes requirements common to more than one section of Division 23..

B. Provide materials, labor, transportation, tools, permits, fees, inspections, utilities and incidentals necessary for the complete installation of HVAC work indicated and described in the Contract Documents.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional details or special construction are required for work indicated or specified under this section of work or work specified in other sections, provide material and equipment which is usually furnished with such systems to complete the installation, whether mentioned or not.

1.03 CODES AND STANDARDS

A. Code Compliance: Comply with most current edition adopted by the Authority Having Jurisdiction of the following:

1. ASTM D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
2. ASTM E814 – Standard Test Method for Fire Tests of Penetration Firestop Systems.
3. ICC (IBC) – International Building Code.
4. ICC (IFC) – International Fire Code.
5. ICC (IFGC) – International Fuel Gas Code.
6. ICC (IMC) – International Mechanical Code.
7. NFPA 70 – National Electrical Code.
8. Washington State Energy Code, Commercial Provisions.
9. Applicable State and local codes, laws, and ordinances.

1.04 SEQUENCE OF WORK

A. Conduct work in sequence to provide least interference to the activities of the Owner, and to permit orderly transfer of activities and equipment to completed areas. To be approved by owner prior to execution

1.05 ALTERNATES

A. All alternate products to be approved in writing by either the owner or engineer prior to installation.

1.06 DEFINITIONS

A. Provide: Furnish and install complete and ready for intended use.

B. Indicated: Indicated on drawings.

C. Noted: Noted on Drawings or in Specifications.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

E. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

F. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

G. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

H. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.07 SAFETY OF PERSONS AND PROPERTY

A. Comply with applicable laws, ordinances, rules, and regulations of any public authority for the safety of persons and property, including requirements of the Washington Department of Safety and Health (DOSH) or the Occupational Safety and Health Act (OSHA) whichever is most stringent, and WSDOT 1-07.1, General and Supplementary Conditions.

1.08 PERMITS AND FEES

A. Obtain and pay for required permits and fees necessary to fully complete work included in the Contract Documents.

1.09 INTENT AND INTERPRETATION

A. Drawings and Specifications supplement each other, and any details contained in one and not the other shall be included as if contained in both. Items not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation shall be included.

B. Drawings are partly diagrammatic and do not necessarily show the exact location of new piping and existing utilities, unless specifically dimensioned.

C. Riser and other diagrams are schematic only and do not necessarily show the physical arrangement of equipment. They shall not be used for obtaining quantities or linear runs of piping.

D. Location of piping and ductwork shall be checked to determine that it clears openings and structural members; that it may be properly concealed; and that it clears cabinets, lights and equipment having fixed locations.

E. Mechanical drawings shall serve as working drawings for Division 23 work. Refer to Architectural, Structural, and Electrical drawings for additional detail affecting the installation of work. The Architectural drawings shall take precedence over the Mechanical drawings if any dimensional discrepancies exist.

F. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details regarding location. Exact locations are to be determined by actual measurements at the building. Not all pipe and duct offsets are indicated on the drawings.

1.10 SUBMITTAL OF EQUIPMENT FOR APPROVAL

A. Refer to WSDOT Standard Specification 1-06 “Control of Materials” for submittal definitions Additional requirements are listed below.

B. Shop drawings, catalog information, and material schedules shall be submitted for approval on materials and equipment prior to ordering.

C. Submit a single, complete submittal package for products in Division 23. Submittal package shall be organized by specification number. PDFs shall be bookmarked.

1.11 GUARANTEE

A. Guarantee satisfactory operation of material and equipment installed under Division 23. Repair or replace any defective materials, equipment, or workmanship which may show itself within one year from the date of Substantial Completion.

PART 2 - PRODUCTS

2.01 GENERAL MATERIALS AND EQUIPMENT REQUIREMENTS

A. Where more than one manufacturer is listed, provide products of only one manufacturer for each type of product.

B. Materials used under this Contract, unless specifically noted otherwise, shall be new and of the latest and most current model line produced by the manufacturer. Outdated “new” equipment is not acceptable.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2.02 EQUIPMENT AND MATERIAL SUBSTITUTIONS

A. Throughout these Contract Documents, various materials, equipment, apparatus, etc., are specified by manufacturer, brand name, type, or catalog number. Such designation is to establish standards of desired quality and construction, and shall be the basis of the bid.

B. Where more than one manufacturer is listed, and only one manufacturer's catalog number is indicated, that standard of quality and construction shall be maintained by materials supplied by other manufacturer(s).

C. Substitutions of equipment or materials shall be made only with prior approval. Prior approval requests must be received at least ten (10) days prior to bid date unless otherwise instructed.

D. Acceptance of a substitution request signifies manufacturer recognition only. No attempt has been made to check each item as to special features, capacities, or physical dimensions required by this project. Verify requirements before submitting for approval. Acceptance of exact features, sizes, capacities, etc., all of which must meet or exceed design requirements will be determined when submitted during the construction phase.

E. Substitution request must include manufacturer, specific model number, special features, physical dimensions, and capacities of proposed equipment. Verify requirements before submitting for approval.

F. The Contractor shall bear full responsibility for substituted equipment and materials, including, but not limited to:

1. Costs.
2. Available space requirements.
3. Effect on other trades.
4. Changes in electrical requirements.
5. Changes in structural requirements.

PART 3 - EXECUTION

3.01 COMMISSIONING

A. At a minimum, comply with the requirements of the Washington State Energy Code.

3.02 COORDINATION

A. Refer to WSDOT Standard Spec 1-08.4 for coordination with other work.

B. Coordinate available space for equipment and systems with other trades. Refer to Architectural, Structural and Electrical Drawings for additional building details necessary for coordination.

C. Cutting, patching, wiring, finishing or any other work required for relocation of work installed due to interferences between the work of the various trades will be at no additional cost to the Owner.

3.03 MANUFACTURER'S INSTRUCTIONS

A. Furnish proper equipment and/or materials required for installation as intended by the manufacturer, for all work described under Division 23. If needed for proper installation or operation, request advice and supervisory assistance from the representative of the specific manufacturer. Manufacturer's published instructions shall be followed for preparing, assembling, installing, erecting, and cleaning manufactured materials or equipment, unless otherwise indicated. Promptly notify the Prime Engineer in writing of any conflict between the requirements of the Contract Documents and the manufacturer's directions and obtain the Prime Engineer's instructions before proceeding with the work.

3.04 EXAMINATION OF SITE

A. Visit site of proposed work and become familiar with conditions affecting work. Verify measurements at the building before beginning work.

3.05 LAYING OUT WORK

A. Locations of equipment and devices, as shown on the drawings, are approximate unless dimensioned. Exact locations of such items shall be determined from the Construction Drawings. Verify physical dimensions of each item of mechanical equipment, ductwork system and piping system, to fit available space and promptly notify the Prime Engineer prior to roughing-in if conflicts appear. Coordinate equipment to available space and access routes through construction. Offsets or transitions in ductwork or piping systems required for proper system operation and/or installation, whether indicated on drawings or not, shall be provided at no additional cost to Owner.

3.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project site properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials at the site unless offsite storage is authorized in writing. Protect stored equipment and materials from damage.

C. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

3.07 ACCESSIBILITY

A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate location of concealed equipment and devices requiring access with location of access panels and doors. Allow ample space for removal of parts that require replacement or servicing.

3.08 CUTTING AND PATCHING

A. Cutting shall be performed with masonry saws, core drills, or similar equipment to provide neat and uniform openings.

B. Patching shall match adjacent surfaces in materials and finish. Do not endanger or damage installed work through procedures and processes of cutting and patching.

C. Arrange for repairs required to restore other work, which was damaged as a result of mechanical installations. Upon receipt of written authorization from Prime Engineer, Contractor will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

D. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.

E. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

1. Uncover work to provide for installation of ill-timed work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Prime Engineer, uncover and restore work to provide for observation of concealed work.

F. Cut, remove, and legally dispose of selected mechanical equipment, components, and materials as indicated, including, but not limited to removal of mechanical piping, heating units, and other mechanical items made obsolete by new work.

G. Protect structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

H. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

End of Section 23 05 00

SECTION 23 05 05 – PROJECT CLOSEOUT FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and WSDOT Standard Specification Sections, apply to work of this section.

1.02 SCOPE OF WORK – GENERAL

A. This section specifies procedural requirements for HVAC installations project closeout, including but not limited to:

1. Project Record Document submittal.
2. Operation and Maintenance (O&M) Manual submittal.
3. Operation and Maintenance instruction and training.
4. HVAC equipment and systems startup.
5. Final cleaning.
6. Owner training session agenda.

B. Related Sections include the following:

1. WSDOT Standards Section 1-06, “Control of Materials”.

1.03 PROJECT RECORD DOCUMENTS

A. Record the differences between the HVAC work as installed and as shown in the Contract Drawings on a set of prints of HVAC drawings furnished by Prime Engineer. Return these prints to the Prime Engineer at the completion of project. Notations made on drawings shall be neat and legible..

B. Mark drawings to indicate revisions to HVAC piping and ductwork, size and location both exterior and interior; including locations of coils, dampers, and other control devices, filters, motors, and similar items requiring periodic maintenance; actual equipment locations; concealed equipment and control devices; mains and branches of piping systems, with valves and control devices located and numbered.

C. Revise the equipment and fixture schedules on the Drawings to indicate actual installed manufacturer and model numbers.

D. Mark specifications to indicate change orders; actual equipment and materials used.

1.04 OPERATION AND MAINTENANCE MANUALS

A. Prepare and submit Operation and Maintenance (O&M) Manuals for HVAC systems provided.

B. Provide primary index at beginning of Manual showing sections and items included.

C. Cover section: List name, address, and phone number of Project Prime Engineer, General Contractor, Mechanical Engineer, HVAC Contractor, and all HVAC Subcontractors. Provide a list of equipment suppliers with address and phone number.

D. Provide a separate section for each Section of the Specifications. Provide an index for each section listing equipment included. Include all specified items.

E. Include descriptive literature (manufacturer's catalog data) of each manufactured item. Literature shall show capacities and size of equipment used and be marked indicating each specific item with applicable data underlined. Data sheets shall be originals or clean copies of originals.

F. One (1) draft copy of the manual shall be submitted for review, comment, and approval, as applicable, at least 15 days prior to substantial completion or training, whichever is first. After approval, submit three (3) copies of the manual to the Prime Engineer for approval unless otherwise directed.

1. Information to be included in manual:

a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

b. Manufacturer's printed operating procedures to include startup, break-in, routine and normal operating instructions; regulation, control, stopping shutdown, and emergency instructions; and summer and winter operating instructions.

c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

d. Servicing instructions and lubrication charts and schedules.

e. Schematic control diagrams for each automatic control system. Mark the correct operating setting for each control instrument on these diagrams.

f. Valve schedule indicating the valve symbol (tag number), valve location by room number and description, valve purpose and system served, and valve size. Provide one (1) corresponding set of full-size HVAC prints showing these valve locations for cross-reference. A second complete set of valve schedules (8.5 inches x 11 inches)

encased in transparent plastic laminate and fitted in an aluminum holding frame shall be furnished to the Owner.

g. Testing, Adjusting, and Balancing Report.

h. Test records and certifications.

i. Equipment startup reports.

j. Warranty information and letters of guarantee.

k. Instruction period checklist for each equipment item.

G. Complete O&M Manual shall be available for use by Owner's representatives during instruction and training sessions.

1.05 OPERATION AND MAINTENANCE INSTRUCTION AND TRAINING

A. Instruct Owner's Representative(s) in the Operation and Maintenance procedures described in Operation and Maintenance Manual.

B. Enlist the services of qualified personnel, including each sub-trade and factory trained specialists for each major piece of equipment, to attend training sessions and provide operation and maintenance instructions.

C. Submit training agenda, schedule, and list of representatives for review 30 days prior to training sessions. Confirm attendance by written notification to all participants.

D. Prepare a checklist of all equipment and systems requiring instruction and maintenance for verification and agreement by the Owner's Representative of satisfactory startup and instruction. The checklist shall include a statement of completion by the Contractor, date and topic(s) covered in each training session, and an attendance list of all participants at each training session. Submit a copy of checklist for review 30 days prior to training sessions. Include copy of the completed checklist in Operation and Maintenance Manual.

E. Refer to individual Division 23 Sections for additional instruction/training requirements.

F. All HVAC systems shall be properly functioning prior to instruction period.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 HVAC EQUIPMENT AND SYSTEMS STARTUP

A. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and demonstrate and train Owner's maintenance personnel.

B. Include certification of factory-authorized representative status as part of equipment submittal from manufacturer. Include copies of any installation and startup instructions, manufacturer's checklists, and other forms used in startup as part of the equipment submittal.

C. Include written startup reports with test data for equipment in Operation and Maintenance Manual.

D. All construction debris, including electrical wiring debris, shall be removed from units prior to equipment startup. Areas surrounding and served by equipment being started must be free of construction debris, sheetrock dust, and any materials that may adversely affect the equipment.

3.02 FINAL CLEANING

A. At time of final cleanup, clean all fixtures and equipment, and leave in condition for use intended. Vacuum cabinet interiors of control panels, air handling units, etc. to remove all construction debris including electrical wiring debris.

End of Section 23 05 05

SECTION 23 05 11 – ELECTRICAL PROVISIONS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.

1.02 SUMMARY

A. This section specifies basic requirements for field-installed accessory electrical components specified as a part of packaged mechanical equipment. These components include, but are not limited to controllers, motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment, but not factory installed.

B. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specifications or scheduled on the Drawings.

C. Make all required electrical connections from mechanical equipment to accessory electrical components furnished by manufacturer as a part of equipment but intended to be field installed, including pushbuttons, pilot lights, interlocks, speed controllers, and similar devices.

D. Provide all required electrical connections of field-mounted float control switches, flow control switches, and similar mechanical/electrical devices provided for pumps and similar mechanical equipment.

E. Provide interconnecting wiring between mechanical equipment shipped in multiple parts and designed by the manufacturer to have field-installed interconnecting wiring.

F. All electrical work shall comply with applicable requirements of Division 26.

G. CODES AND REFERENCES

H. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
3. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
4. NFPA 70 – National Electrical Code.

1.03 SUBMITTALS

A. No separate submittal is required.

1.04 QUALITY ASSURANCE

A. All electrical components shall be labeled by an approved testing agency (UL, ETL, CSA, etc.).

B. Comply with the following: NEMA ICS 2, NEMA 250, NEMA KS 1, and NFPA 70.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with applicable requirements of Division 26 and NFPA 70

B. Install equipment and wiring per manufacturer's instructions.

End of Section 23 05 11

SECTION 23 09 13 – INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Damper Operators:

1. Electric operators.

B. Wall-, Surface-, and Duct-Mounted Sensors:

1. Temperature sensors.
2. Building static pressure transmitters.
3. Room pressure monitors.
4. Static air pressure sensors.
5. Damper position indicators.
6. Carbon monoxide sensors.
7. Carbon dioxide sensors.

C. Thermostats:

1. Electric thermostats.
2. Freezestats.
3. Room-mount thermostat accessories.
4. Outdoor-reset thermostats.
5. Airstream thermostats.
6. Electric high/low limit duct thermostats.

D. Fan and pump motor run-status monitoring.

1.02 REFERENCE STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. ASHRAE Std 135 – A Data Communication Protocol for Building Automation and Control Networks.
2. IEC 60529 – Degrees of Protection Provided by Enclosures (IP Code).
3. NEMA DC 3 – Residential Controls – Electrical Wall-Mounted Room Thermostats.

1.03 SUBMITTALS

A. See Section 23 05 00 – Common Work Results for HVAC 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.

E. Project Record Documents: Record actual location of control components, including panels, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

F. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

PART 2 - PRODUCTS

2.01 EQUIPMENT – GENERAL

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

2.02 DAMPER OPERATORS

A. General:

1. Provide actuators with torque capacity sized for minimum of 20% greater than maximum design stream velocity and hold tight seal against maximum system pressures.

2. Provide spring return for two-position control and for fail-safe operation.

3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

4. Provide one operator for maximum 36 square feet damper section.

5. See Division 25 for field-mount damper actuators and operators.

B. Electric Operators:

1. Manufacturers:

a. Honeywell International, Inc.

b. Johnson Controls International, PLC.

c. Belimo Aircontrols (USA) Inc.

2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

C. Inlet Vane Operators:

1. High pressure with pilot positioners and sufficient force to move vanes when fan is started with vanes in closed position. Return vane operator to closed position on fan shutdown.

2.03 WALL-, SURFACE-, AND DUCT-MOUNT SENSORS

A. Temperature Sensors:

1. Manufacturers:

a. Dwyer Instruments Inc.

b. Johnson Controls International, PLC.

c. Veris Industries.

d. Siemens Corporation

2. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.

3. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70°F.

4. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

5. Temperature Sensing Device: Compatible with project DDC controllers.

6. Performance Characteristics:

a. Temperature Transmitter:

1) Accuracy: 0.10°F minimum or ±0.20% of span.

2) Output: 4 to 20 mA.

b. Sensing Range:

1) Provide limited range sensors if required to sense the range expected for a respective point.

2) Use RTD type sensors for extended ranges beyond −30°F to 230°F.

3) Use temperature transmitters in conjunction with RTDs when RTDs are incompatible with DDC controller direct temperature input.

c. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

d. Room Temperature Sensors with Integral Digital Display:

1) Construct for surface or wall box.

2) Provide a four-button keypad with the following capabilities:

a) Indication of space and outdoor temperatures.

b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, and Sequence of Operation.

B. IAQ (Indoor Air Quality) Sensors:

1. Form Factor: Surface mounted, desk mounted, or single-gang electrical-box-mounted module made of high-impact plastic or other resilient material.

2. Temperature Sensor:

a. Solid-state, integrated circuit type, 32°F to 122°F range.

b. Accuracy: ±2% within 0.1°resolution.

3. Carbon Dioxide (CO_2) Monitoring Sensor:

a. Non-dispersive infrared (NDIR) type, 0 to 100% RH range.

b. Accuracy: ±30 ppm within 3% of measured value.

4. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.

C. Building Static Pressure Transmitters:

1. Single port for direct or tubing connection into wall or ceiling static pressure tip, direct acting, double bell, scale range 0.01 to 6.0 in-wc positive or negative, and sensitivity of 0.0005 in-wc. Transmit electronic signal to receiver with matching scale range.

D. Room Pressure Monitors:

1. Transmitter: 5% accuracy, adjustable zero and span, 100 to 1 turndown, 0.1% of calibrated span linearity, 30 to 50 millisecond response time, minimum overpressure of 150% over highest range value, alphanumeric indicating display, wired or wireless connectivity for configuration, and terminal strip within enclosed electronic components.

E. Static-Air Pressure Sensors:

1. Unidirectional with ranges not exceeding 150% of maximum expected input.

2. Temperature compensate with typical thermal error or 0.06% of full scale in temperature range of 40°F to 100°F.

3. Accuracy: 1% of full scale with repeatability 0.3 percent.

4. Output: 0 to 5 VDC with power at 12 to 28 VDC.

F. Damper Position Indicators: Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 to 100% damper travel.

G. Carbon Monoxide (CO) Sensors:

1. Gas sensing module that holds fixed or replaceable carbon monoxide gas-sensor cartridge.
2. Form Factor: IEC 60529, IP20 enclosure, single-gang electrical box mounted.
3. Electromechanical sensor with 0 to 500 ppm measurement range.
4. Accuracy: ±5% of range with 1 ppm resolution.
5. Hardwired Output: Three-wire, 4 to 20 mA, loop powered.
6. Alarm: Auxiliary dry contact relay driven by setpoint adjustable between 25 to 180 ppm.

H. Carbon Dioxide Sensors, Duct and Wall:

1. General: Provide nondispersive infrared (NDIR), diffusion sampling CO^2 sensors with integral transducers and linear output.
2. Air Temperature: Range of 32°F to 122°F.
3. Relative Humidity: Range of 0% to 95% (noncondensing).
4. Calibration Characteristics:
   a. Automatically compensating algorithm for sensor drift due to sensor degradation.
   b. Maximum Drift: 2%.
   c. User calibratable with a minimum calibration interval of 5 years.
5. Construction:
   a. Sensor Chamber: Noncorrosive material for neutral effect on carbon dioxide sample.
   b. Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.
   c. Housing: High-impact plastic.

2.04 FAN AND PUMP MOTOR RUN-STATUS MONITORING

A. Current Switches:

1. Micro-Split Core: 2-state, On/Off digital output of motor status.
2. Maximum AC Current Monitoring Value: As indicated on drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Check and verify location of thermostats with plans and room details before installation. Locate 60 inches above floor. Align with lighting switches and humidistats; see Division 26.

C. Mount freeze protection thermostats using flanges and element holders.

D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

E. Provide thermostats in aspirating boxes in front entrances.

F. Provide guards on thermostats in entrances.

G. Provide conduit and electrical wiring in accordance with Division 26. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

End of Section 23 09 13

SECTION 23 09 23 – DIRECT-DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. System description.

B. Operator interface.

C. Controllers.

D. Power supplies and line filtering.

E. System software.

F. Controller software.

G. HVAC control programs.

1.02 REFERENCE STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. ASHRAE Std 135 – A Data Communication Protocol for Building Automation and Control Networks.

2. MIL-STD-810 – Environmental Engineering Considerations and Laboratory Tests.

3. NFPA 70 – National Electrical Code.

4. UL (DIR) – Online Certifications Directory.

1.03 SUBMITTALS

A. See Section 23 05 00 – Common Work Results for HVAC for submittal procedures.

B. Product Data: Provide data for each system component and software module.

C. Shop Drawings:

1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.

2. List connected data points, including connected control unit and input device.

3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations.

4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.

5. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer's Qualification Statement.

E. Installer's Qualification Statement.

F. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

G. 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.

H. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.04 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.

C. Installer Qualifications: Company specializing in performing work of the specified type and with minimum three years of documented experience.

D. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for purpose specified and indicated.

1.05 WARRANTY

A. Correct defective Work within a five-year period after Substantial Completion.

B. Provide five-year manufacturer's warranty for field programmable microprocessor-based units.

PART 2 - PRODUCTS

2.01 QUALIFIED MANUFACTURERS/QUALIFIED INSTALLERS

A. Alerton provided by ATS Automation.

B. Delta Controls provided by ATS Automation.

C. Johnson Controls provided by JCI Branch Office.

D. Siemens provided by Siemens Branch Office.

2.02 SYSTEM DESCRIPTION

A. Automatic temperature control field monitoring and control system using field programmable microprocessor-based units.

B. Base system on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, and actuators.

D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, dedicated outside air units, variable refrigerant flow systems, and the like when directly connected to the control units. If equipment is supplied without control units, the DDC can either control the units directly or field controllers can be supplied by controls manufacturer to control the equipment.

E. Provide 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 specified functions.

F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 OPERATOR INTERFACE

A. Laptop PC-Based Workstation:

1. Workstation, controllers, and control backbone to communicate using BACnet or TCP/IP protocol and addressing.

2. BACnet protocol to comply with ASHRAE Std 135.

B. Hardware:

1. Laptop:

a. Laptop(s) to be provided by DDC controls manufacturer.

b. Quantity: Provide allowance for one computer.

c. System shall have minimum RAM, processing speed, hard drive memory, and ports as required by the controls system software.

d. Operating System: Microsoft Windows 11

e. Network Connection: Ethernet interface card.

2.04 CONTROLLERS

A. Building Controllers:

1. General:

a. Manage global strategies by one or more independent, standalone, microprocessor-based controllers.

b. Provide sufficient memory to support controller's operating system, database, and programming requirements.

c. Share data between networked controllers.

d. Controller operating system manages input and output communication signals, allowing distributed controllers to share real and virtual object information, and allowing for central monitoring and alarms.

e. Utilize real-time clock for scheduling.

f. Continuously check processor status and memory circuits for abnormal operation.

g. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

h. Communication with other network devices to be based on assigned protocol.

2. Communication:

a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol or TCP/IP network.

b. Perform routing when connected to a network of custom application and application specific controllers.

c. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within waterproof enclosures.

2) Rated for operation at 40 to 150°F.

b. Conditioned Space:

1) Mount within dustproof enclosures.

2) Rated for operation at 32 to 120°F.

4. Provisions for Serviceability:

a. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:
    a. Maintain operation at 90 to 110% of nominal voltage rating.
    b. Perform orderly shutdown below 80% of nominal voltage.
    c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

B. Application-Specific Controllers (ASC):
1. General:
    a. Not fully user programmable, microprocessor-based controllers dedicated to control specific equipment.
    b. Customized for operation within the confines of equipment served.
    c. Communication with other network devices to be based on assigned protocol.
2. Communication:
    a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol or TCP/IP network.
    b. Provide service communication port for connection to a portable operator's terminal or handheld device with compatible protocol.
3. Anticipated Environmental Ambient Conditions:
    a. Outdoors and/or in Wet Ambient Conditions:
        1) Mount within waterproof enclosures.
        2) Rated for operation at 40 to 150°F.
    b. Conditioned Space:
        1) Mount within dustproof enclosures.
        2) Rated for operation at 32 to 120°F.
4. Provisions for Serviceability:
    a. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
6. Power and Noise Immunity:
    a. Maintain operation at 90 to 110% of nominal voltage rating.
    b. Perform orderly shutdown below 80% of nominal voltage.
    c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.

C. Input/Output Interface:

1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.

2. All Input/Output Points:

   a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.

   b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

3. Binary Inputs:

   a. Allow monitoring of On/Off signals from remote devices.

   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.

   c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Comply with all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:

   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).

   b. Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:

   a. Used for ON/OFF operation or a pulsed low-voltage signal for pulse width modulation control.

   b. Outputs provided with three position (ON/OFF/AUTO) override switches.

   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:

   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.

   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.

   c. Drift to not exceed 0.4% of range per year.

2.05 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% 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% combined line and load with 100 microsecond response time for 50% load changes.
6. Provide over-voltage and over-current protection to withstand a 150% current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120°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.
2. Minimum surge protection attributes:
   a. Dielectric strength of 1000 volts minimum.
   b. Response time of 10 nanoseconds or less.
   c. Transverse mode noise attenuation of 65 dB or greater.
   d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.06 SYSTEM SOFTWARE

A. Operating System:

1. Concurrent, multi-tasking capability.
2. System Graphics:
   a. Animation displayed by shifting image files based on object status.
   b. Provide method for operator with password to perform the following:
      1) Move between, change size, and change location of graphic displays.
      2) Add, delete, or change dynamic objects consisting of:

a) Analog and binary values.

b) Dynamic text.

c) Static text.

d) Animation files.

B. Workstation System Applications:

1. Automatic System Database Save and Restore Functions:

a. Current database copy of each Building Controller is automatically stored on hard disk.

b. Automatic update occurs upon change in any system panel.

c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

2. Manual System Database Save and Restore Functions by Operator with Password Clearance:

a. Save database from any system panel.

b. Clear a panel database.

c. Initiate a download of a specified database to any system panel.

3. Software provided allows system configuration and future changes or additions by operators under proper password protection.

4. Help System:

a. Context-sensitive system assists operator in operation and editing.

b. Available for all applications.

c. Relevant screen data provided for particular screen display.

d. Additional help is available via hypertext.

5. Security:

a. Operator log-on requires username and password to view, edit, add, or delete data.

b. System security is selectable for each operator.

c. System supervisor sets passwords and security levels for all other operators.

d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

f. All system security data stored in encrypted format.

6. Alarm Processing:

a. All system objects are configurable to “alarm in” and “alarm out” of normal state.

b. Configurable Objects:

1) Alarm limits.

2) Alarm limit differentials.

3) States.

4) Reactions for each object.

7. Alarm Messages:

a. Descriptor: English language.

b. Recognizable Features:

1) Source.

2) Location.

3) Nature.

8. Custom Trend Logs:

a. Definable for any data object in the system including interval, start time, and stop time.

b. Trend Data:

1) Sampled and stored on the building controller panel.

2) Archivable on hard disk.

3) Retrievable for use in reports, spreadsheets, and standard database programs.

4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.

5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

9. Alarm and Event Log:

a. View all system alarms and change of states from any system location.

b. Events listed chronologically.

c. Operator with proper security acknowledges and clears alarms.

d. Alarms not cleared by operator are archived to the workstation hard disk.

10. Object, Property Status and Control:

a. Provide a method to view, edit if applicable, the status of any object and property in the system.

b. Status Available by the Following Methods:

1) Menu.

2) Graphics.

3) Custom Programs.

11. Reports and Logs:

a. Reporting Package:

1) Allows operator to select, modify, or create reports.

2) Definable as to data content, format, interval, and date.

3) Archivable to hard disk.

b. Real-time logs available by type or status such as alarm, lockout, normal, etc.

c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.

d. Set to be printed on operator command or specific time(s).

12. Reports:

a. Standard:

1) Objects with current values.

2) Current alarms not locked out.

3) Disabled and overridden objects, points, and standard network variable types (SNVTs).

4) Objects in manual or automatic alarm lockout.

5) Objects in alarm lockout currently in alarm.

6) Logs:

a) Alarm History.

b) System messages.

c) System events.

d) Trends.

b. Electrical, Fuel, and Weather:

1) Electrical Meter(s):

a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):

a) Monthly showing daily natural gas consumption for each meter.

b) Annual summary showing monthly consumption for each meter.

3) Weather:

a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C. Workstation Applications Editors:

1. Provide editing software for each system application at PC workstation.
2. Downloaded application is executed at controller panel.
3. Full screen editor for each application allows operator to view and change:
   a. Configuration.
   b. Name.
   c. Control parameters.
   d. Set points.
4. Scheduling:
   a. Monthly calendar indicates schedules, holidays, and exceptions.
   b. Allows several related objects to be scheduled and copied to other objects or dates.
   c. Start and stop times adjustable from master schedule.

2.07 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

C. PID Control Characteristics:

1. Direct or reverse action.
2. Anti-windup.
3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
4. User selectable controlled variable, set point, and PED gains.

D. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.

2. Order of equipment startup is user selectable.

E. Anti-Short Cycling:

1. All binary output objects protected from short-cycling.

2. Allows minimum on-time and off-time to be selected.

F. On-Off Control with Differential:

1. Algorithm allows binary output to be cycled based on a controlled variable and set point.

2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

G. Runtime Totalization:

1. Totalize runtimes for all binary input objects.

2. Provides operator with capability to assign high run-time alarm.

2.08 HVAC CONTROL PROGRAMS

A. Supply Air Reset:

1. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:

a. Raising cooling temperatures to highest possible value.

b. Reducing heating temperatures to lowest possible level.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

3.02 INSTALLATION

A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

B. Install software in control units and in operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Provide conduit and electrical wiring in accordance with Section 26 05 83. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.

3.03 MANUFACTURER'S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for startup and commissioning prior to placing control systems in permanent operation.

3.04 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

End of Section 23 09 23

SECTION 23 09 34 – VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.

B. Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

A. Section 23 05 29 – Hangers and Supports for HVAC Piping and Equipment.

B. Section 26 05 26 – Grounding and Bonding for Electrical Systems.

C. Section 26 28 13 – Fuses.

1.03 REFERENCE STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. IEC 60529 –°of Protection Provided by Enclosures (IP Code).
2. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
3. NEMA ICS 2 – Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
4. NEMA ICS 6 – Industrial Control and Systems: Enclosures.
5. NEMA ICS 7 – Industrial Control and Systems: Adjustable-Speed Drives.
6. NEMA ICS 7.1 – Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable-Speed Drive Systems.
7. NEMA ICS 7.2 – Application Guide for AC Adjustable Speed Drive Systems.
8. NEMA ICS 61800-2 – Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems.
9. NEMA KS 1 – Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
10. NEMA MG 1 – Motors and Generators.
11. NETA ATS – Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
12. NFPA 70 – National Electrical Code.

13. UL 98 – Enclosed and Dead-Front Switches.
14. UL 508A – Industrial Control Panels.
15. UL 61800-5-1 – Standard for Adjustable Speed Electrical Power Drive Systems – Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. ABB

B. Danfoss

C. Yaskawa America, Inc.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

A. Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.

B. Provide products listed, classified, and labeled as suitable for purpose intended.

C. Controller Assemblies: Comply with NEMA ICS 7, NEMA ICS 7.1, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.

D. Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA ICS 7.2, NEMA MG 1 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:

1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 1 design letter or inverter duty rating for induction motors.
2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
3. Motor nameplate data.
4. Requirements for speed control range, speed regulation, and braking.
5. Motor suitability for bypass starting method, where applicable.

E. Devices on Load Side of Controller: Suitable for application across full controller output frequency range.

F. Operating Requirements:

1. Input Voltage Tolerance: ± 10% of nominal.
2. Input Frequency Tolerance: ± 5% of nominal.

3. Efficiency: Minimum of 96% at full speed and load.
4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.
5. Overload Rating:
    a. Variable Torque Loads: Minimum of 110% of nominal for 60 seconds.
    b. Constant Torque Loads: Minimum of 150% of nominal for 60 seconds.

G. Control System:

1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
3. Control Functions:
    a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
        1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
        2) Vector Control: Provide selectable autotuning function.
    b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
    c. Selectable braking control; DC injection or flux braking.
    d. Adjustable minimum/maximum speed limits.
    e. Adjustable pulse width modulation switching carrier frequency.
    f. Adjustable motor slip compensation.
    g. Selectable auto-restart after noncritical fault; programmable number of time delay between restart attempts.
4. Status Indications:
    a. Motor run/stop status.
    b. Motor forward/reverse status.
    c. Local/remote control status.
    d. Output voltage.
    e. Output current.
    f. Output frequency.
    g. DC bus voltage.

h. Motor speed.

5. Protective Functions/Alarm Indications:

a. Overcurrent.

b. Motor overload.

c. Undervoltage.

d. Overvoltage.

e. Controller overtemperature.

f. Input/output phase loss.

g. Output short circuit protection.

h. Output ground fault protection.

6. Inputs:

a. Digital Input(s): Three.

b. Analog Input(s): Two.

7. Outputs:

8. Features:

a. Password-protected security access.

b. Event log.

H. Power Conditioning/Filtering:

1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.

2. Reactor Impedance: 3 percent, unless otherwise indicated or required.

I. Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.

1. Disconnects: Circuit breaker or disconnect switch type.

a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.

b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.

c. Provide auxiliary interlock for disconnection of external control power sources where applicable.

2. Provide door-mounted remote operator interface.

J. Service Conditions:

1. Provide controllers and associated components suitable for operation under following service conditions without derating:
    a. Altitude: Less than 3,300 feet.
    b. Ambient Temperature: Between 32°F and 104°F.
2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.

K. Short Circuit Current Rating:
1. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

L. Conductor Terminations: Suitable for use with conductors to be installed.

M. Enclosures:
1. Comply with NEMA ICS 6.
2. NEMA 250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
3. Finish: Manufacturer's standard unless otherwise indicated.
4. Cooling: Forced air or natural convection as determined by manufacturer.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Overload Relays:
1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
2. Comply with NEMA ICS 2.
3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
4. Trip-free operation.
5. Visible trip indication.
6. Resettable:
    a. Employ manual reset unless otherwise indicated.
    b. Do not employ automatic reset with two-wire control.

B. Fusible Disconnect Switches:
1. Description: Quick-make, quick-break, dead-front fusible switch units complying with NEMA KS 1, and listed and labeled as complying with UL 98; ratings, configurations, and features as indicated or as required.

2. Fuse Clips: As required to accept indicated fuses.

3. Provide externally operable handle with means for locking in OFF position. Provide means for locking switch cover in closed position. Provide safety interlock to prevent opening of cover with switch in ON position with capability of overriding interlock for testing purposes.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install in accordance with NEMA ICS 7.1 and manufacturer's instructions.

C. Do not exceed manufacturer's recommended maximum cable length between controller and motor.

D. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

E. Provide required support and attachment in accordance with Section 23 05 29.

F. Install controllers plumb and level.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Install field-installed devices, components, and accessories.

I. Provide fuses complying with Section 26 28 13 for fusible switches as indicated.

J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.

K. Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.02 FIELD QUALITY CONTROL

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

B. Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.

C. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.

D. Correct deficiencies and replace damaged or defective controllers or associated components.

3.03 ADJUSTING

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

3.04 CLEANING

A. Clean dirt and debris from controller enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

3.05 PROTECTION

A. Protect installed controllers from subsequent construction operations.

End of Section 23 09 34

SECTION 26 05 00 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section specifies general requirements for electrical system installations and includes requirements common to more than one section of Division 26..

B. Provide all required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment, and satisfactorily complete all electrical work shown on the Drawings, included in these Specifications, or required for a complete and fully operating facility. In addition, provide wiring for the equipment that will be provided under other Divisions of these Specifications.

C. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional details, manufacturer installation details/instructions, or special construction is required for work indicated or specified under this section of work or work specified in other sections, provide material and equipment which is usually furnished with such systems in order to complete the installation, whether mentioned or not.

1.02 RELATED REQUIREMENTS

D. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.

E. Section 02 84 00 – Polychlorinate Biphenyl (PCB) Remediation: Removal of equipment and materials containing substances regulated under the Federal Toxic Substances Control Act (TSCA), including but not limited to those containing PCBs and mercury.

1.02 REFERENCE STANDARDS

A. The publications listed below form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1. ICC (IBC) – International Building Code.
2. ICC (IFC) – International Fire Code.
3. ICC (IFGC) – International Fuel Gas Code.
4. ICC (IMC) – International Mechanical Code.

5. NETA ATS – Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
6. NFPA 70 – National Electrical Code.
7. Washington State Energy Code, Commercial Provisions.
8. Applicable State and local codes, laws, and ordinances.

1.03 DEFINITIONS

A. Provide: Furnish and install complete and ready for intended use.

B. Indicated: Indicated on drawings.

C. Noted: Noted on Drawings or in Specifications.

D. Finished Spaces: Spaces other than mechanical and electrical equipment rooms,

E. furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

F. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

G. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

H. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

I. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.04 SUBMITTALS

A. . Refer to WSDOT Standard Specification 1-06 “Control of Materials” for submittal definitions. Additional requirements are listed below.

B. Submit a single, complete submittal package for products in Division 26. Submittal package shall be organized by equipment type. PDFs shall be bookmarked.

C. Nameplate schedule.

D. Conduit tag schedule.

E. Qualifications of testing organization and personnel meeting requirements of NETA ATS Section 3.

F. Inspection and acceptance testing reports per NETA ATS for equipment for which tests are required in this section.

G. Field test results specified in Subsection 3.03.

H. Submittals not meeting the following requirements will be returned for revision:

1. Provide a cover page for each item or group of items.
2. Submittal package shall be organized by equipment type.
3. Each cover page must be clearly identified with the project name, specification number, and paragraph number.
4. Submittal package must be accompanied by an itemized index listing specification section, paragraph number, item, and manufacturer; larger projects will be index tabbed by specification section with index for each section.

1.05 DRAWINGS AND SCHEDULES

A. Drawings and Specifications supplement each other, and any details contained in one and not the other shall be included as if contained in both. Items not specifically mentioned in the specifications or noted on the drawings, but which are obviously necessary to make a complete working installation, shall be included.

B. Electrical drawings shall serve as working drawings for Division 26 work. Refer to Architectural, Structural, and Mechanical drawings for additional detail affecting the installation of work.

C. The Electrical Drawings are diagrammatic. The approximate location of each item is indicated on the drawings. These drawings are not intended to give complete and exact details regarding location. Exact locations are to be determined by actual measurements at the building and shall be verified with the Engineer prior to installation. Except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this section shall take precedence in the event of conflict.

D. Field-verify scaled dimensions on Drawings.

E. Review the drawings and specification divisions of other trades and perform the electrical work that will be required for the installations.

F. Submit in writing to the Prime Engineer details of any proposed changes in or departures from these Contract Documents along with the reasons, therefore. Make no changes or departures without the prior written favorable review of the Prime Engineer.

G. Maintain a set of As-Built Drawings on-site that documents changes made. Upon completion of the work, transfer these changes to a clean set of full-size drawings with red ink to indicate additions and green ink to indicate deletions. Submit these full-size drawings to the Prime Engineer.

1.06 DEVIATIONS

A. Conduit size, wire size/quantities/type, estimated wire length and all other values are based on the information and design contract requirements available during the design. Changing site/project conditions, substitutions, Owner/Prime-Engineer-

requested changes, and Contractor-approved changes may affect the values in the schedule. All power studies shall require the Contractor to field-verify cable lengths based on field conditions and not on the estimated lengths in this table. The Contractor shall redline the schedule and provide the redlines to the Owner depicting the “as constructed” project documents.

PART 2 - PRODUCTS

2.01 STAND

A. Products that are specified by manufacturer, trade name, or catalog number, establish a standard of quality, and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Architect prior to installation.

B. It is the intent of these Specifications and Drawings to secure high-quality materials and equipment to facilitate operation and maintenance of the facility. Equipment and materials shall be new, and the products shall be from reputable suppliers with adequate experience in the manufacture of these items. For uniformity, only one manufacturer will be accepted for each type of product. Equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for stresses that may occur during fabrication, transportation, erection, and continuous or intermittent operation. Equipment shall be adequately stayed, braced, and anchored and shall be installed in a neat and skillful manner. Appearance, as well as utility, shall be given consideration in the design of details.

C. Components and devices installed shall be standard items of industrial grade or better, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light-duty, fragile, and commercial grade devices of doubtful durability shall not be used.

2.02 MATERIALS

A. Provide first quality, new materials, free from defects, and suitable for the intended use and space. Where two or more units of the same class of material are required, provide products of a single manufacturer.

B. Unless otherwise indicated, provide materials and equipment that are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturer’s latest standard design that conforms to these Specifications.

2.03 EQUIPMENT NAMEPLATES

A. Provide nameplates on new and Owner-furnished equipment.

B. Panel Nameplates: For equipment such as automatic transfer switches, switchgear, variable frequency drive (VFD) panels, motor starter panels, control panels, electrical equipment enclosures, disconnect switches, motors, and pumps, the nameplates shall be:

1. Located on the enclosure face.
2. Rectangular screw-on type with self-tapping 316 stainless steel screws.
3. -inch-tall laminated phenolic plastic nameplate with white letters on black backgrounds. Length as required.
4. -inch-high lettering for equipment name with ½-inch-high lettering for tag number.
5. Nameplate text shall include:
    a. Line 1: Descriptive name (e.g., “MAINTENANCE BYPASS AUTOMATIC TRANSFER SWITCH”).
    b. Line 2: Asset Number (e.g., “ATS29-100”).

C. Nameplate schedule shall be included with all equipment submittals.

2.04 GENERAL FASTENING AND SUPPORT HARDWARE

A. Fasteners, anchors, clamps, supports, strut, plates, posts, and brackets shall be galvanized. Expansion shields and tamperproof pin style anchors are not acceptable. Size anchors to meet load requirements. Cut ferrous metal shall be coated with zinc-rich paint.

2.05 PAINTING AND COATING

A. Equipment: Refer to each electrical equipment section of these Specifications for painting and coating requirements of equipment and enclosures. Repair any final finish that has been damaged or is otherwise unsatisfactory using touchup materials approved by the manufacturers, to the satisfaction of the Prime Engineer.

PART 3 - EXECUTION

3.01 GENERAL

A. Work shall be performed by craftsmen skilled in their trade. Work shall present a neat, finished appearance.

B. Install equipment in strict accordance with the manufacturer’s instructions unless directed otherwise. Wherever a conflict occurs between manufacturer’s instructions, codes and regulations, or these Contract Documents, follow Prime Engineer’s direction. Keep a copy of manufacturer’s installation instructions on the job site available for review at times.

C. Provide protection for materials and equipment against loss or damage. Protect everything from the effects of weather. Prior to installation, store items in indoor locations. In addition, items subject to corrosion under damp conditions, and items containing insulation, such as transformers, motors, and control, shall be stored in indoor, heated, dry locations.

D. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction.

E. Do not cut or notch any structural member or building surface without specific approval of Prime Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition using skilled craftsmen of the trades involved at no additional cost to the Owner.

F. Keep the premises free from accumulation of waste material or rubbish. Upon completion of work, remove materials, scraps, and debris from premises and from interior and exterior of devices and equipment. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish.

G. Label electrical and control equipment, including electrical switchgear, VFD panels, motor starter panels, generator sets, automatic transfer switches, control panels, equipment within electrical and control panels, disconnect switches, motors, pumps, local control stations, instrument transmitters, analytical controllers.

3.02 GROUNDING

A. Bond and ground equipment for which a ground connection is required per NFPA 70 whether not specifically shown on the Drawings.

3.03 DAMAGED PRODUCTS

A. Notify the Prime Engineer in writing when any equipment or material is damaged.

B. Obtain prior favorable review by the Prime Engineer before making repairs to damaged products.

3.04 EXAMINATION

A. Verify that abandoned wiring and equipment serve only abandoned facilities.

B. Beginning of demolition means installer accepts existing conditions.

3.05 JOB CONDITIONS

A. Operations:

1. Keep power shutdown periods to a minimum.

2. Carry out shutdowns only after the Prime Engineer has favorably reviewed the schedule.

3. Shutdowns to be scheduled with Owner no less than 2 weeks in advance.

B. Construction Power:

1. Arrange for the required construction power.

2. When required, provide equipment, materials, and wiring in accordance with the applicable codes and regulations.

3. Upon completion of the project, remove temporary construction power equipment, material, and wiring from the site as the property of the Contractor.

4. Storage: Provide conditioned storage for equipment and materials per manufacturer's requirements that will become part of the completed facility so that it is protected from weather, dust, water, or construction operations.

3.06 LOCATIONS

A. General: Use equipment, materials, and wiring methods suitable for the types of locations in which they are located, as defined in Paragraph B herein.

B. Definitions of Types of Locations:

1. Dry Locations: Indoor areas which do not fall within the definitions below for Wet, Damp, Hazardous, or Corrosive Locations and that are not otherwise designated on the Drawings.

2. Wet Locations: Locations exposed to the weather, whether under a roof or not, or designated as Wet Locations by applicable codes and regulations, unless otherwise designated on the Drawings.

3. Damp Locations: Location wholly or partially underground; or having a wall or ceiling forming part of a channel or tank; or designated as "Damp Locations" by applicable codes and regulations, unless otherwise designated on the Drawings.

4. Hazardous: Hazardous locations per NFPA 70 Article 501 are identified in the Drawings.

3.07 SAFETY OF PERSONS AND PROPERTY

A. Comply with applicable laws, ordinances, rules, and regulations of any public authority for the safety of persons and property, including requirements of the Washington Department of Safety and Health (DOSH) or the Occupational Safety and Health Act (OSHA) whichever is most stringent, and, General and Supplementary Conditions.

3.08 GUARANTEE

A. Guarantee satisfactory operation of material and equipment installed under Division 26. Repair or replace any defective materials, equipment, or workmanship which may show itself within one year from date of Substantial Completion.

3.09 PERMITS AND FEES

A. Obtain and pay for required permits and fees necessary to fully complete work included in the Contract Documents.

3.10 FIELD TESTS

A. Perform inspection and acceptance testing and submit test reports for the equipment specified in this section.

B. Give a 2-week notice to the Prime Engineer and Owner prior to any test so to permit them to witness the test.

C. Retesting will be required for unsatisfactory tests after the equipment or system has been repaired. Retest related equipment and systems if required by the Prime Engineer. Repair and retest equipment and systems that have been satisfactorily tested but later fail, until satisfactory performance is obtained.

3.11 CLEANING AND REPAIR

A. See Section 01 74 19 – Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts.

End of Section 26 05 00

SECTION 26 05 01 – PROJECT CLOSEOUT FOR ELECTRICAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions

1.02 SCOPE OF WORK – GENERAL

A. This section specifies procedural requirements for Electrical installations project closeout, including but not limited to:

1. Project Record Document submittal.
2. Operation and Maintenance Manual submittal.
3. Operation and Maintenance Instruction and Training.
4. Fire Suppression Equipment and Systems Startup.
5. Final Cleaning.
6. Owner Training Session Agenda.

1.03 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. , WSDOT Standard Specification 1-06 “Control of Materials”

1.04 PROJECT RECORD DOCUMENTS

A. Record differences between Fire Suppression work as installed and as shown in Contract Drawings on a set of prints of Fire Suppression drawings furnished by Prime Engineer. Return these prints to Prime Engineer at completion of project. Notations made on drawings shall be neat and legible.

B. Mark drawings to indicate revisions to Fire Suppression piping, size and location both exterior and interior; including locations of coils, dampers, and other control devices, filters, motors, and similar items requiring periodic maintenance; actual equipment locations; concealed equipment and control devices; mains and branches of piping systems, with valves and control devices located and numbered.

C. Revise equipment and fixture schedules on the Drawings to indicate actual installed manufacturer and model numbers.

D. Mark specifications to indicate change orders; actual equipment and materials used.

1.05 OPERATION AND MAINTENANCE MANUALS

A. Prepare and submit Operation and Maintenance (O&M) Manuals for Fire Suppression systems provided.

B. Provide master index at beginning of Manual showing sections and items included.

C. Cover section: List name, address, and phone number of Project Architect, General Contractor, Fire Suppression Contractor, and all Fire Suppression Subcontractors. Provide a list of equipment suppliers with address and phone number.

D. Include descriptive literature (manufacturer's catalog data) of each manufactured item. Literature shall show capacities and size of equipment used and be marked indicating each specific item with applicable data underlined. Data sheets shall be originals or clean copies of originals.

E. One draft copy of the manual shall be submitted for review, comment, and approval, as applicable, at least 15 days prior to substantial completion or training, whichever is first. After approval, submit three (3) copies of manual to Prime Engineer. Information to be included in manual::

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

2. Manufacturer's printed operating procedures to include startup, break-in, routine, and normal operating instructions; regulation, control, stopping shutdown, and emergency instructions; and summer and winter operating instructions.

3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing instructions and lubrication charts and schedules.

5. Valve schedule indicating the valve symbol (tag number), valve location by room number and description, valve purpose and system served, and valve size. Provide one (1) corresponding set of full-size Fire Suppression prints showing these valve locations for cross-reference. A second, complete set of valve schedules (8½ inches x 11 inches) encased in transparent plastic laminate and fitted in an aluminum holding frame shall be furnished to the Owner.

6. Test records and certifications.

7. Equipment startup reports.

8. Warranty information and letters of guarantee.

9. Instruction period checklist for each equipment item.

F. Complete O&M Manual shall be available for use by Owner's representatives during instruction and training sessions.

1.06 OPERATION AND MAINTENANCE INSTRUCTION AND TRAINING

A. Instruct Owner's Representative(s) in the Operation and Maintenance procedures described in Operation and Maintenance Manual.

B. Enlist services of qualified personnel, including each sub-trade and factory trained specialists for each major piece of equipment, to attend training sessions and provide operation and maintenance instructions.

C. Submit training agenda, schedule, and list of representatives for review 30 days prior to training sessions. Confirm attendance by a written notification to all participants.

D. Prepare checklist of all equipment and systems requiring instruction and maintenance for verification and agreement by the Owner's Representative of satisfactory startup and instruction. Checklist shall include a statement of completion by the Contractor, date and topic(s) covered in each training session, and an attendance list of all participants at each training session. Submit a copy of checklist for review 30 days prior to training sessions. Include copy of the completed checklist in Operation and Maintenance Manual.

E. Refer to individual Division 21 Sections for additional instruction/training requirements.

F. All Fire Suppression systems shall be properly functioning prior to instruction period.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 ELECTRICAL EQUIPMENT AND SYSTEMS STARTUP

A. Provide the services of a factory-authorized service representative to test and inspect unit installation, provide startup service, and demonstrate and train Owner's maintenance personnel.

B. Include certification of factory-authorized representative status as part of equipment submittal from manufacturer. Include copies of any installation and startup instructions, manufacturer's checklists, and other forms used in startup as part of the equipment submittal.

C. Include written startup reports with test data for equipment in Operation and Maintenance Manual.

D. All construction debris, including electrical wiring debris, shall be removed from units prior to equipment startup. Areas surrounding and served by equipment being started must be free of construction debris, sheetrock dust, and any materials that may adversely affect the equipment.

3.02 FINAL CLEANING

A. At time of final cleanup, clean all fixtures and equipment, and leave in condition for use intended. Vacuum cabinet interiors of control panels, air handling units, etc. to remove all construction debris including electrical wiring debris.

End of Section 26 05 01

SECTION 26 05 33.13 – CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Flexible metal conduit (FMC).

1.02 RELATED REQUIREMENTS

A. Section 03 30 00 – Cast-in-Place Concrete: Concrete encasement of conduits.

B. Section 07 84 00 – Firestopping.

C. Section 26 05 26 – Grounding and Bonding for Electrical Systems.

D. Section 26 05 29 – Hangers and Supports for Electrical Systems.

E. Section 26 05 33.16 – Boxes for Electrical Systems.

F. Section 26 05 48 – Vibration and Seismic Controls for Electrical Systems.

G. Section 26 05 53 – Identification for Electrical Systems: Identification products and requirements.

H. Section 31 23 16 – Excavation.

I. Section 31 23 16.13 – Trenching: Excavating, bedding, and backfilling.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 – American National Standard for Electrical Rigid Steel Conduit (ERSC).

B. NECA 1 – Standard for Good Workmanship in Electrical Construction.

C. NECA 101 – Standard for Installing Steel Conduits (Rigid, IMC, EMT).

D. NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.

E. NFPA 70 – National Electrical Code.

F. UL 1 – Flexible Metal Conduit.

G. UL 6 – Electrical Rigid Metal Conduit-Steel.

H. UL 514B – Conduit, Tubing, and Cable Fittings.

I. UL 1203 – Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.

J. UL 2419 – Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds.

K. The publications listed above form a part of this Specification to the extent referenced. References and standards listed herein are to be the latest edition available, unless specifically stated otherwise.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.

2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.

3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.

4. Coordinate work to provide roof penetrations that preserve integrity of roofing system and do not void roof warranty.

5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 SUBMITTALS

A. .

B. See Section 26 05 00 – Common Work Results for Electrical for submittal procedures.

C. Product Data: Provide manufacturer’s standard catalog pages and data sheets for conduits and fittings.

D. Shop Drawings:

1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.

E. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

PART 2 - PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

2.02 CONDUIT – GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.

C. Provide conduit, fittings, supports, and accessories required for complete raceway system.

D. Provide products listed, classified, and labeled as suitable for purpose intended.

E. Minimum Conduit Size, Unless Otherwise Indicated:

1. Branch Circuits: ¾-inch trade size.
2. Branch Circuit Homeruns: ¾-inch trade size.
3. Underground, Interior: ¾-inch trade size.
4. Underground, Exterior: 1-inch trade size.

F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:

1. Allied Tube & Conduit, a division of Atkore International.
2. Nucor Tubular Products.
3. Western Tube, a division of Zekelman Industries.
4. Wheatland Tube, a division of Zekelman Industries.
5. Substitutions: To be approved by owner prior to installation.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit, complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:

1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.

2. Hazardous/Classified Locations: Use fittings listed and labeled as complying with UL 1203 for classification of installed location.

3. Material: Use steel or malleable iron.

4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:

B. 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.

C. 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.

2.05 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for conduits and roofing system to be installed; designed to accommodate existing penetrations where applicable.

C. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

D. Duct Bank Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for concrete encasement in open trench installation; suitable for conduit/duct arrangement to be installed.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer’s instructions.

B. Install conduit in accordance with NECA 1.

C. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.

D. Conduit Routing:

1. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
2. Unless otherwise approved, do not route exposed conduits:
   a. Across floors.
   b. Across roofs.
   c. Across building exterior surfaces.
3. Arrange conduit to maintain adequate headroom, clearances, and access.
4. Arrange conduit to provide no more than the equivalent of four 90-degree bends between pull points.
5. Group parallel conduits in same area on common rack.

E. Conduit Support:

1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
2. Provide required vibration isolation and/or seismic controls; see Section 26 05 48.
3. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

F. 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. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
5. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
6. Secure joints and connections to provide mechanical strength and electrical continuity.

G. Penetrations:

1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
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. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
6. 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.
7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.

H. 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 conduits are subject to earth movement by settlement or frost.

I. Conduit Sealing:

1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
   a. Where conduits enter building from outside.
   b. Where service conduits enter building from underground distribution system.
   c. Where conduits enter building from underground.
   d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

J. Provide grounding and bonding; see Section 26 05 26.

3.02 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Correct deficiencies and replace damaged or defective conduits.

End of Section 26 05 33.13