Factoria Recycling and Transfer Station

Contract C00678C12

CONTRACT VOLUME 7 of 15

RFP Volume 3 of 7

Request for Proposal
Technical Specifications
Divisions 11 thru 30

June 2014

King County

Department of Natural Resources and Parks
Solid Waste Division

Factoria Recycling and Transfer Station Project

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TABLE OF CONTENTS
FACTORIA RECYCLING AND TRANSFER STATION PROJECT
CONTRACT C00678C12

VOLUME 3

SECTION 11 40 00
MUNICIPAL SOLID WASTE COMPACTOR

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Scope of Services for Solid Waste Compacting Equipment.
   2. Equipment Specifications:
      a. One compactor, with hydraulic power unit (HPU), remote HPU radiator, load cells, base plates and frames.
      b. Control panels and motor starters.
      c. Electrical wire and conduit.
   3. Installation.
   4. Equipment Start-up and No-load Testing.
   5. Facility Start-up.
   6. Compacting Equipment Performance Guarantees and Performance Testing.
   7. Delivery to the site, unloading, storage and protection, and assemblies are part of this Section.
   8. Trailer latching and support structures for the compactor and wheel guides.
   9. Provide in-feed chute hopper, interface, and supports.
   10. Service Obligations.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 05 50 00 – Metal Fabrications.
   3. Section 09 91 00 – Painting and Protective Coatings.
   4. Division 26 - Electrical.
   5. Section 40 05 05- Equipment: Basic Requirements.
   6. Section 40 05 16 – Pipe Support Systems.
   7. Section 40 20 13 – Pipe: Steel.
   8. Section 40 90 10 – Supervisory Control and Data Acquisition System.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
   2. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.

3. American Society for Testing and Materials (ASTM):
    a. A36, Standard Specification for Carbon Structural Steel.
    b. A48, Standard Specification for Gray Iron Castings.
    c. A90, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. National Electrical Manufacturers Association (NEMA):
    a. ICS 6, Enclosures for Industrial Controls and Systems.
5. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. Compacting Equipment: One new compactor used to compact municipal solid waste at the Factoria Recycling and Transfer Station, as defined herein. Compacting Equipment shall refer to new compactor unless otherwise specified.

B. Facility: Factoria Recycling and Transfer Station.

C. Owner: King County Department of Natural Resources & Parks Solid Waste Division.

D. TSO: Transfer Station Operator.

E. MSW: Municipal Solid Waste.

F. TPH: Tons Per Hour.

G. TPD: Tons Per Day.

H. HPU: Hydraulic Power Unit.

I. VFD: Variable Frequency Drive.

J. Trailer: Transfer station trailers with walking floors with interior dimensions of 7 FT 9-5/8 IN wide and 7 FT 6 IN high, and 45 FT to 53 FT long. Top of trailer floor is approximately 50 IN to 52 IN from top of floor elevation. Verify trailer dimensions with Project Representative prior to final installation.

K. Compactor Vendor: The party under subcontract to the Contractor to provide compactor equipment, supports, equipment installation, and/or requirements for installation.

L. Startup Period: The period prior to the commencement of commercial operations when the Owner conducts startup and training activity.

M. Compacting Equipment Performance Test: Performance Testing of the Compacting Equipment performed by the Contractor pursuant to Part 1 Section 1.09.

N. Performance Guarantees: The Guarantees applicable to the testing of the Compacting Equipment set forth in Part 1 Section 1.09.

1.04 SCOPE OF SERVICES

A. Provide a complete and functional solid waste compactor system:
   1. Compactor system shall comply with the specifications herein and is capable of meeting the Performance Guarantees specified in Paragraph 1.09 herein.
   2. Equipment shall be configured, fabricated and assembled to withstand harsh working environment associated with a solid waste transfer station.
   3. Provide installation and commissioning of all Compactor Equipment.
   4. Provide a fully functioning system including (not limited to); equipment installation, compactor supports and anchorage, in-feed chute including interface with tipping floor hopper, electrical conduits and connections, etc.
   5. Provide training and performance testing.
   6. Provide Shop Drawings as listed in Part 1.05, and static and dynamic loading calculations stamped by a Professional Structural Engineer licensed to practice in the State of Washington for all structural elements of the Work, including the compactor supports and attachment.
      a. Final foundation slab shall be based on compactor loading calculations, and compactor support and anchorage requirements.
   7. Provide and install compactor steel pedestal embeds in the concrete compactor foundation slab to attach the compactor. Provide final location and design based on the compactor Shop Drawings and coordinate the embed locations with the structural slab pour.
   8. Equipment shall be provided with the conduit for electrical power, controls, and signal between the various components of the compactor system.
   9. Provide and install the hydraulic piping and hoses including supports between the compactor and the HPU.
   10. Provide exterior wall mounted heat exchanger (radiator) for HPU.
      a. Provide complete installation of HPU radiator including; platform on which the HPU radiators and wall louver are installed and sheet metal plenum to which the HPU radiators are attached, see Drawings.
      b. Provide and install piping between the HPU and the exterior wall (louver) mounted heat exchanger. Piping shall be Schedule 40 steel, pickling treated. See Specification Section 40 20 13 – Pipe: Steel; for general requirements.
   11. Install hydraulic piping sleeves as required for wall penetrations.
   12. Provide list associated with any items specified that are excluded from bid.
   13. Provide list of accessories, options or upgrades not specified that may benefit the Owner or improve compactor performance.

14. Provide in-feed chute collar design, fabrication and installation of final interface connection to tipping floor hopper chute such that waste will be contained to feed directly into compactor.
15. Provide flat concrete surface (See Drawings) for equipment support.
    a. Coordinate final foundation and anchorage requirements.
    b. Provide foundation slab based on Compactor Vender provided information and requirements as required in Part 1.04.A.6.
16. Provide and install conduit and telephone cabling to the locations of the compactor control cabinets.
17. Provide and install permanent electrical power up to and including the junction boxes indicated on the Drawings for the HPUs and for the compactors.
18. Provide and install truck wheel guides and trailer latch.

B. Operator Training: At the commencement of the Transition Period and prior to the commencement of the Compacting Equipment Performance Test:
    1. Provide qualified factory trained personnel on-site for a period of five (5) working days to fully train the Owner's personnel in the proper operation and maintenance of the Compacting Equipment:
        a. Provide training to Owner Maintenance Personnel on daily, weekly, monthly, annual, etc. maintenance requirements.
        b. Provide training to operators and supervisors on the use of the compactor from the control center.
        c. Train TSOs (Transfer Station Operators) on the proper hopper loading, reader board display and compactor cycling rates.
    2. Provide detailed Operation and Maintenance Manuals containing instruction on the content and frequency of maintenance procedures and the sequence of operating procedures.
    3. On completion of the Owner's training program, provide a certification that the Owner's personnel are fully trained and capable of performing the Compacting Equipment maintenance and operations procedures specified in the Operations and Maintenance Manual. Absent such certification, it is required that the Contractor shall be responsible for providing personnel on-site to perform required maintenance during the Warranty period stipulated in 1.09 of this Section at no cost to the Owner.

C. Performance Testing:
    1. An Equipment Vendor representative or Equipment Vendor trained representative shall be on site during all testing procedures.
    2. Conduct the Preliminary and Final Field Tests described in Part 3 Section 3.02 to demonstrate that the Compacting Equipment installation is mechanically complete, with equipment instrumentation and controls fully functional in an energized state.

3. With the involvement of the Project Representative and Commissioning Agent, prepare a coordinated plan for conducting the Compacting Equipment Performance Test as outlined in 1.09 of this Section over a two-day test period.
4. The qualified factory trained technical personnel on-site during the Compacting Equipment Performance Testing to coordinate with the Project Representative. The Owner will provide personnel to staff and operate the Facility including front loader operators and transfer trailer drivers during Compacting Equipment Performance Testing.
5. Perform Compacting Equipment Performance Test and provide the Project Representative with a written certification that the Test has or has not been conducted in accordance with the requirements of Part 1, Section 1.10 hereof.

D. Maintenance: See Part 3.04.

1.05 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Leadership in Energy and Environmental Design (LEED®) Documentation: Submit the following in accordance with Section 01 81 30 – Sustainable Design Requirements:
1. Provide completed LEED Materials Submittal Form to declare recycled content, regional manufacture or source, and regional harvest content, as applicable, of the materials contained in this Section for steel and concrete.

C. Approval Submittals:
1. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Heat rejection of HPU radiator unit.
   d. Arrangement and assembly Drawings with dimensions.
   e. Load cells.
   f. In-feed chute, support, anchor bolts, and embed details for complete installation.
   g. Wheel guide and trailer latch details for complete installation.
   h. Required clearances for equipment service and operation.
   i. Control equipment.
   j. Motors.
   k. Control panel and motor control center Drawings.
   l. Control circuits and instrument schematic diagrams.
   m. Wiring diagrams including internal wiring and control diagrams.

n. Electrical one-line and general arrangement.

o. Provide annual estimated electrical consumption (in kWh/yr) for entire compactor unit, including but not limited to HPU and cooling system, based on 2,080 HRS of operation at 135 TPH.

p. 28 days after Notice to Proceed 1, submit all loadings to structures and foundations, including anchor bolt requirements.

q. At least 10 days prior to installation, submit schedule of activities and roles of parties involved. Include schedules for installation, testing, start up and training.

r. Provide list of spare parts provided.

D. Closeout Submittals:

1. Operation and Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

a. Replacement parts list (including cost) for annual preventative maintenance and the anticipated useful life of major equipment components under conditions of normal ware and tear for 2,080 HRS of annual operation and assuming performance of maintenance specified in the Operations and Maintenance Manual.

b. Shop manuals including but not limited to a complete description of programming, wiring, and troubleshooting, and operating practices.

c. Maintenance Schedule detailing recommended preventive maintenance practices and parts replacement for the useful life of the equipment detail daily, weekly, monthly and annual maintenance practices to keep machine operating within performance guarantees and to keep warranty valid.

2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.06 QUALIFICATIONS

A. The following experience is required in the design, manufacture, installation, and testing of equipment of the specific type covered in these Contract Documents.

1. Ten years experience in and responsibility for design, manufacture, and installation of MSW compacting systems.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Schedule delivery of items to site to provide the minimal time required for on-site storage before installation.

B. Store all components and accessories off the ground in areas where they will be protected from physical damage, exposure to the environment and theft.

1.08 GENERAL WARRANTY

A. General warranty shall be for all components associated with the Compacting Equipment listed in Part 1.01 A. of this Section. Contractor shall provide that the Equipment Components are free from manufacturing defects in materials and workmanship.

B. The two (2) year general warranty shall provide the Owner the sole right to choose repair or replacement of any defective parts, components or workmanship. During the warranty period the Contractor shall pay 100 percent of costs associated with the repair or replacement of any defective parts, components or workmanship, including all shipping, handling, labor, travel, and taxes. The Owner shall provide the Contractor written notice of a warranty claim and the Contractor shall provide personnel on site within 48 HRS to perform warranty work. Such work shall be performed continuously and expeditiously until repair or replacement is complete. If the Contractor fails to initiate or promptly perform such warranty repairs the Owner may hire all such work done by an outside party and bill the Contractor for all costs incurred in making the repair. Warranty shall acknowledge that if such outside repair action are necessary because of Contractor's failure to perform in a timely fashion the outside repair actions will not in any way infringe upon, invalidate or diminish the warranty.

C. General warranty acknowledges the Compacting Equipment is used in a municipal solid waste transfer station and that it does not exclude waste types or activities routinely associated with such facilities and their waste transfer operations.

D. General warranty may exclude normal wear and maintenance items such as filters, fuses, wear strips, o-rings, and adjustments, provided they are identified in the O&M manuals as items subject to routine and scheduled maintenance and repair. However, normal wear items that fail due to faulty workmanship, design or defect will be included will be replace by Contractor at no cost to Owner.

E. General warranty excludes damage due to accidents, abuse, neglect, misuse, improper repair, modifications and alterations not performed by Compactor Manufacturer, or failure to comply with requirements clearly identified in the Contractors O&M manuals and Maintenance Schedules.

1.09 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   a. Finishes on metal fabrications is five (5) years from date of Substantial Completion.

1.10 COMPACTING EQUIPMENT PERFORMANCE TEST AND PERFORMANCE GUARANTEES

A. The Compacting Equipment Performance Test shall commence after the installation of equipment and completion of the Preliminary and Final Field Tests set forth in Part 3 Section 3.02. Satisfactory completion of the Compacting Equipment Performance Test is a requirement of Substantial Completion.

B. A Manufacturer Representative shall be present during performance testing and submit certification that the Compacting Equipment Performance Test has been passed is a condition of Substantial Completion of the facility.

C. One month in advance of the commencement of the Compacting Equipment Performance Test, prepare a detailed test protocol for conducting the Compacting Equipment Performance Test to demonstrate compliance with the Performance Guarantees and shall submit the protocol to Project Representative and Commissioning Agent to review for consistency and compliance with the requirements of this Section. The Test protocol shall assume the following Test conditions:
   1. Owner-managed waste will be delivered as collected by the Owner in accordance with its normal waste collection practices and policies in the quantities required for the Compacting Equipment Performance Test.
   2. The Owner shall provide personnel and equipment required to operate the Facility including front loader operators and transfer truck operators, during the Compacting Equipment Performance Test.
   3. Compactor weigh cells will be used to determine the payload for each container. During the test, the tare and gross vehicle weight of empty and full trailers shall be checked on the Facility truck scale.
   4. If the difference between the weight given by the compactor weigh cells and by the truck scale is more or less than 2.5 percent, then the Contractor shall adjust the compactor weigh cells to correct this difference.

D. Develop a Coordination Plan with the Project Representative and Commissioning Agent identifying the roles and responsibilities of its personnel and the Owner's personnel in conducting the Compacting Equipment Performance Test.

E. The Compacting Equipment Performance Test shall demonstrate that the Compacting Equipment is capable of meeting Performance Guarantees in accordance with the requirements set forth herein. The Project Representative will arrange to have Owner's authorized representatives present to witness the Compacting Equipment Performance Test.

F. The Compacting Equipment Performance Test shall include:
   1. Operation of the compaction cycle to demonstrate compaction of waste material to preset dimensions and weight.
   2. Transfer of compacted waste into trailers.

G. The Compacting Equipment Performance Test shall demonstrate that the Compacting Equipment is capable of meeting Performance Guarantees in accordance with the requirements set forth herein.

H. The Performance Guarantees applicable to the Compacting Equipment Performance Test are:
   1. Loading of transfer trailers with walking floors with interior dimensions of 7 FT 9-5/8 IN wide and 7 FT 6 IN high, and 45 FT to 53 FT long with a net weight of 27 long tons (60,480 LBS) each.

2. Two 2-HR peak processing tests (Peak Processing Test) shall be conducted each day over two consecutive days during the Compacting Equipment Performance Test.
3. Each 2 HR Peak Processing Test shall demonstrate that the Compacting Equipment has processed 270 gross tons of waste into no more than nine (9) trailers.
4. During the tests, the compacted refuse log (refuse log) extruded into trailers shall meet the following compaction and extrusion characteristics:
    a. Refuse logs must be compatible with transport in transfer trailers size of 7 FT 9-5/8 IN wide and 7 FT 6 IN high, and 45 FT to 53 FT long (internal dimensions).
    b. Refuse log(s) should not abrade or exert forces on trailer roof or side walls during loading.
    c. Refuse log(s) should maintain integrity so that only negligible amounts of material falls back after extrusion into the trailer.
    d. The compactor shall be capable of extruding the refuse log(s) into the trailer such that the refuse log extends a minimum of 5 FT clear of the end of the compactor.

I. All Performance Guarantees for the Compacting Equipment shall be demonstrated during the test period. No later than 2 weeks after the end of the Compacting Equipment Performance Test, the Contractor shall prepare and submit a report to the Project Representative certifying whether the results of the Compacting Equipment Performance Test have demonstrated compliance with the Performance Guarantees.

J. The Project Representative shall witness the Compacting Equipment Performance Test, review the certification contained in the Contractor's Test report and advise the Owner on whether the Compacting Equipment Performance Test was conducted in compliance with the approved test protocol. The Contractor’s submittal of a test report certifying that the Compacting Equipment Performance Test has been passed is a condition of Substantial Completion of the facility.

K. If the Compacting Equipment Performance Test is not passed, the Contractor shall have the option of repeating the test. The Contractor shall make any required equipment modifications and retest equipment within two months of conducting the first performance test. Any required modifications or repairs to the Compacting Equipment and the costs of retesting shall be at no additional cost to the Owner.

L. If, on re-testing, the Compacting Equipment Performance Test is not passed, the Contractor shall not earn and shall not be paid the Performance Test Completion Payment, as set forth in its bid.

M. Provide vibration testing in accordance with Specification 40 05 05 – Equipment: Basic Requirements.

1.11 COMMISSIONING

A. The Work of this Section shall include labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers or equal are acceptable:
   1. Compactors:
      a. Harris Equipment Co.
      b. SSI.
      c. Or approved equal.
   2. Submit requests for substitution in accordance with Section 01 60 00 – Product Requirements.

2.02 MATERIALS

A. Reference applicable Division 05 - Metals Sections.

2.03 EQUIPMENT

A. Furnish equipment in accordance with Section 40 05 05 – Equipment: Basic Requirements.

B. Compactor:
   1. Compactor will be top loaded, feed from hopper located in tipping floor above.
   2. Furnish compactor complete with drive system, support structure, base plates, frame and controls.
   3. Type: Horizontal, single ram or multiple ram.
      a. Feature a multiple of single stage cylinders, or telescoping multiple cylinders, sufficient to pass the compacted bales five (5) feet beyond the opening of the trailer or container.
   4. Design condition:
      a. Readily achieve 135 gross TPH of MSW.
      b. Achieve bale density of 970 LB/CY.
   5. Trailer payload: Average 27 long tons (60,480 LBS) of compacted MSW.
   6. Major components such as cylinders should be designed to maximize their useful life and minimize breakdowns.
   7. Construction:
      a. Major sub-assemblies shall be plate and structural weldments of cellular construction welded onto main chamber assembly.
      b. Final assembly shall be bolted and keyed.

c. Wear surfaces, including the chamber floor and walls, shall be fitted with weld-on abrasion resistance wear plates of heat treated alloy steel.

d. Shear knives shall be securely seated in press frame and platen.

e. Pipe: Electrically welded and securely anchored.

f. Pipe flanges: Steel, bolted, o-ring gaskets.

g. Compactor shall be completely assembled and operated before shipment. Notify County at least one week in advance prior to shop operation.

h. Fasteners: Provide English or metric sized fasteners, do not provide both.

8. Chamber liner:

a. Provide replaceable abrasion resistant steel floor liner fabricated from 500 Brinell steel, 1/2 IN minimum thickness.

b. Provide replaceable abrasion resistant steel wall liners fabricated from 400 Brinell steel, 1/2 IN minimum thickness.

c. Abrasion resistant liners:

1) Hardox.

2) Titus “Moly-Bond”.

3) Leeco.

4) Endura.

5) Or approved equal.

9. Platen:

a. Platen shall travel on replaceable slider bearings and wear strips.

b. Platen shall provide built-in jam release.

10. Provide displays, such as hydraulic gages, at key locations.

a. Identify proper operating range (minimum and maximum) on all gages.

b. Operator’s console display.

1) See Part 2.03.D for requirements.

11. Provide display boards located per Project Representative.

a. See Part 2.03.D for additional requirements.

12. Provide a means of securing trailers during loading. Provide alignment mechanisms.

13. Provide in-feed chute to interface with tipping floor loading hopper.

a. See Part 2.04.E.

14. Lubrication fittings shall be “Zerk Hydraulic” type or the “Alemite” type.

15. Provide simplified hydraulic power unit with adequate cooling system and NEMA 4 enclosures.
16. Cooling system to include a remotely located exterior wall (louver) mounted heat exchanger system. Provide all associated equipment required for fully functioning remote cooling system including heat exchanger, piping, etc. See plans for remote radiator location.
17. Provide hydraulic system, to be located in separate equipment room located behind compactor, inside curbed area.
    a. Include specific installation requirements of the hydraulic power unit.
    b. Nameplate drive horsepower: Maximum of 250 HP.
        1) Provide HPU with variable frequency drive (VFD) on main motors
        2) HPU with VFD shall meet performance requirements of Part 1.09 in this Specification.
        3) Provide Submittals as required in Part 1.05.
        4) Note: The Owner is pursuing LEED certification; energy savings configurations over standard configurations will be investigated and taken into account during bid evaluation.
    c. Design and supply required flexible hydraulic lines, hard piping and isolation valves, and coordinate to ensure proper routing of hydraulic lines and piping.
    d. Hydraulic lines shall be predominantly hard piping, using the minimum amount of flexible hoses necessary.
    e. Provide isolation valves at the HPU units and at the compactors.
    f. Hydraulic pumps and equipment shall be designed for required length and pipe routing (to be determined in field) from HPU to compactor and HPU to radiator.
    g. Provide appropriately sized hydraulic line for connection from HPU to compactor.
        1) Hydraulic line length from HPU to compactor: Approximately 15 FT in plan.
        2) Hydraulic line length will vary depending on final routing to be determined in field.
    h. See Drawing for HPU and compactor locations.
18. Housings of grease-lubricated bearings shall be automatically exhausted to atmosphere to prevent excessive greasing.
19. Platforms, stairs, and ladders:
    a. Provide as required for routine maintenance, lubrication, and operation.
    b. Provide access to all drives and electrical connections.
    c. Provide access platforms with stairs to top of compactor at the gate.

d. Material: Steel, painted.

e. Supported from equipment or concrete.

f. Adequate size to perform maintenance activities.

C. Electrical Requirements:

1. All electrical and control equipment shall carry UL label.

2. Furnish and install complete system with all electrical power, controls, control panels and controls for the compaction system, ready for single source power connection at control panel.

3. Provide all power and control wiring for the compactor.

4. Provide NEMA 4 enclosures and wiring.

5. Equipment shall be installed in accordance with the requirements of the NEC.

6. Motors:

a. See Section 40 05 05 – Equipment: Basic Requirements.

b. Provide reduced voltage starting on main hydraulic system motors to limit the inrush current.

c. TEFC, NEMA Design B with Class F insulation.

7. Provide in accordance to Section 26 05 00 – Electrical: Basic Requirements.

D. Instrumentation and Control Requirements:

1. One control panel shall provide power to and control compactor.

2. HPU controller shall be interlocked with HPU room heat detector (normally closed contact). In the event of a fire detected the HPU shall automatically shutdown.

3. All electrical and control equipment shall carry UL label.

4. Operator's Station Enclosure:

a. Operator's station shall be located on a wall near the interface between the compactor and trailer. See plans for station location.

b. One operator's station enclosure to include oil tight control switches and signal lights, wired to terminal strips.

c. Console display bale weight, length, system hour meter, and numerical diagnostic functions and emergency stop.

1) Include automatic high hydraulic pressure safety shut off switch (with manual reset) wired to turn off the hydraulic unit.

2) Include a low hydraulic fluid level shut off switch.

d. Provide means of lock out / tag out on switches exterior of control panel for:

1) Power on/off.

2) Maintenance mode on/off.

3) Manual mode on/off.

5. Provide in accordance to Section 26 05 00 – Electrical: Basic Requirements.
6. Load Cells:
   a. Electronic, front and rear load cells to be provided.
   b. Weights are totalized with visual readouts on Operators Station, and display boards.
   c. Display weights on display boards.
   d. Load cell electronic data shall be tied into the programmable controller for automatic operation.
      1) The bale weight data shall also be available and be able to be connected to an industrial data terminal, PC computer based system, and/or ticket printing system for use to produce weight tickets and historical reports that require bale weight information.
7. Display boards:
   a. Provide Two (2) display boards.
      1) One (1) to be located at tipping floor.
      2) One (1) to be located near Operator Station.
      3) See Drawings for locations.
   b. Minimum of 6 IN high multiple character display.
   c. NEMA 4 enclosure.
   d. Indication operating parameters including:
      1) Platten position indicator.
      2) Weight at all times.
      3) Run light, bale done light, and error lights.
8. Remote Control:
   a. Provide two (2) wireless remote controls for complete operation of compaction system.
   b. Minimum range of 300 FT.
   c. Control for:
      1) Emergency stop.
      2) Clear hopper and return home.
      3) Compaction stroke and return home.
      4) Stop stroke and return home.
      5) Bale done.
   d. NEMA 4 enclosure.

9. Control Panels shall include:
    a. NEMA 4 construction and located in operators console.
    b. Automate bale building program with consistent density.
    c. Change weight, length and compaction sequence goals at any time.
    d. View cylinder and platen locations at all times through display.
    e. Remote monitoring, diagnostics, and programming capabilities by manufacturer (by modem link).
    f. Display indicating operational parameters including modes and diagnostics.
    g. Manual bale discharge.
    h. Record and store data on last 15 number of loads and weights (minimum).
    i. Ethernet RJ45 port for transmission of data to SCADA network. Include data I/O map with available data points, register addresses, and ranges for programming of the main controller.
    j. Diagnostics: Built-in trouble shooting capabilities including error message recording.
    k. Temperature of oil in system (also recorded at tank).
    l. Main disconnect circuit breaker with external operating handle.
    m. Accept a single 480V, 3-phase power feed.
    n. 20A, 125 V AC receptacle.
    o. Combination motor starters, control power transformer, control relays, interlocks, panel mounted selector switches, panel mounted indicating lights, circuit breakers, push button switches, contacts for remote mounted equipment.
        1) Motor starters may be separately mounted where panel space is limited.
    p. Communication module to provide Ethernet TCP/IP communications with the facility's SCADA system. See Section 40 90 10 – Supervisory Control and Data Acquisition System for SCADA requirements.
    q. Interlock with heat detector.
    r. Interlock with remote exhaust fan.

2.04 ACCESSORIES

A. Environmental Controls:
    1. Minimize dust and noise from loading and operation.
    2. Auto-shutdown of HPU in the event of a hydraulic failure.
    3. Secondary containment of HPU reservoir. Minimum 110 percent of the capacity of the reservoir.

4. HPU controller shall be interlocked with HPU room heat detector (normally closed contact). In the event of a fire detected the HPU shall automatically shutdown.
5. Provide additional interlock such that the remote exhaust fan (See Plans) will only operate while the HPU is in operation.

B. Provide safety guards for drive components to protect personnel against possible injury from moving parts.
   1. Guards shall be constructed of heavy-duty expanded metal.

C. Provide a means of securing containers/trailers during loading and trailer alignment mechanisms such as wheel guides and trailer hooks.

D. Support Structure:
   1. Provide steel support structure for equipment floor tie-in and/or pedestal design.
   2. Steel structures shall conform with Sections 05 50 00 – Metal Fabrications.
   3. Design support structure for Seismic Loads:
      a. Seismic (Earthquake) Loads:
         1) Occupancy category: II.
         2) S_s: 1.226.
         3) S_1: 0.650.
         4) Site Class: D.
         5) Seismic design category: D.
      b. The seismic restraint and anchorage of permanent equipment and associated systems listed below to building structure shall be designed to resist the total design seismic force prescribed in the latest edition of the IBC.
         1) Floor mounted equipment weighing 400 LBS or more.
         2) Suspended or wall-mounted equipment weighing 20 LBS or more.
         3) Vibration-isolated equipment.
         4) Piping 1 1/4 IN nominal diameter and larger located in mechanical equipment enclosure.
         5) Electrical conduit 2 1/2 IN trade size and larger.
      c. Seismic support structures shall also conform to requirements in Section 40 05 16 – Pipe Support Systems and Section 26 05 48 – Seismic Bracing Systems.

E. In-feed Chute:
   1. Feed chute shall direct waste from tipping floor hopper into compactor
   2. Material: Steel 1/2 IN thickness minimum, abrasion resistant.
   3. Suitably stiffened.
   4. Provide edge reinforcement.

5. Provide easily removable access hatches, accessible from top of compactor roof.
6. Feed chute supports to be coordinated among all subsuppliers.
7. Provide tipping floor chute collar to interface with compactor in-feed chute.
    a. Provide final interface connection between collar and in-feed chute.

F. Access:
1. As required supply platforms, walkways, stairs, and ladders as required for routine maintenance, lubrication and operation.
2. Platforms if required shall be steel, supported from equipment or grade.
3. Fabricated metal items, railings, and grating shall conform to Section 05 50 00 – Metal Fabrications.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Prior to erecting equipment review final compactor Shop Drawings, check the dimensions of foundations, anchor bolt spacing, and other interfacing connection points to ensure the satisfactory erection of equipment.

B. Prior to setting equipment, clean and prepare the surfaces of all foundations, anchor bolts, base plates, etc.

C. Erect and install equipment in accordance with manufacturer's recommendations, Section 40 05 05 – Equipment: Basic Requirements, Division 26 - Electrical and the requirements of the Contract Documents.
1. Set equipment to a true centerline and elevation.
    a. Check setting and plumbness before jacking down and torqueing anchor bolts.
    b. Provide locking or jam nuts with all anchor bolts.
2. Provide all necessary conduits and wiring for compactor, HPU, scoreboard and all other accessories for complete compactor system.
3. See Specification Sections 40 05 16 - Pipe Support Systems and Specification Section 26 05 48 - Seismic Bracing Systems for further requirements.

D. Unless specified otherwise herein, comply with Division 26 - Electrical and Manufacturer's recommendations.

E. Provide all anchoring devices and supports.
1. Use supports, pedestals, and anchoring devices rated for the equipment load and as recommended by the Manufacturer.
2. Supports, pedestals, and anchoring devices shall be rated and sized based on compactor dimensions and weights per Manufacturer.
3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.

4. Do not cut, or weld to, building structural members.
5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.
6. See Specification Sections 40 05 16 - Pipe Support Systems and Specification Section 26 05 48 - Seismic Bracing Systems for further requirements.

F. Provide concrete foundations or pads required for equipment as indicated or specified.
   1. Provide final anchoring of HPU and Compactor to concrete foundations or pads.
   2. Floor-mounted equipment shall be mounted on a 4 IN high concrete housekeeping pad or as shown on the Drawings. Pad shall be poured on top of the finished floor or slab. Coordinate housekeeping pad limits for ADA compliance and egress requirements.

G. Provide tagging of electrical equipment in accordance with the manufacturer's standard and OSHA requirements.

H. Factory paint:
   1. Assure that metal surfaces are protected by a minimum of one (1) rust prohibitive primer coat and one (1) coat of high quality corrosion resistive paint.
   2. Agree to repair any coating or finish installed under this Section that peels, flakes, cracks, chips or becomes un-adhered, and that is attributable to poor or otherwise inadequate surface preparation for the duration of the warranty period.
   3. Painting shall conform to Section 09 91 00 – Painting and Protective Coatings.

I. Device Mounting Schedule:
   1. Dimensions are to center of item unless otherwise indicated.
   2. Mounting heights as indicated below:
      a. Safety switch: 54 IN.
      b. Panelboard (to top): 72 IN.
      c. Motor starter: 54 IN.
      d. Pushbutton motor control station: 48 IN.

J. Terminate instrumentation and control wiring, including spare wires, at control panels on terminal boards mounted inside the equipment.
   1. Supply terminal boards as required.
   2. Do not field wire directly to devices.
   3. Ground both ends of spare wires.

K. Grounding shall be in accordance with Division 26 - Electrical and NEC.

L. Motor installation in accordance with Division 26 - Electrical and NEC.

3.02 FIELD QUALITY CONTROL

A. Initial Checkout and Operation (non-exhaustive list):
   1. Upon completing installation of the Compacting Equipment, furnish the services of competent start-up personnel for a period suitable to perform the following Compacting Equipment Start-up Test:
      a. Perform start-up and tuning of the system, adjusting components as required for optimum operation including instruction in all instrumentation and controls.
      b. Test equipment as recommended by manufacturer.
      c. Perform ground-fault performance testing as required by NEC Article 230.
      d. Set all adjustable trip protective devices as required for system protection and proper trip coordination.
      e. Adjust installed equipment for proper operation of all electrical and mechanical components.
      f. Test Equipment Interface:
         1) Verify system coordination and operation.
   2. Replace equipment and systems found inoperative or defective and re-test.
      a. If equipment or system fails re-test, replace it with products which conform to Contract Documents.
      b. Continue remedial measures and re-tests until satisfactory results are obtained.
      c. Remedial measures and re-tests will be done at no cost to the Owner.
   3. Test to ensure all equipment is free of short circuits and improper grounds.

B. Prior to Substantial Completion, conduct the Preliminary and Final Field Tests to establish that the Compacting Equipment is energized and functional. The Contractor, in coordination with the Project Representative, shall then conduct Equipment Performance Test to demonstrate equipment operation. The Project Representative will arrange to have their authorized representatives present to witness these scheduled tests. If deficiencies are disclosed which cannot be corrected at the time, then the corrections as well as retesting shall be entirely at the expense of the Contractor, including labor costs, prior to the Compacting Equipment Performance Test.
   1. Perform static tests to ensure proper installation, lubrication, and cleanup of equipment for subsequent load tests.
   2. Perform the following no-load tests to demonstrate that the equipment shall operate for a sustained period.
      a. Compactor operation.
      b. Individual component operation.
      c. Instrumentation and controls functioning.

3. Subject the equipment to infeed material at various infeed rates to demonstrate satisfactory functioning of equipment over a range of throughput values.

3.03 ACCEPTANCE

A. Acceptance requires the following, but is not limited to:
   1. Complete installation of the Compactor at the above identified location.
   2. Connection of the compactor to the building structural, electrical and other systems sufficient to operate the compactor on a continuous basis.
   3. Completion of the required commissioning and performance testing.
   4. Completion of the corrective items identified by the Project Representative.
   5. Completion of Operation and Maintenance manuals.
   6. Completion of training of Owner's staff.
   7. Completion of all other tasks and obligations apart from the warranty, service obligations, and maintenance obligations under this Contract.

3.04 SERVICE OBLIGATIONS

A. Items requiring maintenance shall be identified to ensure their performance and reliability.

B. Provide a detailed schedule of Manufacturer recommended maintenance inspections, cleaning, and replacement of parts.
   1. Provide schedules for daily, weekly, monthly, semi-annual, and annual activities.
   2. Provide costs associated with maintenance schedule, including replacement parts and labor hours required.

C. Contractor will make itself available, within 72 HRS of notification, during first year, to provide assistance and/or training with monthly, quarterly, semi annual and annual preventative maintenance.

D. Provide 24 HR emergency response in case of catastrophic failure during first year operations to assist in recovery.

E. Assure that capable, experienced person or persons with skills for writing, troubleshooting, and optimizing software patches, and fixes; and that such person(s) are reasonably available.

F. Provide all consumable materials (i.e. filters, cylinder packing, wiper materials, greases, hydraulic oil, etc.) for first year preventative maintenance and operations.

G. Provide all parts listed (and quantity) in recommended parts on hand list (i.e. hoses, belts, relays, fuses, load cell, etc.) and any specialized tools required to work on equipment of this Section.

H. Provide training to operators and supervisors on the use of the compactor from the control center.

I. Train TSOs on the proper hopper loading, reader board display and compactor cycling rates.

J. Include the maintenance price in the Contract.

END OF SECTION

SECTION 11 45 10
RESIDENTIAL APPLIANCES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. This Section includes the following:
   1. Refrigerator/freezers.
   2. Ranges.
   3. Kitchen Exhaust Ventilation.
   4. Microwave Oven.
   5. Dishwasher.
   6. TV Monitor.

B. Related Specifications include the following:
   1. Division 22 - Plumbing Fixtures.
   2. Division 26 - Electrical.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product Data: For each appliance type required indicating compliance with requirements. Include complete operating and maintenance instructions for each appliance.
   2. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

C. Closeout Submittals:
   1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
   2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the residential appliance manufacturer for both installation and maintenance of appliances required for this Project.

B. Source Limitations: Obtain residential appliances through one source from a single manufacturer.
   1. Provide products from the same manufacturer for each type of appliance required.
   2. To the greatest extent possible, provide appliances by a single manufacturer for entire Project.

C. Product Options: Drawings indicate sizes, profiles, and dimensional requirements of residential appliances and are based on the specific types and models indicated. Other manufacturers' appliances with equal performance characteristics may be considered. Refer to Specification Section 01 60 00 – Product Requirements for "Substitutions" procedures.

D. Electrical Appliances: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

E. UL and NEMA Compliance: Provide electrical components required as part of residential appliances that are listed and labeled by UL and that comply with applicable NEMA standards.

F. AGA and ANSI Standards: Provide gas-burning appliances that carry the design certification seal of AGA and that comply with ANSI Z21-Series standards.

G. AHAM Standards: Provide appliances that comply with the following AHAM standards:
   1. Refrigerators and Freezers: Total volume and shelf area ratings certified according to ANSI/AHAM HRF-1.

H. Energy Ratings: Provide ENERGY STAR® Certified products. Provide residential appliances that carry labels indicating energy-cost analysis (estimated annual operating costs) and efficiency information as required by the Federal Trade Commission.

1.05 DELIVERY

A. Deliver appliances only after utility rough-in is complete and construction in the spaces to receive appliances is substantially complete and ready for installation.

1.06 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is five (5) years commencing on the date of Substantial Completion.

PART 2 – PRODUCTS

2.01 RESIDENTIAL APPLIANCES.

A. Top-Mount Refrigerator/Freezer: Freestanding, two-door refrigerator with top-mounted freezer, listed by UL, and complying with requirements specified in the Residential Appliance Schedule.

B. Electric Range: Slide-in range with one oven and complying with AHAM-ER-1.

C. Kitchen Exhaust Ventilation: Under cabinet Range Hood.

D. Microwave Oven.

E. Dishwasher.

F. TV Monitor.

2.02 FINISHES

A. Finish: Stainless Steel.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing, mechanical, and electrical services, with Installer present, to verify actual locations of services before residential appliance installation.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General: Comply with manufacturer's written instructions.

B. Built-in Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.

C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

D. Utilities: Refer to Division 22 for Plumbing requirements and Division 26 for electrical requirements.

3.03 ADJUSTING AND CLEANING

A. Test each item of residential appliances to verify proper operation. Make necessary adjustments.

B. Verify that accessories required have been furnished and installed.

C. Remove packing material from residential appliances and leave units in clean condition, ready for operation.

3.04 RESIDENTIAL APPLIANCE SCHEDULE

A. Top-Mount Refrigerator TMR: Where this designation is indicated, provide refrigerator/freezers complying with the following:
   1. Products: Provide one of the following:
      a. Frigidaire: 18.28 CU FT Top Freezer Refrigerator:
         1) Model: FPUI1888LR.
      b. Maytag: 19 CU FT EcoConserve Refrigerator:
         1) Model: M9BXXGMYM.
      c. Whirlpool: 19 CU FT Top-Freezer Refrigerator:
         1) Model: WRT359SFYF.
      d. Or approved equal.
   2. Type: Freestanding, frost-free, two-door, top-mount freezer refrigerator/freezer with ABS thermoplastic-copolymer interior cabinet liners.
   3. Refrigerator Storage Capacity: 18- 20 CU FT total interior refrigerator volume measured according to ANSI/AHAM HRF-1 and certified by AHAM.
   4. Refrigerator Shelf Area: Total interior refrigerator shelf area measured according to ANSI/AHAM HRF-1 and certified by AHAM.
   5. Energy Consumption: ENERGY STAR® Certified.
   6. Temperature Controls: Separate temperature controls for each compartment and a switch for condensation-control heating element at freezer opening.
   7. Standard storage features include the following:
      a. Fresh Food Compartment:
         1) Gallon (Liter) container size door storage shelves.
         2) Vegetable crisper.
         3) Meat compartment.
         4) Utility bin.
         5) Dairy compartment.
         6) Removable egg trays.
      b. Freezer Compartment:
         1) Door shelves.
         2) Ice storage bin.
         3) Two ice cube trays.
         4) Interior light.
   8. Finish: Stainless steel.

9. Standard features include the following:
    a. Interior light in fresh food compartment.
    b. Adjustable rollers.
    c. Adjustable compartment shelves.

B. Electric Range - 30 IN (RG-30):
1. Products provide one of the following:
    a. Frigidaire: 30 IN Slide-In Electric Range:
        1) Model: FFES3015LS.
    b. GE: 30 IN Slide-In Electric Range:
        1) Model: JSP39SNSS.
    c. Whirlpool: 30 IN Slide-In Electric Range:
        1) Model: RY160LXTS.
    d. Or approved equal
2. Electric Burner Elements: Four.
    a. Coil Type: Manufacturer's standard.
    b. Controls: Digital panel controls, located on front.
3. Oven Features:
    a. Minimum 3.3 CU FT.
    b. Operation: Baking and self-cleaning.
    c. Broiler: located in top of oven.
    d. Oven Door: Counterbalanced, removable with observation window.
    e. Electric Power rating:
        1) Oven: Manufacturer's standard.
        2) Broiler: Manufacturer's standard.
4. Anti-Tip Device: Manufacturer's standard.
5. Electric Power: Voltage Rating: 240V / 208V, 60Hz.
6. Material: Stainless Steel with manufacturer's standard cooktop.

C. Electric Range - 24 IN (RG-20):
1. Products provide one of the following:
    a. GE: 24 IN Free Standing Electric Range:
        1) Model: JAS02SNSS.
    b. Avanti: 24 IN Free Standing Electric Range:
        1) Model: ER2402CSS.
    c. Or approved equal.

2. Electric Burner Elements: Four.
    a. Coil Type: Manufacturer's standard.
    b. Controls: Digital panel controls, located on front.
3. Oven Features:
    a. Minimum 2.92 CU FT.
    b. Operation: Baking and self-cleaning.
    c. Broiler: located in top of oven.
    d. Oven Door: Counterbalanced, removable with observation window.
    e. Electric Power rating:
        1) Oven: Manufacturer's standard.
        2) Broiler: Manufacturer's standard.
4. Anti-Tip Device: Manufacturer's standard.
5. Electric Power: Voltage Rating: 240V / 208V, 60Hz.
    a. Material: Stainless Steel with manufacturer's standard cooktop.

D. Kitchen Exhaust Ventilation:
1. Products provide one of the following:
    a. Air King ESDQ Series.
    b. Broan APE Series.
    c. Whirlpool.
    d. Or approved equal.
2. Type: Under cabinet range Hood.
3. Exhaust Fan: Built into hood.
4. Externally Vented.
5. Finish: Stainless Steel.
6. Removable grease filter.
7. ENERGY STAR® Certified.
8. Size to be field verified.

E. Microwave Oven:
1. Products provide one of the following:
    a. Frigidaire Model: FFCE1638LS .
    b. Maytag: UMC516AS.
    c. Whirlpool: WMC30516AS.
    d. Or approved equal.
2. Mounting: Counter top.
3. Type: Conventional.

4. Dimensions (min.):
    a. Width: 21 3/4 IN.
    b. Depth: 18 1/2 IN.
    c. Height: 12 7/8 IN.
5. Capacity: Minimum 1.6 CU FT.
6. Oven Door: Door with observation window.
7. Microwave Power Rating: Manufacturer's standard.
8. Electric Power: Voltage Rating: 120V, 60Hz.
9. Other features: Turntable.
10. Material: Stainless Steel.

F. Dishwasher (DW):
1. Products provide one of the following:
    a. Frigidaire Model: FDB2410HIC.
    b. General Electric: GLDT696DSS.
    c. BOSCH: SGE6315UC.
    d. Or approved equal.
2. Type: Undercounter.
3. Dimensions:
    a. Width: 24 IN.
    b. Depth: 23 IN.
    c. Height: 34 1/2 IN.
4. Capacity:
    a. International Place Settings of China: Eight.
5. Tub and Door Liner: Manufacturer's standard with sealed detergent and automatic rinsing-aid dispenser.
6. Rack System: PVC-coated sliding dish racks with removable cutlery basket.
7. Controls: Touch Pad controls with 4 wash cycles and hot-air and heat-off drying cycle options.
8. Features:
    a. Self-cleaning food-filter system.
    b. Hot-water booster heater for 140 Deg F wash water with incoming water at 100 Deg F.
    c. Lock-out feature.
    d. Half-load option.
    e. Delay-wash option.

f. Digital display panel.

g. Water softener.

h. Soil-sensing water use control system.

9. ENERGY STAR® Certified.

10. Front Panel: Stainless Steel.

G. TV Monitor:

1. Products provide one of the following:

a. LG Model: 55LS4500.

b. Sony- Bravia: KDL-55EX620.

c. Samsung F6300 Series: UN55F6300.

d. Or approved equal.

2. TV Technology: LED-LCD.

3. TV Definition: HDTV.

4. ENERGY STAR® Certified.

5. Screen Size: 55 IN.

6. Vertical Resolution: 1080 pixels.

7. Screen Refresh Rate: 120 Hz.

8. HDMI Inputs included.

9. USB port included.

10. USB Input included.

11. Sleep Timer included

12. Remote Control included.

13. Ethernet Port included.

14. Provide metal support capable of supporting the weight of the TV Monitor with the ability to pivot and tilt.

END OF SECTION

SECTION 12 24 14
ROLLER SHADES

PART 1 – GENERAL

1.01 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for Roller Shades, as indicated, in accordance with provisions of Contract Documents.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09 91 00 - Painting and Protective Coatings.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM-G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
   2. NFPA-70, National Electrical Code.
   3. NFPA-701-99, Fire Tests for Flame-Resistant Textiles and Films.
   4. Anti-Microbial Characteristics: 'No Growth' per ASTM-G21 results for fungi ATCC9642, ATCC 9644, ATCC9645.

B. Electrical Components: NFPA Article 100 listed and labeled by either UL or ETL or other testing agency acceptable to authorities having jurisdiction, marked for intended use, and tested as a system. Individual testing of components will not be acceptable in lieu of system testing.

C. Include a mock-up if the project size and/or quality warrant. The following is one example of how a mock-up on a large project might be specified. When deciding on the extent of the mock-up, consider the major different types of work on the project.
   1. Mock-Up: Provide a mock-up (manual shades only) of one roller shade assembly for evaluation of mounting, appearance and accessories.
   2. Locate mock-up in window designated by Project Representative.
   3. Do not proceed with remaining work until, mock-up is accepted by Project Representative.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Leadership in Energy and Environmental Design (LEED) Documentation: Submit the following in accordance with Section 01 81 30 – Sustainability Requirements:
   1. Product Data for MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content; include statement indicating costs for each product having recycled content.
   2. Product Data for MR 5: For products and materials required to comply with requirements for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
   3. Product Data for IEQ 4.1: For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.

C. Approval Submittals:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Fabrication and/or layout Drawings.
      a. Scaled drawing showing expansion joint locations, special conditions, profile, fastening and jointing details.
         1) Minimum plan scale: 1/8 IN = 1 FT.
         2) Minimum detail scale: 1-1/2 IN = 1 FT.
   3. Samples:
      a. Finish and color samples for each product specified for Project Representative's preliminary color selection.
      b. For final color selection, provide 2IN x 3 IN colored metal samples for each color selected during the preliminary color selection.

D. Quality Assurance Submittals:
   1. Fabricator qualifications.
   2. Installer qualifications.

E. Closeout Submittals:
   1. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1.06 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is twenty-five (25) years commencing on the date of Substantial Completion for Roller Shade Hardware, Chain and Shadecloth.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

A. Roll shades:
   1. Base:
      a. Atrium Shade (www.**atriumshade**.com).
      b. Or approved equal.

2.02 SHADE CLOTH

A. Color: Selected from manufacturer's standard colors.

B. Shadecloth: Fabricated from TPO for both core yarn and jacket, single thickness, non-raveling 0.030 IN (0.762 mm) thick fabric.
   1. Weave: 5 percent open 2 x 2 basket weave.

2.03 SHADE BAND

A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
   1. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for shades within one room.

2. Shade band and Shade Roller Attachment:

   a. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 IN in diameter for manual shades, and less than 2.55 IN for motorize shades are not acceptable.

   b. Provide for positive mechanical engagement with drive / brake mechanism.

   c. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" snap-off" spline mounting, without having to remove shade roller from shade brackets.

   d. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.

   e. Any method of attaching shade band to roller tube that requires the use of: Adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

2.04 SHADE FABRICATION

A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb, unless specifically indicated otherwise.

B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 IN in either direction per 8 FT of shade height due to warp distortion or weave design. Fabricate hem as follows:
   1. Bottom hem weights.

C. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadebands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.

D. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Project Representative. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.

E. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadebands.

2.05 COMPONENTS

A. Access and Material Requirements:
   1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
   2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
   3. Use only Delrin engineered plastics by DuPont for plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

2.06 ACCESSORIES

A. Fascia:
   1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
   2. Fascia shall be able to be installed across two or more shade bands in one piece.
   3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
   4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
   5. Notching of Fascia for manual chain shall not be acceptable.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Project Representative of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

A. Install roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 IN to interior face of glass. Allow proper clearances for window operation hardware.

B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

D. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

3.04 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 12 35 53

LABORATORY WORK SURFACE

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Laboratory Work Surfaces.

1.02 QUALITY ASSURANCE

A. Reference Standards:

1. Americans with Disability Act (ADA):
   a. Americans with Disability Accessibility Guidelines(ADAAG).
2. Work shall conform to recommended practices of Scientific Equipment and Furniture Association (SEFA), current version, except as superseded by this specification:
   a. SEFA 2 - Installation.
   b. SEFA 3 - Work Surfaces.

B. System Structural Performance:

1. Work Surfaces: In addition to SEFA test requirements, work surface spans without continuous base cabinet support shall support 2 50 LB/SF; deflection shall be limited to 1/180 of the length of the span, not to exceed 1/4 IN.

C. Qualifications:

1. Fabricator shall have minimum of ten (10) years experience in design and fabrication of architectural cabinetwork with minimum of three (3) successfully completed projects with similar scope in the last two (2) years.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Leadership in Energy and Environmental Design (LEED®) Documentation: Submit the following in accordance with Section 01 81 30 – Sustainability Requirements:

1. Completed LEED Materials Submittal Form:
    a. Product Data for MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content; include statement indicating costs for each product having recycled content.
    b. Product Data for IEQ 4.1: For sealants and sealant primers used inside the weather proofing system, documentation including printed statement of VOC content.

C. Approval Submittals:

1. Shop Drawings.
    a. Submit complete shop fabrication and installation Drawings, including plans, elevations, Sections, details and schedules.
    b. Show relationship to adjoining materials and construction.
2. Submit samples of each of the following items for Project Representative's approval:
    a. 4 IN sample of each laboratory work surface specified.

D. Closeout Submittals:

1. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

E. Project Information:

1. Structural:
    a. Submit detailed anchorage and attachment drawings and calculations to show compliance with seismic restraint requirements.
    b. Engineering design shall be performed and sealed by registered Engineer, licensed to practice Structural Engineering in state of Washington.
2. Wood products and painted metal finish:
    a. Provide letter from a third-party testing agency, verifying independent chemical resistance test results.

F. Contract Closeout Information:

1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

2. Certificates:

a. Certify factory tests specified for mechanical service fixtures have been performed and products or systems meet or exceed specified requirements.

b. Submit certification stating equipment is complete and ready for intended function.

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:

1. The warranty period for laboratory work surface is five (5) years commencing on the date of Substantial Completion.

1.05 QUALIFICATIONS

A. Work in this Section shall be performed by a company having a minimum of eight years documented experience manufacturing the respective products specified herein, and an established organization and production facilities including all tools, equipment and special machinery necessary for the fabrication and installation of the type of equipment required, with skilled personnel, factory trained workmen and an experienced engineering department.

1. Each shall have the demonstrated knowledge, ability and the proven capability to produce the specified equipment of the required quality and the proven capacity to complete an installation of this size and type within the required time limits.

2. Upon request, manufacturers shall produce evidence of financial stability and bonding capacity required to perform on this project.

1.06 PRODUCT HANDLING

A. Contractor shall schedule the delivery of laboratory work surface when spaces are sufficiently complete so materials can be installed immediately following delivery.

B. Protection: Use all means necessary to protect work of this section before, during and after installation including installed work and materials of other trades.

C. Replacement: Any damaged work shall be replaced, repaired and restored to original condition to the approval of the Project Representative at no additional cost or inconvenience to the Owner.

D. Approved mock-up may be relocated to the project and reinstalled. Scratches, blemishes, dents, holes, etc. resulting from disassembly and reassembly shall not be acceptable.

1.07 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:

1. The warranty period for laboratory work surface is five (5) years commencing on the date of Substantial Completion.

PART 2 – PRODUCTS

2.01 LABORATORY WORK SURFACES

A. Epoxy Resin:

1. Acceptable Manufacturers:
   a. Base:
      1) Durcon Inc.
      2) Epoxyn Products.
      3) Kewaunee Scientific Corporation.
      4) Or approved equal.
   b. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.
2. Thickness:
   a. Typical work surface: 1 IN.
   b. Fume hood work surfaces:
      1) 1-1/4 IN thick at outer edge, indented 6mm 1/4 IN, nominal, to provide a raised rim around all exposed edges 1 IN wide, minimum, work surface or as to allow for the fume hood sash.

2) Front top edge of the raised rim and exposed vertical corners of the top shall be rounded or chamfered to a 1/8 IN radius.

3) Juncture between the raised rim and the top surface shall be coved or chamfered to a 1/4 IN radius.

3. Color:

a. Black.

4. Provide the following:

a. Drip Grooves:

1) Provide under all work surface exposed edges, unless noted otherwise on the Laboratory Furnishing Drawings.

2) Where the top overhangs 1 IN: 1/2 IN from the edge.

3) Where the top overhangs 1/2 IN: 1/4 IN from the edge.

b. Edge profile:

1) All exposed upper edges and corners: 1/8 IN bevel.

c. Indented areas:

1) Profile: 1/4 IN deep with chamfered or radiused sides.

2) Internal and external corners: 1/4 IN to 1/2 IN radius.

d. Curbs and Splashes:

1) Curbs and Splashes: 1 IN thick.

2) Height: 4 IN.

3) Bonded to the surface of the top to form a square joint.

e. Provide all holes and cutouts as required for built-in equipment and mechanical and electrical service fixtures. Verify size of opening with actual size of equipment to be used prior to making openings. Form inside corners to a radius of not less than 1/8 IN. After sawing, rout and file cutouts to ensure smooth, crack-free edges. Seal exposed edges after cutting with a waterproofing material recommended by the manufacturer.

5. Physical Properties:

a. Chemical resistance:

1) Organic solvents test:

a) Saturate a cotton ball with the test chemical; place in a one ounce bottle with a reservoir of liquid above the ball.

b) Invert the container on the test material surface for a period of 24 HRS.

c) Test temperature: 23 DegC ±2 DegC.

2) Other test chemicals test:

a) Place five drops (1/4 cc) of the test chemical on the test material surface.

b) Cover the chemical with a 25mm diameter watch glass for a period of 24 HRS.

c) Test temperature: 23 DegC ±2 DegC.

3) Evaluation:

a) After 24 HRS exposure: Wash exposed areas with water, then with a detergent solution, finally with naphtha, then rinse with distilled water, dry with a cloth, and rate as follows:

0	No effect	No detectable change in the material surface.
1	Excellent	Slight detectable change in color or gloss but no change in function or life of the surface.
2	Good	A clearly discernable change in color or gloss but no significant impairment of surface life or function.
3	Fair	Objectionable change in appearance due to discoloration or etch, possibly resulting in deterioration of function over an extended period of time.
4	Failure	Pitting, cratering, or erosion of the surface. Obvious and significant deterioration.

4) Test results:

Test chemical	Concentration	Black	Dark gray	Light gray	Beige
Chromic acid	40%	3	2	2	2
Hydrochloric acid	10%	0	0	0	0
Hydrochloric acid (conc.)	37%	0	0	0	0
Nitric acid	40%	0	0	0	0
Nitric acid (conc.)	70%	0	0	0	0
Sulfuric acid	60%	0	0	0	0
Sulfuric acid (conc.)	96%	4	4	4	4
Acetic acid	5%	0	0	0	0
Acetic acid (glacial)		0	0	0	0
Citric acid	1%	0	0	0	0
Oleic acid		0	0	0	0
Phenol solution	5%	0	0	0	0
Ammonium hydroxide	10%	0	0	0	0
Sodium carbonate sol.	20%	0	0	0	0
Sodium hydroxide sol.	60%	0	0	0	0
Sodium hypochlorite sol.	4%	0	0	0	0
Acetone		1	1	1	1
Benzene		1	1	1	1
Carbon tetrachloride		1	1	0	0
Diethyl ether		0	0	1	1

Test chemical	Concentration	Black	Dark gray	Light gray	Beige
Dimethyl formamide		0	0	0	0
Ethyl acetate		0	1	1	0
Ethyl alcohol	95%	0	0	0	0
Ethylene dichloride		0	0	0	0
Heptane		0	0	1	0
Isooctane		0	0	0	0
Kerosene		0	0	0	0
Methyl alcohol		0	0	0	0
Toluene		0	0	0	0
Aniline		0	0	0	0
Mineral oil		0	0	0	0
Olive oil		0	0	0	0
Soap solution	1%	0	0	0	0
Transformer oil		0	0	0	0
Turpentine		0	0	0	0

b. Heat resistance tests:

1) High temperature test:

a) Heat a porcelain crucible to a dull red color, place on the test material, and allow to cool to ambient temperature.

b) Result: No observable surface deformation.

2) Flame test:

a) Overturn a 3/8 IN Bunsen burner, adjusted to a quiet flame, with a 1-1/2 IN inner cone, on the test material, and allow to stay for 5 minutes.

b) No observable surface deformation.

c. Physical properties:

Compressive strength	ASTM D695	216mPa 31,400 PSI
Tensile strength	ASTM D638	55mPa 8,000 PSI
Flexural strength	ASTM D790	81mPa 11,700 PSI
Rockwell hardness "M"	ASTM D785	122
Specific density	ASTM D792	1960kg/m^2 122.4 PSF
Water absorption	ASTM D570	0.01%
Fire Resistance	ASTM D635	ATB (sec)=0
Heat deflection @ 264 psi (1.82 MPa)	ASTM D648	172 degC 342 degF

PART 3 – EXECUTION

3.01 SITE CONDITIONS

A. Inspection:

1. Prior to installation of the work of this Section, carefully inspect the installed work specified in other Sections and verify that all such work is complete to the point where this installation may properly commence.
2. Verify that all work may be installed in complete accordance with the original design, reviewed submittals, and the manufacturer's recommendations.

B. Project Conditions: Casework and furnishings shall not be delivered and installed prior to completion of the followings items:

1. Windows and doors shall be installed and the building shall be weather-tight.
2. Finished ceilings, if specified, overhead ductwork, piping, electrical, and lighting work shall be installed.
3. Painting shall be complete.
4. Flooring shall be installed.
5. Interior building temperature shall be maintained between 18.3 and 26.7 DegC 65 and 80 DegF, and ambient relative humidity shall be maintained between 25 percent and 55 percent prior to delivery, and during and after installation. Frequent and/or excessive changes in temperature and/or humidity levels during casework installation, or once casework is installed, must be avoided to prevent damage to materials.

C. Discrepancy: In the event of discrepancy, immediately notify the Architect.

3.02 INSTALLATION

A. Installation of items specified in this Section shall be performed by installers experienced in the installation of the respective item as determined by the respective manufacturer.

B. Coordinate work with any Owner furnished and/or installed components indicated on Drawings.

C. Laboratory Tops:

1. Scribe tops as necessary for close and accurate fit.
2. Field Joints: Factory-prepared and identical to factory joints, locate only where indicated on approved Shop Drawings. Field processing of top and edge surfaces is not acceptable, except as described by manufacturer in approved Submittal Data. Provide full length, one-piece tops and backsplashes wherever possible, and keep field joints to an absolute minimum.
3. Abut top and edge surface in one true plane, with internal supports placed to prevent any deflection. Joints in top units shall be flush and the narrowest for the respective materials of construction.
4. Epoxy Resin: Cement joint in accordance with the manufacturers' Specifications.

D. Tolerances:

1. Variation of Work Surfaces from Level: 1/16 IN in 10 FT.

E. Sealant:

1. Caulk edges of tops, backsplashes and side splashes to adjacent wall surface, and around all work surface penetrations, with sealant.
2. Sealant application shall be in accordance with manufacturer's published recommendations.

F. Repair or remove and replace defective work as approved by the Project Representative at no additional cost to the Owner.

1. Where approved by Project Representative, touch-up finishes applied to damaged surfaces shall have a VOC content of no more than 250 g/L in accord with SCAQMD Rule No. 1168.

3.03 CLEANING

A. Clean counter tops with diluted dishwashing liquid and water leaving tops free of all grease and streaks. Use no wax or oils.

3.04 PROTECTION

A. Cover tops with 1/4 IN corrugated cardboard, secured in place, after installation for protection against scratching, soiling, and deterioration during remainder of construction period. Remove protection prior to final cleaning.

END OF SECTION

SECTION 12 48 13
ENTRANCE FLOORING SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Entrance Flooring Systems.

1.02 QUALITY ASSURANCE

A. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 23 - Heating, Ventilating and Air-Conditioning (HVAC).

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Leadership in Energy and Environmental Design (LEED®) Documentation: Submit the following in accordance with Section 01 81 30 – Sustainability Requirements:
   1. Completed LEED Materials Submittal Form:
      a. Product Data for IEQ 4.1: For sealants and sealant primers used inside the weather proofing system, documentation including printed statement of VOC content.

C. Approval Submittals:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Product data sheet on each component included in the system.

D. Samples:
   1. Manufacturer's full range of grid insert and exposed aluminum colors, textures, finishes, and patterns available.
   2. Minimum 6 IN long sample of each color and type selected.

E. Closeout Submittals:
   1. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is two (2) years commencing on the date of Substantial Completion.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. American Floor Mats (americanfloormats.com).
   2. The C/S Group (c-sgroup.com).
   3. Ronick Matting Systems (www.ronick.com).
   4. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 MANUFACTURED UNITS

A. Drainable Recessed Foot Grid System:
   1. Framing members shall be straight frame or ledged frame style.
      a. Aluminum, minimum 16 GA, 6063-T5 alloy.
      b. Maximum depth: 4-1/4 IN.
   2. Grids:
      a. Tread rails shall be aluminum 6063-T5.
      b. Lock bars shall be aluminum 6061-T6.
         1) Maximum 10 IN OC spacing.
      c. Grid inserts shall be recycled rubber.
         1) Color of grid insert shall be black.
      d. Tread spacing shall be between 1-1/4 IN and 1-3/4 IN OC.
   3. Finish:
      a. All exposed aluminum surfaces shall receive anodized black finish.
      b. Concealed aluminum surfaces shall have mill finish.
   4. Structural loading: All grid and framing sections, when completely installed, shall be capable of supporting a minimum of 200 LB/SF uniform loading.
   5. All aluminum members which will come in contact with concrete or masonry shall receive dissimilar materials protection.

6. Unit shall be completely prefabricated and preassembled at the factory.
    a. Provide watertight, minimum 16 GA aluminum pan complete with 2 IN IPS drain and stainless steel strainer.
    b. Pan shall be attached to bottom surface of the frame.
7. Entrance Mats shall be a minimum of 10 FT 0 IN in length in the direction of travel.
8. See Division 23- Heating, Ventilating and Air-Conditioning (HVAC) for drain piping, traps and connections.
9. Unit: C/S Group PediTred Series with a Drain Pain, model G4 with ECO Surfaces © Recycled Rubber Insert - High slip resistant rubber insert.

PART 3 – EXECUTION

3.01 PREPARATION

A. Verify substrate and correct all unsatisfactory conditions.
    1. Installation of unit indicates acceptance of substrate.

3.02 INSTALLATION

A. Follow manufacturer's printed instruction for installation.

B. Set units flush with surrounding floor finish level if unit is recessed.
    1. Refer to Room Finish Schedule for floor finish.

C. Provide all trim, fillers, inserts, anchors or other miscellaneous items required for complete installation.

D. Provide temporary wood filler in recess and cover frames with minimum 1/2 IN plywood or fiberglass.

E. Protect installed unit from damage until acceptance by Project Representative.

END OF SECTION

SECTION 21 13 00
FIRE-SUPPRESSION SPRINKLER SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Provide all material, labor, equipment, design and services necessary to perform the complete installation of the building fire sprinkler system as indicated on the Drawings and described in the Specifications, except where specifically excluded herein.

B. The design and installation of hydraulically calculated automatic wet and dry system(s) complete and ready for operation, for all portions of the Transfer Station including attached canopies and buildings, mechanical equipment rooms, office space, telephone rooms, etc.

C. The fire protection system(s) shall comply with requirements of the *2009 International Fire Code*, *NFPA 13, Installation of Sprinkler Systems* and *FM Global Loss Prevention Data Sheets*, except as modified and supplemented by this Specification.

D. The existing Scale House is excluded.

1.02 SCOPE OF WORK

A. Provide fire sprinkler riser(s) located within the heated portions of the Administration Building, Household Hazardous Waste (HHW) Building and Transfer Station Lower Level, as indicated on Drawings, with water supply from the exterior fire sprinkler main as indicated on the Drawings.

B. Provide fire department connection(s) (FDC's), as required and at location(s) indicated on the Drawings including piping between the FDC and riser in accordance with NFPA 24.

C. Provide tamper switches, flow switches and pressure switches for connection to the fire detection and alarm system specified in Section 28 3100 - Fire Detection and Alarm. Optional attachments such as, but not limited to, accelerators may be required to meet NFPA 13 requirements, and shall be provided as necessary.

D. Provide design, permitting and installation of the dry pipe sprinkler system(s) serving all unheated areas of the building(s) including but not limited to the following:
   1. Transfer Station and Recycling – Ground Level.
   2. Transfer Station and Recycling – Lower Level.
   3. Exterior canopies including the HHW Canopy and Barrel Storage.

E. Provide design, permitting and installation of wet pipe sprinkler system(s) serving all heated areas of the building(s) including but not limited to the following:
   1. Administration Building.
   2. HHW Building.

F. Drawings show system hazard classifications and minimum sprinkler water density requirements as required by NFPA 13 except where higher density requirements stipulated by FM Global are shown.

G. Provide compressed air from the building compressed air system or small compressor for maintenance of air pressure in dry pipe sprinkler system and provisions for air removal including exhausters and accelerators as required to meet water delivery times.

H. Routing of sprinkler mains and branch lines shall be coordinated with the building architectural elements, structural steel elements, electrical lighting and raceway, mechanical piping and ductwork, and within limitations indicated on the Drawings including the compactor and top load bay clearance requirements.

I. Where there is conflict between local authority requirements or other standards agency requirements and these Drawings and Specifications, requirements of standards agencies of local authorities shall govern.

1.03 RELATED SECTIONS

A. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

B. Section 01 09 05 - Reference Standards.

C. Section 01 33 00 - Submittal Procedures.

D. Section 01 73 00 - Operation and Maintenance Manuals.

E. Section 01 60 00 - Product Requirements.

F. Section01 78 02 - Close Out Procedures: Two-Year Warranty.

G. Section 07 84 00 - Firestopping, For Treatment Of Penetrations Through Rated Enclosures.

H. Section 09 91 00 - Painting And Protective Coatings, For Painting Of Exposed Pipe.

I. Section 21 30 00 - Fire Pump.

J. Section 28 31 00 - Fire Detection And Alarm.

K. Section 33 11 13 – Water Main Construction.

L. Additional Sections of the Specifications may be required to provide a fully functional system. Refer to the Specifications index.

1.04 CODES AND STANDARDS

A. Comply with the requirements of 01 09 05 - Reference Standards and as listed herein.

B. Applicable provisions of the most recent adopted edition of the following standards shall apply to the work of this Section, except as modified herein, and are hereby made a part of these Contract Specifications to the extent required:
   1. International Code Council: www.iccsafe.org.

a. International Building Code (IBC), 2009 edition, including Washington State and City of Bellevue Amendments.

b. International Fire Code (IFC), 2009 edition, including Washington State and City of Bellevue Amendments.

c. International Mechanical Code (IMC), 2009 edition, including Washington State and City of Bellevue Amendments.

2. City of Bellevue Code Amendments: www.Bellevuewa.gov.

3. National Fire Protection Association (NFPA): www.nfpa.org.

   a. NFPA 13 - 2010, Standard for the Installation of Sprinkler Systems.

   b. NFPA 24 - 2007, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

   c. NFPA 25 - 2008, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.

   d. NFPA 70 - 2008, National Electric Code.

   e. NFPA 72 - 2010, National Fire Alarm Code.

4. FM Global (FM): www.fmglobal.com.

   a. FM Global Approval Guide.

   b. FM Global Property Loss Prevention Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers.

   c. FM Global Data Sheet 2-1, Prevention and Control of Internal Corrosion in Automatic Sprinkler Systems.

   d. FM Global Data Sheet 2-8, Earthquake Protection for Water-Based Fire Protection Systems.

   e. FM Global Data Sheet 2-7, Installation Rules for Sprinkler Systems using Control Mode Specific Applications Ceiling Sprinklers for Storage Applications.

   f. FM Global Data Sheet 3-10, Installation of Private Fire Service Mains.

   g. FM Global Data Sheet 3-26, Fire Protection Water Demand for Nonstorage Sprinklered Properties.

   h. FM Global Data Sheet 7-29, Ignitable Liquid Storage in Portable Containers.

   i. FM Global Data Sheet 8-9, Storage of Class 1, 2, 3, 4 and Plastics Commodities.

5. Underwriters Laboratories Fire Protection Equipment Directory (UL): www.ul.com

6. Washington Administrative Code (WAC) apps.leg.wa.gov/wac.

   a. Chapter 212-80, Fire Sprinkler System Contractors.

7. American Society of Civil Engineers (ASCE): www.asce.org.
    a. ASCE 7-05, “Minimum Design Loads for Buildings and Other Structures.”
8. ASTM International: www.astm.org.
    a. ASTM A 53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded And Seamless.
    b. ASTM A 135, Electric-Resistance-Welded Steel Pipe.
    c. ASTM A 795, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
9. American Welding Society (AWS): www.aws.org
    a. AWS D10.12, Guide for Welding Mild Steel Pipe.
10. American Society of Mechanical Engineers (ASME): www.asme.org.
    a. ASME B 16.1, Cast Iron Pipe Flanges and Flanged Fittings.
    b. ASME B 16.3, Malleable Iron Threaded Fittings.
    c. ASME B 16.4, Cast Iron Threaded Fittings.
    d. ASME B 16.5, Steel Pipe Flanges and Flanged Fittings.
    e. ASME B 16.9, Factory-Made Wrought Steel Buttweld Fittings.
    f. ASME B 16.11, Forged Steel Fittings, Socket-Welded and Threaded Copper.

1.05 DEFINITIONS

A. Approved or Approval: Use of the word "approved" or "approval" in this Section shall require the approval or acceptance from the authority having jurisdiction and Project Representative.

B. Authority Having Jurisdiction: For purposes of code compliance, the Authority Having Jurisdiction (AHJ) for this installation will be the City of Bellevue.

C. Dry Pipe Sprinkler System: A sprinkler system employing automatic sprinklers that are attached to a piping system containing air under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve. Water then flows into the piping system and out the opened sprinklers.

D. Listed: Use of the word "listed" for fire protection equipment, components, etc. in this Section shall mean listed by UL and approved for fire protection.

E. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches (IN).

F. MEP: Mechanical, Electrical, and Plumbing

G. Shop Drawings or Working Plans: As used in this Section refer to Construction Documents (including Drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of AHJ.

H. Wet Pipe Sprinkler System: A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire.

I. Other definitions for fire protection systems are included in referenced I-Codes and NFPA standards.

1.06 GENERAL REQUIREMENTS

A. Give necessary notices, obtain permits and pay taxes, fees and other costs, including utility connections or extensions for the work.
   1. File necessary drawings, prepare documents and obtain necessary approvals of governmental departments having jurisdiction. Include all costs associated with notices, permits, taxes, fees, utility connections or extensions, government approvals and other related costs in original bid.
   2. Obtain required certificates of inspection for work and deliver to the Project Representative before request for acceptance and final payment for the work.

B. Comply with laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the work.
   1. If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify the Project Representative in writing and any necessary changes shall be accomplished by appropriate modification.
   2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to the Project Representative, he shall assume full responsibility, and shall bear all costs.

C. All of the Work of this Section requires system design performed by the Contractor, assisted by the Sprinkler Contractor, in compliance with WAC 212-80 and the IBC.

D. This responsibility includes preparation of fire sprinkler Shop Drawings and engineering calculations by a Qualified Professional Engineer/Designer.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Firms who's equipment and devices shall be of a make and type listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

B. Installing Contractor's Qualifications:
   1. Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment in accordance with NFPA. A qualified firm is one who is a Licensed Fire Sprinkler Contractor per the Fire Sprinkler Licensing requirements in the State of Washington and that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the AHJ.
   2. Submit evidence of qualifications to the Project Representative upon request.

C. Designer's Qualifications:
   1. System shall be designed by a State of Washington licensed Fire Protection Engineer or a fire sprinkler designer with a current Washington State Certificate of Competency Level III in accordance with WAC 212-80, Fire Sprinkler System Contractors.

D. Design and installation shall meet the standards and requirements of the Project Representative's insurance company, FM Global, referenced codes and standards, and AHJ review comments.

E. Sprinkler Contractor shall participate in preparation of the MEP Coordination Shop Drawing submittal specified in Section 01 33 00 – Submittal Procedures.

1.08 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from AHJ for fire protection systems specified.
   1. The fire protection work shall comply with all requirements of the codes and regulations of authorities having jurisdiction and local and state authorities.
   2. The Fire Sprinkler Installer shall develop and coordinate Drawings with other design disciplines in order to obtain a sprinkler system permit prior to the start of work.
      a. The Contractor shall field verify all dimensions and piping locations and modify the Drawings as necessary prior to fabrication of piping.
   3. Any materials shown or specified in the Drawings and Specifications shall be furnished and installed by the Contractor.
      a. Materials reasonably implied and usually included under good industry practice and/or for proper and safe completion and operation of the work described herein, shall also be furnished by the Contractor.
      b. The Drawings and/or Specifications, when more stringent than NFPA, IFC or the local authority requirements, shall take precedence.

B. The sprinkler systems shall be hydraulically designed in accordance with NFPA 13 and FM Global Loss Prevention Data Sheets.
   1. A margin of safety for available water flow and pressure of 10 PSI shall be provided; including losses through water service piping, valves and backflow preventers.

C. The Contractor is advised that the Drawings are diagrammatic in nature and are not intended to show all details.

1.09 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Submit as one package in accordance with Section 01 33 00 - Submittal Procedures, Shop Drawings, product data, and samples.
   2. Submit Shop Drawings, hydraulic calculations, and seismic bracing calculations to the City of Bellevue for review, comment, and approval. Two copies of the sprinkler (FB), fire alarm (FA), and underground mains (FD) should be submitted under the proper permit type to the City of Bellevue Permit Center.
   3. Incomplete submittals will be rejected unless prior approval is requested and given from the Project Representative for partial submittals.
   4. Shop Drawings, calculations, and product data shall be submitted and approved by the AHJ prior to submittal to the Project Representative.
      a. FM Global review and approval: Direct submittals to Plan Review, FM Global, 601 – 108th Ave NE, Suite 1400, Bellevue, WA 98004. Phone: 425-709-5064.
      b. City of Bellevue review, approval and permit: Direct submittals to Development Services, 10900 NE 4th St, Bellevue, WA 98004.
      c. Contractor is responsible for making changes to system design as required to satisfy requirements of Authorities Having Jurisdiction and is responsible for obtaining installation permit for system including paying all fees.
      d. Allow sufficient time for review assuming at least a second round of submittals to the Authorities Having Jurisdiction.
      e. All comments and requirements of FM Global and the City of Bellevue shall be incorporated and revised Drawings submitted to the Project Representative.
   5. Design Basis Information. Provide design, materials, equipment, installation, inspection, and testing of the automatic sprinkler system in accordance with the requirements of NFPA 13 and FM Global Property Loss Prevention Data Sheets.
      a. Recommendations in appendices shall be treated as requirements.
      b. Sprinklers shall be located so as to minimize obstructions to discharge as required by NFPA 13 and FM Global Data Sheet 2-0. This includes, but is not limited to equipment obstructions such as the compactors, that require sprinkler protection beneath them.
      c. Sprinklers shall be provided beneath skylights exceeding 32 SQFT.

d. Drawings show system hazard classifications and minimum sprinkler water density requirements as required by NFPA 13 except where higher density requirements stipulated by FM Global are shown.

e. Due to low clearance between chassis and concrete ceiling, sprinklers are prohibited from being located above chassis in lower level. See Drawing 02F101 for associated areas where ceiling sprinklers are not allowed (Rm 02-001, 02-003, 02-006, 02-007).

f. Tipping floor: Design for the tipping floor area is based on FM Global Data Sheet 3-26 (Hazard Category HC-3, Engineering Bulletin 04-12) and Data Sheet 2-0. The design shall be a density of 0.30 GPM/SQ FT over the hydraulically most remote 4,600 SQ FT. Use FM Approved non-storage sprinklers with a minimum K-factor of 11.2. This design is based on dry-pipe sprinkler systems using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

g. Recycling area: Design for the baled waste and recycled material area is based on NFPA 13 and FM Global Data Sheet 8-9. Design for maximum 12 FT storage of uncartoned, unexpanded Group A plastics in metal roll-off bins. The design shall be a density of 0.70 GPM/SQ FT over the hydraulically most remote 3,250 SQ FT (dry-pipe system). Use FM Approved storage sprinklers with a minimum K-factor of 11.2. This design is based on using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

h. Container Chassis Stalls: Design automatic sprinkler protection for this area in accordance with FM Global Data Sheet 3-26 (Hazard Category HC-3) and FM Global Data Sheet 2-0 based on loaded storage containers. The design shall be a density of 0.30 GPM/SQ FT over the hydraulically most remote area 3,500 SQ FT for a dry-pipe sprinkler system. Use FM Approved non-storage sprinklers with a minimum K-factor of 11.2. This design is based on a dry system using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 gpm in the hydraulic design.

i. Vehicle maintenance area: Design automatic sprinkler protection for the vehicle maintenance area in accordance with FM Global Data Sheet 3-26 (Hazard Category HC-3) and Data Sheet 2-0. The design shall be a density of 0.30 GPM/SQ FT over the hydraulically most remote 2,500 SQ FT (wet-pipe system) or 0.30 GPM/SQ FT over the hydraulically most remote 3,500 SQ FT (dry-pipe system). Use FM Approved non-storage sprinklers with a minimum K-factor of 8.0. This design is based on using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

j. Areas containing hydraulic equipment: Where mineral-oil-based hydraulic fluid is used, design fire protection for the portions of the facility housing hydraulic equipment in accordance with FM Data Sheet 7-98, Hydraulic Fluids or NFPA 13, Extra Hazard Group 1, whichever is more demanding.

   1) FM Design requirement: Provide a density of 0.20 GPM/SQ FT over the hydraulically most remote area of 5,000 SQ FT for a dry-pipe sprinkler system, or the physical area of the hydraulically operated equipment if smaller. Use FM Approved non-storage sprinklers with a minimum K factor of 8.0 if the ceiling height is 30 FT or less (K 11.2 if ceiling height is greater than 30 FT). Include a hose stream allowance of 500 GPM in the hydraulic design.

   2) NFPA 13, Extra Hazard Group 1: Provide a density of 0.30 GPM/SQ FT over the hydraulically most remote area of 2,440 SQ FT for a dry-pipe sprinkler system, or the physical area of the hydraulically operated equipment if smaller. Use FM Approved nonstorage sprinklers with a minimum K factor of 8.0. Include a hose stream allowance of 500 GPM in the hydraulic design.

k. HHW Processing Area: Design for the processing area is based on NFPA 30 and FM Global Data Sheet 7-32 and Data Sheet 2-0. The design shall be a density of 0.30 GPM/SQ FT over the hydraulically most remote area of 4,000 SQ FT for a wet-pipe sprinkler system. Use FM Approved sprinklers with a minimum K-factor of 8.0, and maximum 10 FT spacing. This design is based on a wet system using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

l. HHW Exterior Covered Barrel Storage Area: Design for the flammable liquid storage area is based on NFPA 30 and FM Global Data Sheet 7-29, 7-32 and Data Sheet 2-0 to protect one 55 GAL drum high, on-end storage of Class 1B Flammable Liquid. The design shall be a density of 0.40 GPM/SQ FT over the entire room with a minimum end head pressure of 7 PSI. Use FM Approved sprinklers with a minimum K-factor of 11.2, and maximum 10 FT spacing. This design is based on a dry sprinkler system using upright, standard-response sprinklers with a temperature rating of 165 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

m. HHW Drop-off Canopy Area: Design for the HHW drop-off area is based on FM Global Data Sheet 7-32 and NFPA 13 Ordinary Hazard 2. The design shall be a density of 0.30 GPM/SQ FT over the area of the canopy. Use FM Approved non-storage sprinklers with a minimum K-factor of 8.0. This design is based on a dry system using upright, standard-response sprinklers with a temperature rating of 286 DegF. Include a hose stream allowance of 500 GPM in the hydraulic design.

n. Office area: Design automatic sprinkler protection for the office areas to provide a density of 0.10 GPM/SQ FT over a demand area of 1,500 SQ FT on a wet system, using K5.6, 155 DegF, FM Approved, quick response sprinkler heads. Include a hose stream allowance of 250 GPM in the hydraulic design.

o. The available water flow to the site is a static pressure of 80 PSI and 1,250 GPM at a residual pressure of 64 PSI at the existing hydrant. Preliminary design shall be based on providing a pump designed to deliver 2000 U.S. gallons per minute (GPM) at a total differential pressure of 60 PSI. Final sprinkler system design and pump selection shall not occur until field testing of available water flow is conducted after installation of underground mains.

6. Zoning:

   a. For each sprinkler zone provide a control valve, flow switch and a test and drain assembly with pressure gage.

7. Shop Drawings:

   a. Shop Drawings and Specifications shall provide all information as required by the applicable code/standard and AHJ.

   b. Submit floor plans drawn with AUTOCAD to same scale as the Contract Drawings, showing equipment hardware location, wiring and mounting details.

      1) Submit detailed 1:100 (1/8 IN) scale (minimum) working Drawings conforming to NFPA 13. Include a site plan showing the piping to the water supply test location.

   c. Shop Drawings shall indicate relationship of all overhead items, including structural elements, HVAC system, air terminals, ductwork, piping, conduit, lighting fixtures, skylights, equipment, and similar items.

   d. Include seismic bracing, fittings and details.

   e. Drawings shall conform to and include all items set forth in NFPA 13 and NFPA 24 for working plans, and City of Bellevue Submittal requirements.

   f. Provide complete details and sections as required to clearly define and clarify the design, including a materials list describing all proposed materials by manufacturers' name and catalog number.

8. Calculations:

   a. Submit hydraulic calculations in accordance with design criteria indicated on Drawings for the hazard classifications listed.

      1) Perform hydraulic calculations in accordance with NFPA 13 utilizing the Area/Density method.

      2) Calculated demand including hose stream requirements shall fall no less than 10 PSI below the available water supply curve.

b. Submit calculations for dry pipe system water delivery in accordance with NFPA 13, 7.2.3.6.

c. Submit seismic bracing calculations based on ASCE 7-05 or NFPA 13. Design sway bracing, fasteners, assemblies, pipe hangers and equipment supports, using performance requirements and design criteria indicated.

1) Design Spectral Response Acceleration at Short Periods (0.2 Second): Ss = 1.403.

2) Design Spectral Response Acceleration at 1-Second Period: S1 = 0.725.

9. Manufacturers Data Sheets:

a. Provide for all materials and equipment proposed for use on the system (e.g., Pipe, fittings, hangers, valves, alarm devices, sprinklers).

b. Include listing information and installation instructions in data sheets.

c. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.

d. Include UL listing and FM approval (for the specified application) for all system components.

C. Quality Assurance Submittals:

1. Comply with provisions of Section 01 43 00 – Quality Assurance and Control and the requirements of this Section.

2. Evidence of Fire Protection Engineer's and/or designer's qualifications.

3. Test Reports and Certificates: Include "Contractor's Material & Test Certificate for Aboveground Piping" and "Contractor's Material & Test Certificate for Underground Piping", as described in NFPA 13.

4. Certification of acceptance of installation by AHJ.

D. Closeout Submittals:

1. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

2. Provide Record Drawings, testing and maintenance instructions in accordance with the requirements in Section 01 78 00 - Closeout Procedures.

3. Submittals shall include, but not be limited to, the following:

a. Record Documentation:

1) Include Shop Drawings, hydraulic calculations and seismic bracing calculations for the installed system(s).

2) One complete set of reproducible Record Drawings shall indicate installed location of components including piping, sprinklers, hangers, valves, inspector's test stations, auxiliary drains, and other system specialty components.

3) Also include corrections noted during the site observation process and reflect revisions, addenda, and construction change directives implemented on the project.

b. Material and Testing Certificate:

1) Upon completion of the sprinkler system installation or any partial section of the system, including testing and flushing, provide a copy of a completed Material and Testing Certificate as indicated in NFPA 13.

4. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:

a. Manufacturer's operation and maintenance manual containing cut sheets, manufacturer's operation and maintenance manual, troubleshooting guide, operating instructions, spare parts list, program printout, and data file servicing requirements, inspection data, and owner's manuals for each type of fire protection specialty specified. Provide on CD-ROM, and Record Drawings.

b. Maintenance Material:

1) Provide two (2) copies of NFPA 25 Standard for Inspection, Testing and Maintenance of Water-Based Fire Protection Systems to be delivered to Project Representative.

c. Commissioning Data:

1) Submit system commissioning data (in a format recommended by the manufacturer and per the instructions provided by the manufacturer) within 30 days of completion of the installation.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 60 00 - Product Requirements, and the following:
1. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

2. Handle sprinkler system components carefully to avoid damage to components, enclosures, and finish.

3. Store sprinkler system components in a clean, dry space and protect from weather.

B. Comply with FM Global Data Sheet 2-1, Paragraph 2.3.1 for cleaning of fabricated piping and protection of piping on the job site prior to installation including certification in the Contractor's Material and Tests Certificate for Above-ground Piping per NFPA 13.

1.11 PROJECT SITE CONDITIONS

A. Be responsible for work and equipment until finally inspected, tested and accepted; protect work against theft, injury or damage; and carefully store material and equipment received on site which are not immediately installed.
1. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

B. At the completion of each portion of work, all waste material, rubbish, equipment, and surplus material shall be removed from the site.
   1. Contractor is responsible for the daily clean-up of their work.

C. Protect work from damage and deterioration until completion and acceptance by Project Representative.

1.12 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. The Warranty Period for Work of this Section is two (2) years commencing on the date of Substantial Completion.
      a. The full cost of maintenance, labor and materials required to correct any defect during this two-year period shall be included in the submittal bid.

PART 2 – PRODUCTS

2.01 GENERAL

A. Specific manufacturers and model numbers where noted are to indicate a standard of design and are not intended to be restrictive.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed whether or not specifically shown on the Drawings or specified herein.

C. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service.
   1. Where type, grade, or class is not indicated, provide proper selection as determined by installer for installation requirements, and comply with governing regulations and industry standards.

D. All materials and equipment in the system shall be new and current products of the manufacturer's latest design and suitable to perform the functions intended, as listed under MANUFACTURERS.
   1. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

E. All devices, components and equipment shall be the products of the same manufacturer.

F. All components and equipment within the scope of the FM Global Approval Guide shall be listed by FM Global for the purpose for which they are used and shall bear their listing mark.

G. All components and equipment within the scope of the UL Testing Laboratory Service shall be listed by the Underwriters' Laboratories for the purpose for which they are used and shall bear their listing mark.

H. Product Marking. Each major component shall be furnished with legible markings indicating: Name of the manufacturer, part numbers and serial numbers, and markings as required per ASTM Standards.
   1. All pipes shall be marked continuously along its length by the manufacturer in such a way as to properly identify the type of pipe.
      a. Pipe identification shall include the manufacturer's name, model designation or schedule.
   2. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

I. Sprinklers must be selected based on the associated hazards within the occupancy to be protected in accordance with the requirements in NFPA 13 and the IFC.

J. Corrosion Protection:
   1. All piping and hangers, where exposed to the weather or installed in a corrosive atmosphere, shall be protected against corrosion.
   2. Piping and hangers in such areas shall be stainless steel and/or hot dipped galvanized.
   3. Piping having an external only galvanized finish in such areas is unacceptable.

2.02 MANUFACTURERS

A. Subject to compliance with requirements of the Contract Documents, Products of one of the following Manufacturers shall be incorporated in the Work of this Section:
   1. Reliable: www.reliablesprinkler.com.
   2. Tyco Fire and Building Products: www.tyco-fire.com.
   3. Victaulic: www.victaulic.com.
   4. Viking: www.vikingsprinkler.com.
   5. Or Approved Equal.

2.03 FIRE PROTECTION PIPING – BELOW GROUND

A. Below ground pipe and fittings shall be as specified in Section 33 11 13 – Water Main Construction.

2.04 FIRE PROTECTION PIPING – ABOVE GROUND

A. Pipe and fitting standards shall comply with the requirements of FM Global, NFPA 13 and the City of Bellevue.

B. Above ground pipe: Steel pipe, conforming to the applicable requirements of FM Global, NFPA 13, and ASTM A 53, ASTM A 135, or ASTM A 795, as applicable.
   1. Pipe sizes 2 IN and smaller shall be Schedule 40; threaded.
   2. Pipe sizes 2-1/2 IN and larger shall be minimum Schedule 10; roll groove.

C. Galvanized pipe: Dry pipe systems, non-pressurized fire department pumper connection piping, and pipe located in corrosive environments shall be Schedule 40, galvanized, zinc coated internally and externally. Galvanized pipe shall be used for dry pipe sprinkler systems, except where ambient temperatures exceed 130 DegF. Fittings need not be galvanized. A Hazen-William's 'C' value of 120 may be used in system hydraulic calculations.

D. Coat all exposed threads and non-galvanized steel pipe with rust inhibitive paint in accordance with Section 09 91 00 - Painting and Protective Coatings, For Painting Of Exposed Pipe.

E. Coat all exposed threads on galvanized pipe with a zinc rich coating.

2.05 FITTINGS AND PIPING SPECIALTIES

A. Welded, threaded, or grooved fittings shall be used at connections to sprinkler heads, sprinkler head riser nipples, and drop nipples.

B. Rust Inhibitive Paint: Coat grooved fittings and couplings with a rust inhibiting paint in accordance with Section 09 91 00 - Painting and Protective Coatings.

C. Nipples: No close nipples will be permitted. For short pipe connections use standard short nipples.

D. Adjustable Nipples: Adjustable drop nipples must be of double o-ring seal design.

E. Thread-O-Lets: Shop-welded Thread-O-Lets may be used where a certified welder is used and if the Thread-O-Lets are listed and approved.

F. Plain End Couplings: No plain end couplings (Roust-A-Bouts, Plainloks or similar couplings) may be used.

G. Hole Cut Outlets: No hole cut outlets may be used.

H. Flexible Drops:
   1. At Contractor’s option, UL listed and FM approved flexible piping connections to sprinklers may be used for both acoustical panel and gypsum board ceilings when suitable for their intended use.
   2. If flexible drops are used, they must include ceiling system modifications as required for a complete system.
      a. Description: Connections shall include a fully welded (non-mechanical fittings), leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1 IN.
      b. Flexible piping lengths shall not exceed 6 FT.
      c. Installation shall not exceed the minimum bend radius and maximum allowable bends as specified by the manufacturer.
      d. Change in direction shall be gradual enough to allow flexible piping to bend without crimping, distorting or reducing internal diameter.

I. Pipe Escutcheons:
   1. Provide manufactured wall and ceiling escutcheons and floor plates, with an inside diameter to closely fit around pipe and tube.

2. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings.

3. Stainless steel or cast brass escutcheons, solid or split hinged with concealed hinge and set screw; polished chrome-plate finish.

2.06 HANGERS AND SUPPORTS

A. Hangers:
   1. Provide hangers to support all piping in perfect alignment without sagging or interference, to permit free expansion and contraction, and meet the requirements of NFPA 13.
      a. Restraint:
         1) Adjustable band hangers shall be Tolco Fig. 200 or equal.
         2) The end sprinkler on a line shall be restrained against excessive vertical and lateral movement.
         3) For end of branch line restraint provide Tolco Fig. 25 Restrainer or equal installation method.

B. Hanger Rods: Hanger rods shall be zinc or electro-galvanized for dry systems.

C. C-clamps: Equip all c-clamps (beam clamps) with earthquake retaining straps.

D. Pipe Clamps:
   1. The pipe clamps need be only UL listed. Use Tolco Fig. 4/4/A or equal.

E. Concrete anchors:
   1. Concrete anchors shall be prequalified for seismic applications in accordance with ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary, and installed in accordance with the manufacturer's instructions.

2.07 EARTHQUAKE PROTECTION

A. Seismic protection: Provide protection of piping against earthquake damage in accordance with NFPA 13 and FM Global Property Loss Prevention Data Sheet 2-8 requirements.

B. Seismic Bracing Structural Attachments: Seismic brace structural attachments shall be Tolco Fig. 910, Tolco, Fig. 980, or equal.

C. Seismic Brace Pipe Attachments: Seismic brace pipe attachments shall be Tolco Fig. 1000, Tolco Fig. 1001, Tolco Fig. 4A, or equal.

2.08 FIRE PROTECTION SERVICE VALVES

A. General:
   1. UL listed and FM Approved with minimum 175 PSI, non-shock working pressure rating.

   2. Valves for grooved end piping may be furnished with grooved ends instead of ends specified.

B. Gate Valves, 2-1/2 IN and Larger:
   1. Gate valves for system isolation or control shall be iron body, bronze mounted, taper wedge, outside screw and yoke, rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
   2. Provide tamper switch for all such valves, including fire pump valves.

C. Butterfly Valves:
   1. Butterfly valves 2 IN and larger for sprinkler system isolation or control shall be gear-operated slow-close butterfly valves with flag type indicator, ductile iron grooved body, EPDM coated disc, stainless steel stem with bronze bushings, and two internal single-pole, double-throw monitor switches.
   2. Provide tamper switch for all such valves.

D. Supervised Valves, 1-1/2 IN and Smaller:
   1. Sprinkler control valves 1-1/2 IN and smaller shall be slow-close butterfly or ball valve with position indicator and tamper switch, one-piece, full-port, bronze body, threaded ends.

E. Drain Valves: Drain valves need only be approved, screw-in bonnet bronze globe valves, by Nibco, United, or equal. Low point drain valves shall have, in addition, a 3/4 IN brass nipple with 3/4 IN male hose threads and cap.

F. Check Valves:
   1. Check valves shall be grooved, iron body, bronze seat, stainless steel clapper with a replaceable rubber seal (a rubber seal integral with the seat is not acceptable).
   2. Swing Check Valves, 3 IN and Larger:
      a. Cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze disc ring and flanged ends.

2.09 SPECIALTY VALVES

A. Riser Check Valve:
   1. Grooved, iron body, bronze seat, stainless steel non-slamming, spring loaded clapper with replaceable rubber seal.
   2. Provide with basic trim kit including main drain valve and pressure gages on upstream and downstream side.
   3. Pressure gages shall be equipped with valve and plug so that they may be services.

B. Dry-Pipe Valve:
   1. 175 LB UL listed, FM approved, differential-pressure type flanged, iron body.
   2. Provide basic trimmings for alarm test bypass, water flow alarm, high-low air pressure monitoring switch, gages, drain connections, drip funnel, accelerator and necessary pipe, fittings and accessories required to provide a complete installation.

C. Double-Check Backflow Prevention Assembly:
   1. Provide double check valve assembly consisting of shutoff valves on inlet and outlet.

2. Include test cocks with 2 positive-seating check valves for continuous pressure application.

3. Provide tamper switches for shutoff valves.

4. The assembly shall be approved listed in the most recent Washington State Department of Health, Drinking Water Program's "Backflow Prevention Assemblies Approved Installation in Washington State".

2.10 AIR SUPPLY

A. Provide UL Listed air compressor for dry system located in HHW Building as noted on the Drawings, sized to completely refill the dry system within 30 minutes. Plant air will be used for dry systems located in the Mechanical Room (03-109).

B. Air supplies provided for sprinkler systems from plant air or tank mounted air compressors shall be equipped with an automatic air pressure maintenance device. Air maintenance device shall be equipped with a 1/4 IN air supply bypass with a field adjustable air pressure regulator with a built-in ball check valve to eliminate air loss when system is in service.

C. Air maintenance device shall have a factory setting of 40 PSI. Air supply shall be from an air reservoir or a tank mounted compressor.

D. Compressor(s) shall operate on 120 volt, 1-phase power and shall have a fractional horsepower rating.

E. Set the dry pipe system air pressure at the maximum recommended by the information sheet for the dry pipe valve or at 20 PSI greater than the standard calculated trip pressure.

2.11 ALARM DEVICES

A. Type and sizes shall match piping and equipment connections.
   1. Equipment in this section shall be provided, installed, and adjusted by the sprinkler contractor.

   2. Conduit, wiring, and terminations shall be by others.

B. Valve Supervisory Switch:
   1. Electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to signal controlled valve in other than full open position.

   2. Each sprinkler system water supply control valve or zone control valve (ie, PIV, OS&Y, Butterfly, gate, fire pump valves, etc.) shall be equipped with a supervisory switch.

      a. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

   3. Mount switch so as not to interfere with the normal operation of the valve and adjust to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one-fifth of the distance from its normal position.

4. The mechanism shall be contained in a weatherproof aluminum housing, that shall provide a 3/4 IN tapped conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. Switch housing to be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this Section and installed by Contractor.

C. Waterflow Switches:
1. Vane-type waterflow detector, electrical-supervision type, SPDT (single-pole, double-throw) circuit switches to provide isolated alarm and auxiliary contacts; complete with factory-set, field-adjustable retard element (0-60 seconds) to prevent false signals and tamper-proof cover.
2. Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type.
3. Flow switches shall be located a minimum of one (1) FT from a fitting that changes the direction of the flow and a minimum of three (3) FT from a valve.

D. Pressure Type Waterflow Switch:
1. Pressure activated flow detector, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to operate on rising pressure and signal water flow.
2. Switch shall be provided with a 1/2 IN NPT male pressure connection and shall be connected to the alarm port outlet of dry pipe valve.
3. Switch be factory adjusted to operate on a pressure increase of 4 - 8 PSI.
4. Housing shall be weatherproof with tamper resistant cover.

E. High-Low Air Pressure Monitoring Switch:
1. Equip dry-pipe sprinkler system riser with air pressure supervisory switch.
2. Switch shall be provided with a 1/2 IN NPT male pressure connection to be connected into the air supply line on the system side of any shut-off valve.
3. Bleeder valve as supplied or equivalent shall be connected in line with the switch unit to provide a means of testing the operation of the supervisory switch.
4. The switch unit shall contain two SPDT (Form C) switches.
5. One switch shall operate at a pressure decrease of 10 PSI from normal.
6. The second switch shall operate at a pressure increase of 10 PSI from normal.
7. The unit shall be adjustable from 10 to 175 PSI.
8. Switch housing shall be weatherproof with tamper resistant cover.

F. Quick Opening Device: A listed quick-opening device shall be installed as needed to help meet the water delivery requirements of NFPA 13.
   1. Where required to meet water delivery times, the sprinkler system quick opening device shall be an accelerator with a separate external anti-flooding device.
   2. Accelerator shall be UL Listed and Factory Mutual Approved. Accelerator shall be of the same manufacturer as the dry pipe valve or deluge valve and be listed for use together.

2.12 SPRINKLERS

A. Sprinkler heads shall be selected based on the Contractor's hydraulic design and to meet FM Global and NFPA criteria for application rate, spacing, temperature rating and orifice size.
   1. Upright or pendent to meet building conditions; sidewall heads acceptable only where indicated on Contract Documents and with prior approval from Project Representative.

B. Sprinkler Finishes:
   1. Factory painted white enamel with factory painted white enamel escutcheon plates in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes, unless otherwise indicated on the Contract Documents.

C. Provide quick response, glass bulb, ordinary temperature, recessed sprinklers in all finished lay-in, glue-on tile, or gypsum board ceilings.
   1. In areas with suspended T-Bar ceilings, sprinklers shall be positioned along the tile center-line, no closer than six (6) IN from the end of a tile.

D. Standard response heads shall be provided in areas served by the dry pipe sprinkler system as required by NFPA 13.

E. Areas subject to high temperatures exceeding 110 DegF or as noted in NFPA 13 shall have intermediate temperature sprinklers or high temperature sprinklers as required by AHJ.

F. Sprinklers under glass or plastic skylights exposed to the direct rays of the sun shall be of the intermediate temperature classification.

G. Escutcheons:
   1. Provide escutcheons at all surface penetrations of piping into finished areas.
   2. Where finished areas are separated by partitions through which the piping passes, provide escutcheons on both sides of the partition.
   3. Where suspended ceilings are installed, provide escutcheons at the underside only.
   4. Escutcheons used on pendent heads in all ceilings shall be painted white enamel.

2.13 SPRINKLER GUARDS

A. Provide UL Listed sprinkler guards for sprinkler heads subject to mechanical damage or for any sprinkler lower than 7 FT 0 IN above the floor and as indicated elsewhere in the Contract Documents.

2.14 SPRINKLER CABINETS

A. Finished steel cabinet and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting.
   1. Include number of sprinklers required by NFPA 13 and 2 wrenches for sprinklers.
   2. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.
   3. Cabinet shelves shall be marked with a permanently attached etched metal or plastic sign to indicate each type of sprinkler head installed and their locations within the building.

2.15 FIRE DEPARTMENT CONNECTION

A. Provide fire department connection(s) (FDC) with horizontal type connections, dual clapper, 2-1/2 IN inlets and 4 IN outlet, with rocker lug caps, and chains.

B. Provide signage indicating "AUTO SPRINKLER" or similar as a part of the nameplate.
   1. Signage shall meet the requirements of the City of Bellevue Fire Department.

C. Connection shall include check valve with automatic drip to drain to nearest floor drain.

2.16 PRESSURE GAGES

A. Pressure Gages:
   1. UL 393, 3-1/2 to 4-1/2 IN DIA dial with dial range of 0-150 PSIG, aluminum white coated dials, drawn brass cases, glass crystals, phosphor bronze bourdon tube, and 1/4 IN male connection.
   2. Accuracy shall be 2 percent in midscale, 3 percent elsewhere.
   3. Gages shall be equipped with a shut-off valve and plug so that they may be serviced.

2.17 SIGNAGE

A. Provide all control, drain and test valves with signs identifying the type of valve and the area affected by the valve.
   1. The control valve sign shall identify the portion of the building served.

B. The installing contractor shall provide a hydraulically designed sprinkler system with signage containing the information required in NFPA 13.
   1. Such signs shall be placed at the alarm valve, dry pipe valve, preaction valve, or deluge valve supplying the corresponding hydraulically designed area.

C. The installing Contractor shall provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
   1. Such signs shall be placed at each system control riser, antifreeze loop, and auxiliary system control valve, and contain the information required in NFPA 13.

D. Systems with low point drains shall have a sign at the dry pipe or preaction valve indicating the number of low point drains and the location of each individual drain.

E. Caution signs shall be attached to all valves controlling sprinklers, in accordance with NFPA 13.

F. Each fire department connection to sprinkler systems shall be designated by a sign meeting the requirements of the Bellevue Fire Department.
   1. The sign must identify what is being served and also indicate the pressure required at the inlets to deliver the greatest system demand.

G. All signs shall be permanently marked weatherproof metal or rigid plastic.
   1. The signs sign shall be secured with corrosion-resistant wire, chain, or other approved means.

2.18 EQUIPMENT DEVIATIONS

A. Where the term “approved equal” is used, alternative and/or substitute products shall be submitted for review, in accordance with Section 01 60 00 – Product Requirements.
   1. Where the term “or equal” is used, contractor shall use a product that is equal to that specified.
   2. The Project Representative shall determine if two products are “equal”.

B. When submitting an alternative and/or substitute product, Contractor shall include complete product literature of original specified item.

C. Provide redesign to any part of the work resulting from the use of equipment and material other than specified or indicated on the Drawings.
   1. Obtain approval of redesign from the Project Representative.
   2. Redesign cost and additional construction cost resulting from the redesign shall be at the Contractor's expense.

PART 3 – EXECUTION

3.01 GENERAL

A. Requirements prior to installation:
   1. Do not order, fabricate, or install any material prior to receipt of all approvals as stipulated in Part 1 of this Section.

B. Standards and requirements:
   1. Perform all installation work in accordance with the reference standards without exception, and as required by the AHJ.

C. Changes to the work:
   1. Install all piping as shown on the approved Shop Drawings.
   2. Carefully note any minor deviations on the Record Drawings as outlined in Part 1 of this Section.
   3. Before making significant deviations from the approved drawings, obtain written approval from the Project Representative and the AHJ.

D. Coordination of Work:
   1. Carefully coordinate work with other trades so that unnecessary offsets and revisions to the approved Drawings are avoided.
   2. Failure to coordinate does not relieve Contractor from meeting performance standards.

E. All equipment shall be installed and identified in accordance with the noted Codes and Standards and the manufacturer's guidelines and design manuals.
   1. Comply with manufacturer's instructions, including technical bulletins and product catalog data.
   2. Retain manufacturer's written installation instructions at the project site.

3.02 EXAMINATION

A. Electrical, Mechanical, Structural and Architectural Drawings of the building and systems shall be reviewed by the Sprinkler Contractor and its work shall be arranged to avoid interferences.
   1. Refer to MEP (mechanical, electrical, and plumbing) Coordination requirements in Section 01 33 00 – Submittal Procedures.

B. Verify conditions are satisfactory to receive Work of this Section.
   1. Do not commence Work until unsatisfactory conditions have been corrected.

C. Beginning Work constitutes acceptance of conditions.

D. Coordinate with other trades to confirm that subsequent construction activities do not involve procedures that will damage installed materials.
   1. Materials damaged during construction shall be replaced at the Contractor's expense.

3.03 PREPARATION

A. Field Measurements: Verify on job before beginning work.

B. Protect surrounding areas and surfaces from damage prior to beginning work.

C. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

3.04 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
   1. Indicated locations and arrangements were used to allow for ceiling space and other design considerations.

2. Equipment locations indicated on the Drawings are approximate and require Contractor field coordination for exact placement.

3. Coordinate actual layout with other disciplines as necessary.

B. Route piping in an orderly manner; plumb and parallel to the building structure.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
   1. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

D. Install piping at right angles or parallel to building walls.
   1. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping to conserve building space and not interfere with the use of space or other work.

F. Do not penetrate building structural members unless indicated or approved by Project Representative.

G. Install piping at required slopes.
   1. Piping shall be pitched to ensure complete drainage of the system and where practicable, arranged to drain at the main drain valves.

H. Install piping straight and true to bear evenly on hangers and supports.
   1. Install piping free of sags and bends.

I. Provide fittings for changes in direction of piping and for connections.
   1. Make changes in piping size through tapered reduced pipe fitting; bushings will not be permitted.

J. All piping that passes through floors, walls, or ceilings of finished spaces shall be fitted with chromium-plated escutcheons secured with set screws.

K. Fire-Barrier Penetrations:
   1. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.

   2. Seal pipe penetrations with firestopping materials.

   3. Refer to Section 07 84 00 - Firestopping for materials and installation.

L. Penetrations through building seismic joints shown on the Drawings shall be provided with seismic joints in the sprinkler piping to accommodate design movement between the structures.

M. Hangers and Supports: Install in accordance with manufactures directions and NFPA 13.

3.05 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:
   1. Thread pipe with tapered pipe threads conforming to ASME B1.20.1.

2. Cut threads full and clean using sharp dies.
3. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
    a. Damaged threads:
        1) Do not use pipe or pipe fittings with threads that are corroded or damaged.
        2) Do not use pipe sections that have cracked or open welds.

D. Grooved-End Pipe and Grooved-End Fitting Joints:
1. Use grooved-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together.
2. Groove pipe and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

E. Welded Joints:
1. Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
2. Perform welding in the shop; field welding will not be permitted.

F. Flanged Joints:
1. Select appropriate gasket material, size, type, and thickness for service application.
2. Install gasket concentrically positioned.
3. Align flange surfaces parallel.
4. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible.
5. Use suitable lubricants on bolt threads.
6. Tighten bolts gradually and uniformly using torque wrench.

G. Dissimilar Materials Piping Joints:
1. Make joints using adapters compatible with both piping materials.

3.06 VALVE INSTALLATIONS

A. Install valves in accessible location to allow for maintenance and removal.
1. Install valves with stems upright or horizontal.

B. Adjust for unencumbered, smooth operation and verify mechanisms function properly.
1. Replace damaged or defective items.

C. Check Valves:
1. Install valves in horizontal or vertical position for proper direction of flow.

D. Control Valves:
1. Install fire-protection service valves supervised-open, located to control sources of water supply except from fire department connections.
2. Provide permanently marked identification signs indicating portion of system controlled by each valve.

3. Install all control valves, supply valves and test valves in easily accessible locations, with the valve handle or wheel no higher than 7 FT above the finished floor.

3.07 DRAINS AND INSPECTOR'S TEST CONNECTIONS

A. General: Terminate all drainage piping or test piping from the sprinkler systems, fire pump or associated appurtenances (i.e., circulation relief valve, bowl drains, inspectors test connections, etc.), including backflow preventers, to the exterior of the building so it will not cause damage. Discharge to the exterior must not interfere with exiting from the building. Water discharge must not cross an exit or exit discharge.

B. Provide concrete splash blocks at main drain and inspector test connection discharge locations if not discharging to a paved surface.

C. Provide "Inspector's Test Connections" for each system. Inspector's test assembly shall be provided complete with shutoff valve and sized according to NFPA 13.
   1. Locate in the hydraulically most remote location of the system and discharge outside the building.
   2. Where outside discharge is not feasible, discharge into a drain riser located adjacent to the system riser or into a drain for a remote inspectors test valve when provided.
   3. The valve shall be readily accessible, at a location no higher than 7 FT above finished floor.

D. Main drains: Provide main drains at all system risers.

E. Auxiliary Drains:
   1. Provide auxiliary drains at all low points of the system in accordance with NFPA 13.
      a. For wet pipe systems where the trapped section of pipe exceeds 5 GAL, drain assembly shall consist of a tee fitting, 3/4 IN ball valve, and short 3/4 IN threaded nipple and cap.
      b. For dry pipe system where the trapped section of pipe is less than 5 GAL, drain assembly shall consist of a 3/4 IN ball valve, and short 3/4 IN threaded nipple and cap.
      c. For dry pipe systems where the trapped section of pipe exceeds 5 GAL, drain shall be a drum drip consisting of two 1 IN valves, one (1) 2 IN condensate nipple or equivalent, and a 1 IN nipple and cap.

3.08 ALARM DEVICES

A. Equipment in this Section shall be provided, installed, and adjusted by the sprinkler Contractor.
   1. Conduit, wiring, and terminations shall be by others.

B. Valve Supervisory Switch:
   1. Equip isolation and control valves with supervisory switch.
   2. Butterfly isolation valves shall be equipped with two internal single-pole, double-throw monitoring switches.

C. Waterflow Indicator:
   1. Equip wet-pipe sprinkler system riser with vane-type waterflow detector.
   2. Set adjustable delayed signal at 30 seconds.
   3. Mount water flow indicators no higher than 7 FT above finish floor.

D. Pressure Type Waterflow Switch:
   1. Equip dry-pipe sprinkler system riser with pressure activated flow detector.
   2. Connect switch to the alarm port outlet of dry pipe valve.

E. High-Low Air Pressure Monitoring Switch:
   1. Equip dry-pipe sprinkler system riser with air pressure supervisory switch.
   2. Connect switch into the air supply line on the system side of shut-off valve.
   3. Set pressure switch at 10 PSI below the air compressor start and at 10 PSI above the air compressor stop.

3.09 SPRINKLER INSTALLATIONS

A. Accurately align sprinkler heads in suspended ceilings symmetrically with diffusers, lights, and ceiling tiles.
   1. Install sprinkler heads in the center of the ceiling tiles unless directed otherwise.

B. Sprinkler head and escutcheon shall be listed as a single assembly.

3.10 FIELD QUALITY CONTROL

A. Install all above-ground piping in such a manner that there will be no visible leakage or drop in gage pressure when the system is subjected to the hydrostatic and pneumatic pressure test.
   1. Test(s) shall be in conformance with NFPA 13.
   2. Contractor shall repair any leaks or drips immediately.
   3. Do not use additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals for testing systems or stopping leaks.

B. Hydrostatic Testing of Aboveground Piping:
   1. Hydrostatic tests shall be made of all above ground piping at not less than 200 PSI for 2 HRS or 50 PSI above static pressure in excess of 150 PSI for 2 HRS.
   2. Differential dry pipe valve clappers shall be left open during the test to prevent damage.

C. Dry-Pipe System Air Pressure Leakage Test:
   1. In addition to the standard hydrostatic test, an air pressure leakage test at 40 PSI shall be conducted for 24 HRS.
   2. Any leakage that results in a loss of pressure in excess of 1-1/2 PSI for the 24 HRS shall be corrected and the system retested.

D. Inspection of Piping before Re-Installation of Wall/Ceiling Material:
   1. Piping, hangers and sway bracing shall be considered satisfactorily installed when the installation is in conformance with the Contractor's approved shop drawings and NFPA 13.
   2. The Project Representative shall approve any deviations from the approved Shop Drawings.
   3. When, in the opinion of the Project Representative, the installation deviates greatly from the approved Shop Drawings, revised Shop Drawings and hydraulic calculations may be required to verify the installation.

E. Partial System Test or Sprinkler Coverage Inspections:
   1. Perform tests with the sprinklers installed in their final positions.
   2. Where it is critical to the continuance of the project as a whole to cover portions of the piping with ceilings or walls prior to the completion of the entire system, perform partial testing of the system after receiving written approval from the Project Representative.
   3. In this case "partial" indicates an entire zone or floor of one system.
   4. A satisfactory partial test does not relieve Contractor from performing all final testing procedures.

F. Final Piping Inspection:
   1. Final sprinkler placement shall be considered satisfactorily complete when all sprinkler heads are installed in accordance with their listing or approval and Contractor's approved Shop Drawings.
   2. The Contractor may be required to relocate or add additional sprinklers if proper sprinkler coverage is not provided due to unforeseen or modified architectural conditions.

G. Punch List:
   1. Should the results of the inspection/test not be satisfactory to the Project Representative, deficiencies will be recorded on a punch list and delivered to Contractor.
   2. Make corrections within two weeks of receipt of the punch list, no exceptions, at the Contractor's expense; a re-inspection/test will be made.

H. Final Functional Test:
   1. The final functional test shall be considered satisfactorily complete when all valves and switches perform in accordance with the Contractor's approved Shop Drawings and the following test procedures:
      a. Operate all control valves to verify proper operation of the valve and associated tamper switch.
      b. Operate all test connections to verify waterflow switch operation.
      c. Dry-Pipe Valve Operation:
         1) Operate the dry system inspector's test connection.

2) Record the following information on the Contractor's Material and Test Certificate during the valve operational test:

a) Time for valve to operate, time to receive water at inspector's test connection, static supply water pressure, system air pressure and air pressure at valve release.

b) The inspector's test connection shall receive water within 60 seconds of its operation.

I. Replace piping system components that do not pass test procedures specified.
   1. Then retest to demonstrate compliance.
   2. Repeat procedure until satisfactory results are obtained.
   3. Report test results promptly and in writing to Project Representative.
   4. Report test results promptly and in writing to AHJ when required.

3.11 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (Cx) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

B. Before the systems are accepted, all system components and equipment shall be thoroughly cleaned.
   1. Remove temporary labels and protective coverings.
   2. Remove foreign materials including dust and dirt, and excess adhesive using materials and methods in accordance with manufacturer's written instructions.

C. The completed system shall be reviewed and tested by qualified personnel to meet the approval of the authorities having jurisdiction.

D. The system shall be tested in accordance with requirements of NFPA 13, FM Global and the City of Bellevue.
   1. City of Bellevue Fire Inspector and FM Global representative shall be invited to witness all operational tests.
   2. Submit completed Contractor's Material and Test Certificate for Above Ground Piping from NFPA 13.

E. Deliver a completed Contractor's Test and Materials Certificate to the Project Representative upon satisfactory completion of the work.

F. Final Approval:
   1. After the sprinkler system has been completely installed, tested and all punch list items corrected, obtain acceptance of the system by the City of Bellevue and the FM Global Representative.
   2. Submit the certification of acceptance by both agencies to the Project Representative.

3.12 TRAINING

A. Provide sixteen (16) HRS of on-site training for operations and maintenance staff including:
   1. Two (2) four (4) HR days of operations training during which staff will be trained on the functional operation of the sprinkler system including the following:
      a. Zone by zone description of the system.
      b. Actions to be taken for trouble alarms.
      c. Actions to be taken for inadvertent tripping of the sprinkler system.
      d. Actions to be taken upon fire sprinkler system activation.
   2. One (1) eight (8) HR day of maintenance training covering requirements of NFPA 25.

END OF SECTION

SECTION 21 30 00
FIRE PUMP

PART 1 – GENERAL

1.01 SUMMARY

A. Provide a fire pump system complete with fire pump, jockey pump, and pump controllers as specified, detailed, and scheduled, meeting all applicable referenced requirements.

B. The fire pump system shall comply with requirements of the current editions of the 2009 International Fire Code, NFPA 20, Installation of Stationary Pumps for Fire Protection and FM Global Loss Prevention Data Sheets, except as modified and supplemented by this Specification.

1.02 SCOPE OF WORK

A. Provide fire pump and associated equipment to supply four dry systems supplying automatic sprinkler protection to the transfer station building. This Section covers providing all labor and materials for the installation of a diesel motor driven fire pump and electric jockey pump complete with controllers, valves, piping, supports, alarms and supplementary items necessary for a complete, operational, code compliant and approved system.

B. Section includes the following:
   1. Diesel-drive, in-line centrifugal fire pump.
   2. Full-service fire-pump controller.
   3. Fire pump accessories and specialties.

1.03 RELATED SECTIONS

A. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

B. Section 01 09 05 - Reference Standards.

C. Section 01 33 00 - Submittal Procedures.

D. Section 01 73 00 - Operation and Maintenance Manuals.

E. Section 01 60 00 - Product Requirements.

F. Section01 78 02 - Close Out Procedures: Two-Year Warranty.

G. Section 07 84 00 – Firestopping.

H. Section 09 91 00 - Painting And Protective Coatings.

I. Section 21 13 00 - Fire Suppression Sprinkler Systems.

J. Section 28 31 00 - Fire Detection And Alarm.

K. Section 33 11 13 – Water Main Construction.

L. Additional Sections of the Specifications may be required to provide a fully functional system. Refer to the Specifications Index.

1.04 CODES AND STANDARDS

A. Comply with the requirements of 01 09 05 - Reference Standards and as listed herein.

B. Applicable provisions of the most recent adopted edition of the following standards shall apply to the work of this Section, except as modified herein, and are hereby made a part of these Contract Specifications to the extent required:

1. International Code Council: www.iccsafe.org.
    a. International Building Code (IBC), 2009 edition, including Washington State and City of Bellevue Amendments.
    b. International Fire Code (IFC), 2009 edition, including Washington State and City of Bellevue Amendments.
    c. International Mechanical Code (IMC), 2009 edition, including Washington State and City of Bellevue Amendments.
2. City of Bellevue Code Amendments: www.Bellevuewa.gov.
3. National Fire Protection Association (NFPA): www.nfpa.org.
    a. NFPA 13 - 2010, Standard for the Installation of Sprinkler Systems.
    b. NFPA 20 – 2010, Installation of Stationary Pumps for Fire Protection.
    c. NFPA 24 - 2007, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.
    d. NFPA 25 - 2008, Inspection, Testing and Maintenance of Water-Based Fire Protection Systems.
    e. NFPA 70 - 2008, National Electric Code.
    f. NFPA 72 - 2010, National Fire Alarm Code.
4. FM Global (FM): www.fmglobal.com.
    a. FM Global Approval Guide.
    b. FM Global Property Loss Prevention Data Sheet 2-0, Installation Guidelines for Automatic Sprinklers.
    c. FM Global Data Sheet 2-1, Prevention and Control of Internal Corrosion in Automatic Sprinkler Systems.
    d. FM Global Data Sheet 2-7, Installation Rules for Sprinkler Systems using Control Mode Specific Applications Ceiling Sprinklers for Storage Applications.
    e. FM Global Data Sheet 2-8, Earthquake Protection for Water-Based Fire Protection Systems.
    f. FM Global Data Sheet 3-7N, Fire Protection Pumps.
    g. FM Global Data Sheet 3-10, Installation of Private Fire Service Mains.
5. Underwriters Laboratories Fire Protection Equipment Directory (UL): www.ul.com.

6. Washington Administrative Code (WAC) apps.leg.wa.gov/wac.
    a. Chapter 212-80, Fire Sprinkler System Contractors.
7. American Society of Civil Engineers (ASCE): www.asce.org.
    a. ASCE 7-05, "Minimum Design Loads for Buildings and Other Structures."
8. ASTM International: www.astm.org.
    a. ASTM A 53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded And Seamless.
    b. ASTM A 135, Electric-Resistance-Welded Steel Pipe.
    c. ASTM A 795, Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
9. American Society of Mechanical Engineers (ASME): www.asme.org.
    a. ASME B 16.1, Cast Iron Pipe Flanges and Flanged Fittings.
    b. ASME B 16.3, Malleable Iron Threaded Fittings.
    c. ASME B 16.4, Cast Iron Threaded Fittings.
    d. ASME B 16.5, Steel Pipe Flanges and Flanged Fittings.
    e. ASME B 16.9, Factory-Made Wrought Steel Buttweld Fittings.
    f. ASME B 16.11, Forged Steel Fittings, Socket-Welded and Threaded Copper.

1.05 GENERAL REQUIREMENTS

A. Give necessary notices, obtain permits, and pay taxes, fees and other costs, including utility connections or extensions for the work.

B. File necessary Drawings, prepare documents and obtain necessary approvals of governmental departments having jurisdiction. Include all costs associated with notices, permits, taxes, fees, utility connections or extensions, government approvals and other related costs in original bid.

C. Obtain required certificates of inspection for work and deliver to the Project Representative before request for acceptance and final payment for the work.

D. Comply with laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the work.

E. If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify the Project Representative in writing and any necessary changes shall be accomplished by appropriate modification.

F. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to the Project Representative, he shall assume full responsibility, and shall bear all costs.

G. All of the Work of this Section requires system design performed by the Contractor, assisted by the Sprinkler Contractor, in compliance with WAC 212-80 and the IBC.

H. This responsibility includes preparation of fire sprinkler Shop Drawings and Engineering calculations by a Qualified Professional Engineer/Designer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms who's equipment and devices shall be of a make and type listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

B. Installing Contractor's Qualifications:
   1. Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment in accordance with NFPA 13 and NFPA 20. A qualified firm is one who is a Licensed Fire Sprinkler Contractor per the Fire Sprinkler Licensing requirements in the State of Washington and that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction.
   2. Submit evidence of qualifications to the Project Representative upon request.

C. Designer's Qualifications:
   1. System shall be designed by a State of Washington licensed Fire Protection Engineer or a fire sprinkler designer with a current Washington State Certificate of Competency Level III in accordance with WAC 212-80, Fire Sprinkler System Contractors.

D. Design and installation shall meet or exceed the standards and requirements of the Project Representative's insurance company, FM Global, referenced codes and standards, and Authority Having Jurisdiction's review comments.

E. Contractor shall participate in preparation of the MEP Coordination Shop Drawing submittal specified in Section 01 33 00 – Submittal Procedures.

F. Maintain at least one copy of all system related documents on Site.

G. Provide listing/approval stamp, label, or other marking on equipment made to specified standards.

H. Comply with local fire department/marshal standards pertaining to material, hose threads, and installation.

1.07 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from authority having jurisdiction for fire protection systems specified.
   1. The fire protection work shall comply with all requirements of the codes and regulations of authorities having jurisdiction and local and state authorities.
   2. Contractor shall develop and coordinate Drawings with other design disciplines in order to obtain a sprinkler system permit prior to the start of work.
   3. Contractor shall field verify all dimensions and piping locations and modify the Drawings as necessary prior to fabrication of piping.

4. Any materials shown or specified in the Drawings and Specifications shall be furnished and installed by the Contractor.
5. Materials reasonably implied and usually included under good industry practice and/or for proper and safe completion and operation of the work described herein, shall also be furnished by the Contractor.
6. The Drawings and/or Specifications, when more stringent than NFPA, IFC or the local authority requirements, shall take precedence.

B. The fire pump shall be designed and installed in accordance with NFPA 20 and FM Global Loss Prevention Data Sheets.

C. A margin of safety for available water flow and pressure of 10 PSI shall be provided; including loses through water service piping, valves and backflow preventers.

D. The Contractor is advised that the Drawings are diagrammatic in nature and are not intended to show all details.

1.08 SUBMITTALS

A. Submittals shall be in accordance with the Conditions of Contract and Section 01 33 00 - Submittal Procedures.

B. Submit as one package each item specified in this section. Partial submittals shall not be accepted.

C. Fire Pump Submittals must be included with sprinkler system submittals (See Section 21 13 00 – Fire-Suppression Sprinkler Systems). Separate submittals will not be accepted.

D. Leadership in energy and environmental design (LEED®) documentation: Submit the following in accordance with section 01 81 30 – Sustainability Requirements:
1. Completed LEED VOC Submittal Form.

E. Approval Submittals:
1. Submit as one package in accordance with Section 01 33 00 - Submittal Procedures, Shop Drawings, product data, and samples.
2. Submit Shop Drawings, hydraulic calculations, and seismic bracing calculations to the City of Bellevue for review, comment, and approval. Two copies of the sprinkler (FB), fire alarm (FA), and underground mains (FD) shall be submitted under the proper permit type to the City of Bellevue Permit Center.
3. Incomplete submittals will be rejected unless prior approval is requested and given from the Project Representative for partial submittals.
4. Shop Drawings, calculations, and product data shall be submitted and approved by the AHJ prior to submittal to the Project Representative.
   a. FM Global review and approval: Direct submittals to Plan Review, FM Global, 601 – 108th Ave NE, Suite 1400, Bellevue, WA 98004. Phone: 425-709-5064.
   b. City of Bellevue review, approval and permit: Direct submittals to Development Services, 10900 NE 4th St, Bellevue, WA 98004.

c. Contractor is responsible for making changes to system design as required to satisfy requirements of Authorities Having Jurisdiction and is responsible for obtaining installation permit for system including paying all fees.

d. Allow sufficient time for review assuming at least a second round of submittals to the AHJ.

e. All comments and requirements of FM Global and the City of Bellevue shall be incorporated and revised Drawings submitted to the Project Representative.

5. Design Basis Information:

   a. The fire pump furnished for fire protection service shall be supplied with the specified drivers, controls and pump accessory items by the pump manufacturer. The pump, driver and control shall be:

      1) Underwriters Laboratories (UL) Listed.

      2) Factory Mutual Research Corporation (FM) Approved.

   b. The pump and associated equipment shall be installed as recommended in NFPA 20.

   c. Required pump performance shall be based on supplying the sprinkler system(s) demands with suction from the public mains. The available water flow to the site is a static pressure of 80 PSI and 1,250 GPM at a residual pressure of 64 PSI. Preliminary design shall be based on providing a pump designed to deliver 2000 U.S. gallons per minute (GPM) at a total differential pressure of 60 PSI. Final sprinkler system design and pump selection shall not be completed until field testing of available water flow is conducted after installation of underground mains.

   d. The fire pump shall also be capable of delivering not less than 150 percent of rated flow at not less than 65 percent rated head.

   e. The Pump shall be furnished with driver, controller and accessories as detailed in this Specification.

   f. Pump manufacturer shall have unit responsibility for the proper operation of the complete unit assembly as indicated by field acceptance tests.

6. Shop Drawings:

   a. Shop Drawings shall conform to and include all items set forth in NFPA 13, NFPA 20 and NFPA 24 for working plans, and City of Bellevue Submittal requirements.

   b. Submit floor plans drawn with AUTOCAD to same scale as the Contract Drawings, showing piping, equipment and hardware location, wiring and mounting details.

   c. Submit detailed 1:100 (1/8 IN) scale (minimum) working Drawings. Include a site plan showing the piping to the water supply test location.

d. Shop Drawings shall indicate relationship of all overhead items, including structural elements, HVAC system, air terminals, ductwork, piping, conduit, lighting fixtures, skylights, equipment, and similar items.

e. Include seismic bracing, fittings and details.

f. Provide complete details and sections as required to clearly define and clarify the design, including a materials list describing all proposed materials by manufacturers' name and catalog number.

7. Manufacturers Data Sheets:

a. Provide manufacturers literature including general assembly, pump curves showing performance characteristics with pump and system with operating point indicated, NPSH curve, controls, wiring diagrams, and service connections. Obtain approval before proceeding.

b. Provide for all materials and equipment proposed for use on the system (eg. Pumps, controllers, pipe, fittings, hangers, valves, alarm devices, sprinklers, etc.).

c. Where data sheet describes items in addition to that item being submitted, clearly identify proposed item on the sheet.

d. Include UL listing and FM approval (for the specified application) for all system components.

F. Quality Assurance Submittals:

1. Comply with provisions of Section 01 43 00 – Quality Assurance and Control and the requirements of this Section.

2. Provide evidence of Fire Protection Engineer's and/or designer's qualifications.

3. Test Reports and Certificates: Include documentation of required testing, as described in NFPA 20.

4. Provide certification of acceptance of installation by AHJ.

G. Closeout Submittals:

1. Provide Record Drawings, testing and maintenance instructions in accordance with the requirements in Section 01 78 00 - Closeout Procedures.

2. Submittals shall include, but not be limited to, the following:

a. Record Documentation:

1) Shop Drawings: Indicate layout, general assembly, components, dimensions, weights, clearances, and methods of assembly.

2) Manufacturer's Certificate: Certify that fire pump meets or exceed specified requirements at specified operating conditions. Submit summary and results of shop tests performed in accordance with NFPA 20.

3) Field Reports: Indicate summary of hydrostatic test and field acceptance tests performed in accordance with NFPA 20.

4) Manufacturer's Installation Instruction: Indicate support details, connection requirements, and include start-up instructions for fire pump system.

5) Regulatory Requirements: Provide certificate of compliance from authority have jurisdiction indicating approval of field acceptance tests.

6) One complete set of reproducible record Drawings shall indicate installed location of components including piping, sprinklers, hangers, valves, test stations, auxiliary drains, and other system specialty components.

7) Also include corrections noted during the site observation process and reflect revisions, addenda, and construction change directives implemented on the project.

b. Material and Testing Certificate:

1) Upon completion of the fire pump installation, provide documentation of required testing, as described in NFPA 20.

2) Commissioning Data: Submit system commissioning data (in a format recommended by the manufacturer and per the instructions provided by the manufacturer) within 30 days of completion of the installation.

3. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:

a. A complete set of instructions covering the installation, maintenance and operation of the fire pump system shall be bound in booklet form and furnished to the Project Representative. Provide on CD-ROM, and Record Drawings.

b. Operation Data: Include manufacturer's instructions, start-up data, and trouble-shooting check lists for pumps, drivers, and controllers.

c. Maintenance Data: Include manufacturer's literature, cleaning procedures, preventive maintenance recommendations and procedures, replacement parts lists, and repair data for pumps, drivers and controllers.

d. Maintenance Material: Provide two (2) copies of *NFPA 20 Installation of Stationary Pumps for Fire Protection* delivered to Project Representative.

1.09 DELIVERY, STORAGE AND HANDLING

A. Comply with requirements of Section 01 60 00 - Product Requirements, and the following:

1. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

2. Handle components carefully to avoid damage to components, enclosures, and finish.

3. Store all components in a clean, dry space and protect from weather.

B. Accept fire pumps and components on site in factory packing. Inspect for damage. Comply with manufacturer's rigging and installation instructions.

C. Protect fire pumps and components from physical damage including effects of weather, water, and construction debris.

D. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.10 PROJECT SITE CONDITIONS

A. Be responsible for work and equipment until finally inspected, tested and accepted; protect work against theft, injury or damage; and carefully store material and equipment received on site which are not immediately installed.
   1. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

B. At the completion of each portion of work, all waste material, rubbish, equipment, and surplus material shall be removed from the site.
   1. Contractor is responsible for the daily clean up of their work.

C. Protect work from damage and deterioration until completion and acceptance by Project Representative.

PART 2 – PRODUCTS

2.01 GENERAL

A. Specific manufacturers and model numbers where noted are to indicate a standard of design and are not intended to be restrictive.

B. Provide all materials necessary to make the installation complete in every detail shall be furnished and installed whether or not specifically shown on the Drawings or specified herein.

C. Provide pipe, tube and fittings of the type, fitting requirements, grade, class, size and weight indicated or required for each service.
   1. Where type, grade, or class is not indicated, provide proper selection as determined by designer for installation requirements, and comply with governing regulations and industry standards.

D. All materials and equipment in the system shall be new and current products of the manufacturer's latest design and suitable to perform the functions intended, as listed under MANUFACTURERS.
   1. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

E. All devices, components and equipment shall be the products of the same manufacturer.

F. All components and equipment within the scope of the FM Global Approval Guide shall be listed by FM Global for the purpose for which they are used and shall bear their listing mark.

G. All components and equipment within the scope of the UL Testing Laboratory Service shall be listed by the Underwriters' Laboratories for the purpose for which they are used and shall bear their listing mark.

H. Product Marking: Each major component shall be furnished with legible markings indicating: Name of the manufacturer, part numbers and serial numbers, and markings as required per ASTM Standards.

I. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

J. Pressure ratings of pumps, pipe, fittings, valves, gauges and all other water carrying appurtenances shall be suitable for the anticipated system pressures in which they are installed.

K. The Contractor shall ascertain for himself the space and access available for the installation of a factory assembled packaged unit and as an option may assemble the various components in place at the Site in lieu of providing a factory assembled unit. However, all components of the system shall be compatible and be furnished by a single source manufacturer and all electrical services and interconnecting equipment wiring must be provided for within this Contractor's bid.

L. All of the equipment listed herein, shall be mounted on a structural steel base that is equipped with grout holes, unless otherwise approved. All wiring and piping including pressure sensing lines, bypass with check valve and shut-off valves, as well as approved pump suction and discharge valves shall be furnished firmly anchored to the steel base by means of structural steel supports and arranged such that single point connections are required for piping and power supply.

M. Packaged pumping systems shall include all electrical wiring between components and shall be completed and tested at the factory prior to shipment. The entire assembly shall be painted red after hydrostatic and electrical tests.

N. All pilot lights and visual indicators shall be illuminated from the rear by long life LED lamps. Neon and incandescent lamps are not acceptable.

2.02 MANUFACTURERS

A. Subject to compliance with requirements of the Contract Documents, Products of one of the following Manufacturers shall be incorporated in the Work of this Section:
   1. Allison Chalmers.
   2. Aurora Pump.
   3. Patterson Pump Company.
   4. Peerless Pump Company.
   5. Or Approved Equal.

2.03 FIRE PUMP

A. Description, General: FM Approved, UL 448, factory-assembled and -tested, diesel-drive, fire pump capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Churn pressure shall not exceed 140 percent of rated design pressure.

1. Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
2. Nameplate: Complete with capacities, characteristics, and other pertinent data.

B. Install attachment to fire pumps and controllers with reinforcement to resist movement of pumps and controllers during a seismic event when they are anchored to building structure.

C. The pump shall be a centrifugal, double-suction, bronze-fitted, pump with the pump driver complete with flexible coupling and coupling guard.

D. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

E. Impeller: Bronze double suction fully enclosed, statically and dynamically balanced and keyed to shaft.

F. Bearings: Grease lubricated ball bearings, greaseable and replaceable without opening casing, selected for minimum 50,000 HR life.

G. Wear Rings: Replaceable, bronze.

H. Shaft: Alloy steel with replaceable bronze shaft sleeve.

I. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 230 DegF maximum continuous operating temperature.

J. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

K. Baseplate: Cast iron with integral drain rim.

2.04 DIESEL ENGINE

A. Diesel Engines: The pump driver shall be a horizontal shaft type internal combustion engine.
1. The engine shall be provided by the pump manufacturer with, at a minimum, the following accessories for automatic operation.
a. UL listed emergency manual operator, factory wired and mounted on the engine junction box for standby engine starting and operation in case of main controller or interconnecting wiring malfunction.
b. Cooling waterlines, pressure regulator, strainer, bypass lines and necessary fittings for engine cooling system, pre-piped and factory mounted.
c. Flexible exhaust connector.
d. Exhaust silencer.
e. Engine jacket water heater, factory installed.
f. One set dual batteries, lead acid storage type.

g. Fuel system as recommended in NFPA 20.

1) Fuel storage tank shall be designed and constructed in accordance with recognized engineering standards including ANSI/UL 142, Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.

2) Fuel storage tank shall be sized to provide a minimum supply of one gallon of fuel per engine maximum rated horsepower plus 5 percent for sump area plus 5 percent for expansion area. The tank shall be furnished for floor mounting and with a direct reading level gage. The fuel tank shall be double wall with containment, fuel system, fill cap, level switch, UL listed. Terminate vent lines outside the building as required.

3) Provide AST spill containment with drain valve at fuel fill point and minimum 2 IN fuel fill line (Schedule 40 black), complete with overfill prevention valve.

2.05 FIRE-PUMP CONTROLLER

A. Diesel Engine Fire Pump Controller:
1. The fire pump controller shall be a factory assembled, wired and tested unit and shall be listed by Underwriters' Laboratories, Inc., in accordance with UL218, Standard for Fire Pump Controllers, and approved by Factory Mutual. It shall be built to meet or exceed the requirements of the approving authorities as well as NEMA and the latest editions of NFPA 20 and NFPA 70.

B. Fire Pump Controller, General: UL 218 listed for diesel-drive, fire-pump service and service entrance; combined automatic and manual operation; factory-assembled and wired; and factory-tested for capacities and electrical characteristics.
1. Available Manufacturers: Cutler-Hammer; Firetrol, Inc.; Hubbell Industrial Controls, Inc.; Joslyn Clark; Master Control Systems, Inc.; Metron, Inc, or approved equal.

2. Rate controllers for scheduled fire-pump horsepower and short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.

3. Enclosure: UL 50, NEMA Type 2, drip proof, for indoor installation. Include manufacturer's standard red paint applied to factory-assembled and tested unit before shipping.

4. Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed.

5. Isolating means and circuit breaker.

6. Automatic and manual operation and minimum run-time relay to prevent short cycling.

7. System pressure recorder, electric ac driven with spring backup.

8. Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.

9. Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with orifice in clapper or ground-face union with noncorrosive diaphragm with orifice.
10. Time delay circuit breaker set at 300 percent motor full load current.
11. Isolation switch with single external operating handle interlocked with circuit breaker. Operating mechanism shall be flange or side mounted.
12. START and STOP pushbuttons for manual control.
13. Ammeter test links and voltmeter test studs.
14. Surge protector wired to the line side of the isolation system.
15. Solid state pressure switch and transducer with energize to start relay. Pressure switch shall be differential adjustable type with LED indicators for trip and reset.
16. Minimum run time, adjustable 0 - 10 minutes with timed-out LED indicator. Per NFPA 20 and FM pump should be arranged for “manual stop” the run-timer and auto stop function may be required to be disabled.
17. Magnetic contactors with externally operable mechanical start mechanism.
18. Two sets of dry form "C" remote alarm contacts shall be provided for ENGINE FAILED TO START, MAIN SWITCH IN OFF, and LOW DISCHARGE PRESSURE.
19. A separate pressure switch shall be supplied to monitor discharge pressure.
20. All indicators shall be illuminated from the rear by long life LED lamps. Incandescent lamps are not acceptable.

C. Operator Interface:
   1. The fire pump controller shall feature an operator interface with user keypad.
   2. Door mounted display/interface panel shall feature a backlit LED graphical display, Membrane Type User Control Push-buttons and easy to read LED Indicators for:
      a. AC POWER AVAILABLE.
      b. ALARM.
      c. MAIN SWITCH IN AUTO.
      d. MAIN SWITCH IN MANUAL.
      e. SYSTEM PRESSURE LOW.
      f. ENGINE RUNNING.
      g. ENGINE FAIL TO START.
      h. ENGINE TEMPERATURE HIGH.

i. ENGINE OIL PRESSURE LOW.

j. ENGINE OVERSPEED.

k. ENGINE ALTERNATE ECM.

l. ENGINE FUEL INJECTOR MALFUNCTION.

m. FUEL LEVEL LOW.

n. AUTOMATIC SHUTDOWN DISABLED.

o. CHARGER MALFUNCTION.

p. BATTERY #1 TROUBLE.

q. BATTERY #2 TROUBLE.

3. All alarms, events, and pressure conditions shall be displayed with a time and date stamp.

4. The display and interface shall be NEMA rated for Type 2, 3R, 4,4X, and 12 protection and shall be fully accessible without opening the controller door.

D. Battery Chargers:

1. The controller shall include a minimum of two fully automatic, 200 amp hour, 4 step battery chargers.

2. The chargers shall feature a qualification stage, in which the batteries are examined by the charger to insure that they are not defective and are capable of accepting a charge.

3. The battery charger shall feature:

a. Selectable AC Power Voltage.

b. Selectable Battery Voltage.

c. Selectable Battery Type.

d. Charge Cycle Reset Push-button.

2.06 FIRE PUMP ACCESSORIES AND SPECIALTIES

A. Provide tamper switches, flow switches and pressure switches for connection to the fire detection and alarm system specified in Section 28 3100 - Fire Detection and Alarm System. Optional attachments may be required to meet NFPA 20 requirements, and shall be provided as necessary.

B. Eccentric suction reducer and OS&Y gate on suction side of pump. No butterfly valve shall be installed on suction side of pump.

C. Concentric increaser and check valve in pump discharge and OS&Y gate or butterfly valve on system side of check valve.

D. Fire pump bypass fitted with normally open and supervised OS&Y gate or butterfly valves and double-check valve assembly.

E. Suction pressure gauge, 3-1/2 IN minimum diameter dial with snubber, valve cock and lever handle.

F. Discharge pressure gauge mounted on board attached to pump, 3-1/2 IN minimum diameter dial with snubber, valve cock and lever handle.

G. Venturi flow meter system, FM approved, meter reading in GPM, flow sensor, and all required accessories.

H. Fire pump test header with number and size of hose valves per NFPA 20.

I. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:
   1. Automatic air-release valve.
   2. Circulation relief valve.
   3. Suction and discharge pressure gauges: UL 393, 4.5 IN DIA dial with range of 0 PSI to 250 PSI minimum. Include caption "WATER" on dial face.
   4. Main Relief Valve: UL 1478, pilot operated or spring loaded.
   5. Water Measuring Device: Capable of water flow of not less than 175 percent of pump rated capacity, to test the pump.

J. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.

2.07 PIPING, FITTINGS AND VALVES

A. Piping, fittings and valves as specified in Section 21 13 00 – Fire-Suppression Sprinkler Systems.

2.08 PRESSURE MAINTENANCE (JOCKEY) PUMP

A. Electrically operated, horizontal turbine close-coupled or vertical multi-stage centrifugal type with standard open drip-proof motor.

B. The following manufacturers are acceptable provided their products meet or exceed these Specifications and the Contract Drawing Schedules:
   1. Grundfos.
   2. Aurora.
   3. Peerless.
   4. Allis-Chalmers.
   5. Or Approved Equal.

C. Pump shall be close coupled turbine type, cast iron frame and case, bronze impeller, bronze fitted, stainless steel shaft, tungsten carbide mechanical seal.

D. Jockey Pump Controller: UL Listed, with magnetic starter, fusible disconnect switch, hand-off automatic selector switch, control circuit transformer, running period timer, adjustable Mercury tube pressure switch, and NEMA 2, drip tight.

2.09 JOCKEY PUMP CONTROLLER

A. The electric jockey pump controller shall include a circuit breaker, magnet starter with overloads, pressure switch, H-O-A selector switch, minimum run timer, dual fused control power transformer, START pushbutton, two sets of dry form "C" remote alarm contacts for PUMP RUNNING and NEMA 3R enclosure.

2.10 EQUIPMENT DEVIATIONS

A. Where the term “or approved equal” is used, alternative and/or substitute products shall be submitted for review, in accordance with Section 01 60 00 – Product Requirements.
   1. Where the term “or equal” is used, contractor shall use a product that is equal to that specified.
   2. The Project Representative shall determine if two products are “equal”.

B. When submitting an alternative and/or substitute product, Contractor shall include complete product literature of original specified item.

C. Provide redesign to any part of the work resulting from the use of equipment and material other than specified or indicated on the Drawings.
   1. Obtain approval of redesign from the Project Representative.
   2. Redesign cost and additional construction cost resulting from the redesign shall be at the Contractor's expense.

PART 3 – EXECUTION

3.01 GENERAL

A. Requirements prior to installation:
   1. Do not order, fabricate, or install any material prior to receipt of all approvals as stipulated in PART 1 of this Section.

B. Standards and requirements:
   1. Perform all installation work in accordance with the reference standards without exception, and as required by the AHJ.

C. Changes to the work:
   1. Install all piping as shown on the approved Shop Drawings.
   2. Carefully note any minor deviations on the Record Drawings as outlined in PART 1 of this Section.
   3. Before making significant deviations from the approved Drawings, obtain written approval from the Project Representative and the AHJ.

D. Coordination of Work:
   1. Carefully coordinate work with other trades so that unnecessary offsets and revisions to the approved Drawings are avoided.
   2. Failure to coordinate does not relieve Contractor from meeting performance standards.

E. All equipment shall be installed and identified in accordance with the noted Codes and Standards and the manufacturer's guidelines and design manuals.
   1. Comply with manufacturer's instructions, including technical bulletins and product catalog data.
   2. Retain manufacturer's written installation instructions at the project site.

3.02 EXAMINATION

A. Electrical, Mechanical, Structural and Architectural Drawings of the building and systems shall be reviewed by the Contractor and its work shall be arranged to avoid interferences.
   1. Refer to MEP Coordination requirements in Section 01 33 00 – Submittal Procedures.

B. Verify conditions are satisfactory to receive Work of this Section.
   1. Do not commence Work until unsatisfactory conditions have been corrected.

C. Beginning Work constitutes acceptance of conditions.

D. Coordinate with other trades to confirm that subsequent construction activities do not involve procedures that will damage installed materials.
   1. Materials damaged during construction shall be replaced at the Contractor's expense.

E. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of fire pumps.

F. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-pump installation.

3.03 PREPARATION

A. Field Measurements: Verify on job before beginning work.

B. Protect surrounding areas and surfaces from damage prior to beginning work.

C. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

3.04 INSTALLATION

A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

B. Install fire pump, controller, associated equipment and accessories in accordance with Manufacturer's Instructions:
   1. Comply with manufacturer's instructions, including technical bulletins and product catalog data.
   2. Retain manufacturer's written installation instructions at the project site.

C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

D. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings or pump suction and discharge.

E. Locate fire pump test hose valve header on exterior wall, above the concrete base wall, accessible from grade level. Isolation valves shall be located within the fire pump room.

F. Provide piping to, and route discharge from all relief valves and drains to exterior of building and terminate at a location and in a manner to prevent any damage to surrounding areas.

G. Provide full line size bypass around fire pump.

H. Coordinate connection to electrical service.

I. Install and align fire pump and controller according to manufacturer's requirements and NFPA 20.

J. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

K. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
   1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near anchor bolts, to provide 20 to 40 mm gap between pump base and concrete base for grouting.
   2. Adjust metal supports or wedges until pump and driver shafts are level. Verify that coupling faces and pump suction and discharge flanges are level and plumb.

L. Alignment:
   1. Align in-line fire-pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
   2. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
   3. Align piping connections.
   4. Align pump and driver shafts for angular and parallel alignment according to tolerances specified by manufacturer.

M. Piping installation requirements are specified in 21 13 00 - Fire-Suppression Sprinkler Systems. Drawings indicate general arrangement of piping, fittings, and specialties.

N. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

O. Support pumps and piping separately so weight of piping does not rest on pumps.

P. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.

Q. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

R. Connect wiring according to Section 26 05 19 - Wire and Cable: 600 Volt and Below.

S. Ground equipment according to Section 26 05 26 - Grounding.

3.05 INSTRUCTIONS AND START-UP

A. Contractor shall provide for the service of a competent factory-trained supervising agent from the fire pump manufacturer to inspect the completed installation, start the system and acquaint the operators with the proper operation and maintenance of the equipment.

3.06 FIELD QUALITY CONTROL

A. Perform acceptance and operation testing on entire system in accordance with NFPA 20.

B. A field performance characteristic curve shall be produced and compared for verification to the factory performance curve.

C. Submit verification of test results to Project Representative and include within operation and maintenance manual.

D. Check, align, lubricate and certify pumps per NFPA 20 prior to startup. Notify Project Representative 48 HRS in advance of alignment check.

E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Submit report results in writing.

F. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, and then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, and then retest to demonstrate compliance. Verify that fire pump performs as indicated.

G. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
      a. Lubricate oil-lubrication-type bearings.
      b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.

c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.

3. Follow manufacturers suggested starting procedure for pump, including the follow:

a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.

b. Open sealing-liquid supply valves if pump is so fitted.

c. Start motor.

d. Open discharge valve slowly.

e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.

f. Check general mechanical operation of pump and motor.

H. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

I. Field Acceptance Test:

1. A field acceptance performance test shall be conducted upon completion of pump installation.

2. The test shall be made by flowing water through calibrated nozzles, approved flow meters or other such accurate devices as may be selected by the authority having jurisdiction.

3. The test shall be conducted as recommended in NFPA 20 by the installing contractor in the presence of the AHJ and with that authority's final approval and acceptance.

4. Failure to submit documentation of factory and field tests will be just cause for equipment rejection.

3.07 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (Cx) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

B. Before the systems are accepted, all system components and equipment shall be thoroughly cleaned.

1. Remove temporary labels and protective coverings.

2. Remove foreign materials including dust and dirt, and excess adhesive using materials and methods in accordance with manufacturer's written instructions.

C. The completed system shall be reviewed and tested by qualified personnel to meet the approval of the authorities having jurisdiction.

D. The system shall be tested in accordance with requirements of NFPA 13, NFPA 20, FM Global and the City of Bellevue.
   1. City of Bellevue Fire Inspector and FM Global representative shall be invited to witness all operational tests.
   2. Submit completed Contractor's Material and Test Certificate for Above Ground Piping of or from NFPA 13.

E. Deliver a completed Contractor's Test and Materials Certificate to the Project Representative upon satisfactory completion of the work.

F. Final Approval:
   1. After the sprinkler system has been completely installed, tested and all punch list items corrected, obtain acceptance of the system by the City of Bellevue and the FM Global Representative.
   2. Submit the certification of acceptance by both agencies to the Project Representative.

3.08 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps, drivers and controllers.

B. Provide eight (8) HRS of on-site training for operations and maintenance staff including:
   1. Two (2) four (4) HR days of operations training during which staff will be trained on the functional operation and maintenance of the fire pump system.

END OF SECTION

SECTION 22 20 00
PLUMBING FIXTURES AND EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Plumbing fixtures, trim, and equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 40 05 05 - Equipment: Basic Requirements.
   4. Section 40 05 13 - Pipe and Pipe Fittings: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Americans with Disabilities Act Accessibility Guidelines (ADAAG).
   2. American National Standards Institute (ANSI):
      a. Z358.1, Emergency Eyewash and Shower Equipment.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. 90.1 2007 IP, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   4. American Society of Mechanical Engineers (ASME):
      a. A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   5. American Society of Sanitation Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breaker.
   6. Canadian Standards Association (CSA).
   7. NSF International (NSF).
   8. Underwriters Laboratories, Inc. (UL).
   9. Building Code:
      a. International Code Council (ICC):
         1) International Building Code and associated standards, 2009 Edition including all amendments, referred to herein as Building Code.

b. Local Codes:

1) 2009 State of Washington Energy Code.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Requirements for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
1. See Specification Section 40 05 05 - Equipment: Basic Requirements and Specification Section 40 05 13- Pipe and Pipe Fittings: Basic Requirements.
2. Color selection charts for Project Representative color selection.
3. Fabrication and/or layout Drawings:
   a. Layout plan(s) showing dimensions, elevations, etc.
   b. Details showing connections, installation, rough-in locations, etc.
4. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Manufacturer's installation instructions.
   c. Chemical-resistance data.

C. Closeout Submittals:
1. Operation and Maintenance (O&M) Manuals: Provide O&M Manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
1. Warranty period for Domestic Hot Water Heater against corrosion for two (2) years commencing on the date of Substantial Completion.
2. Warranty period for all Vitreous China against manufacturers and installation deficiencies for two years from substantial completion.
3. All equipment and work shall be covered for deficiencies for a period of two years from the date of substantial completion.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Plumbing fixtures (vitreous china):
      a. American Standard.
      b. Crane.
      c. Kohler.
      d. Eljer.
      e. Or approved equal.
   2. Stainless steel sinks:
      a. Just Manufacturing.
      b. Elkay.
      c. Or approved equal.
   3. Premolded mop sinks:
      a. Powers - Fiat.
      b. Standard - Elsmer Granite Co.
      c. Williams.
      d. Florestone.
      e. Or approved equal.
   4. Service sink:
      a. American Standard.
      b. Kohler.
      c. Eljer.
      d. Or approved equal.
   5. Premolded shower:
      a. Powers - Fiat.
      b. Standard - Elsmer Granite Co.
      c. Williams.
      d. Florestone.

e. Or approved equal.

6. Washfountains:
   a. Bradley.
   b. Acorn Engineering.
   c. Or approved equal.
7. Water closet seats:
   a. Church.
   b. Beneke.
   c. Or approved equal.
8. Lavatory fittings:
   a. American Standard.
   b. Chicago Faucets.
   c. Kohler.
   d. Sloan.
   e. Or approved equal.
9. Service sink fittings:
   a. American Standard.
   b. Chicago Faucets.
   c. Kohler.
   d. Or approved equal.
10. Mop sink fittings:
    a. American Standard.
    b. Chicago Faucets.
    c. Kohler.
    d. Or approved equal.
11. Sink fittings:
    a. American Standard.
    b. Kohler.
    c. Just.
    d. Or approved equal.
12. Shower fittings:
    a. Symmons.
    b. Leonard.
    c. Or approved equal.

13. Flush valves:
    a. Sloan.
    b. Zurn.
    c. Delany.
    d. Or approved equal.
14. Emergency shower and eyewash:
    a. Speakman.
    b. Haws.
    c. Guardian Equipment.
    d. Or approved equal.
15. Drains, roof drains, carriers, and shock absorbers:
    a. Wade.
    b. Josam.
    c. Zurn.
    d. Smith.
    e. Or approved equal.
16. Trap Primers:
    a. Precision plumbing products.
    b. Watts.
    c. Or approved equal.
17. Hose reels:
    a. Hannay and Son, Inc.
    b. Aeromative Mfg Co.
    c. Or approved equal.
18. Hose bibs:
    a. Nibco.
    b. Woodford.
    c. Or approved equal.
19. Hydrants:
    a. Wade.
    b. Josam.
    c. Smith.
    d. Or approved equal.
20. Domestic water heater:
    a. A. O. Smith.

b. Bosch.
c. Rheem.
d. State.
e. Or approved equal.

21. Reduced pressure backflow preventer:
    a. Watts.
    b. Febco.
    c. Clayton.
    d. Or approved equal.
22. Hot water circulating pump:
    a. Bell and Gossett.
    b. Thrush.
    c. Taco.
    d. Or approved equal.
23. Prefabricated trench drain system:
    a. ACO Drain, Inc.
    b. Poly Drain, Inc.
    c. L.M. Scofield Company.
    d. Or approved equal.
24. Hose valve:
    a. Guardian Fire Equipment.
    b. Wilkins.
    c. Or approved equal.
25. Booster Pump System:
    a. Xylem.
    b. Aurora.
    c. Or approved equal.
26. UV Disinfection System:
    a. Atlantic Ultraviolet Corporation.
    b. Neptune Water Treatment.
    c. Or approved equal.
27. High Efficiency Filter System:
    a. Culligan.
    b. Vortisand by Sonitec.
    c. Or approved equal.

28. Water Meters:
    a. Neptune.
    b. Watts.
    c. Or approved equal.
29. Sewer Flow Meter:
    a. HACH Sigma 950
    b. No substitutions permitted.
30. Yard Clean out:
    a. Zurn.
    b. Jay R. Smith Company.
    c. Or approved equal.
31. Tempering thermostatic mixing valve:
    a. Lawler.
    b. Zurn.
    c. Watts.
    d. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00- Product Requirements.

2.02 MANUFACTURED UNITS

A. Plumbing Fixtures (Vitreous China):
1. Water closet (WC):
    a. White.
    b. 1.28 GAL per flush.
    c. Siphon jet.
    d. Elongated bowl.
    e. 1-1/2 IN top spud or close coupled tank.
    f. Bolt caps.
    g. Type:
        1) WC-1 (wall hung).
        2) WC-2 (handicapped wall hung).
2. Urinal (U):
    a. White.
    b. Top spud.
    c. Type:
        1) U-1 (wall hung).

3. Lavatory (L):
    a. White.
    b. Front overflow.
    c. Type:
        1) L-1 (wall hung 20 x 18 IN).
        2) L-2 (oval, self-rimming, 24 x 18 3/8 IN).

B. Sinks (S):
1. Stainless steel sink:
    a. Type 304, 18-8 stainless steel.
    b. Self-rimming, drop-in mount.
    c. Fully coated underside.
    d. Drain punch centered in each bowl.
    e. Basket strainer and tailpiece.
    f. 3-faucet holes on 4 IN centers.
    g. ASME A112.19.3.
    h. Type:
        1) S-1: 19 IN x 22 IN, Ledge type, single bowl, 18 gage stainless steel, fully coated underside, 3 faucet holes on 4 IN centers, 7 1/2 IN depth, 3 1/2 IN drain connection.
        2) S-2: 33 IN x22 IN, Ledge type, single bowl, 18 gage stainless steel, fully coated underside, 3 faucet holes on 4 IN centers, 8 IN depth, 3 1/2 IN drain connection.
2. Mop sink (MS):
    a. Precast terrazzo (marble chips cast in Portland cement, ground and polished with all air voids grouted).
    b. One-piece.
    c. Drop front.
    d. 2 IN wide shoulder.
    e. Stainless steel threshold.
    f. 24 IN Stainless Steel wall Guards.
    g. Mop holder.
    h. Integral drain body, removable strainer and 3 IN drain pipe.
    i. Type:
        1) MS-1 (square) 24 x 24 x 12 IN.

C. Service Sink (SS):
1. Enameled cast iron 21 x 16 3/8 IN.

2. Wall hanger.
3. Rim guard.
4. Cast iron P-trap, acid-resisting enamel inside.
5. Chrome strainer.
6. Type:
    a. SS-1 (with holes for faucet).

D. Showers (SH):
1. SH-1 Shower:
    a. Precast shower floor:
        1) One-piece molded stone with slip-resistant surface.
        2) Shoulder not less than 3-1/16 IN high.
        3) Tiling flange not less than 1-1/2 IN above shoulder.
        4) Threshold not less than 5 IN high.
        5) Factory installed drain stainless steel with removable stainless steel strainer plate.
        6) Provide drain with lead calk joint for 2 IN drain pipe.
        7) Basin of dimensions and shape as shown on Drawings.
        8) Color as selected by Project Representative.
2. SH- Shower: Ceramic tile per Drawings.

E. Washfountain (WF):
1. Bowl: Precast terrazzo, steel reinforced.
2. Pedestal:
    a. Die formed galvanized steel legs.
    b. Stainless steel panels.
3. Footrail and treadle:
    a. Carbon steel.
    b. Rubber or plastic coated.
4. Foot control mechanism:
    a. Self-closing.
    b. Actuated by footrail to treadle.
5. Supplies:
6. Type:
    a. WF-1, 54 IN, semi-circular.

F. Toilet Seat:
1. Molded plastic.

2. Open front.
3. No cover.
4. Stainless steel hinge with check.
5. For elongated bowl.

G. Lavatory Fittings:
   1. Lavatory faucets:
      a. Lever handles.
      b. Renewable washer.
      c. Renewable seats.
      d. Aerator.
      e. Stopper and 1-1/4 IN tail piece.
      f. Coupling nuts.
      g. Chrome plated.
   2. Handicapped lavatory faucets:
      a. Chrome-plated wrist handles.
      b. Chrome-plated gooseneck.
      c. Aerator.
      d. Renewable seat.

H. Service Sink Fittings:
   1. Type:
      a. Sink with holes (hot and cold service) American Standard 8341.076.

I. Mop Sink Fittings:
   1. Type:
      a. Mounted on wall without pipe chase behind faucet.

J. Sink Fittings:
   1. Lever handle.
   2. Renewable washer.
   3. Goose neck.
   4. Renewable seats.
   5. Aerator.
   6. Stopper and 1-1/2 IN tail piece.
   7. Coupling nuts.
   8. Chrome plated.

K. Shower Fittings:
   1. American Standard Flowise 1.5 GPF:
      a. Concealed valve.
      b. Integral volume control and stops.
      c. 1.5 GPM flow restrictor.
      d. Shower head, arm and flange.

L. Sensor Operated Flushometer Hardwired Type (Water closets and urinals):
   1. Diaphragm type.
   2. Chrome plated.
   3. Permex synthetic rubber diaphragm.
   4. ADA compliant non hold open handle.
   5. Courtesy flush override button.
   6. Non-hold open fixed bypass operator.
   7. Two (2) chrome plated wall covers.
   8. Screw driver Bak-Chek angle stop.
   9. Wall and spud flanges.
   10. Spud size as required.

M. Emergency Fixtures:
   1. Emergency shower and eye/face wash (ESEW):
      a. ANSI Z358.1.
      b. Flow switch:
         1) Rating: 125/250 V, 5 A.
         2) Single pole, double throw.
         3) UL listed.
      c. Deluge shower head:
         1) Stay-open ball valve.
         2) Pull-chain.
      d. Eye/face wash:
         1) Aerated eye/face wash with stainless steel bowl.
         2) Stay-open full port ball valve.
         3) Push handle control for eye/face wash.
         4) Supply line strainer for eye/face wash.
      e. Type:
         1) ESEW-1 (free standing, cast flange base and pull-chain for shower).

N. Carriers:
   1. Closets (wall hung):
      a. No-hub or SV hub, single and double adjustable vertical carrier fitting.
      b. No-hub, single and double adjustable horizontal carrier fitting.
   2. Urinals: Universal hanger plate carrier with pipe uprights and rectangular base feet.
   3. Lavatories: Single concealed arm lavatory carroer with non-slip locking devices.
   4. Drinking fountains (electric water coolers): Universal hanger plate carrier with pipe uprights and rectangular base feet.
   5. Service sinks: Single sink carrier with hanger support plate.

O. Drains, Roof Drains and Downspout Nozzle:
   1. Floor drain (FD):
      a. Bottom outlet.
      b. Clamping seepage flange.
      c. Seepage openings.
      d. Size as shown on Drawings.
      e. Type: Cast iron body.
         1) FD-1 (unfinished area) sediment bucket, bucket shall support grate.
         2) FD-2 (finished area) adjustable satin nickel bronze strainer.
         3) FD-3 (finished area with tile floor) adjustable satin nickel bronze square strainer.
   2. Roof drain (RD):
      a. Bottom outlet cast iron drain with flashing clamp, removable cast iron mushroom-type dome and cast iron deck clamp.
      b. Provide cast iron extension flange (-DF) where insulation thickness exceeds 2 IN.
      c. Type:
         1) RD-1: Cast iron roof drain, flange, flashing ring with gravel stop and polypropylene mushroom locking dome.
         2) RD-2: Cast iron roof drain with flashing ring and gravel stop, 6 in. adjustable plastic standpipe and polypropylene mushroom dome.

P. Traps:
   1. Floor and equipment drains:
      a. Same material and coating as the piping system.
      b. 3 IN minimum seal.
      c. Provide trap primers on all floor drains in finished areas.

2. Fixture drains:
    a. 2 IN minimum seal.
    b. Cast brass.
    c. Chrome plated.
    d. Size as required.
3. Ventilation housing drains: Extra-deep seal sufficient to maintain seal against static pressure maintained in fan housing.

Q. Cleanouts (CO):
1. Cleanouts for cast iron pipe:
    a. Tapped extra heavy cast iron ferrule.
    b. Calked into cast iron fittings.
    c. Extra heavy brass neoprene seal screw plug with solid hexagonal nut.
2. Cleanouts for steel pipe: Extra heavy brass screw plug in drainage fittings.
3. Access housing with adjustable anchor flange and secured scoriated cast: Wade W-3800-MF.
4. Cleanouts turning out through walls and up through floor shall be made by long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to architectural finish in room.
    a. Where definite finish is not indicated, wall plates shall be chrome-plated cast-brass and floor plates polished brass.
5. Code:
    a. Provide cleanouts of same size as pipe up to 4 IN and not less than 4 IN for larger pipes.
    b. Close access openings for concealed cleanouts with flush floor or flush wall cover plates or flush ceiling access panels.
    c. Provide wall plates with chrome plated cast-brass round cleanout cover with flanged ring.
    d. Provide screws which match cover plate material.
6. Cleanouts installed in floor with a resilient tile finish: Square tile top, cast iron with threaded adjustable housing, SV hub or spigot outlet.
7. Cleanouts installed in floor with ceramic tile, concrete, or Terrazzo finish: Terrazzo, cast iron with threaded adjustable housing, SV hub or spigot outlet.
8. Cleanouts installed in finished rooms flush with wall: Square nickel bronze frame with secured smooth stainless steel access cover.
9. Cleanouts installed in completely accessible pipe chases or where piping is exposed do not require special covers.

10. Cleanouts in tipping floors:
    a. Wade 8300-MF housing and cover with 8550 cleanout body and closure plug.
    b. Smith 4250 or 4260 Series housing and cover with 4280 or 4290 Series cleanout body and closure plug.
    c. Or approved equal.

R. Hose Bibb (HB-1):
1. 3/4 IN boiler drain with attached vacuum breaker-backflow preventer.
2. Vacuum breaker: Non-removable, manual draining, meeting the requirements of the ASSE 1011.

S. Hose Valve:
1. Cast brass.
2. Minimum pressure rating 150 psi.
3. Angle configuration.
4. Hose outlet connection 1-1/2 IN or 2-1/2 IN as shown on Drawings or scheduled.
5. Pin lug protective hose thread cap with chain.

T. Hose Reel (HR):
1. HR-1:
    a. Wall-mounted.
    b. Capacity for 100 FT of 1 1/4 or 1 1/2 IN ID hose.
    c. Direct crank rewind.
    d. 1 1/2 IN IPT female swivel joint inlet and nozzle type outlet.
    e. Isolation valve at inlet.

U. Domestic Water Heater (DWH):
1. Gas-fired Instantaneous type:
    a. Size and capacity as scheduled on Drawings.
    b. Certified by CSA and bear NSF approval.
    c. Provide internal surfaces:
        1) Provide Stainless Steel heat exchangers.
    d. Equip heaters with safety shutoff in case of pilot failure, gas pressure regulator, certified draft diverter and pressure and temperature relief valve.
    e. Heavy gage steel jacket with baked enamel finish over bonderized undercoating.
2. Electric tank type:
    a. Size and capacity as scheduled.

b. UL listed.

c. Internal surfaces:

1) Glass-lined with alkaline borosilicate composition fused-to-steel.

2) Provide magnesium rods rigidly supported for cathodic protection.

d. Low watt density heating elements with zinc-plated copper sheath.

1) Provide thermostat with each element, high temperature cutoff and temperature and pressure relief valve.

e. Insulate tank with vermin-proof glass fiber insulation or equal.

f. Heavy gage steel jacket with baked enamel finish.

g. Provide water heaters meeting ASHRAE/IESNA 90.1 IP for energy efficiencies.

V. Reduced Pressure Backflow Preventer:

1. Backflow preventers consist of two (2) check valves, test cocks and relief valve, all assembled as an integral unit.

2. Reduced pressure backflow preventers Watts 909.

3. Backflow preventer to have threaded ends in sizes through 2 IN, flanged 2-1/2 IN and larger.

4. Pressure loss through backflow preventer not exceeding 14 PSI at design flow.

5. Provide air gap and pipe discharge to within 6 IN of finished floor.

W. Water Meter:

1. As indicated of a type approved by Water Department.

a. Coordinate meters furnished by Water Department as to type and size.

b. Provide valve on each side of meter and 3/4 IN drain valve spilling over floor drain.

2. Install full sized bypass line around meter with a sealed valve approved by Water Department.

a. Meters 2 IN and less: Threaded fittings.

b. Meters 2-1/2 IN and larger: Flanged connections.

X. Domestic Hot Water Circulating Pump:

1. Pump casing and impeller: Bronze, designed for domestic water circulating.

2. Provide pump as scheduled on Drawings.

Y. Prefabricated Trench Drain System:

1. Grating: Heavy-duty cast iron rated for 56,000 LB rubber tire wheel loads.

Z. Booster Pump System:
   1. Packaged multi-stage pump system.
   2. Pump coupled to standard motor.
   3. Temperature variation -20 to 250 DegF.
   4. Motor shall be NEMA ODP 3600 RPM.
   5. All metal parts in contact with liquid are stainless steel.
   6. Mechanical Seal according to En12756 and ISO 3069.
   7. Provide with packaged control panels that can communicate on MODBUS TCP network.

AA. UV Water Treatment:
   1. Provide self contained systems with single electrical connection.
   2. Provide with electronic ballasts.
   3. Provide with automatic wiper system.
   4. Provide sight port, quartz sleeve.
   5. Provide with fabricated stand to floor mount.
   6. Turbidity 5 Nephelometric Turbidity units.
   7. Total suspended solids 10 milligrams/liter.
   8. pH: 6.5-9.5.
   9. Max 6 grains of hardness.
   10. Less than 0.3 milligrams/liter of iron.
   11. UV transmission 80 percent through 1 centimeter.

BB. High Efficiency Water Filtration:
   1. Single Tank Configuration.
   2. Provide Smart controller that is modbus compatible.
   3. Regeneration shall be by pressure differential.
   4. Carbon filters for flows to 98 GPM.
   5. Depth filters to flows of 295 GPM.
   6. Tanks shall be epoxy coated interior low steel type.
   7. Provide pressure differential switch for back wash.
   8. Provide gage taps for manual reading.

CC. Water Meter:
   1. Accuracy +/- 1 1/2 percent accuracy over entire range.
   2. NSF/ANSI 61, Annex G certified and Annex F compliant.
   3. In line serviceability.
   4. Direct coupled rotor and gear train.

5. Copper allow maincase.
6. 4-20 mA signal on loop power to transmit flow to SCADA system.

DD. Yard Clean out
1. Cast Iron clean out with Round Scoriated Cast iron top.
2. Non tilt Tractor Cover.
3. Closure Plug type.
4. Built to withstand heavy load traffic.

EE. Thermostatic mixing Valves
1. ANSI Z358.1-2009.
2. Three thermometers to measure each stream temperature.
3. Stainless steel sliding piston control that is independent for each stream.
4. Positive hot water shut off in event of failure.
5. Max pressure 125 psi.
6. Valve material shall be rough bronze.

2.03 FABRICATION

A. Trench Sections:
1. Cast in place 12 IN wide by 24 IN deep channels.
2. Nominal Dimensions: 12 IN interior. 2.0 percent minimum slope at bottom.
3. Vertical side walls and a squared bottom.
   a. OutletSide outlet size as shown on drawing 1/4 IN above bottom of low point of trench.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Fixtures:
1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
2. Connect plumbing supply, drain and vent line sizes as shown on Drawings.
3. Set proper grounds to form secure base for each fixture and rigid setting.
4. Install fixtures except water closets with water supply above rim and with Code approved backflow preventers.
5. Seal fixture joints abutting walls and floors with silicone sealant.

6. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.
7. Install emergency fixtures in accordance with ANSI Z358.1.

C. Drains:
1. Install drains at locations indicated on Drawings and in compliance with local Codes.
2. In quarry tile floors:
   a. 24 IN x 24 IN 6 LB lead sheet clamped to drain.
   b. Set 1-1/2 IN above structural slab for mortar set and 1/2 IN for thin set.
3. In uncovered concrete slabs:
   a. Install at the low points of surface areas to be drained or as indicated.
   b. Set tops of drains flush with the finished floor.
   c. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces.
   d. Maintain the integrity of waterproof membranes, where penetrated.
4. Trench drains:
   a. Install in accordance with manufacturer's instructions and approved Shop Drawings.
   b. Install trench sections with the top edges level and straight at elevations indicated.
      1) Support channel sections in place while concrete is placed under and around sections as indicated.

D. Wall Hydrants:
1. Install 24 IN above exterior grade.
2. Support units from the structure and mount flush with structure face.
3. Prior to final setting, fill the back of the face with a non-hardening silicone calk and press firmly in place to stop infiltration and water leakage.
4. Install isolation valves in line to each wall hydrant.

E. Hose Racks:
1. Adjacent to hose bibbs, top of rack 36 IN above finished floor or grade.
2. Concrete or masonry walls: Mount with 5/8 IN x 2-1/2 IN stainless steel expansion anchors.
3. Handrail:
   a. Bolt hose rack to 24 IN x 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.
   b. Attach to handrail with 3/8 IN stainless steel through bolt at each corner of the plate.

4. Pedestal:
    a. Bolt hose rack to 24 IN to 24 IN x 1/4 IN aluminum plate with 5/8 IN stainless steel bolts.
    b. Attach to pedestal with two (2) 1/2 IN stainless steel bolts through handrail.

F. Hose Bibbs:
1. Install 36 IN above finished floor.
2. In exterior locations, provide interior isolation valve.

G. Shock Absorbers:
1. Install on hot and cold water lines adjacent to each battery of fixtures or other equipment where indicated on Drawings.
2. Size as recommended by manufacturer for length of pipe served.
3. Locations having two (2) fixtures or less, install capped air chamber 12 IN long on hot and cold water runouts to each fixture, same size as runout.
4. Runouts to hose bibbs and wall hydrants do not require air chambers.
5. Install units vertically on top of pipe or as detailed on the Drawings.

H. Cleanouts:
1. Install cleanouts:
    a. Above floor in each vertical riser that connects to horizontal branch below floor.
    b. At test tee to receive proper test plugs in each vertical riser at least every other floor.
    c. As required by local Code.

I. Wall Plates and Escutcheons: Install as specified in Specification Section 40 05 13 – Equipment: Basic Requirements or this Specification Section.

J. Water Heater:
1. Install all water heaters in accordance with details, manufacturer's recommendations, and applicable Codes.
2. For units located on concrete pads, plumb level and orient to allow access to the controls, elements and other items requiring service.
3. Connect hot and cold water piping to the unit with line-size, isolation valves and dielectric unions.
4. Connect recirculating hot water to cold inlet piping with unions and valves at check valves as detailed.
5. Connect gas piping as detailed in accordance with Specification Section 40 05 13 - Equipment: Basic Requirements and located so as not to interfere with the unit service.
6. Connect the flue to the draft hood for proper venting in accordance with Specifications and local codes

7. Start up the unit and adjust all controls for proper temperature control and maximum efficiency.
8. Where indicated, install instantaneous electric water heaters in enclosure rated for area classification.
    a. Silicone seal all piping and wiring penetrations.

K. Reduce Pressure Backflow Preventer: Install on water lines as required by Code.

3.02 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 40 05 13 - Equipment: Basic Requirements.

END OF SECTION

SECTION 22 30 00
DUST AND ODOR SUPPRESSION

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Provide a complete and operational dust reduction system, including the following components:
      a. Atomized spray nozzles.
      b. Bulk chemical storage tank.
      c. Water filtration system.
      d. Piping, valves, and appurtenances.
      e. Chemical pumps.
      f. Pumps.
      g. System controls.
      h. Miscellaneous accessories.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 05 50 00 - Metal Fabrications.
   3. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

B. Qualifications:
   1. The dust and odor control systems manufacturer shall have at least five (5) years experience in the manufacture of dust control equipment, according to these general design concepts, and can provide evidence of continued successful operation with limited maintenance, limited replacement of parts, and a good record of acceptance by operators at other installations.
      a. The manufacturer shall have a least five (5) similar dust and odor control systems in operation for at least two (2) years.
      b. Submit qualifications in Article 1.4.

2. The manufacturer shall have available a local factory authorized service representative for service, emergency repair, and warranty work. Provide contact information including name, address, and phone number of local representative.

1.03 SYSTEM DESCRIPTION

A. The dust suppression system shall control dust emission due to unloading, sorting, pushing and loading of municipal solid waste inside the Transfer Station.

B. The odor suppression system will be utilized to remove volatile malodorous components characteristic of solid waste.
   1. These gases could contain but are not limited to ammonia, chlorine, dimethyl sulfide, diphenyl sulfide, ethyl mercaptans, indole, hydrogen sulfide, methyl amine, methyl mercaptans, and skatole.

C. Odor control agent will be injected automatically (normally) into dust control water supply.
   1. Provide option for operator to turn off odor control independently of dust suppression system operation.

D. Refer to the Drawings for locations of dust and odor suppression zones and individual equipment.

E. Dust and Odor Suppression systems manufacturer will be responsible for complete coordination of all equipment, piping, controls and conduit and wiring required for the dust and odor suppression systems.
   1. The dust and odor suppression systems may include but are not limited to the following items:
      a. Pump skids.
      b. Water filtration and water treatment (if required).
      c. Odor reduction equipment.
      d. Chemical pumps.
      e. PH and ORP sensors and meter-controllers.
      f. Chemical feed control.
      g. Control panel.
      h. Remote controls (wireless control).
      i. Pipes, valves, nozzles and other various fittings.
      j. Supports and attachments for piping, tubing, fittings and nozzles.
      k. Chemical storage tank.

F. The dust and odor reduction systems manufacturer shall review the Contract Drawings and this Section of the Specifications to assure all equipment necessary for a fully operational system is provided.
   1. If additional equipment, piping, controls, conduit and wiring or miscellaneous items are required above those shown or specified, manufacturer shall design, furnish, and install such equipment.

2. Additional equipment piping, controls, conduit and wiring or miscellaneous items required must be of a quality that is at least equal in terms of materials and efficiency as specified herein.

G. Dust and odor control systems shall include and have the capability of controlling several zones.

H. The dust and odor control systems shall be equipped with programmable timer for each zone and have the ability to be manually turned on and off throughout the zoned systems.
   1. Controller to provide for each misting zone and odor system options of; automatic control (timer on/off), local control, and remote control (timer off).
      a. Selector switches shall be provided on outside of panel indicating setting of each zone and odor control system.

I. Wireless hand-held controllers shall be provided for operators to activate system remote of main control panel.
   1. The wireless controller shall be equipped with on/off switches for each zone and on/off switch for odor control.
      a. Wireless controllers shall be tied into the main control panel, control system.
      b. System shall time out automatically with programmable timer.

J. A single manufacturer shall provide both the odor reduction and dust suppression systems.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Leadership in Energy and Environmental Design (LEED®) Documentation: Submit the following in accordance with Section 01 81 30 – Sustainability Requirements:
   a. Completed LEED VOC Submittal Form.
   b. LEED Materials Tracking Form: Form to be provided in an electronic format to the Contractor to record LEED materials used on the project.

C. Approval Submittals:
   1. Product data:
      a. Manufacturer's technical data on equipment used.
   2. Dimensional layout of piping systems, zone layout, control panels, chemical metering pump(s), chemical tank(s), pumps, supports, and other equipment used.
      a. See Drawings for dimensional limitation of dust and odor equipment skid area.
      b. Details for connection tubing, fittings and nozzles.
   3. Schematic Drawings to include itemized components, flow rates, pump horsepower, pressures, control panels and equipment tag numbers.

4. Control and power wiring diagrams.
5. Ladder logic schematic control diagrams.
6. Certifications: Qualifications cited in Paragraph 1.2B.
7. It is the responsibility of the Contractor to review/conduct water quality testing deemed necessary to provide a functioning system.
    a. Contractor to provide documentation stating that the standard water filtration method with no further water treatment (including softening) of Paragraph 2.3.A.5 is acceptable for their system or provide recommendation of alternative water treatment.
8. Samples: Tubing, nozzles, neutralizing agent.

D. Quality Assurance Submittals: Odor reduction field test report.

E. Closeout Submittals:
1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturer's are acceptable:
1. MicroCool.
2. MistAmerica.
3. Fogco.
4. Big Fogg.
5. BryCo Systems.
6. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 MATERIALS

A. As described in Article 2.3.

2.03 COMPONENTS

A. System Pumps and Components:
1. Pumps:
    a. All pumps shall be mounted on common skid.

b. Skid shall have a single electrical power supply termination points for all pumps and auxiliaries.

c. Pump body shall be brass or cast iron, ASTM A48, Class 25.

d. Stuffing box shall be cast iron, ASTM A48, Class 25.

e. Eccentric shall be cast iron, ASTM A48, Class 25.

f. Shaft shall be steel with a minimum of 125,000 PSI yield strength.

g. Pump shall be positive displacement or other type capable of meeting the design and system requirements, as well as the requirements of ASTM and locally enforced code.

h. Low water safety cut-off switch.

i. Base shall be fabricated steel.

j. Pump performance and configuration requirements:

1) Pumps shall be rated at 1,000 psi.

2) Pumps: 460 V, 3 PH, 60 Hz.

3) The minimum number of pumps provided shall be based on all zones operating simultaneously at the maximum flow rate or pump(s) with VFD that is compatible with pump supplying sufficient flow rate as stated in an efficient manner.

a) Pumps operating with VFD's shall be designed such that the pump's speed does not drop below pump manufacturer's recommended minimum continuous speed.

b) Odor control system shall be served by separate pump(s) that can be turned on/off independently from the dust suppression system.

c) Flow rate shall be based on the following or manufacturer's recommended nozzle flow rate may be submitted for approval, nozzle spacing and line spacing which ever is greater:

i Tipping Floors and Loadout Areas:

I Nozzle flowrate: 0.025 GPM to 0.050 GPM.

II Nozzle spacing: 2 FT to 10 FT OC.

III Line spacing (maximum): 10 FT.

k. Pressure gages:

1) 2-1/2 IN dial-type with cases and scales to match temperature gages.

2) Accuracy: 1 percent of scale range, with recalibration screw in face of dial.

2. Flow meter:

a. Variable area and indicator in pump skid suction line prior to chemical injection.

3. Tubing and Fittings:
    a. Tubing:
        1) Provide piping as required.
        2) Piping shall be 316L stainless steel.
        3) Wall thickness suitable for 3,000 psi working pressure.
        4) Minimum burst pressure of 6,000 psi.
        5) Supports:
            a) Stainless steel cable and tubing attachment clamps.
    b. Fittings:
        1) 316L stainless steel, double ferrule type.
        2) 3,000 psi working pressure.
    c. Pump discharge shall use flexible line to connect to stainless steel header.
        1) Flexible line, nylon core with a spiraled fiber reinforcement and black urethane cover with stainless steel end connections.
            a) Minimum pressure rating: 1,500 psi.
4. Valves:
    a. Provide isolation valves on each pump suction and discharge.
    b. Check valve balls shall be solid neoprene or lead impregnated neoprene.
    c. Valve seats shall be stainless steel.
    d. Body shall be fabricated steel.
5. Atomization Nozzle:
    a. Droplet size range: 5 microns to 20 microns.
    b. Flow rate:
        1) Tipping Floors and Loadout Areas:
            a) Nozzle flowrate: 0.025 GPM to 0.050 GPM.
            b) Nozzle spacing: 2 FT to 10 FT OC.
    c. Anti-drip, cleanable, corrosion and scale resistant.
    d. Material: 316L stainless steel.
    e. Use quick disconnect/nondestructive stainless steel fittings.
        1) Provide 10 percent of total spare nozzles and mounting piping for field replacement.

6. Water Filtering System:
    a. Base:
        1) Stainless steel industrial filter, series of 5 micron and 1 micron cartridges.
    b. If Dust Suppression Vendor determines that base filtration does not provide adequate filtration based on local water quality, Vendor is responsible for proposing an alternative water treatment that would meet their system required quality.

B. Chemical Feed System Components:
1. Chemical pumps:
    a. Type: Double diaphragm.
    b. Diaphragm material: EPDM, Viton, Hypalon, or Teflon.
    c. Guided, controlled travel, check valves on both suction and discharge.
    d. Adjustable anti-siphon pressure relief valve.
        1) Resistant to chemical pumped.
        2) Drain back into tank.
    e. Diaphragm housing material:
        1) Polyvinyl chloride (PVC) or Kynar.
    f. Enclosed drive unit:
        1) Material: Cast iron.
        2) Oil submerged gearing.
        3) 0 to 100 percent manual capacity adjustment with $\pm$ 1 percent accuracy.
    g. Motors:
        1) Electric conforming to NEMA standards.
        2) Coupled to drive unit.
        3) 460 V, 3 PH, 60 Hz.
    h. Solid metal removable coupling guard.
    i. Discharge relief valve sized to match pump capacity and pressure rating of case.
    j. Finish of metal parts: Chemical-resistant paint.
2. Chemical Injector:
    a. Type: Water Driven Injector.
    b. Shall include bypass, easily readable ratio settings, adequate chemical corrosion resistance and mixing chamber.
3. Piping, valves, and fittings: PVC.

4. Pulsation dampeners: Materials resistant to pumped solution, size as recommended by the manufacturer.
5. Siphon valves: Material resistant to pumped solution.
6. Flow meter: Variable area type with indicator.

C. Main Control Panel:
1. Floor or wall mounted.
2. Pressure gages for panel mounting:
   a. 2-1/2 IN dial-type.
   b. Accuracy: 1 percent of scale range, with recalibration screw in face of dial.
3. Status lights:
   a. Full voltage type, 120 V.
   b. Include equipment on and fault lights.
   c. Push-to-test.
   d. Heavy duty, oil tight for unclassified areas.
   e. Heavy duty, NEMA 4X for corrosive and wet areas.
   f. Lens color as specified.
4. Selector switches:
   a. Full voltage type, 120 V.
   b. Knob-operated.
   c. Two or three-position and number of contact blocks as required.
   d. Maintained contact.
   e. Heavy duty, oil tight for unclassified areas.
   f. Heavy duty, NEMA 4X for corrosive and wet areas.
5. Panel enclosures:
   a. NEMA 12 for unclassified areas with hinged door.
   b. NEMA 4X for corrosive and wet areas with hinged door.
      1) Furnish enclosures with windows for panels requiring gages.
   c. Provide all motor starters with thermo overloads.

D. Remote Controls (wireless):
1. Provide radio frequency transmitter / receiver system to independently control the operation of the Dust and Odor Suppression System Zones.
   a. Provide four (4) wireless, hand-held, remote control pad/transmitters with belt clip that will allow operation control of the nine (9) Transfer Building dust suppression zones and one (1) odor control. Each control pad/transmitter shall be capable of independently controlling all nine (9) Zones and one (1) for odor control.

b. Transmitters shall be omni-directional, of rugged design, capable of transmitting through window glass and operate on 9-volt DC batteries. Operational distance shall be at least 200 FT.

c. Central radio-receiving units shall be located by the Vendor to ensure a continuous signal interface to dust suppression system.

d. Receivers shall decode signals from individual transmitters and operate intended dust systems.

e. Receiver shall operate on 120 VAC.

f. Radio frequency transmitter/receiver systems shall be TeLe Radio System T60 or Approved Equal for compatibility with other King County facility radio systems.

1) Pad/Transmitters shall be permanently labeled for each controlled zone.

E. Chemical Storage Tanks:

1. Construction:

a. One-piece cross-linked high-density polyethylene with UV inhibitor.

b. Calibration molded into the tank in gallons and liters; molded in tie-down lugs.

2. Fittings:

a. 1/2 IN heavy-duty PVC bulkhead fitting with EPDM gasket and PVC siphon tube.

b. Located as indicated on the Contract Drawings for complete drainage.

c. Nalgene 97001 or equal.

3. Capacity: 30 GAL – 55 GAL.

2.04 ACCESSORIES

A. Timer, intermittent.

B. Hour/meter indicates system use times for service, maintenance and oil changes.

C. Air compressor:

1. Air compressor shall activate automatically when each zone is shutdown to blow water out of lines and nozzles.

2. Air compressor shall provide adequate pressure and flow to completely blow out entire system.

D. Electric Drain Valve:

1. 1200 PSI minimum, normally open pressing.

2. 120 VAC coil rating to be installed on discharge side of each pump.

2.05 FABRICATION

A. Control Panels:

1. In NEMA 12 enclosures surface mount all gages, switches, status lights, etc.

2. In NEMA 4X enclosures surface mount switches and status lights only.

2.06 SOURCE QUALITY CONTROL

A. Hydrostatic Test:
   1. Hydrostatically test each pump at 150 percent of rated discharge pressure.
      a. Provide documentation of test.

2.07 MAINTENANCE MATERIALS

A. Furnish the Project Representative the following extra parts for each pump service category:
   1. One (1) set of packing.
   2. One (1) set of ball seats and ball bearings.
   3. One (1) static free belt.

B. Five-Micron Water Cartridges: 24.

C. One-Micron Water Cartridges: 24.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install dust and odor reduction system in accordance with manufacturer's recommendations.

B. Piping and Equipment - General:
   1. Utilize template for location of unit anchorage.
   2. Align, level, wedge and plumb units to match piping interfaces as shown on Contract Drawings.
   3. Prefabricate all stainless steel branch lines with nozzle bushings welded to tubing as required by system design.
   4. System shall automatically drain / blow out when shutoff.
      a. Provide compressed air system to blow out system completely when shutoff.
         1) Compressed air system shall have the ability to independently blow out completely each zone individually as the zones are shutoff.
         2) System shall be designed so that all lines and nozzles are blown out.
         3) Provide submittals including: air compressor cut-sheets and layout.
   5. Main line branch to have a minimum 6 IN rise with 90 degree bend.
      a. Tubing support to include isolation-type clamps, threaded cushion-type hangers and/or stainless steel cabling.
   6. Install pump skids in location as shown on Drawings.

7. Install pump skids and floor mounted equipment on concrete pads.
8. Install control panels located as shown on Drawings so visual observation and necessary adjustments can be made from floor level.
9. Provide permanent label for each line and pump to indicate which zone it feeds.

C. Dust and Odor Suppression System:
1. Zones to be located per Drawings.
2. Zones are interlocked on an individual time clocks and can be operated simultaneously or at different times as desire by the operator.
   a. Pumps shall be controlled by local control panel.
   b. Alternative configurations using a variation in the quantity of pumps are acceptable only if similar levels of zonal control and flow are provided.
3. Odor control agent will be injected automatically (normally) into dust control water supply.
   a. Provide option for operator to turn off odor control independently of dust suppression system.

D. Chemical Feed System Piping:
1. Install ball valve on the suction side of each pump and ball valve and check valve on the discharge side of each pump.
2. Install pressure relief valve in discharge line of each chemical metering pump as recommended by pump manufacturer.
   a. Pipe pressure relief valve directly back to tank.
3. Install back pressure valves in discharge line of each chemical metering pump as recommended by pump manufacturer.
4. Install unions near the pump suction and discharge valves to facilitate removal or pump heads for routine maintenance.
5. Install a calibration chamber on each pump suction line unless otherwise shown on Contract Drawings, with isolation valves and pipe connection to pump discharge lines.
6. Install a strainer on the suction line from each tank to the metering pumps.
7. Install pulsation dampeners on the discharge and suction of each diaphragm pumps.
8. Install anti-siphon valves where required.
9. Install flow meters where indicated on Contract Drawings.

3.02 FIELD QUALITY CONTROL

A. Neutralizing Agent Usage Rate Test:
1. Supply a quarterly analysis of the quantity of neutralizing agent used.

B. Manufacturer's Services:
   1. A manufacturer's representative for the equipment specified herein shall be present at the jobsite and classroom designated by the Project Representative for the minimum man-day(s) listed below for work under this Section, travel time excluded:
      a. Pre-demonstration services, inspection and certification of installation:
         1) 16 HRS.
      b. Instruct Owner's personnel on operation and maintenance:
         1) 12 HRS.
            a) A maximum of 6 HRS instructions shall be scheduled on equipment per day.
      c. System testing:
         1) Manufacturer shall provide to Project Representative the results of:
            a) A nozzle flow test.
            b) Analysis of the droplet size.
         2) Both tests shall be completed by an independent laboratory proposed by the manufacturer and accepted by the Project Representative.
   2. A manufacturer's representative for the equipment specified herein shall inspect field assembled components and equipment installation, including piping and electrical connections.
      a. Manufacturer’s representative must report results in writing including results for the following:
         1) Leak test:
            a) After installation of entire system, charge system and test for leaks.
               i All leaks must be repaired.
               ii This test will be separate from hydrostatic test.
         2) Operational test:
            a) Observe all functions of system.
               i All malfunctioning equipment must be repaired or replaced.
         3) Test all controls and safety appliances.
   3. System must be flushed of any impurities prior to commissioning of the system.
   4. A manufacturer’s representative for the equipment specified shall be available for adjustment to systems post commissioning.
      a. If desired by the Project Representative, provide adjustment to system (plugging / removal of nozzles, etc) so that system provides the Project Representative’s desired level of misting.

b. System Provider shall include one trip with a minimum of 16 HRS for adjustment services.

END OF SECTION

SECTION 23 05 93
HVAC SYSTEMS: BALANCING AND TESTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems, including the following systems.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 23 80 00 - HVAC: Equipment.
   4. Section 23 31 00 - HVAC: Ductwork.
   5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   2. American Industrial Hygiene Association (AIHA):
      a. Z9.5, Laboratory Ventilation.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Laboratories."
      b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing."
   4. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:
   1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
      a. Associated Air Balance Council (AABC).
      b. National Environmental Balancing Bureau (NEBB).
      c. Other certification entity approved by Project Representative.

2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Certifications:
      a. Letter stating the name and qualifications of the firm proposed.
      b. Evidence that relevant subcontractors have been notified of the requirement to coordinate balance and test elements in the work with the testing and balancing firm.
   2. Report forms:
      a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

C. Quality Assurance Submittals:
   1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
      a. Insert recorded information on report forms required by specifications and approved for use on project.
      b. Additional written verification and other related information clearly identifying project, date and specifics of verification.
      c. Utilize report forms similar to those shown in Section V of AABC Standard.
      d. Provide forms typed and signed by the testing and balancing firm.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 – EXECUTION

3.01 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:
   1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.

2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.
   1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review Design Drawings, Specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.
   1. Report deficiencies to the Project Representative.
   2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

3.02 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:
   1. Adjust equipment RPM to design requirements.
   2. Report motor full load amperes.
   3. Obtain design CFM at fans.
      a. Make pitot tube traverse of main supply and exhaust ducts within 5 percent.
   4. Test and record system static pressures, suction and discharge.
   5. Obtain design CFM for recirculated air.
   6. Obtain design CFM outside air.
   7. Test and record entering air temperatures, (DB, heating and cooling).
   8. Test and record leaving air temperatures, (DB, heating and cooling).
   9. Test and record leaving air temperatures, (WB, cooling).
   10. Adjust dampers in supply, exhaust and return air ducts to design CFM.
   11. Test diffusers, grilles, and registers as follows:
      a. Adjust to comply with design requirements within 10 percent.
      b. Identify location and area of each.
      c. Adjust face velocity to establish required CFM.
         1) Retest after initial adjustments.

d. Adjust to minimize drafts and to ensure uniform air distribution in all areas.

12. Identify and list size, type and manufacturer of diffusers, grilles, registers, and HVAC equipment.
    a. Use manufacturer's ratings on equipment to make required calculations.
13. Adjust and assure that the operation of automatically operated dampers are as specified.
    a. Check and calibrate controls.
14. Prepare and submit reports.

END OF SECTION

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Instrumentation and control for HVAC systems.
   2. Temperature control.
   3. Ventilation control.
   4. Heating control.
   5. Cooling control.
   6. Sub metering
   7. Control wiring.
   8. Panels and accessories.
   9. Miscellaneous.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 -Identification Devices.
   4. Section 23 31 00 - HVAC: Ductwork.
   5. Section 23 80 00 - HVAC: Equipment.
   6. Division 26 - Electrical.
   7. Division 40- Process Integration.

1.02 QUALITY ASSURANCE

A. See Specification Section 40 05 05 – Equipment: Basic Requirements.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
   2. Instrumentation, Systems, and Automation Society (ISA):
      a. S5.1, Instrumentation Symbols and Identification.
      b. S5.4, Standard Instrument Loop Diagrams.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).

4. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL).

C. Miscellaneous:
1. Controls to be in compliance with Specification Section 26 05 00 – Electrical: Basic Requirements for NEMA and NFPA 70 enclosure class requirements unless noted or specified otherwise.
2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

1.03 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, damper operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on Drawings, together with thermometers, gages and other accessory equipment.
1. Assemble control system with complete system of wiring and air piping to fulfill requirements of the Contract Documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operation," are designed to illustrate operating functions only.
1. Control sequence shall be considered supplementary to "Sequence of Operation."
2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the Contract Documents, shall be furnished and installed at no additional cost to Owner to make a complete system.

E. Sequence of Operation - General:
1. See Drawings for sequence of operations.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
1. Shop Drawings:
    a. Wiring diagrams showing point to point termination with auxiliary interlocks for each item in each control loop.
    b. Information on equipment proposed for use including corrosion protection.

c. Instrument loop diagrams and word description of loop function for each individual unit controlled including auxiliary interlocks in full compliance with ISA S5.4.

1) Show components in system and ensure diagrams are in full compliance with ISA S5.1 (Instrumentation Symbols and Identification) and other related ISA standards.

C. Quality Assurance Submittals:
1. Secure from equipment manufacturers, detailed and complete control and power wiring diagrams, word descriptions of controls provided as part of the HVAC equipment or equipment interfaced or interlocked thereto, and submit with equipment manufacturer's submittals.

a. Provide the above information to control manufacturer.

D. Closeout Submittals:
1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.05 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
1. Warranty period for software updates, labor and any materials shall be five (5) years commencing on the date of Substantial Completion.

1.06 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the latest versions of the following manufacturers are acceptable:
1. Instrumentation and control systems:

a. Siemens.

b. Honeywell.

c. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 EQUIPMENT

A. Control panels and Front End Computer:
   1. Front End Computer shall be desk top type PC computer complete with 32 GB or RAM, Intel i7 quad core processor and 1 TB hard drive.
      a. Any pertinent software shall be installed on this front end computer as well as other computers serving the BAS. Web based systems will not be accepted.
      b. Final location of Front End Computer to be determined by Owner.
   2. Remote control panels:
      a. All panels shall be bacnet compatible.
      b. Panels shall be daisy chained via communications trunk and terminated at main network control panel.
      c. Programming shall reside in local controllers so that in the event of communication loss the equipment will continue to operate.
      d. Contractor shall provide layout of communications wiring as part of submittal.

B. Dampers: Refer to Specification Section 23 31 00 – HVAC: Ductwork.

C. Damper Operators:
   1. Provide operators of proper size and number to secure true throttling or two-position action as required.
   2. Furnish damper operators for installation inside ductwork and attached to frame of damper, or installed outside ductwork and connected to extended shaft as required.
   3. Provide operators for outside air, spring-loaded with sufficient power to assure tight closing of dampers on fan shutdown or in the fail safe position indicated by "Sequence of Controls."
   4. Electric operators:
      a. Provide operators:
         1) Fully immersed in oil gear train.
         2) Enclosed in closed cast aluminum housing.
      b. As an alternate to 5.a.: Provide operators in NEMA 4X enclosure, Belimo ZS-300.
      c. Provide damper operators with integral spring return motor springs to make controls fail safe in position specified under "Sequence of Controls."
      d. Provide fully modulating operators from proportional electric controllers.
      e. Provide end switches or proportioning controllers permitting simultaneous operation or interlocking with other equipment.

f. Provide separate electrical circuits for damper operators with no more than four (4) operators on a circuit.

5. Coordinate with dampers provided:
   a. Provide damper operators that are rated for the required torque.
   b. If single damper operator can not meet torque requirement, provide sectional dampers to match operator torque.
6. Use of electric operators shall be limited to small dampers in those applications where it is impractical to provide pneumatic operators and are to be approved by the Project Representative.
7. Ensure coordination to provide for the installation of tight closing dampers low leakage type (6 CFM per SF at 4 IN WC pressure across damper) with compatible dampers, damper operators and related controls.

D. Motor-Operated Valves:
   1. Valves shall have modulating plugs and contoured disc type inner valve construction to ensure modulation of flow and shut-off features as the application demands.
   2. Furnish valves 2 IN and smaller with high grade bronze bodies with screwed ends.
      a. Reducers and fittings necessary to install smaller than pipe size valves shall be furnished and installed under applicable piping Sections.

E. Valve Operators:
   1. Provide operators of proper size and number to secure true throttling or two-position action as required.
   2. Provide electric operators with fully immersed in oil gear train, in tightly closed cast aluminum housing.
      a. Provide valve linkage.

F. Control Instruments:
   1. Use remote stainless steel element temperature transmitters for points of temperature measurement occurring in air ducts, in mechanical piping system or in corrosive atmospheres.
      a. Instruments shall incorporate feedback to assure an exact and proportional relationship between measured temperature and transmitted pressure.
      b. Transmitted range shall be compatible with receiver controller or indicating receivers.
      c. Supply instruments with 50, 100, or 200 DegF range spans as required to assure temperature "Read-Out" at associated receivers at maximum accuracy and most convenient readability.
      d. Averaging elements for air handling units shall be 20 FT.

e. Ranges or instruments supplied shall be in accordance with the following schedule:

1) Outdoor air -50 to +150 DegF.

2) Return air: +45 to + 85 DegF.

3) Chilled water: +30 to +150 DegF.

4) Domestic hot water: +50 to +250 DegF.

5) Room air:

a) Heating: +40 to 75 DegF.

b) Cooling: +75 to 105 DegF.

f. Instruments shall employ solid liquid filled stainless steel elements to assure linear response.

1) Provide averaging elements of minimum 20 FT in length for measurement of mixed air and where air temperatures are measured in discharge of a heating or cooling coil.

2) Where water temperatures are measured, provide element with stainless steel separable socket permitting element removal without loss of fluid.

3) Use heat transfer compound in all separable sockets.

2. Provide strap-on thermostats, as required by Paragraph "Sequence of Operation."

3. Provide low limit thermostat of electric two-position type with 20 FT stainless steel bulb and manual reset.

a. String stainless steel bulb across inlet face of coil.

b. String shall be capable of opening thermostat circuit if any 1 FT section of bulb is subjected to a temperature below thermostat setting.

c. Each thermostat shall have two (2) circuits, one (1) to shut down fan, another for alarm.

1) Install all freeze-stats to override starter circuits regardless of position.

4. Enthalpy Controller:

a. Furnish controller sensing total enthalpy of both return and fresh air.

b. Controller shall on a rise of total enthalpy of outdoor air above return air, return fresh air damper to its minimum setting, and fully open return air.

c. With total enthalpy of outdoor air below return air controller shall operate system on mixed air cycle.

5. Mount relays, PE switches, pressure switches, etc., on rear of panels.

6. Tag each instrument corresponding to symbols used on control diagrams and "Sequence of Controls."

7. Remote stainless steel element pressure transmitters shall be similar to temperature transmitters in design, operation and ranges.
    a. Use pressure transmitters for panel mounted gages to avoid necessity of piping liquids to control panels.
    b. Receiver gages, while receiving standard 3 to 15 psi air signal from transmitters shall be calibrated to read in correct numerical units on their dials.
8. Mount controlling receivers remote from associated transmitters and at a location adjacent to equipment being served.
    a. Controllers shall be direct or reverse acting (field reversible) as control applications dictate.
    b. Units shall be capable of accepting air signals from one (1) or two (2) transmitters and combining them with a local or remote setpoint signal to produce a linear output which varies in proportion to input signals.
        1) Units shall incorporate feedback principle.
        2) Provide units with "Gain" adjustment of 0 to 250 percent.
    c. On dual instruments provide "ratio" adjustment to 0 to 100 percent.
        1) Provide Instrument Society of American Standard Color Coded Test Points for checking of input and output signals.
        2) Where remote setpoint is provided, range of remote adjustment shall be 10 to 50 percent of transmitter span.
9. Provide temperature sensing wells of sufficient length to reach midway into pipe, with extension necks where installed on insulated piping.
    a. Temperature sensing wells shall be brass or stainless steel.
    b. Install in lines using tees or Thread-O-Lets.
10. Provide each thermostat with an accurate red-reading thermometer, sensing temperature outside of enclosure.
11. Provide multi point mass flow meter in sufficient manner to accurately monitor air flow.
    a. Accuracy 1 percent of reading + 0.5 percent of full scale.
    b. Repeatability of 0.2 percent of full scale.
    c. Mass flow meters shall be designed for dirty airflows and still provide accurate measurement.

G. Electric Control Instruments:
1. Provide stainless steel sensing elements type thermostats with liquid filled, compensated thermal systems so that equally spaced dial graduations are possible over entire range.
    a. Make thermal systems field detachable with averaging or plain bulbs as installation conditions dictate.

b. Provide sensing elements minimum of 60 IN in length and suitable for operation from -30 to 300 DegF.

c. Provide reverse acting on-off type thermostats for controlling ventilating fans.

d. Provide multiple stage thermostats where designated in Paragraph "Sequence of Operation."

2. Provide transformers for supplying current to control equipment operating at less than 120 V and where required by manufacturer's automatic control system design capable of supplying 125 percent of energy requirements of equipment connected for not less than 1 HR.

   a. Enclose transformers in UL listed cabinets with conduit connections.

   b. Provide fused disconnect switches on both primary and secondary sides.

   c. Provide in full compliance with Division 26 – Electrical Specification Sections.

3. Provide low limit electric thermostats of two-position type with 20 FT bulb and manual reset.

   a. Shall be capable of opening thermostat circuit if any 1 FT section of bulb is subjected to a temperature below thermostat setting.

   b. Each thermostat shall have two (2) circuits, one (1) to shut down fan, another for alarm.

   c. Install all freeze-stats to override starter circuits regardless of position.

   d. For corrosive environments provide thermostats with stainless steel sensing elements.

      1) Ensure element is installed to sense coldest point should stratification occur.

4. Provide each thermostat with an accurate red-reading thermometer sensing temperature outside of enclosure.

5. Label thermostat with identification tag of HVAC equipment controlled using phenolic nameplate in accordance with Specification Section 10 14 00 – Identification Devices.

6. Electronic (and electric) controller shall have three (3) control mode capabilities of proportional rate (time), and dead band within following minimum performance and application criteria:

   a. Setpoint adjustment: 0 to 110 percent of span.

   b. Repeatability: Setpoint repeats within +0.1 percent of span.

   c. Dead band: 1 percent of span, standard.

   d. Rate: 5 to 30 seconds adjustable.

   e. Response level: 50 milliseconds for a step change of 1 percent of span beyond setpoints.

   f. Output: SPDT relay contacts, 5 amps at 117 Vac noninductive.

7. Controller shall be capable of remote setpoint adjustment, permanently mounted in air flow control panel unless otherwise indicated.
8. Provide each controller with instruments (pressure gages, milliampmeters, voltmeters, etc.) to indicate magnitude of output signal in both medium of signal (psig, mA, volt DC, etc.) and percentage of full output signal.
9. Recording controllers:
    a. Where recording controllers are required by "Sequence of Controls," they shall be 10 IN chart, 24 HR or 30-day charts (field selection), with one (1), two (2), or three (3) pens as listed in control sequence.
    b. Pens shall have capillary ink supply and cartridge type ink supply.
    c. Recorders shall operate on 110 V power supply.
    d. Optional 4 IN strip chart recorders may be used with the strip traveling vertically.

H. Static Pressure Gages:
1. Install gages on control panel for each system.
    a. One (1) gage shall serve each filter while others shall serve as a check on system.
    b. Gages shall be Magnahelic by Dwyer 2000 ASF, Trerice, Weiss, or approved equal flush mounted with signal flag for filter gage.
    c. Install static pressure tips as scheduled under control panel indication points.
    d. Static pressure ranges:
        1) Filter (cartridge): 0 to 2.0 IN WC.
        2) Air-handling systems: 0 to 10.0 IN WC (one (1) per air-handling unit).

I. Local Temperature Control Panel and controllers:
1. Panel shall be floor or wall-mounted and be sized to accommodate electrical switches, protective devices (except electrical switches and devices furnished as an integral part of air handling unit).
    a. Where two (2) similar items of equipment, such as pumps, are installed adjacent to each other a single panel may be used to contain all instruments.
2. Fully compensated capillaries connected to instruments shall be of sufficient length to allow them to be run between equipment and placed in such a position so that they will not obstruct service of equipment or become damaged.
3. Miniature milliamp meters for electronic temperature transmission may be used.
4. Manufacture panels in one (1) of the following manners:
    a. NEMA electrical panel boxes with windows.

b. Install gages flush mounted in swing out panel behind window with instruments and other control items located inside enclosures behind panel.

1) Refer to Paragraph "Corrosion Protection."

5. Temperatures, pressures, equipment operation, and related items shall be continuously indicated on as noted on drawings at front end graphics.
6. Points to be monitored are scheduled on the Drawings.
7. All trends will be done at network head end.
8. Controller shall continue operate upon loss of network connection.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Comply with requirements of Specification Section 26 05 19 – Wire and Cable: 600 Volt and Below and Specification Section 26 05 33 – Raceways and Boxes.

B. Identification: See Specification Section 10 14 00 – Identification Devices.

C. Connect control devices to perform functions indicated and perform in required sequence.

D. Use remote element temperature transmitters for points of temperature transmitters for points of temperature measurement occurring in air ducts or shafts, or in mechanical piping system.

E. Use remote element pressure transmitters of panel-mounted pressure gages.

F. Where continuous indication of space temperature is on local control panels, install a thermostat and a temperature transmitter side by side.
1. Pipe continuous indication signal to a receiver on panel.
2. A resistance element or thermocouple signal may be used with continuous indicating meter, calibrated in degrees Fahrenheit.

G. In general, locate thermostats for room control immediately inside door, above light switch, unless shown otherwise.
1. Where light switch is in an entryway to room, locate thermostat on wall within room so it is capable of sensing true space conditions.
2. Prior to installation, coordinate thermostat location with Project Representative.

H. Mount local control panels adjacent to equipment served.

I. Where a temperature indicating gage is used at the panel, a pressure gage indicating transmitter signal is not required.

J. Provide appropriate type continuous reading indicator for each controller, transmitter and transducer.
1. Mount in-line or tapped on controller.

2. Mount at local control panel.

K. Gages with flexible hose terminating with hypodermic needle may be used for checking control system.
   1. Do not substitute for in-line gages.

L. Locate panels so visual observation and adjustment can be accomplished from floor level.

END OF SECTION

SECTION 23 21 00
HYDRONIC SPECIALTIES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Hydronic specialties.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 23 05 93 - HVAC Systems: Balancing and Testing.
   4. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   5. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. American Society of Mechanical Engineers (ASME).
   3. ASTM International (ASTM):
      a. A159, Standard Specification for Automotive Gray Iron Coating.
      b. B36, Standard Specification for Brass Plate, Sheet, Strip and Rolled Bar.
      c. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
      d. B85, Standard Specification for Aluminum-Alloy Die Castings.
      e. B99, Standard Specification for Copper-Silicon Alloy Wire for General Purposes.
      f. B371, Standard Specification for Copper-Zinc-Silicon Alloy Rod.
      g. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
   4. Expansion Joint Manufacturer's Association (EJMA).
   5. National Electrical Manufacturers Association (NEMA).

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. See Section 40 05 05.

2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Manufacturer's catalog cuts and technical information.
    d. Pump curves.

C. Quality Assurance Submittals:
    1. Certifications.
    2. Test reports.

D. Closeout Submittals:
    1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Automatic air vents:
        a. Armstrong Machine Works; Model No.21AR.
        b. Amtrol; Model No.720.
        c. Or approved equal.
    2. Combination strainer and air separator:
        a. Bell and Gossett.
        b. Taco.
        c. Or approved equal.
    3. Tank fittings:
        a. Bell and Gossett; Model ATFL.
        b. Taco.
        c. Or approved equal.
    4. Balancing valves and readout meters:
        a. Bell and Gossett.

b. Taco.

c. Or approved equal.

5. Flow measuring devices and meters:
   a. Aeroquip.
   b. Barco.
   c. Dieterich Standard Corp.
   d. Or approved equal.
6. Heating water pumps:
   a. Bell and Gossett.
   b. Taco.
   c. Armstrong.
   d. Or approved equal.
7. Expansion joints:
   a. Flexonics Div.
   b. Zallea Brothers, Inc.
   c. Pathway Bellows, Inc.
   d. Or approved equal.
8. Flexible connections:
   a. Flexonics Div.
   b. Barco.
   c. Anaconda Metal Hose.
   d. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 EQUIPMENT

A. Automatic Air Relief Vents:
   1. Type: Single-lever.
   2. Material: Cast iron.
   3. Vessel design limitations (psig): 150 at 250 DegF minimum.
   4. Relief tubing: K copper.
   5. Size: As required.

B. Manual Air Relief Vents:
   1. Type: Class 150 bronze gate with rising stem and solid wedge.
   2. Material:
      a. Bonnet, body and wedge: Bronze ASTM B62.

b. Packing nut and packing gland: Bronze ASTM B62 or ASTM B584 alloy C84400.

c. Stem: Silicon Bronze ASTM B371 Alloy C69400 or ASTM B99 alloy C65100 H04.

d. Hand wheel: Aluminum ASTM B85 Alloy A03800.

e. Hand wheel nut: Zinc-plated steel with clear chromate.

3. Design limitations: 150 psi steam at 406 DegF minimum.
4. Relief tubing: K copper.
5. Size: As required.

C. Combination Strainer and Air Separator:
1. ASME code constructed.
2. Type: Tangential flow.
3. Design pressure: 125 psig minimum at 350 DegF.
4. Air collector tube:
   a. Stainless steel.
   b. 63 percent open area design (minimum).
5. NPT vent connection.
6. NPT blowdown connection.
7. Tangential nozzles:
   a. NPT up to 3 IN DIA.
   b. Flanged, 4 IN and larger.
8. Strainer:
   a. Galvanized steel.
   b. Free area not less than five (5) times the cross sectional area of the connecting pipe.
   c. Removable.
9. GPM: As indicated.

D. Tank Fittings:
1. Body: Cast iron.
2. Tubes: Copper and copper plated.
3. Vent tube plug: Brass.
4. Ball check: Stainless steel.
5. Design pressures: 125 psi minimum.

E. Balancing Valve:
1. Type: Calibrated balance valve.

2. Connections:
    a. NPT up to 3 IN DIA.
    b. Flanged for 4 IN or larger.
3. Readout valve: Brass fitted with integral EPT insert and check valve.
4. Calibrated nameplate.
5. Integral seals.
6. Preformed polyurethane insulation.
7. Working pressure: 125 psig at 250 DegF minimum.

F. Readout Meter for Balancing Valves.
1. Type: Portable.
2. Range: 0 to 100 FT of water.
3. Increments: 0.5 FT.
4. Accuracy: +0.5 percent.
5. Accessories:
    a. Carrying case.
    b. 10 FT hoses.
    c. Shut-off and vent valves.
    d. Balance valve calculator.
6. Maximum operating temperature: 250 DegF liquids and gases.

G. Water Flow Measuring Devices:
1. Venturi type (non-corrosive areas).
    a. Material:
        1) Bronze to 3 IN DIA.
        2) Cast steel for 4 IN or larger.
    b. Connections:
        1) NPT to 3 IN or larger.
        2) Flanged for 4 IN or larger.
    c. Minimum length: 1.6 x pipe diameter.
    d. Accuracy: +1 percent.
        1) Accuracy obtained with as little as five (5) pipe diameters of straight pipe upstream and two (2) pipe diameters downstream.
    e. Two (2) sensing taps, nipples, shut-off valves, and quick connect couplings.
    f. Body rating: ANSI 150 LB minimum.

2. Pivot type (corrosive areas).
    a. Material: 316 stainless steel.
    b. Permanent pressure loss to system: 5 IN water of head on sizes over 1-1/2 IN, maximum.
    c. Impact port size:
        1) Pipes 2 to 5 IN: 0.125 IN ID minimum.
        2) Pipes 4 IN or larger: 0.281 IN ID minimum.
    d. Nominal 1/4 IN SAE flare safety shut-off instrument valves.
    e. Accuracy: +2 percent of actual valve.
    f. Repeatability: +2 percent of actual valve.
    g. Maximum temperature rating in water: 300 DegF.
    h. Maximum pressure rating in water: 500 psig.

H. Readout Meter for Water Flow Measuring Devices:
1. Type: Portable.
2. Range: 0 to 100 IN of water.
3. Accuracy: +2 percent.
4. Increments: 1 IN of water.
5. Accessories:
    a. Carrying case.
    b. 10 FT hoses.
    c. Shut-off valves.
    d. Operating manual.
6. Maximum operating temperature: 250 DegF water at 250 psig.

I. Expansion Joints:
1. For piping 2-1/2 IN or smaller.
    a. Type: Bellows.
    b. Material:
        1) Bellows: Two-ply stainless steel.
        2) Shrouds and end fittings: Carbon steel.
    c. Stroke: 1-3/4 IN compression, 1/4 IN extension minimum.
    d. Maximum operating temperature: 750 DegF.
    e. Maximum working pressure: 175 psi.
    f. Maximum test pressure: 250 psi.
    g. Fittings: NPT.

2. For piping 3 IN or larger:
    a. Type: Controlled flexing bellows.
    b. Material:
        1) Bellows: Stainless steel.
        2) Carrier rings and fittings: Steel.
    c. Maximum transverse travel: 7-1/2 IN.
    d. Temperature limits: -20 to 850 DegF.
    e. Allowable pressure: Vacuum to 300 psi.
    f. Fittings: Flanged.

J. Pipe Guides:
1. Type: System consisting of a spider which rigidly attaches to pipe and is housed in a sleeve which can be rigidly anchored.
2. Material: Steel.

K. Flexible Connectors:
1. Type: Flexible corrugated single braid hose.
2. Material: Stainless steel.
3. Maximum working pressure: 150 psig.
4. Maximum test pressure: 250 psig.
5. Normal burst pressure: 650 psig minimum.
6. Fittings:
    a. For sizes up to 2-1/2 IN DIA: NPT.
    b. For sizes 3 IN or larger: Flanged.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install hydronic specialty items where indicated or required.

B. Install at high point in closed water systems and at high point of coil headers an automatic relief vent.
1. Install shut-off valve ahead of each vent.
2. Extend relief tubing from vent to drip pan or drain.

C. Install flexible connectors at pump suction and discharge and where indicated.

D. Install pipe guides in accordance with EJMA Standards.
1. Space at 4 and 14 pipe diameters from expansion joints.
2. Install at expansion loops as indicated.

3.02 FIELD QUALITY CONTROL

A. See Section 23 05 93.

END OF SECTION

SECTION 23 31 00
HVAC: DUCTWORK

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: HVAC ductwork and accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 09 91 00 - Painting and Protective Coatings.
   4. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   5. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. DAF 45, Designation System for Aluminum Finishes.
   2. American Architectural Manufacturers Association (AAMA):
      a. 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 52, Method of Testing Air Conditioning Devices Used in General Ventilation for Removing Particulate Matter.
   4. ASTM International (ASTM):
      a. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   5. National Fire Protection Association (NFPA).
   6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. Ducted Electric Heat Guide for Air Handling Systems.
      b. HVAC Duct Construction Standards - Metal and Flexible.
   7. Underwriters Laboratory, Inc. (UL):
      a. 555, Standard for Safety Fire Damper and Ceiling Fire Damper.
      b. 555S, Standard for Safety Leakage Rated Dampers for Use in Smoke Control Systems.

c. Building Materials Directory.

8. Building Code:

a. International Code Council (ICC):

1) International Building Code and associated standards, 2009 Edition including all amendments, referred to herein as Building Code.

B. Qualifications:
1. Fabricator: Firms regularly engaged in the manufacture of the specific product, of type, size required, whose products have been in use in similar service for not less than three (3) years.

2. Installers: Firm with at least five (5) years installation experience on products similar to that required for this Project.

1.03 DEFINITIONS

A. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.

2. Installer and applicator are synonymous.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
1. Shop Drawings:

a. See Specification Section 40 05 05.

b. Efficiency ratings per ASHRAE 52 for factory built and assembled filter units.

c. Scaled ductwork drawings (1/4 IN equals 1 FT) showing duct and accessory layout and support.

C. Quality Assurance Submittals:
1. Documentation of qualifications for fabricators and installers.

D. Closeout Submittals:
1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.05 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is two (2) years commencing on the date of Substantial Completion.

1.06 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Transverse joints (factory fabricated aluminum):
      a. Ductmate Industries, Inc.
      b. Shop fabricated T-22 companion flanges.
   2. Fiberglass ductwork:
      a. Peabody Spunstrand.
      b. Ceilcote.
      c. Or approved equal.
   3. Flexible ducts:
      a. Thermaflex.
      b. Condu-flex.
      c. Glass-flex.
      d. Or approved equal.
   4. Turning vanes:
      a. Barber - Colman.
      b. Titus.
      c. Tuttle and Bailey.
      d. Or approved equal.
   5. Flexible duct connections:
      a. Vent Fabrics.
      b. Duro-Dyne.
      c. Or approved equal.

6. Flexible connector thrust restraint:
    a. Mason WB.
    b. Metraflex.
    c. US Pipe.
    d. Or approved equal.
7. Access doors in ductwork:
    a. Vent Fabrics.
    b. American Warming.
    c. Or approved equal.
8. Backdraft dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
    d. Or approved equal.
9. Fire:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
    d. Or approved equal.
10. Ceiling diffusers:
    a. Anemostat.
    b. Carnes.
    c. Titus.
    d. Or approved equal.
11. Grilles and registers:
    a. Anemostat.
    b. Carnes.
    c. Titus.
    d. Or approved equal.
12. Air filters:
    a. American Air Filter.
    b. Farr.
    c. Continental.
    d. Or approved equal.

13. Manual (volume) dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
    d. Or approved equal.
14. Duct sealers:
    a. Chicago Mastic.
    b. 3M Co.
    c. Permatex.
    d. Benjamin Foster.
    e. Or approved equal.
15. Temperature control and automatic dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
    d. Or approved equal.
16. Louvers:
    a. Ruskin.
    b. Air Balance.
    c. American Warming.
    d. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 COMPONENTS

A. Duct and Fittings (Metallic):
1. Materials: Galvanized steel (G90): ASTM-A653/A653M.
2. Fabrication:
    a. Minimum sheet material thickness:
        1) Ducts with largest side or diameter to 30 IN: 0.05 IN thick.
        2) Ducts with largest side or diameter greater than 30 IN: 0.08 IN thick.
    b. Utilize SMACNA HVAC Duct Construction Standards for minimum of 4 IN water gage static pressure for the minimum sheet material thickness specified herein.
        1) Heavier gage sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.

2) Lighter gage sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.

c. Continuously weld seams on factory assembled units.

d. Transverse joints (Alternate A):

1) SMACNA T-22 companion flange.

2) Gasketed.

3) Rigidity class:

a) Ducts with largest side or diameter to 30 IN: SMACNA Class D (1-1/2 x 1-1/2 x 1/8 IN angles).

b) Ducts with largest side or diameter greater than 30 to 54 IN: SMACNA Class H (2-1/2 x 2-1/2 x 3/16 IN angles).

e. Transverse joints (Alternate B):

1) Materials and fabrication:

a) Angles: Galvanized steel.

b) Corners: Galvanized Steel.

c) Snap cleats: Aluminized or stainless steel.

d) Gaskets: Closed cell neoprene.

e) Bolts: Stainless steel.

f) Sheet metal screws: Self-drilling stainless steel with unthreaded section under head.

2) Fabrication:

a) Rigidity class: SMACNA Class H.

b) 3/8 IN DIA x 1 IN bolts.

B. Supports and Hangers:

1. Materials:

a. Support angles: Aluminum or stainless steel.

b. Hanger rods: Stainless steel.

c. Anchors: Stainless steel wedge type.

2. Fabrication: Trapeze type units.

C. Turning Vanes:

1. Materials: Same as duct.

2. Fabrication:

a. Fabricate double vane units.

b. Pressure drop through elbows: Maximum 20 percent of velocity pressure.

D. Flexible Connections:
   1. Materials: Hypalon, double coated closely woven glass fabric.
   2. Fabrication: Withstand 4.5 IN water column, positive and negative pressure.

E. Access Doors:
   1. Materials:
      a. Inner panel, out panel and frame: Same as duct.
      b. Gaskets: Closed cell neoprene.
      c. Insulation: 1 LB density fiberglass.
      d. Hinges: Stainless steel.
      e. Latches:
         1) Aluminum-zinc alloy.
         2) Outside lever handle.
         3) Adjustable spacer.
         4) Beveled inside flange.
         5) Studs:
            a) Minimum 3/8 IN DIA stud for doors up to 24 IN wide x 48 IN high.
            b) Minimum 1/2 IN DIA stud for doors larger than 24 x 48 IN.
   2. Fabrication:
      a. Provide four-side continuous gaskets.
      b. Utilize continuous piano hinges.
      c. Latches required:
         1) 12 IN in any direction: One (1).
         2) Up to 18 x 18 IN: Two (2).
         3) Up to 24 x 48 IN: Two (2) with inside handles.
         4) Up to 24 x 72 IN: Three (3) with inside handles.
         5) Minimum door size: 12 x 12 IN.

F. Volume Extractors:
   1. Materials:
      a. Mounting bracket: 0.071 IN aluminum.
      b. Movement bar: 0.080 IN aluminum.
      c. Blades: 0.050 IN aluminum.
   2. Fabrication:
      a. Gang operated parallel blade, fully adjustable.

b. Minimum two (2) manually operated adjustment arms.

c. Rotating shaft: Minimum 3/8 IN SQ.

G. Flexible Duct:
1. Material: Continuous steel supporting spiral covered with 100 percent continuous filament fiberglass with nonporous fiberglass/vinyl liner and reinforced Mylar/neoprene outer cover.
2. UL listed, Class 1 with flame spread of 25 or less and smoke development rating not to exceed 50.

H. Drain Pan:
1. Materials: Stainless Steel.
2. Fabrication: 0.080 IN.

I. Acoustical Liners:
1. Materials:
   a. Thickness: 1 IN.
   b. 3 LBS/CF density fiberglass.
   c. UL listed, Class 1, non-combustible.

J. Backdraft Dampers:
1. Material:
   a. 6063 T5 aluminum.
   b. Blade edge seals: Extruded vinyl.
2. Fabrication:
   a. Frame thickness: 0.125 IN minimum.
   b. Blade thickness: 0.070 IN minimum.
   c. Linkage: 1/2 IN tie bars.
   d. Bearings: Synthetic.

K. Fire Dampers:
1. Materials:
   a. Frame, blades, enclosure: Galvanized steel.
2. Fabrication:
   a. Frame: 20 GA, G60.
   b. Blades:
      1) Curtain type.
      2) 24 GA, G60.
   c. Enclosure: 20 GA, G60.
   d. Fusible link: 212 DegF, UL listed.

e. Fire rating: 1-1/2 HR per UL 555.

f. Mounting: Vertical or horizontal.

g. Design with blade package out of air stream.

L. Diffusers:
1. Materials:
a. Body: Extruded aluminum.
b. Ceiling diffuser gaskets: Sponge rubber.
2. Fabrication:
a. Type: Square or rectangular with removable core.
b. Key operated opposed blade damper mounted in neck except where indicated on Drawings to be omitted.
1) Dampers to be housed in round to square adapters.
c. Linear supply diffusers:
1) Internal pattern control vanes which also function as volume control dampers, adjustable through slots.
2) Mounting: Hanger inside ductwork.
3) Clear anodized face.
4) Length: As indicated on Drawings.
5) Number of slots, size, location, and throw: See Drawings.
d. Finish:
1) Circular diffusers: Clear satin anodized.
2) Interior of perforated supply and return diffusers: Flat black paint.

M. Volume Dampers and Flow Equalizers for Round Neck Diffusers:
1. Material: Aluminum.
2. Fabrication:
a. Design for neck velocity: 2500 FT/MIN.
b. Center rod operator accessible through diffuser without removing diffuser.
c. Furnish with screws, duct collars, transitions and air pattern deflectors as required.

N. Air Grille and Register Assembly:
1. Materials:
a. Assembly: Extruded aluminum.
b. Gaskets: Sponge rubber.
2. Fabrication:
a. Supply registers: Two (2) sets individually adjustable louvers.

b. Exhaust and return registers: 45-degree deflection front blades.

c. Dampers: Key-operated opposed blade.

d. Screws, duct collars, and transitions as required.

e. Finish for units installed in finish areas where ductwork is concealed: Prime painted with primer compatible with paint specified in Specification Section 09 91 00 – Painting and Protective Coatings.

O. Air Filters:
1. Materials:
   a. Holding frame: Aluminum.
2. Fabrication:
   a. Factory built and assembled unit.
   b. Efficiency rating as per ASHRAE 52.
   c. 2 IN thickness minimum.
   d. Efficiency: MERV 13.
   e. Air velocity: 450 FPM maximum.
   f. Clean pressure drop: 0.2 IN WG maximum.
   g. Size, capacity, and type: As indicated on Drawings.

P. Temperature Control, Automatic and Manually (Volume) Operated Dampers:
1. Material:
   a. Body: 6063 T5 aluminum.
   b. Seal blade edge: Extruded vinyl.
2. Fabrication:
   a. Frame thickness: 0.125 IN minimum.
   b. Blades:
      1) Two-position damper: Parallel blade.
      2) Mixing and volume damper: Opposed blade.
      3) Airfoil shape.
      4) Maximum 6 IN width.
   c. Linkage: Concealed in frame.
   d. Axles: 1/2 IN plated steel hex.
   e. Bearings: Molded synthetic.
   f. Seals:
      1) Jamb: Flexible compression type.
   g. Control shaft: Removable, 1/2 IN DIA.

h. Air leakage (4 FT SQ damper) at 4 IN WG pressure: 99 cfm maximum.

i. Motors for motor operated damper: See Specification Section 23 09 00 – Instrumentation and Control for HVAC Systems.

j. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.

k. Provide stainless steel locking quadrants for manual (volume) dampers.

l. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.

Q. Louvers:
1. Stormproof.
2. Continuous blade appearance.
3. ASTM B221 extruded aluminum, alloy 6063T5, minimum 0.081 IN thick.
4. Minimum free area: As scheduled.
5. Maximum pressure drop: 0.10 IN of water at 900 fpm at zero water penetration.
6. Bird screen:
   a. 1/2 IN SQ mesh.
   b. 16 GA aluminum.
   c. Install in standard, folded frame.
7. Anchors, fasteners, reinforcing: Aluminum or stainless steel.
8. Finish:
   a. AAMA 2605.
   b. AA-M10C22A42 dark bronze anodized finish.

2.03 MAINTENANCE MATERIALS

A. Extra Materials:
1. Furnish Project Representative with the following extra materials:
   a. Twelve complete filter media changes for each filter unit.
   b. Filter media used during construction is in addition to this requirement.

PART 3 – EXECUTION

3.01 INSTALLATION

A. See Specification Section 40 05 05 – Equipment: Basic Requirements.

B. Metal Ductwork:
   1. Install with longitudinal seams sealed for zero leakage.
      a. Welded seams may be used upon acceptance of welded seam samples by Project Representative.
   2. Install gaskets at each transverse joint and fasten sections together with bolts.
      a. Tighten for zero leakage.
   3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
   4. Install turning vanes in square elbows:
      a. Unsupported vane length not to exceed 48 IN.
      b. Position vanes at proper angle to meet specified pressure drop.
   5. Install flexible connections at fans:
      a. Locate as close as possible to fan.
      b. Allow 1 IN of slack to prevent vibration transmission.
      c. Install thrust restraints across connectors.
   6. Install access doors where indicated on Drawings and at smoke and fire damper in accordance with NFPA requirements.
   7. Volume extractors:
      a. Install at supply registers, grilles, diffusers and supply branch connections from ducts.
      b. Provide branch duct extensions into main duct above and below extractor when branch duct is narrower than main duct.

C. Flexible Ductwork:
   1. Install in concealed areas between: low velocity duct work and diffusers, return air grilles or exhaust outlets and ducts.
   2. Use low loss fittings for connection to duct.
   3. Connect to metal duct collars by means of non-combustible synthetic rubber sealing compound and stainless steel drawband.

D. Drain Pans:
   1. Install at fan coil cooling coils, control valves above finished ceilings and at other sources of moisture.
   2. Install metal tubing at drain and terminate above floor drain, equipment drain and as shown on Drawings.

3. Install below any piping run above electrical equipment.

E. Acoustical Liners:
   1. Install for a minimum length of 30 FT from equipment or mechanical room walls, whichever is greater.

F. Dampers:
   1. Install where indicated on Drawings of sizes shown.
   2. Install fire and smoke dampers in ductwork passing through 1 HR or higher fire-rated construction.
      a. Install in wall and floor openings utilizing steel sleeves, angles and other materials following practices required to provide installation in accordance with local Building Codes.

G. Diffusers:
   1. Install where shown on Drawings of size and capacities scheduled on Drawings.
   2. Install painted lay-in type in lay-in ceilings.
   3. Install prime painted diffusers in areas where duct work is concealed.
   4. Install anodized diffusers in exposed duct work.

H. Air Grille and Register Assemblies:
   1. Install where shown on Drawings of size and capacities scheduled on Drawings.
   2. Install prime painted grilles and registers in areas where duct work is concealed.
      a. Field paint to match adjacent surface finish.

I. Roof-mounted Intake Hoods: Install where shown on Drawings.

J. Air Filters:
   1. Install where shown on Drawings of size and capacity scheduled on Drawings.
   2. Do not operate equipment during construction without filters.

END OF SECTION

SECTION 23 74 36
REFRIGERANT PIPING SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Refrigeration piping system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 23 80 00 - HVAC: Equipment.
   4. Section 40 05 13 - Pipe and Pipe Fittings: Basic Requirements.
   5. Section 40 05 16 - Pipe Support Systems.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 15, Safety Code for Mechanical Refrigeration.
   2. ASTM International (ASTM):
      a. B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   3. Federal Specification (FS):
      a. WW-T-799, Tube, Copper, Seamless, Water (For Use With Solder-Flared or Compression-Type Fittings).

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

C. Quality Assurance Submittals:
   1. Test reports:
      a. A dated declaration of the test of the refrigerant piping for each system shall be provided.
         1) The dated declaration shall include the information outlined in Article 12.3 of ASHRAE 15.
      b. Test reports of the refrigerant piping leak tests for all refrigerant piping systems installed.
      c. The test reports shall contain the following information:
         1) System refrigerant and high and low side pressure used.
         2) Listing of the necessary repairs made before the refrigerant piping system passed the leak test.
         3) Identification of specific system by referencing specific equipment identification numbers.
         4) Leak testing media used.
         5) Suction and discharge refrigerant gas pressures and temperatures taken after the refrigerant system has been charged.

D. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
   2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for refrigerant piping system shall be guaranteed to be sufficiently free from leaks so that the loss of refrigerant for two (2) years commencing on the date of Substantial Completion shall not exceed 5 percent loss over that time. Contractor shall verify every six months.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Refrigerant piping specialties:
      a. Sporlan.
      b. Hanson Technologies.
      c. Or approved equal.
   2. Expansion valves:
      a. Sporlan.
      b. Alcoa.
      c. Or approved equal.
   3. Silver solder - "Easy-Flo 45":
      a. Harman.
      b. Lucas Milhaupt.
      c. Or approved equal.
   4. Moisture indicator - "SEE-ALL":
      a. Sporlan.
      b. Tramex.
      c. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 REFRIGERANT PIPING AND FITTINGS

A. Refrigerant Piping:
   1. Copper tubing conforming to ASTM B280 and/or FS WW-T-799, dehydrated for refrigerant use, with high-temperature soldered joints and wrought copper (400 psig) fittings.
      a. For underground use: Type K.
      b. For aboveground use: Type L.

B. Piping Joints:
   1. Joints between copper tubing and fittings to be high temperature soldered (melting point not less than 1000 DegF, but less than that of the metal being joined) with phos-copper alloys.
   2. Joints between copper and brass, steel, etc., shall be silver soldered only.
      a. Silver solder to be "Easy-Flo 45."

C. Precharged Line Sets: Size per manufacturer's recommendations.

D. Field Assembled Units:
   1. Size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
      a. Suction lines: 2 DegF.
      b. Liquid lines: 1 DegF or 2 psi.
      c. Hot gas lines: 1 DegF or 3.6 psi.
      d. Size discharge and hot gas risers for positive oil return to compressors.

E. Hangers: As specified in Specification Section 40 05 16.

2.03 REFRIGERANT PIPING SPECIALTIES

A. Refrigerant Dryer:
   1. "CATCH-ALL" filter-drier with aluminum molded core:
   2. In each liquid line.
   3. A three-valve bypass around filter-drier.
   4. Install so core can be removed without cutting or breaking any refrigerant line.

B. Moisture Indicator:
   1. Show presence of moisture in system by change of color.
   2. Install full size in the main liquid line adjacent to the filter-drier.
   3. Use "SEE-ALL."

C. Strainers:
   1. Design to permit removing screen without removing strainer from piping system.
   2. Screens not larger than 80 mesh.
   3. Strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.

D. Oil Traps: Provide in lines as indicated.

2.04 VALVES

A. All Valves:
   1. All bronze.
   2. 2 IN and less: Solder ends.
   3. 3 IN and over: Four (4) bolt union ends.

B. Shut-Off Valves:
   1. Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure; or sealed diaphragm type.
   2. Wheel, globe, angle or "T" handle.

C. Check Valves:
   1. In liquid lines 5/8 IN and less: Lift check type.
   2. In lines 3/4 to 2 IN: Swing check type.
   3. In lines 3 IN and over: Wafer type swing check with bronze disc.

D. Expansion Valves:
   1. Sized by manufacturer for refrigerant used.
   2. Provide one (1) in each circuit with liquid distributor connection immediately after.

E. Vent and Test Valves: Angle cap type with seal and outlet caps.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Precharged Line Sets: Install per manufacturer's recommendations.

B. Field Assembled Lines: Install per manufacturer's recommendations.
   1. Refrigerant piping:
      a. In accordance with Specification Section 40 05 13 – Pipe and Pipe Fittings: Basic Requirements.
      b. Purge refrigerant piping of all air while connections of refrigerant piping are being made.
         1) Shut-off valves.
         2) Connect tank of dry nitrogen to line on back side of valve.
         3) Introduce dry nitrogen into line as refrigerant piping joints are successively made up from valve to each condenser.
   2. Testing:
      a. Refrigerant piping systems: Follow general testing guidelines of ASHRAE 15, except as modified herein.
      b. Pressurize the high and low pressure sides of the piping system after completion of the refrigerant piping.
         1) Pressurize at the test pressures specified in ASHRAE 15 for the refrigerant type to be used in the system.
      c. Repair any leaks and repeat tests until no further leaks are found and the system passes a static leak test at test pressure for a duration of 24 HRS.

3. Cleaning:
    a. Disconnect suction and discharge lines from compressor for clean up after complete system is tested.
    b. Valve or blank off system into three (3) separate systems for purpose of cleanup.
        1) Suction side including cooling coils.
        2) Discharge side including air cooled condenser.
        3) Hot gas reheat side including heating DX coils.
    c. Thoroughly clean each system using pumped refrigerant until system is proven clean to satisfaction of refrigeration compressor serviceman.
    d. Notify Project Representative for a visual inspection of both cleaning process and completely cleaned system.
4. Evacuation and Drying:
    a. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to gas pressure as recommended by the equipment manufacturer.
    b. Evacuate to 100 micron Hg and hold for 72 HRS.
        1) Use laboratory type vacuum pump capable of holding absolute pressure of 50 micron Hg.
        2) Check the vacuum with a suitable mercury column gage.
    c. Admit another drying charge of refrigerant and allow 4 to 6 HRS to absorb moisture and install dryer cores.
    d. Use second evacuation to remove all refrigerant and moisture.
    e. After second evacuation, charge system with refrigerant.
    f. Charge the system with refrigerant as required after final evacuation.

END OF SECTION

SECTION 23 80 00
HVAC: EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Heating, ventilating, and cooling equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 23 05 93 - HVAC Systems: Balancing and Testing.
   4. Section 23 09 00 - Instrumentation and Control For HVAC Systems.
   5. Section 23 31 00 - HVAC: Ductwork.
   6. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. FM Global (FM).
   6. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. National Roofing Contractors Association (NRCA).
   9. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.

10. Building Code:
    a. International Code Council (ICC):
        1) International Building Code and associated standards, 2009 Edition including all amendments, referred to herein as Building Code.

B. Miscellaneous:
    1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
    2. Corrosion protection of equipment to be as specified herein.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals: Required for all HVAC equipment.
    1. Fabrication and/or layout Drawings.
    2. Product technical data including:
        a. Acknowledgement that products submitted meet requirements of standards referenced.
        b. Manufacturer's installation instructions.
        c. Wiring diagrams.
        d. Control diagrams.
        e. Manufacturer's catalog cuts and technical data.
        f. Corrosion-protection information.
        g. Fan curves.
        h. Sound data.
        i. Vibration isolation.
        j. Control description.
        k. Performance data on all equipment.

C. Quality Assurance Submittals:
    1. Certifications:
        a. Provide certification of thickness of corrosion-protection coating.

D. Closeout Submittals:
    1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
    2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is two (2) years commencing on the date of Substantial Completion.
   2. All equipment listed in this Section including fans, packaged units, coils, etc. shall have a non prorated warranty for a period of five (5) years including all parts and labor to repair or replace the equipment.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Vibration isolation assemblies:
      a. Mason.
      b. Vibration Mounting and Controls Co.
      c. Or approved equal.
   2. Corrosion-protective coatings:
      a. Heresite and Chemical Co.; "Heresite."
      b. Technical Coating Division of Southern Anodizing Co., Inc.; "Technicoat."
      c. Or approved equal.
   3. Cooling coils - direct expansion:
      a. Carrier.
      b. McQuay.
      c. Or approved equal.
   4. Heating coil - electric:
      a. Carrier.
      b. McQuay.
      c. Or approved equal.
   5. Fan coils:
      a. Carrier.

b. McQuay.
c. Or approved equal.

6. Unit heater - electric:
   a. ILG Industries, Inc.
   b. Brasch.
   c. Fostoria.
   d. Or approved equal.
7. Cabinet heaters - electric:
   a. McQuay.
   b. Chromalox.
   c. Or approved equal.
8. Make-up air units - gas:
   a. Hastings.
   b. Titan.
   c. Aaon.
   d. Or approved equal.
9. Make-up air units, direct fired, gas:
   a. Hastings.
   b. Titan.
   c. Aaon.
   d. Or approved equal.
10. Energy recovery units - Wheel type:
    a. Carnes.
    b. Gamewell.
    c. Or approved equal.
11. Air-cooled condensing units - split system:
    a. Carrier.
    b. American Air Filter.
    c. McQuay.
    d. Or approved equal.
12. Packaged roof-top Heat Pump units:
    a. McQuay.
    b. Aaon
    c. Or approved equal.

13. In-line centrifugal fans - tube axial fans:
    a. New York Blower.
    b. Aerovent.
    c. Or approved equal.
14. Utility-type fans:
    a. New York Blower.
    b. Buffalo Forge.
    c. Twin City.
    d. Loren Cook Co.
    e. Or approved equal.
15. Vane axial fans:
    a. Loren Cook.
    b. Aerovent.
    c. Or approved equal.
16. Mixed flow inline fans:
    a. Loren Cook.
    b. Aerovent.
    c. Or approved equal.
17. Roof-mounted centrifugal exhaust fans:
    a. Loren Cook.
    b. Greenheck.
    c. Penn Ventilator Co., Inc.
    d. Or approved equal.
18. Roof-mounted upblast propeller-type exhaust fans:
    a. Loren Cook.
    b. Aerovent.
    c. Penn Ventilator Co., Inc.
    d. Or approved equal.
19. Roof-mounted propeller-type exhaust fans:
    a. Loren Cook.
    b. Aerovent.
    c. Penn Ventilator Co., Inc.
    d. Or approved equal.
20. Unitary split system heat pump:
    a. Carrier.

b. Lennox.

c. Bryant.

d. Or approved equal.

21. VAV box with or without electric reheat.

a. Titus.

b. Krueger.

c. Or approved equal.

22. Vehicle Exhaust Systems:

a. NSGV.

b. Monoxivent.

c. Or approved equal.

23. Lab Fume Hood:

a. Labconco.

b. Cole-parmer.

c. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 GENERAL

A. All Manufactured Units:

1. Comply with Specification Section 40 05 05 – Equipment: Basic Requirements.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
   a. Type: As per Table 42, Chapter 47, ASHRAE HVAC Applications Handbook.
   b. Corrosion-resistant coating:
      1) 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 DegF.
      2) 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 DegF.
      3) Factory applied.
      4) Provide factory certification of application.

2.03 MANUFACTURED UNITS

A. Equipment Coils:
   1. Cooling coils - direct expansion:
      a. ARI certified.
      b. Material:
         1) Aluminum.
         2) Copper with aluminum fins for use in administration units only.
      c. Fin spacing: Minimum 80 fins/FT.
      d. Minimum standard operating limit: 250 psi.
      e. Size and capacity as scheduled.
   2. Heating coil - electric:
      a. ARI certified.
      b. 80-percent nickel, 20-percent chromium elements.
      c. Maximum heating density: 35 watts/SQ IN.
      d. Built-in thermal protection.
      e. Airflow switch.
      f. Built-in circuit fusing.
      g. Control voltage transformer.
      h. Terminal block.
      i. Magnetic contactor.
      j. Fused disconnect switch.
      k. Step controller as required by instrumentation.
      l. Single point electrical connection.
      m. Size and capacity as scheduled on Drawings.

B. Unit Heater - Electric:
   1. Type: Vertical.
   2. UL listed for non-rated areas.
   3. Material:
      a. Cabinet: 18 GA steel.
      b. Heating elements: Copper-clad steel.
   4. Fan motors:
      a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
      b. Built-in automatic reset overload protection.
   5. Dynamically balanced fan.

6. Built-in automatic reset cutout protection.
7. Accessories:
    a. Mounting bracket.
    b. 40 to 90 DegF, 5 DegF differential wall-mounted thermostat.
8. Electrical, fan motor, and airflow data as scheduled on Drawings.

C. Cabinet Heaters - Electric:
1. Type: Vertical.
2. UL listed.
3. Material:
    a. Cabinet: 18 GA steel minimum.
    b. Chassis: Galvanized steel.
4. Electric heating coils:
    a. 200-600 cfm: Hydronic type finned-tube construction with resistance elements inserted in tubes.
    b. 800-1800 cfm: Spiral sheath type.
    c. Factory wired.
5. Unit-mounted heat switch.
6. Magnetic contactors.
7. High temperature cutout safety control.
8. Fan override thermostat.
9. Fan: Centrifugal, forward curve, double-width.
10. Filters: See Specification Section 23 31 00 – HVAC: Ductwork.
11. Stamped inlet and outlet grilles.
12. Insulation: Glass fiber.
13. Integral junction box.
14. Accessories:
    a. Subbase.
    b. Unit leveling screws.
15. Size and capacity as scheduled on Drawings.

D. Make-Up Air Units - Gas:
1. CSA design certified heating section.
2. Materials:
    a. Cabinet: 16 GA aluminized steel.
    b. Base channels: 12 GA aluminized steel or 1/4 IN hot rolled steel.

c. Heat exchanger tubes: Aluminized steel, 18 GA tubes and 16 GA header plates minimum.

d. Burners: 18 GA aluminized steel with stainless steel ribbon inserts.

e. Insulation: Fiberglass.

3. Blower section:

a. Blower wheels:

1) Statically and dynamically balanced.

2) Forwardly curved, double-width, double-inlet.

3) Mounted on solid turned ground shaft with keyway.

b. Bearings: Ball-bearing, self-aligning, permanently lubricated, pillow block-type.

c. Blower scrolls, bearings, and adjustable base to be mounted on reinforced angle iron frame.

d. Driver and driven sheaves:

1) Keyed hub type.

2) Drive sheave: Fixed pitch diameter.

3) Driver:

a) Shipped with variable pitch diameter sheave.

b) Fixed pitched diameter size based on approved test and balance report.

4) V-belt drives sized for 150 percent motor horsepower.

e. Insulated cabinet.

f. Motors: See Specification Section 40 05 05 – Equipment: Basic Requirements.

4. Furnace section:

a. Slide out burner tray.

b. Main gas cock.

c. Main gas pressure regulator.

d. Main solenoid gas valve.

e. Pilot gas cock.

f. Pilot gas pressure regulator.

g. Pilot solenoid gas valve.

h. Intermittent spark ignition system.

i. 24 V control transformer.

j. Temperature control: Non-electric modulating gas valve.

k. Vent cap and combustion air opening on outdoor units.

l. Flue outlet with power vent on indoor units.

m. Combustion air intake on both sides of furnace.

5. NEMA 4X remote control station with switches and indicating lights.
6. NEMA 3R fused disconnect switch.
7. Accessories:
   a. Prefabricated insulated roof curb.
   b. Inlet hood with birdscreen.
   c. "V" bank filter section.
   d. Filter: See Specification Section 23 31 00 – HVAC: Ductwork.
   e. Inlet shut-off damper.
8. Size and capacity as scheduled on Drawings.

E. Rotary Wheel Type Energy Recovery Ventilator:
1. Regenerative type heat recovery wheel shall be furnished with desiccant coated aluminum heat transfer media.
2. Unit shall have weatherproof housing suitable for rooftop mounting with lifting lugs, drain connections side access panels and base frame, heavy gage steel casing.
3. Fans, Class I, forward curved, double width/double-inlet shall be supplied for both supply ad exhaust.
4. Warm-side of exhaust shall be insulated with fiberglass of 1 IN thickness to provide for greater energy retention.
5. Factory-wired controls and starters shall be furnished.
   a. A remote control panel with operating switches and indicating lights shall also be included.
6. Backdraft dampers and banks of throw-away filters shall be supplied for both exhaust and supply airstreams a louver and birdscreen shall also be provided for fresh air intake.
7. Size and capacity as scheduled on Drawings.

F. Air-Cooled Condensing Units - Split System:
1. ARI rated.
2. UL listed.
3. Materials:
   a. Casing: Galvanized steel.
   b. Mounting/lifting rails: Steel.
   c. Outdoor coil: Seamless aluminum tubing and aluminum fins.
   d. Fan blades: Aluminum.

4. Weatherproof casing:
    a. Hail screen for condenser coil.
    b. Access panels.
5. Compressor:
    a. Hermetically sealed.
    b. Internal pressure protector.
    c. Crankcase heater.
    d. Internal spring mounts.
    e. Centrifugal oil pump.
    f. Built-in overload protection.
6. Condenser fans and motors:
    a. Vertical discharge.
    b. Direct drive.
    c. Statically and dynamically balanced.
    d. Motor:
        1) See Specification Section 40 05 05 – Equipment: Basic Requirements.
        2) Permanently lubricated bearings.
        3) Built-in current and thermal overload protection.
7. Built-in refrigerant filter dryer.
8. Built-in liquid line and gas line service valves with gage ports.
9. Outdoor coil:
    a. Fins mechanically bonded to tubing.
    b. Lab tested to 2000 psi.
10. 24 V factory-wired controls to include fusing and control power transformer.
11. Size and capacity as scheduled on Drawings.

G. Packaged Roof-Top Heat Pump Units:
1. UL listed.
2. Designed for outdoor application.
3. Materials:
    a. Frame and base: Minimum 14 GA galvanized steel.
    b. Exterior panels: Minimum 17 GA galvanized steel.
    c. Door liners for downstream access doors: Minimum 20 GA galvanized steel.

d. Gaskets: Dual durometer vinyl.

e. Insulation: 1 IN thick neoprene-coated glass fiber.

f. Fans: Painted rolled steel or galvanized steel.

g. Roof curb: Minimum 12 GA galvanized steel.

4. Cabinet, casing and frame:

a. Cross broken-top sections.

b. Designed to operate at total static pressure up to 5.5 IN WG.

c. Hinged side panels with single lever latching.

d. Completely insulated.

e. Base equipped with lifting brackets with lifting holes.

f. Hail screen for condenser coil.

5. Refrigerant condensing section:

a. Compressors:

1) Heavy duty, reciprocating, semi-hermetic type.

2) Positive displacement oil pump.

3) Suction and discharge service valves.

4) Crankcase heater.

5) Thermal overload protection.

b. Refrigeration circuit:

1) Sight glass.

2) Filter dryer.

3) Manual shut-off valve.

4) High pressure relief valve.

c. Compressor isolators.

d. Condenser coils:

1) Nominal 3/8 IN OD seamless copper mechanically bonded to corrugated aluminum fins.

2) Factory leak tested at 315 psig under water.

e. Condenser fans:

1) Direct drive: See Specification Section 40 05 05 – Equipment: Basic Requirements.

2) Propeller-type.

f. Condenser fan motors:

1) Heavy duty, inherently protected, non-reversing.

2) Permanently lubricated bearings.

3) Integral rain shield.

6. Cooling coil section:
   a. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.
   b. Evaporator coil circuiting:
      1) Adjustable thermal expansion valve per circuit with external equalizer.
      2) Combination row/split face circuiting.
   c. Drain pan:
      1) Mastic-coated.
      2) Threaded drain connections.
7. Defrost control: Defrost cycles at a preselected time interval when the outdoor coil is below a preset initiation temperature.
8. Expansion valve: Designed and sized specifically for heat pump service.
9. Reversing valve: Four-way interchange reversing valve, operates on pressure differential between the outdoor unit and indoor unit.
10. Supply fan section:
    a. Supply fans:
       1) Double-width, double-inlet centrifugal type.
       2) Airfoil.
       3) Solid steel shafts.
       4) 200,000 HR relubricative ball-bearings.
    b. Fan motors:
       1) See Specification Section 40 05 05 – Equipment: Basic Requirements.
       2) Relubricative ball-bearings.
       3) Adjustable base.
    c. Driver and driven sheaves:
       1) Keyed hub type.
       2) Drive sheaves: Fixed pitch diameter.
       3) Driver:
          a) Shipped with variable pitch diameter sheave.
          b) Fixed pitch diameter size based on approved test and balance reports.
       4) V-belt drives sized for 150 percent motor horsepower.
    d. Isolated fan assembly.

11. Filter section:
    a. Filters: See Specification Section 23 31 00 – HVAC: Ductwork.
    b. Access doors for filter removal.
12. Return air section:
    a. Return fans:
        1) Double-width, double-inlet, centrifugal type.
        2) Airfoil.
        3) Solid steel shaft.
        4) 200,000 HR relubricative ball-bearings.
    b. Fan motors:
        1) See Specification Section 40 05 05 – Equipment: Basic Requirements.
        2) Relubricative ball-bearings.
        3) Adjustable base.
    c. Driver and driven sheaves:
        1) Keyed hub type.
        2) Drive sheaves: Fixed pitch diameter.
        3) Driver:
            a) Shipped with variable pitch diameter sheave.
            b) Fixed pitch diameter size based on approved test and balance reports.
        4) V-belt drives sized for 150 percent motor horsepower.
    d. Isolated fan assembly.
    e. Designed to form a plenum.
13. Outdoor air section:
    a. Designed to form a plenum.
    b. 0 to 100-percent outside air with economizer control.
    c. Horizontal louvers with rain lip and birdscreen.
    d. Floor sloped for water drainage.
    e. Dampers:
        1) Sized to handle 100-percent supply air volume.
        2) Arranged vertically to encourage mixing of return and outside airstreams.
        3) Airfoil type.
        4) Fully gasketed and side sealed.

f. Adjustable potentiometer.

g. Adjustable enthalpy control outside of airstream.

h. Modulating spring return type damper motor.

14. Electrical:

a. Factory wired in accordance with NFPA 70 requirements.

b. 115 V control circuit transformer.

c. 115 V receptacle.

d. Supply air firestat.

e. System service switch.

f. Control circuit fuse.

g. Individually fused supply and return fan motors, compressor and condenser fan motor branch circuits.

h. Weatherproof control panel with dead-front cover over main power controls.

i. Disconnect switch.

15. Roof curb:

a. Prefabricated.

b. Perimeter type with rail support for condensing unit section.

c. Wood nailer strip.

d. Gasket for installation between curb and unit.

e. Nominal 16 IN high.

f. Approved by NRCA.

16. Size and capacity as scheduled on Drawings.

H. In-Line Centrifugal Fans - Tube Axial Fans:

1. AMCA certified Class I, II, or III.

2. Non-overloading horsepower capability.

3. Materials:

a. Wheel, impeller hub and blades: Aluminum or stainless steel.

b. Housing, innertube and belt well: Aluminum or stainless steel.

c. Inlet cone: Aluminum or stainless steel.

d. Driver shaft: Solid stainless steel.

4. Airfoil design blades.

a. All welded construction.

5. All welded housing, innertube and belt well.

6. Innertube construction:
    a. Isolates bearings and drive from airstream.
    b. Removable end covers.
7. Bearings:
    a. Grease lubricated, self-aligning.
    b. External grease fittings.
8. Motor:
    a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
    b. Driver and driven sheaves:
        1) Keyed hub type.
        2) Drive sheaves: Fixed pitch diameter.
        3) Driver:
            a) Shipped with variable pitch diameter sheave.
            b) Fixed pitch diameter size based on approved test and balance reports.
        4) V-belt drives sized for 150 percent motor horsepower.
9. Adjustable motor base.
10. Flanged inlet and outlet.
11. Accessories:
    a. Weatherproof, louvered motor enclosure for exterior installation.
    b. Internal inlet damper with external control linkage.
    c. Stack hood.
    d. Cam type access door.
    e. Ceramic felt shaft seal.
12. Size and capacity as scheduled on Drawings.

I. Roof-Mounted Centrifugal Exhaust Fans:
1. AMCA certified.
2. Non-overloading horsepower capability.
3. Materials:
    a. Top cap: Spun aluminum.
    b. Wheel and inlet shroud: Aluminum.
    c. Baffle: Aluminum.
    d. Base: One-piece aluminum.
    e. Drive assembly supports: Steel.

f. Drive shaft: Solid stainless steel.

4. Backward inclined blades.
5. Tapered inlet shroud.
6. Statically and dynamically balanced wheel.
7. Bearings:
   a. Permanently sealed, flange type, ball-bearings.
   b. Five-to-one load capability to actual load ratio.
   c. 200,000 HR average life.
8. Weathertight compartment for motor and drives.
   a. Separated from airstream.
9. Motor:
   a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
   b. Driver and driven sheaves:
      1) Keyed hub type.
      2) Drive sheaves: Fixed pitch diameter.
      3) Driver:
         a) Shipped with variable pitch diameter sheave.
         b) Fixed pitch diameter size based on approved test and balance reports.
      4) V-belt drives sized for 150 percent motor horsepower.
10. Vibration isolated drive assembly.
11. Accessories:
    a. Prefabricated insulated aluminum roof curb.
    b. Backdraft damper: See Specification Section 23 31 00 – HVAC - Ductwork.
    c. Bird screen.
    d. Spark-resistant construction:
       1) Type A: All parts in air stream are aluminum or non-ferrous construction.
       2) Type B: Aluminum wheel and aluminum rub ring where the fan shaft passes through the housing.
       3) Type C: Aluminum inlet cone and aluminum rub ring where the fan shaft passes through the housing.
12. Size and capacity as scheduled on Drawings.

J. Roof-Mounted Upblast Propeller-Type Exhaust Fans:
   1. AMCA certified.
   2. Belt-driven.
   3. Materials:
      a. Propeller: Cast aluminum or aluminum.
      b. Stack cap and wind band: Aluminum or stainless steel.
      c. Dampers: Aluminum or stainless steel.
      d. Fan housing: Aluminum or stainless steel.
      e. Base: Aluminum or stainless steel.
      f. Drive shaft: Solid stainless steel.
      g. Sheaves: Cast iron.
   4. Propeller:
      a. Airfoil blades.
      b. Statically and dynamically balanced.
   5. Dampers:
      a. Free action butterfly type.
      b. Heavy-duty damper rods.
      c. Oil-impregnated bearing located outside airstream.
   6. Motor base welded to fan housing:
      a. Adjustable slide rail base for motor.
      b. Vibration isolated motor.
   7. Bearings:
      a. Grease lubricated pillow block-type.
      b. External grease fittings.
   8. Motor:
      a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
      b. Driver and driven sheaves:
         1) Keyed hub type.
         2) Drive sheaves: Fixed pitch diameter.
         3) Driver:
            a) Shipped with variable pitch diameter sheave.
            b) Fixed pitch diameter size based on approved test and balance reports.
         4) V-belt drives sized for 150 percent motor horsepower.

c. Enclosed in housing.

9. Weatherproof motor enclosure.
10. Accessories:
    a. Insulated aluminum roof curb.
    b. Non-fused safety disconnect switch.
    c. Aluminum birdscreen.
11. Size and capacity as scheduled on Drawings.

K. Unitary Split System Heat Pump:
1. Outdoor Unit:
    a. Casing and frame:
        1) Material: Heavy gage galvanized steel.
        2) Insulation: 1 IN thick neoprene-coated glass fiber.
        3) Installation: Base equipped with lifting brackets with lifting holes.
        4) Removable end panel for access to components and connections.
    b. Compressors:
        1) Heavy duty, reciprocating, semi-hermetic type.
        2) Positive displacement oil pump.
        3) Suction and discharge service valves.
        4) Crankcase heater.
        5) Thermal overload protection.
    c. Refrigeration circuit:
        1) Sight glass.
        2) Filter dryer.
        3) Manual shut-off valve.
        4) High pressure relief valve.
    d. Compressor isolators.
    e. Condenser coils:
        1) Nominal 3/8 IN OD seamless copper mechanically bonded to corrugated aluminum fins.
        2) Factory leak tested at 315 psig under water.
    f. Condenser fans:
        1) Direct drive: See Specification Section 40 05 05 – Equipment: Basic Requirements.
        2) Propeller type.

g. Condenser fan motors:

1) Heavy duty, inherently protected, non-reversing.

2) Permanently lubricated bearings.

3) Integral rain shield.

h. Defrost control: Defrost cycles at a preselected time interval when the outdoor coil is below a preset initiation temperature.

i. Expansion valve: Designed and sized specifically for heat pump service.

j. Reversing valve: Four-way interchange reversing valve, operates on pressure differential between the outdoor unit and indoor unit.

2. Indoor unit:

a. Materials:

1) Casing: Heavy gage steel.

2) Framework: Steel angle.

3) Pan insulation: Foam-in-place insulation.

4) Casing insulation: 1 IN, 3/4 LB fiberglass blanket.

b. Casing:

1) Sectionalized construction.

2) Removable access panels.

3) Insulated weatherproof casing.

c. Evaporated fans:

1) Double-width, double-inlet centrifugal type.

2) Forward curved or airfoil.

3) Solid steel shafts.

4) 200,000 HR relubricative ball-bearings.

d. Fan motors:

1) See Specification Section 40 05 05 – Equipment: Basic Requirements.

2) Relubricative ball-bearings.

3) Variable pitch sheave.

4) Adjustable base.

e. V-belts and drives sized for 150 percent motor capacity.

f. Isolated fan assembly.

g. Filter section:

1) Filters: See Specification Section 23 31 00 – HVAC: Ductwork.

2) Access doors for filter removal.

h. Evaporator coils: See paragraph(s) in Article 2.3, Equipment Coils.

i. Evaporator coil circuiting:

1) Adjustable thermal expansion valve per circuit with external equalizer.

2) Combination row/split face circuiting.

j. Drain pan:

1) Mastic-coated.

2) Threaded drain connections.

k. Electric heating coil: See paragraph(s) in Article 2.3, Equipment Coils.

1) Built-in static-pressure airflow switch.

l. Size and capacity as scheduled on Drawings.

L. Vehicle Exhaust Systems:

1. Hose Reel:

a. Provide powder coated steel drum and supports.

b. Provide with 6 IN connections to hose and blower.

c. Provide with integral hose guide and pull cable.

2. Blower:

a. Direct mount direct drive motor sized for 500 CFM with 1 HP motor.

3. Hose and connection:

a. Provide 36 FT of flexible tubing.

b. Provide clamping type adapter.

M. Lab Fume Hood

1. Comply with SEFA 1-2006 and ANSI Z9.5-2003

2. Bypass airflow design with air foil.

3. Provide exhaust air transition adapter.

4. Dry powder epoxy coated aluminum frames with steel rear plenum and baffle.

5. Clear 1/4 IN safety glass for front sash sides and top.

6. Ergonomic 20 degree angles and hinged pivoting sash with wiping seal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with Specification Section 40 05 05 – Equipment: Basic Requirements.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

3.02 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93 – HVAC Systems: Balancing and Testing.

3.03 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

SECTION 23 80 05
VARIABLE FREQUENCY DRIVES: LOW VOLTAGE

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Variable frequency drives (VFDs) for speed control of ventilating fans and related air volume control. HVAC motors driven by VFDs shall be inverter duty motors.
   2. Integrated Building Automation System (BAS) will control HVAC VFDs.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 - Identification Devices.
   4. Division 23 - Heating Ventilating and Air Conditioning.
   5. Section 23 09 00 - Instrumentation and Control for HVAC Systems.
   6. Section 26 05 00 - Electrical: Basic Requirements.
   7. Section 28 31 00 – Fire Detection and Alarm.
   8. Division 40 - Process Integration.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
      b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   4. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.

5. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC):
        1) Article 430, Motors Motor Circuits, and Controllers.
6. Occupational Safety and Health Administration (OSHA).
7. Underwriters Laboratory, Inc. (UL):
    a. 508, Standard for Industrial Control Equipment.
    b. 508A, Standard for Industrial Control Panels.

B. Qualifications:
1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
    a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
3. VFD Supplier shall maintain an authorized service organization within 100 miles of the Project Site.

C. Coordination:
1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
    a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
2. Motor and VFD coordination: See Specification Section 40 05 05.
3. VFD shall be supplied complete with all required control components.
    a. Provide control as indicated:
        1) On the Mechanical Drawings.
        2) As specified in this Specification Section.
        3) As specified in the process control system loop descriptions.
    b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
        1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.

c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, etc.

4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.

   a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.

   b. Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

1.03 DEFINITIONS

A. Variable Torque (VT):
   1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
   2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Constant Torque (CT):
   1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
   2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

C. Constant Horsepower:
   1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
   2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

E. Standard Motor: An AC induction motor that fails to comply with one (1) or more requirements of NEMA MG 1 Part 31.

F. Low Voltage: 600 Vac or less.

1.04 SUBMITTALS

A. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Provide a schedule for each VFD including the following information:
      a. Equipment Tag Number.
      b. VFD Complete Catalog Number.
      c. VFD Amp Frame Size.
      d. Variable or Constant Torque Rating Basis.

e. Rated Input Current.

f. Rated Continuous Output Current.

g. Rated Short Circuit Current.

h. VFD cable type specified (shielded or non-shielded).

i. VFD Maximum Motor Lead Length for the type of cable used.

j. Motor Manufacturer.

k. Motor Frame Size.

l. Motor Full Load Amps.

m. Motor Service Factor.

n. As installed motor Lead Length.

o. VFD options provided to meet harmonic or motor protection Specifications.

2. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.

3. Product technical data:

   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.

   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.

   c. Manufacturer's installation instructions.

   d. Manufacturer's programming and operating instructions.

4. Fabrication and/or layout Drawings:

   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.

   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.

   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.

   d. Interior layout Drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.

   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.

5. Identification and location of closest authorized service organization.

C. Quality Assurance Submittals:
   1. Submit prior to shipment:
      a. Certified factory test reports confirming compliance with specified requirements.
   2. Submit after installation:
      a. Certified field service reports showing:
         1) Each VFD is operational.
         2) Each VFD and its driven equipment motor are compatible.
         3) Each VFD responds correctly to the input control signals.
         4) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
         5) Measured harmonic levels per Harmonic Protection Requirements Article.
         6) Measured motor terminal peak voltages per Motor Protection Requirements Article.

D. Closeout Submittals
   1. Operation and Maintenance (O&M) Manuals Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
      a. Approved copy of VFD schedule per Submittals Article.
      b. Manufacturer's instruction manuals.
      c. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
      d. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
      e. Recommended spare parts list.
      f. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. ASEA Brown Bovari (ABB).
   2. Siemens.
   3. Square D Company.
   4. Allen Bradley.
   5. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
   1. Motor control.
   2. Motor overload protection.
   3. Motor and motor branch circuit short circuit and ground fault protection.
   4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an “engineered” or “configured” drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:
   1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 percent of base speed of the driven equipment.
   2. VFDs shall be compatible with:
      a. Inverter duty induction motors.
   3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
      a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
   4. VFDs shall be designed to operate successfully under the following site conditions:
      a. Ambient:
         1) Temperature: 0-50 DegC.
         2) 95 percent non-condensing relative humidity.
      b. Elevation: Less than 3,300 FT above MSL.
      c. Power supply characteristics:
         1) 480Vac, 3 PH, 60 Hz, 3 wire, (+/- 10 percent).

2) Effectively grounded.

B. Ratings and Performance Specifications:
   1. Voltage rating:
      a. Nominal: 460 or 480 Vac, 3 PH, 60 Hz.
      b. Range for continuous full load operation: +/-10 percent of nominal.
      c. Voltage imbalance tolerance for full load operation: 3 percent minimum.
   2. Current ratings:
      a. Continuous:
         1) Equal to or greater than the motor nameplate full load.
      b. Short-term overload:
         1) VT: 110 percent for 1 minute.
         2) CT: 150 percent for 1 minute.
         3) Permissible for 1 minute every 10 minutes continuously.
      c. Short circuit:
         1) As indicated on the Drawings.
         2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
         3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance Specifications or not.
   3. Efficiency:
      a. 97 percent, minimum, at full speed and full load.
      b. 93 percent, minimum at 1/2 speed and full load.
   4. Displacement power factor:
      a. 95 percent, minimum from 50 percent to 100 percent speed and load.
   5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
   6. Frequency drift:
      a. +0.5 percent of set frequency.
   7. Speed regulation (motor dependent): 3 percent.
   8. Speed range: 10:1.

9. Control type:
    a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
        1) When operating under voltage boost.
        2) At frequencies over 60 Hz.

C. Operational Features:
1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25 percent of rated voltage, or single phase condition: 4 second, minimum.
3. Controls power loss ride-through: 500 msec, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
    a. Minimum of three (3) settings.
    b. Adjustable bandwidth, 1 - 5 Hz.
8. Capable of operating without the motor connected for start-up and troubleshooting.
9. Output Filters.

D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
2. Independent maximum and minimum speeds for forward and reverse operation.
3. Start frequency and hold time.
4. Independent linear acceleration and deceleration time.
5. Preset “jog” speed.
6. Three (3) critical frequency bands.
7. One (1) preset speed selectable by logic input.
8. Volts/Hertz ratio.
9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.

14. Ground fault pickup.

15. DC injection level and time.

2.04 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
   1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 Vac or 24 Vdc.
   1. 120 Vac supplied by CPT in the VFD.
      a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
      b. CPT shall have two (2) fuses on the primary side and one (1) fuse on the secondary side.
      c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
   2. 24 Vdc supplied by Class 2 power supply in the VFD.
      a. Power supply shall have minimum additional capacity of 33 percent greater than that required by control devices.
      b. Provide two (2) current-limiting fuses on the AC supply to the power supply.
      c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
   1. Door mounted sealed keypad, membrane type with LED or LCD display.
      a. Messages shall be in English and engineering units.
      b. Drive operating parameters shall be programmable.
      c. Menu driven.
      d. Password security.
      e. Display fault and diagnostic data.
      f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
      g. Gold plated plug-in contacts.
   2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
      a. Minimum indications:
         1) Run.
         2) Stop.

3) Ready.

4) Alarm.

5) Fault.

6) Local control.

7) Remote control.

8) Control source local.

9) Control source remote.

10) Speed indication.

11) VFD shall sense the loss of load and signal a no load/broken belt warning or fault.

b. Minimum control functions:

1) Local/Remote switch.

2) Stop button.

3) Start button.

4) Reset button.

5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.

a. On occurrence of more than one (1) condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:

1. Local portable computer interface via RS232/RS242 serial communications port:

a. Capability to:

1) Start-Stop VFD.

2) Control VFD Speed.

3) Access fault and diagnostic data.

2. Analog and discrete inputs:

a. Speed reference (set point) signal 4-20 mA DC.

b. Isolated process PID controller with user-programmable set point, gain, rate, reset and span for accepting a remote 4-20 mA DC process variable signal.

3. Analog and discrete outputs:

a. 4-20 mA and 0-10 V DC output for remote speed indication, as a function of frequency, calibrated 0 to 100 percent.

b. Drive FAULT contacts.

c. Drive RUNNING contacts.

d. Drive selector switch in AUTO status contacts.

4. Contacts:
   a. Contacts shall be rated 2 A inductive at 120 Vac.
   b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
   a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
   b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
   c. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.
6. VFD shall be ready to communicate with Building Automation System (BAS), embedded RS485 and Ethernet HVAC protocols:
   a. Siemens Apogee FLN (P1).
      1. No substitutions allowed.
   b. Option boards for the following communications protocols shall be available:
      1) BACnet MS/TP.
      2) MODBUS RTU.
      3) Bacnet IP.
      4) Modbus TCP.
   c. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the port. It shall be possible to Communicate to the VFD through this port without interrupting VFD communications to the BAS system.
   d. Refer to Division 23 and Division 40 for additional requirements.

2.05 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a “dedicated system” in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
   1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
   2. Current distortion: IEEE 519 Table 10.3 based on $I_{SC}/I_L < 20$.

C. PCC shall be considered:
   1. Building service entrance switchgear or switchboard .
   2. Each switchboard, switchgear, or panelboard supplying a VFD branch circuit.

D. The A/E Representative has performed preliminary calculations based on typical VFD data which indicate that the minimum mitigation measures required to meet the specified harmonic criteria is:
   1. 6-pulse rectifier topology with input line reactors and DC link reactors, minimum impedance 3 percent on drive kVA base to protect against input transients, loss of AC line phase, short circuit, ground fault, overvoltage, undervoltage, driver overtemperature and motor overtemperature.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.
   1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
   2. Power system data for analysis shall be taken from the Electrical Drawings and approved equipment submittals.
      a. VFDs provided in a package with equipment specified elsewhere, shall be included in the analysis.

G. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.
   3. The installed digital metering package is available for use for this test.
   4. Provide all setup and/or modifications as required to perform the test.

2.06 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Fire Alarm Interface:
   1. Provide an override input so that opening dry contacts will absolutely stop the motor under any operating condition.
   2. Provide an override input so that opening dry contacts will cause the motor to operate at speed predetermined by VFD programming.

3. Provide a Summary Alarm dry contact, for connection to the Fire Alarm System, indicating that the VFD is not operable.

C. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

D. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.
   1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:
      a. Inverter duty motors: 1280 V.
      b. Rise time shall be greater than or equal to 0.1 microsecond.
      c. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.

E. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10 percent shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.07 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
   1. Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
      a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
      b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
   2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Project Representative's permission may be mounted in a separate enclosure.
   3. Cooling fans, as required, shall be provided to run when drive is running.
   4. Enclosures for separately mounted VFD's:
      a. NEMA Type 1 for installation in Electrical Rooms.
      b. NEMA Type 12 for installation in other unclassified areas.
      c. NEMA Type 4 stainless steel for installations in wet, damp or outdoor areas.

d. Provide enclosure cooling required to not exceed drive temperature ratings.

B. Wiring:
1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
b. Bases with a self-sticking back will not be allowed.
2. All plug-in contacts shall be gold-plated.
3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
a. Provide terminals for shield continuity where required.
4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
a. Non-brittle, interlocking, track-mounted type.
b. Screw terminals will not be allowed.
c. A terminal for each conductor of external circuits plus one (1) ground for each shielded cable.
d. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
e. Not less than 25 percent spare terminals shall be provided.
f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal Drawings.
g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
a. Markings or color code shall match the manufacturer's Drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:
1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 10 14 00.

2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.08 COMPONENTS AND ACCESSORIES

A. Reactors:
1. Impedance: 3 percent.
2. Continuous current: Not less than drive rating.
3. Current overload: 150 percent for 1 minute.
4. Insulation temperature rating: 180 DegC.
5. Copper windings.
6. Saturation current rating: 3.5 to 5 times rated current.
7. Hi-potential rating: 2500 Vac line to ground and line to line, for 1 minute.
8. Noise reduction features:
   a. Epoxy over cast coil.
   b. Extra dips and bakes of varnish over continuous wound coil.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.
2. Prior to final assembly:
   a. Inspect incoming components.
   b. Test and inspect power devices.
   c. Circuit cards:
      1) Component and functional tests:
      2) Burn-in chamber or temperature cycling test.
      3) System test after burn-in or temperature cycling.
3. After final assembly:
   a. Continuity and insulation test of 480 power control circuits.
   b. Drive tests:
      1) Burn-in complete drive at full load for 24 HRS.
      2) Verify all auxiliary circuits operation.

3) Monitor output variables.

c. Systems test:

1) Provide inputs to field connections and simulate on-site operation.

2) Test all auxiliary equipment.

2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 – EXECUTION

3.01 INSTALLATION

A. All HVAC VFD drives and energy management control wiring shall be installed by the BAS manufacturer.

B. All HVAC VFD temperature control wiring, equipment control wiring, and interlock wiring shall be provided by the BAS system manufacturer.

C. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

D. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

E. Provide services of manufacturer's representative to perform start-up services.

F. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
1. The space available on the Drawings shall not be exceeded.

3.02 START UP

A. Pre-start-up Services:
1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period.
2. Shall consist of:
a. Physical and electrical installation check.
b. Final adjustments and calibration of drive parameters.
c. VFD operation from simulated input signals.
3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:
   1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
      a. For each individual VFD.
      b. For the maximum number of VFDs that will be operational at the same time.
      c. When all loads are at 75 percent load minimum.
      d. Duration: 1 HR minimum.
   2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
      a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
         1) Time shall be measured in microseconds.
      b. Tests shall be performed at full:
         1) Full voltage and speed.
         2) Loaded to 75 percent minimum.
         3) Duration: 1 HR minimum.
   3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
   1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
      a. Perform all work in the presence of the Owner's designated representatives.
   2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Project Representative of carrier frequencies set in excess of 5 kHz and reason for setting.
   3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
      a. Ensure compatibility of VFD with associated control and instrumentation signals.
   4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's designated personnel:
   1. Minimum of 8 HRS at the jobsite.
   2. Include both field and classroom instruction.
   3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
      a. Lubrication.
      b. Troubleshooting.

c. Repair and replacement.

d. Parts inventory.

e. Maintenance records.

END OF SECTION

SECTION 23 83 00
RADIANT HEATERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Radiant heaters.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 23 05 93 - HVAC Systems: Balancing and Testing.
   4. Division 26 - Electrical.
   5. Section 40 05 13 - Pipe and Pipe Fittings: Basic Requirements.
   6. Section 40 05 23 - Valves: Basic Requirements.

1.02 QUALITY ASSURANCE

1. American Gas Association (AGA).
2. Local Gas Company Regulations.
3. National Fuel Gas Code.
4. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Fabrication and/or layout Drawings:
      a. System layout Drawings showing connection, burner, and ancillary equipment details.

C. Quality Assurance Submittals:
   1. Test reports:
      a. Factory tested prior to shipment.
      b. Field tested after installation.

D. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.
   2. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.04 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section is two (2) years commencing on the date of Substantial Completion.
   2. All infrared heating equipment and related components shall have a minimum five (5) year non-prorated parts, including electric elements, internal controls, electrical wiring, etc. and labor warranty including travel from the later date of acceptance.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Electric ceiling panels radiant heaters:
      a. Fostoria.
      b. Qmark.
      c. Or approved equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 ELECTRIC CEILING PANEL RADIANT HEATERS

A. Provide electric units with backbox, insulation, heating element, radiant face and mounting configuration.

B. Housing: Galvanized steel housings shall be 24 GA back and 22 GA front with sides formed by overlapping back and front panels and fastened together.

C. Frame, for surface and recessed mounting:
   1. Galvanized steel.

2. Aluminum.
3. Wood.
4. Frame type as indicated on Drawings.
5. T-bar frames by ceiling work.

D. Element: Graphite based with uniform temperature distribution over entire panel surface.

E. Insulation: 1 IN thick, 1 LB density high temperature fiberglass.

F. Surface: Front panel shall be coated using a product as recommended by manufacturer.

G. Wire:
1. Internal wiring shall be 200 DegC rated, 14 GA with Teflon insulation.
2. External wiring shall be 14 GA in 40 IN long flexible conduit and J-box connector.

H. Voltage: 480 volt and 3 phase.
1. Controls: Provide 15 minute timer switch and lockout relay from BAS when outside air goes above 50 DegF.
2. Control voltage: 24 V.
3. For low voltage control systems, 24 V, provide Contactors near panels.

PART 3 – EXECUTION

3.01 GENERAL

A. Install radiant panel system as recommended by manufacturer and as specified.

B. Install units plumb and level.
1. Where units are to be installed at an angle they shall be installed uniform.

C. Maintain heater clearances to combustibles as shown on manufacturer's installation instructions.

D. Piping and electrical connections shall be flexible connectors.

E. Provide control wiring in conduit and install per Division 26 – Electrical work.

F. Verify gas and oil pressures and electrical voltages required by heaters and provide pressure regulators and transformers as necessary.

G. Mounting shall be rigid brackets type and shall conform to manufacturers mounting instructions.

H. Electrical work shall install power and control wiring as shown on Electrical Drawings.
1. Work not shown on Electrical Drawings shall be provided by mechanical work.

I. Install shut-off valve in fuel supply line.
   1. Valve to meet all state and local codes.

3.02 ELECTRIC CEILING PANEL RADIANT HEATERS

A. Verify installation for T-Bar, recessed, wall or surface mounting.

B. T-Bar panels shall match ceiling tile as close as possible.

END OF SECTION

SECTION 26 05 00
ELECTRICAL: BASIC REQUIREMENTS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 19 - Wire and Cable: 600 Volt and Below.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 26 05 48 - Seismic Bracing Systems.
   8. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ETL Testing Laboratories (ETL).
   4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Industrial Control and Systems Enclosures.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.03 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
   2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
   3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
   4. Corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
   5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
   6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.04 SYSTEM DESCRIPTION

A. Coordinate installation of the service transformer and metering with the serving utility.
   1. The serving utility for this Project is Puget Sound Energy (PSE).
      a. Contact: Dan Saarinen, 425-956-7738.
   2. Contractor shall comply with utility standards.
   3. Contractor shall make application for new electrical service and coordinate installation with utility.
      a. Location of transformer and meter shall be coordinated with utility prior to installation.

4. Furnish and install components as noted in the table below and as required by utility.

ITEM	FURNISH	INSTALL
Transformer	Utility	Utility
Transformer Pad/Vault	Utility	Utility
Primary Connection at Transformer	Utility	Utility
Secondary Connection at Transformer	Utility	Utility
Primary Service Cable	Utility	Utility
Primary Service Conduit	Utility	Utility
Trenching/Backfill for Primary Circuit, Transformer Pad/Vault	Contractor	Contractor
Secondary Cable	Contractor	Contractor
Secondary Conduit	Contractor	Contractor
Meter Socket	Contractor	Contractor
Meter	Utility	Utility
Current Transformers (CT)	Utility	Utility
Cable from CT to Meter	Utility	Utility
Conduit from CT to Meter (1-1/4 IN RGS)	Contractor	Contractor

5. Submit switchboard SB0301 Shop Drawings to the serving utility company and obtain approval prior to ordering equipment.

1.05 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. See Specification Section 40 05 05 – Equipment: Basic Requirements and individual specification sections for submittal requirements for products defined as equipment.
   2. General requirements:
      a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      b. Include data sheets that include manufacturer's name and product model number.
         1) Clearly identify all optional accessories.
      c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
      d. Manufacturer's delivery, storage, handling and installation instructions.
      e. Product installation details.
      f. Product schematic wiring diagrams and connection wiring diagram.
      g. See individual specification sections for any additional requirements.

3. Product technical data:

    a. Provide submittal data for all products specified in PART 2 of this Specification Section.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 60 00 – Product Requirements.

B. Protect nameplates on electrical equipment to prevent defacing.

1.07 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
   1. Outdoor areas:

      a. Wet.

      b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

   2. Indoor areas:

      a. Dry.

      b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

   3. Tipping-process building:

      a. The tipping-process building is considered non-hazardous.

      b. All process equipment and materials handling equipment is completely covered and routine housekeeping will keep the area free of filtrated waste or flyings.

      c. All equipment: NEMA 4 construction in accordance with NEMA 250 and NEMA ICS 6.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Division 26 Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

C. Provide all components of a similar type by one (1) manufacturer.

2.02 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
   1. Approved manufacturers:
      a. Modular strut:
         1) Unistrut Building Systems.
         2) B-Line.
         3) Globe Strut.
         4) Or approved equal.
   2. Material requirements:
      a. Modular strut:
         1) Galvanized steel: ASTM A123 or ASTM A153.
      b. Structural members (e.g., I beams, L and C channels):
         1) Galvanized steel: ASTM A123.
         2) Aluminum: AA Type 6063-T6.
      c. Mounting plates:
         1) Galvanized steel: ASTM A123.
         2) Aluminum: AA Type 6063-T6.
      d. Mounting hardware:
         1) Galvanized steel.
         2) Stainless steel.
      e. Anchorage per Specification Section 05 50 00 – Metal Fabrications.

B. Field touch-up of galvanized surfaces.
   1. Zinc-rich primer.
      a. One (1) coat, 3.0 mils.
         1) ZRC Worldwide.
         2) Sherwin Williams Co.
         3) Carboline Co.
         4) Or approved equal.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
   1. NFPA 70.
   2. IEEE C2.
   3. The manufacturer's instructions.
   4. Specification Section 26 05 48 – Seismic Bracing Systems for seismic bracing of suspended components and equipment anchorage.

C. In general, conduit routing is not shown on the Drawings.
   1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
   2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
   1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
   2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
   3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
   4. See Specification Section 26 05 19 – Wire and Cable: 600 Volt and Below for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operating and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 48 IN.
      b. Receptacle in architecturally finished areas (to center): 18 IN.
      c. Receptacle on exterior wall of building (to center): 18 IN.
      d. Receptacle in non-architecturally finished areas (to center): 48 IN.
      e. Telephone outlet in architecturally finished areas (to center): 18 IN.

f. Telephone outlet for wall-mounted phone (to center): 54 IN.

g. Safety switch (to center of operating handle): 54 IN.

h. Separately mounted motor starter (to center of operating handle): 54 IN.

i. Pushbutton or selector switch control station (to center): 48 IN.

j. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Project Representative's approval:
      a. 1 FT at grade, floor and roof level in any direction in the horizontal plane.
      b. 6 IN for equipment other than lighting at ceiling level in any direction in the horizontal plane.
      c. 6 IN for lighting fixtures at ceiling level in any direction in the horizontal plane.
      d. 1 FT on walls in a horizontal direction within the vertical plane.
      e. Changes in equipment location exceeding those defined above require the Project Representative's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   2. Wet areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   3. Corrosive areas:
      a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 05 50 00 – Metal Fabrications.

2. Do not cut, or weld to, building structural members.
3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

N. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

O. Do not use materials that may cause the walls or roof of a building to discolor or rust.

P. Identify electrical equipment and components in accordance with Specification Section 10 14 00 – Identification Devices.

3.02 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
1. See Specification Section 01 73 20 - Openings and Penetrations in Construction.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning: See Specification Section 01 70 00 – Execution Procedures.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
4. Repair surfaces which will be inaccessible after installation prior to installation.
5. See Specification Section 26 05 33 – Raceways and Boxes for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

END OF SECTION

SECTION 26 05 01

ELECTRICAL COMMISSIONING

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes: Definitions, warranties, test equipment requirements, and electrical commissioning requirements as required for LEED® Certification.

B. Related Sections:

1. Section 01 95 00 - Commissioning Requirements.

1.02 WARRANTY

A. Manufacturer's Warranty:

1. Commissioning, inspecting, and testing shall not modify terms or time periods of mechanical equipment, systems, and controls warranties including related equipment and systems, and adjacent work.

PART 2 – PRODUCTS - (NOT APPLICABLE TO THIS SECTION)

PART 3 – EXECUTION

3.01 WORK BY CONTRACTOR

A. Assist the Commissioning Agent in preparing commissioning procedures by providing data pertaining to electrical and control equipment, and installation procedures.

B. As part of the required submittals for the Contract, submit the following:

1. Within 3 months of Notice to Proceed 2, submit for each electrical system and piece of electrical equipment the manufacturer’s startup and installation procedures, including field testing and diagnostic tables requiring completion prior to manufacturer issuing a valid warranty for the installation.

2. Provide for System Status Table electronic files for Excel spreadsheet (Excel format) listing the location, type and status of each device being commissioned, allowing space for “comments” column. Location, type and status variables to be determined by Commissioning Agent based on specified functions of each device. Devices include, but not limited to:

    a. Occupancy sensors.

    b. Daylighting (interior photocell) sensor.

    c. Lighting relay panel.

3. Example of details required in spreadsheet for given device: Column with label for each occupancy sensor by room number. Example of sensor label: “OS102-1” for first occupancy sensor in Room 102. Verify room numbers with Owner prior to submittal. Column for zone # as relating to Shop Drawings (noting that each room should be its own zone), (Y/N) status to the following three mandatory parameters: covers room completely with remaining sensors (Y/N), sensor aimed and mounted properly (Y/N), lights go out after programmed delay, including emergency lighting (Y/N).

C. Complete phases of work so functional electrical and control systems can be started, tested and calibrated.

D. Start of commissioning procedures before system completion does not relieve electrical equipment installer from completing electrical systems in accordance with the Contract Documents and the construction schedule.

E. Ensure that equipment and systems are installed and started in accordance with the Contract Documents and manufacturer’s requirements and recommendations.

F. Assist the Commissioning Agent in functional testing of systems slated for commissioning.

3.02 COMMISSIONING PROCEDURES

A. Commissioning Procedures by Commissioning Agent:

1. Perform and document electrical and control tests for Electrical commissioning systems through each mode of operation.

2. Commissioning Agent will prepare Commissioning Procedures that will include, in field data collection format, the detailed test procedures, test conditions, and criteria for acceptance of test results.

3.03 COMMISSIONING PROCEDURE CONTENT EXAMPLE

A. The following is intended as an example of the degree of rigor to be expected from the Commissioning Procedures. It is not intended to represent actual sequence and tests for this project.

1. Prefunctional Checklist:

   a. Schedule a walk thru with daylighting manufacturer to locate photocells in each daylighting zone. Provide written confirmation from daylighting manufacturer representative that each photocell has been located per his recommendations.

   b. Provide light level measurements using a photometer within each daylighting zone at 0 IN AFF when no natural light is present. Record footcandle measurement, date and time for each zone.

   c. Provide light level measurements using a photometer within each daylighting zone at 0 IN AFF during daylight hours, where no electrical light is present. Record footcandle measurement, date and time for each zone.

2. Preliminary Test Procedures:

   a. Set sensitivity to designed footcandle level for each daylighting zone. Designed light level is measurement taken when no natural light level is present.

   b. Set time delay to minimum. Set deadband to 50 percent.

3. Test Procedures:

   a. Verify luminaires within daylighting zone turn “on” when natural light level drop below designed light level. Adjust sensitivity as necessary to meet designed light level.

   b. Verify luminaires within daylighting zone turn “off” when natural light level reach deadband setpoint. Increase deadband as necessary to avoid cycling of luminaires.

   c. Set time delay to maximum when test procedures are completed.

END OF SECTION

SECTION 26 05 19
WIRE AND CABLE: 600 VOLT AND BELOW

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Instrumentation cable.
      e. Fiber optic cable.
      f. Wire connectors.
      g. Insulating tape.
      h. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   2. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
    a. 568, Commercial Building Telecommunications Cabling Standard.
    b. 598-C, Optical Fiber Cable Color Coding.
5. Underwriters Laboratories, Inc. (UL):
    a. 13, Standard for Safety Power-Limited Circuit Cables.
    b. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
    c. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
    d. 467, Standard for Safety Grounding and Bonding Equipment.
    e. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
    f. 486C, Standard for Safety Splicing Wire Connections.
    g. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
    h. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
    i. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
    j. 1666, Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
    k. 2250, Standard for Safety Instrumentation Tray Cable.

1.03 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:
    1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
    2. The following are specific types of instrumentation cables:
        a. Analog signal cable:
            1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
            2) Commonly used types are defined in the following:
                a) TSP: Twisted shielded pair.
                b) TST: Twisted shielded triad.
        b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in Part 2 of this specification except:
         1) Wire connectors.
         2) Insulating tape.
         3) Cable lubricant.
      b. See Specification Section 26 05 00 – Electrical: Basic Requirements for additional requirements.

1.05 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00 – Electrical: Basic Requirements.

1.06 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. American Insulated Wire Corporation.
      b. General Cable.
      c. Manhattan/CDT.
      d. Southwire Company.

e. Or Approved Equal.

2. Shielded VFD cable:
   a. Belden CDT Inc.
   b. Okonite Company.
   c. Olfex Wire and Cable, Inc.
   d. Priority Wire and Cable (Prysmian).
   e. Rockbestos-Surprenant Cable Corp.
   f. Southwire Company.
   g. Tamaqua Cable Products.
3. Instrumentation cable:
   a. Analog cable:
      1) Alpha Wire Corporation.
      2) American Insulated Wire Corporation.
      3) Belden CDT Inc.
      4) General Cable.
      5) Manhattan/CDT.
      6) Or Approved Equal.
4. Wire connectors:
   a. Burndy Corporation.
   b. Buchanan.
   c. Ideal.
   d. Ilsco.
   e. 3M Co.
   f. Teledyne Penn Union.
   g. Thomas and Betts.
   h. Phoenix Contact.
   i. Or Approved Equal.
5. Insulating and color coding tape:
   a. 3M Co.
   b. Plymouth Bishop Tapes.
   c. Red Seal Electric Co.
   d. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
   5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
   5. Number of conductors as required, including a bare ground conductor.
   6. Individual conductor color coding:
      a. ICEA Method 4.
      b. See PART 3 of this Specification Section for additional requirements.
   7. Conform to NFPA 70 Type TC.

C. Control Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
      a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
   5. Individual conductor color coding:
      a. NEMA/ICEA Method 1, Table E-2.
      b. See Part 3 of this Specification for additional requirements.

6. Conform to NFPA 70 Type TC.

D. Electrical Equipment Control Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to UL 44 for Type SIS insulation.
   5. Conform to UL 83 for Type MTW insulation.

E. Shielded VFD Cable:
   1. Conductor shall be copper, stranded with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Cables No. 1 AWG and less:
      a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type RHW-2 or XHHW-2 insulation with an overall PVC jacket.
      b. Shielding: 85 percent tinned copper braid, full size tinned copper drain wire and 100 percent foil shield.
      c. Number of conductors: 3 PH and 1 full size ground.

F. Instrumentation Cable:
   1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   2. Analog cable:
      a. Tinned copper conductors.
      b. 300 V or 600 V PVC insulation with PVC jacket.
      c. Twisted with 100 percent foil shield coverage with drain wire.
      d. Six (6) twists per foot minimum.
      e. Individual conductor color coding: ICEA Method 1, Table K-2.
      f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
   3. Digital cable:
      a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
      b. Horizontal voice and data cable:
         1) Category 6 per TIA/EIA/ANSI 568.
         2) Cable shall be label-verified.
         3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
         4) Conductors: No. 24 AWG solid untinned copper or as indicated on the Drawings.

5) Rated CMP per NFPA 70.

c. Conform to NFPA 262 and NFPA 70 Type ITC.

G. Fiber Optic Cable:

1. Design and fabrication - Multi-mode:

a. Type:

1) Indoor: Tight buffered or loose tube with a dry gel water blocking system.

2) Outdoor: Loose tube with a wet or dry gel water blocking system.

b. Number of fibers: As indicated on the Drawings.

c. Fiber size: 62.5/125 micrometer (core diameter/cladding diameter).

d. Glass fiber core.

e. Step index.

f. Maximum attenuation:

1) At 850 nm: 3.75 dB/km.

2) At 1300 nm: 1.5dB/km.

g. Minimum bandwidth:

1) At 850 nm: 160 MHz/km.

2) At 1300 nm: 500 MHz/km.

h. Maximum tensile load:

1) Installation: 225 LBS.

2) Long term: 67 LBS.

i. Cable jacket material:

1) In rigid steel conduit: PVC, or polyethylene.

2) In plenum or riser: Flame retardant material, PVC not allowed.

a) Plenum applications: Cable materials shall pass NFPA 262 requirements.

b) Riser applications: Cable materials shall pass UL 1666 requirements.

3) In cable tray: Polyethylene or equivalent; PVC not allowed.

a) Meet vertical flame tray test requirements of NFPA 262.

j. Cables shall be listed and marked in accordance with the requirements of NFPA 70.

k. Optical fiber cable type utilized shall be in accordance with NFPA 70.

l. Utilize ST type connectors:

1) Tip material: Ceramic or ceramic/glass composite.

2) Utilize connectors which do not require adhesive, epoxy, or polish.

H. Wire Connectors:
   1. Twist/screw on type:
      a. Insulated pressure or spring type solderless connector.
      b. 600 V rated.
      c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
      d. Phase and neutral conductors: Conform to UL 486C.
   2. Compression and mechanical screw type:
      a. 600 V rated.
      b. Ground conductors: Conform to UL 467.
      c. Phase and neutral conductors: Conform to UL 486A.
   3. Terminal block type:
      a. High density, screw-post barrier-type with white center marker strip.
      b. 600 V and ampere rating as required, for power circuits.
      c. 600 V, 20 ampere rated for control circuits.
      d. 300 V, 15 ampere rated for instrumentation circuits.
      e. Conform to NEMA ICS 4 and UL 486A.

I. Insulating and Color Coding Tape:
   1. Pressure sensitive vinyl.
   2. Premium grade.
   3. Heat, cold, moisture, and sunlight resistant.
   4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
   5. For cold weather or outdoor location, tape must also be all-weather.
   6. Color:
      a. Insulating tape: Black.
      b. Color coding tape: Fade-resistant color as specified herein.
   7. Comply with UL 510.

J. Electrical Equipment Enclosure and Cable Sealing Bushing:
   1. Galvanized malleable or ductile iron.
   2. Zinc electroplated locknut.
   3. Neoprene sealing ring.

K. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Permitted Usage of Insulation Types:
   1. Type XHHW-2:
      a. Building wire and power cable No. 6 AWG and larger in all exterior areas and non-architectural finished areas.
      b. Building wire and power and control cable in conduit below grade.
   2. Type THHN/THWN and THHN/THWN-2:
      a. Building wire and power and control cable No. 8 AWG and smaller in architectural finished areas.
   3. Type SIS and MTW:
      a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.
   4. Shielded VFD Cable:
      a. For wiring between a VFD and motor when routing in cable trays or conduit.

B. Conductor Size Limitations:
   1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
   2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
   3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

C. Color Code All Wiring as Follows:
   1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

      a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.

b. Conductors larger than No. 6 AWG:

1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:

a) Continuous colored outer finish along its entire length.

b) 3 IN of colored tape applied at the termination.

2) Insulated grounding conductor shall be identified by one (1) of the following methods:

a) Continuous green outer finish along its entire length.

b) Stripping the insulation from the entire exposed length.

c) Using green tape to cover the entire exposed length.

3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA Method 4 with:

a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

b. Ground conductor: Bare.

3. Shielded VFD cable ICEA Method 4 with:

a. Phase conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

b. Ground conductor: Green color insulation or bare.

4. Control cables NEMA/ICEA Method 1, Table E-2:

a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.

b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.

D. Install all wiring in raceway and/or cable tray unless otherwise indicated on the Drawings.

E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:

1. Where specifically indicated on the Drawings.

2. Where field conditions dictate and written permission is obtained from the Project Representative.

3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
    a. The combinations shall comply with the following:
        1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
        2) 125 Vdc shall be isolated from all other AC and DC circuits.
        3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
    a. The combinations shall comply with the following:
        1) Analog signal circuits may be combined.
        2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.
    a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
        1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
        2) The neutral conductors may not be shared.
        3) Up sizing raceway size for the size and quantity of conductors.

F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
    1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
    1. Feeder and branch power circuits:
        a. Device outlet boxes:
            1) Twist/screw on type connectors.
        b. Junction and pull boxes and wireways:
            1) Twist/screw on type connectors for use on No. 8 and smaller wire.
            2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
        c. Motor terminal boxes:
            1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
            2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.

d. Manholes or handholes:

1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.

2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.

2. Control circuits:

a. Junction and pull boxes: Terminal block type connector.

b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.

c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.

3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Project Representative.

a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.

b. Junction and pull boxes: Terminal block type connector.

c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

5. Provide electrical equipment enclosure and cable sealing bushing when exposed conductors or cables enter the enclosure from cable trays.

H. Insulating Tape Usage:

1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.

2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.

3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

I. Color Coding Tape Usage: For color coding of conductors.

J. Fiber Optic Cable:

1. Unless indicated otherwise, install all fiber optic cable in conduit.

2. In cable trays, the cable(s) shall be installed in an interdict that is placed in the tray for protection of the cable.

3. Splicing:

a. Optical fibers shall not be spliced.

b. Utilize dust tight wall-mounted interconnect center to provide the following:

1) Interconnect fiber optic cable to jumper cable assemblies for connection to the opto-electronic interface.

2) Where exposed to contact with electric light or power conductors, the noncurrent carrying metallic members (if applicable) of optical fiber cables entering buildings shall be grounded as close to the point of entrance as practicable in accordance with NFPA 70.

K. Install cables in accordance with the requirements of NFPA 70.

L. Conductor insulation on conductors No. 10 AWG and less shall not be stripped using a side cutter or any other similar tool.

M. The insulation shall be stripped using a stripping tool specifically designed for the conductor size being stripped.

3.02 FIELD QUALITY CONTROL

A. See Specification Section 26 08 13 - Acceptance Testing.

B. Test installed fiber optic cable system to verify the following:
1. Continuity of all installed fibers and associated connectors.

2. Maximum attenuation requirements of specification are not exceeded.

END OF SECTION

SECTION 26 05 26
GROUNDING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 32 31 13 - Chain Link Fence and Gates.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 00 - Electrical: Basic Requirements.
   6. Section 26 05 19 - Wire and Cable: 600 Volt and Below.
   7. Section 26 05 33 - Raceways and Boxes.
   8. Section 26 08 13 - Acceptance Testing.
   9. Section 26 41 13 - Lightning Protection System.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
         1) Article 250, Grounding and Bonding.
         2) Article 610, Cranes and Hoists.
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Grounding clamps, terminals and connectors.
         2) Exothermic welding system.
      b. See Specification Section 26 05 00 – Electrical: Basic Requirements for additional requirements.

C. Miscellaneous:
   1. Ground rod and/or grounding system resistance and continuity test reports signed by the Project's supervising electrical foreman.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. Burndy.
      b. Harger Lightning Protection.
      c. Heary Brothers.
      d. Joslyn.
      e. Robbins Lightning Protection.
      f. Thomas & Betts (Blackburn).
      g. Thompson.
      h. Or Approved Equal.
   2. Exothermic weld connections:
      a. Erico Products Inc., Cadweld.
      b. Harger Lightning Protection.
      c. Thermoweld.
      d. Or Approved Equal.
   3. Prefabricated composite test stations:
      a. Quazite Composolite.
      b. Armorcast Products Company.

c. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 COMPONENTS

A. Wire and Cable:
   1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
   2. Insulated conductors: Color coded green, per Specification Section 26 05 19 – Wire and Cable: 600 Volt and Below.

B. Conduit: As specified in Specification Section 26 05 33 – Raceways and Boxes.

C. Ground Bars:
   1. Solid copper:
      a. 1/4 IN thick.
      b. 2 or 4 IN wide.
      c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
   2. Predrilled grounding lug mounting holes.
   3. Stainless steel or galvanized steel mounting brackets.
   4. Insulated standoffs.

D. Ground Rods:
   1. 3/4 IN x 10 FT.
   2. Copperclad:
      a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
      b. Corrosion resistant bond between the copper and steel.
      c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:
   1. Mechanical type:
      a. Standards: UL 467.
      b. High copper alloy content.
   2. Compression type for interior locations:
      a. Standards: UL 467.
      b. High copper alloy content.
      c. Non-reversible.
      d. Terminals for connection to bus bars shall have two bolt holes.

3. Compression type suitable for direct burial in earth or concrete:
    a. Standards: UL 467, IEEE 837.
    b. High copper alloy content.
    c. Non-reversible.

F. Exothermic Weld Connections:
1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other nonconducting material from contact surfaces before making ground connections.
4. Where ground conductors pass through floor slabs or building walls provide non-metallic sleeves and install per Specification Section 01 73 20 – Openings and Penetrations in Construction.
5. Do not splice grounding conductors except at ground rods.
6. Install ground rods and grounding conductors in undisturbed, firm soil.
    a. Provide excavation required for installation of ground rods and ground conductors.
    b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
    c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld.
    d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
    e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.

2. Grounding conductor terminations:
    a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
    b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
    c. Piping systems use mechanical type connections.
    d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.
    e. At all above grade terminations, the conductors shall be labeled per Specification Section 10 14 00 – Identification Devices.
3. Ground ring grounding system:
    a. Ground ring consists of ground rods and a grounding conductor looped around the structure.
    b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.
    c. Provide a minimum of four (4) ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
    d. Building/Structure grounding:
        1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
    e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
4. Triad grounding system:
    a. Triad consists of three ground rods arranged in a triangle separated by 10 FT and a grounding conductor interconnecting each ground rod.
    b. Place first ground rod a minimum of 10 FT from the structure foundation and 2 FT 6 IN below grade.
    c. Grounding conductor: Bare conductor, size as indicated on the Drawings.

C. Supplemental Grounding Electrode:
1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
2. Metal light poles:
    a. Connect metal pole to a ground rod.
    b. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
    a. Connect metallic structure to a ground rod.

b. Grounding conductor: #6 AWG minimum.

4. Engine generator:

a. Connect generator frame to the ground ring at two locations (opposite corners of frame).

b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

5. Ground cranes and hoists in accordance with NFPA 70, Article 610.

D. Other Bonding Requirements:

1. Chain link fence and gates:

a. Per detail on the Drawings.

E. Lightning Protection System:

1. Connect to ground ring.

2. See Specification Section 26 41 13 - Lightning Protection System.

F. Low Voltage Transformer Separately Derived Grounding System:

1. Ground separately mounted step-down transformers XO terminal to one of the following:

a. Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic weld.

b. Closest water pipe using a mechanical type connection.

c. Ground bar.

2. Grounding bar: 1 FT in length and mounted in electrical room or adjacent to transformer.

3. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar.

a. Terminate the conductors on ground bars with a compression type terminal and bolt it to the ground bar with two bolts.

b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

G. Telecommunications Grounding System:

1. Coil 5 FT of insulated #6 AWG conductor at each telephone terminal board and mechanically connected to the ground bar.

2. Grounding bar: Mounted on or adjacent to telephone terminal board.

3. Interconnect all telecommunication ground bars in a daisy chain or radial fashion to the main ground bar.

a. Grounding conductor: Bare conductor, size as indicated on the Drawings.

H. Raceway Bonding/Grounding:

1. All metallic conduit shall be installed so that it is electrically continuous.

2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

I. Equipment Grounding:
   1. All utilization equipment shall be grounded with an equipment ground conductor.

J. Cable Tray Grounding:
   1. Make metal cable tray electrically continuous by one of the following methods:
      a. Tray sections and fittings suitable for grounding purposes.
      b. Provide bonding jumpers at discontinuous joints.
      c. Lay a grounding conductor within the tray for bonding of each individual tray section.
         1) Provide a minimum of one ground lug per tray section.
         2) Grounding conductor: Bare #4 AWG minimum.
         3) Securely tie the grounding conductor to cable tray every 10 FT. Bond the grounding conductor to the cable tray run a minimum of every 50 FT with a UL listed connector.
   2. Bond the tray or tray grounding conductor to every electrical equipment ground bus or telecomm backboard ground bus where conductors terminate.
   3. Bond all conduits to the tray that extend the conductors to field equipment.

K. Manhole and Handhole Grounding:
   1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
      a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
   2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.02 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Project Representative.

B. See Specification Section 26 08 13 - Acceptance testing.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 05 43 - Electrical: Exterior Underground.
   5. Section 26 27 26 - Wiring Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      c. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      c. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
    a. C80.1, Electric Rigid Steel Conduit (ERSC).
    b. C80.3, Steel Electrical Metallic Tubing (EMT).
    c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
4. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
    a. 1, Standard for Flexible Metal Conduit.
    b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
    c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
    d. 360, Standard for Liquid-Tight Flexible Steel Conduit.
    e. 467, Grounding and Bonding Equipment.
    f. 514A, Metallic Outlet Boxes.
    g. 514B, Conduit, Tubing, and Cable Fittings.
    h. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
    i. 797, Electrical Metallic Tubing - Steel.
    j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
    k. 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
    1. Product technical data:
        a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
            1) Conduit fittings.
            2) Support systems.
        b. See Specification Section 26 05 00 - Electrical: Basic Requirements for additional requirements.

2. Fabrication and/or layout Drawings:
    a. Proposed routing of raceways buried under concrete floors and embedded in concrete walls.
        1) Identify conduit by tag number of equipment served or by circuit schedule number.
    b. Proposed routing and details of construction, including raceway and rebar, for raceways embedded in floor slabs, walls and columns.
        1) Identify conduit by tag number of equipment served or by circuit schedule number.
    c. Proposed location and details of construction for openings in slabs and walls for raceway runs.
    d. Identify dimensional size of pull and junction boxes to be used.
    e. Seismic location installation details.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Rigid metallic conduits:
        a. Allied Tube and Conduit Corporation.
        b. Triangle PWC Inc.
        c. Western Tube and Conduit Corporation.
        d. Wheatland Tube Company.
        e. Or Approved Equal.
    2. PVC coated rigid metallic conduits and repair kits:
        a. Occidental Coating Company.
        b. Perma-Cote.
        c. Rob-Roy Ind.
        d. Raychem "GelTek" tape.
    3. Rigid non-metallic conduit:
        a. Carlon.
        b. Cantex.
        c. Osburn Associates.
        d. Or Approved Equal.

4. Flexible conduit:
    a. AFC Cable Systems.
    b. Anamet, Inc.
    c. Electri-Flex.
    d. Flexible Metal Hose Company.
    e. International Metal Hose Company.
    f. Triangle PWC Inc.
    g. Or Approved Equal.
5. Wireway:
    a. Hoffman Engineering Company.
    b. Wiegmann.
    c. Square D.
    d. Or Approved Equal.
6. Conduit fittings and accessories:
    a. Appleton.
    b. Carlon.
    c. Cantex.
    d. Crouse-Hinds.
    e. Killark.
    f. Osburn Associates.
    g. OZ Gedney Company.
    h. RACO.
    i. Steel City.
    j. Thomas and Betts.
    k. Or Approved Equal.
7. Support systems:
    a. Unistrut Building Systems.
    b. B-Line Systems Inc.
    c. Kindorf.
    d. Minerallac Fastening Systems.
    e. Caddy.
    f. Or Approved Equal.
8. Outlet, pull and junction boxes:
    a. Appleton Electric Co.
    b. Crouse-Hinds.

c. Killark.

d. O-Z/Gedney.

e. Steel City.

f. Raco.

g. Bell.

h. Hoffman Engineering Co.

i. Wiegmann.

j. B-Line Circle AW.

k. Adalet.

l. Rittal.

m. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 RIGID METALLIC CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
   a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
   b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
   c. Nominal 2 mil, minimum, urethane interior coating.
   d. Urethane coating on threads.
   e. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
   f. Female Ends:
      1) Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
      2) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
   g. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.

C. Electrical Metallic Tubing (EMT):
   1. Mild steel with continuous welded seam.
   2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
   3. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
   4. Standards: NEMA/ANSI C80.3, UL 797.

2.03 RIGID NON-METALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
   1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
   2. Rated for direct sunlight exposure.
   3. Fire retardant and low smoke emission.
   4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
   5. Standards: NEMA TC 2, UL 651.

2.04 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
   1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
   2. Standard: UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
   1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
   2. Extruded PVC outer jacket positively locked to the steel core.
   3. Liquid and vaportight.
   4. Standard: UL 360.

2.05 WIREWAY

A. General:
   1. Suitable for lay-in conductors.
   2. Designed for continuous grounding.
   3. Covers:
      a. Hinged or removable in accessible areas.
      b. Non-removable when passing through partitions.
   4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
   5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
   1. 14 or 16 gage steel without knockouts.
   2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Raintight (NEMA 3R) Wiring Trough:
   1. 14 or 16 GA galvanized steel without knockouts.
   2. Cover: Non-gasketed and held in place by captive screws.

D. Watertight (NEMA 4X rated) Wireway:
   1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

E. Dusttight (NEMA 12 rated) Wireway:
   1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

2.06 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:
   1. General:
      a. In hazardous locations listed for use in Class I, Groups C and D locations.
   2. Locknuts:
      a. Threaded steel or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   3. Bushings:
      a. Threaded, insulated metallic.
      b. Grounding or non-grounding type.
   4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
   5. Couplings:
      a. Threaded straight type: Same material and finish as the conduit with which they are used on.
      b. Threadless type: Gland compression or self-threading type, concrete tight.
   6. Unions: Threaded galvanized steel or zinc plated malleable iron.

7. Conduit bodies (ells and tees):
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. Cover:
        1) Clip-on type with stainless steel screws.
        2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. With or without drain and breather.
    d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Expansion couplings:
    a. 2 IN nominal straight-line conduit movement in either direction.
    b. Galvanized steel with insulated bushing.
    c. Gasketed for wet locations.
    d. Internally or externally grounded.
11. Expansion/deflection couplings:
    a. 3/4 IN nominal straight-line conduit movement in either direction.
    b. 30-degree nominal deflection from the normal in all directions.
    c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    d. Internally or externally grounded.
    e. Watertight, raintight and concrete tight.
12. Standards: UL 467, UL 514B, UL 886.

B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS" and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:
   1. Connectors:
      a. Straight, angle and offset types furnished with locknuts.
      b. Zinc plated steel.
      c. Insulated gland compression type.
      d. Concrete and raintight.
   2. Couplings:
      a. Zinc plated steel.
      b. Gland compression type.
      c. Concrete and raintight.
   3. Conduit bodies (ells and tees):
      a. Body: Copper free aluminum with threaded hubs.
      b. Standard and mogul size.
      c. Cover:
         1) Screw down type with steel screws.
         2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
   4. Standard: UL 514B.

D. Fittings for Use with FLEX:
   1. Connector:
      a. Zinc plated malleable iron.
      b. Squeeze or clamp-type.
   2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT:
   1. Connector:
      a. Straight or angle type.
      b. Metal construction, insulated and gasketed.
      c. Composed of locknut, grounding ferrule and gland compression nut.
      d. Liquid tight.
   2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Non-Metallic PVC Conduit:
   1. Coupling, adapters and conduit bodies:
      a. Same material, thickness, and construction as the conduits with which they are used.
      b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.

c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.

2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.

3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Weather and Corrosion Protection Tape:
1. PVC based tape, 10 mils thick.

2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.

3. Used with appropriate pipe primer.

2.07 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.

2. Stamp with the name or trademark of the manufacturer.

2.08 OUTLET BOXES

A. Metallic Outlet Boxes:
1. Hot-dip galvanized steel.

2. Conduit knockouts and grounding pigtail.

3. Styles:

a. 2 IN x 3 IN rectangle.

b. 4 IN square.

c. 4 IN octagon.

d. Masonry/tile.

4. Accessories:

a. Flat blank cover plates.

b. Barriers.

c. Extension, plaster or tile rings.

d. Box supporting brackets in stud walls.

e. Adjustable bar hangers.

5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.

2. Threaded hubs and grounding screw.

3. Styles:
    a. "FS" or "FD".
    b. "Bell".
    c. Single or multiple gang and tandem.
    d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
5. Standards: UL 514A, UL 886.

C. See Specification Section 26 27 26 – Wiring Devices for wiring devices, wallplates and coverplates.

2.09 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four (4) sides.
3. Flat cover fastened with screws.

B. NEMA 4 Rated:
1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
6. Cover with oil resistant gasket.

C. NEMA 7 Rated:
1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
2. Drilled and tapped openings or tapered threaded hub.
3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
4. External mounting flanges.
5. Grounding lug.
6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

D. NEMA 12 Rated:
   1. Body and cover:
      a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
      b. Type 5052 H-32 aluminum, unpainted.
   2. Seams continuously welded and ground smooth.
   3. No knockouts.
   4. External mounting flanges.
   5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   6. Flat door with oil resistant gasket.

E. Miscellaneous Accessories:
   1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   2. Split covers when heavier than 25 LBS.
   3. Weldnuts for mounting optional panels and terminal kits.
   4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

F. Standards: NEMA 250, UL 50.

2.10 SPECIAL PURPOSE BOXES

A. Flush in Floor Duplex Receptacles:
   1. Dual level, fully adjustable box with power fitting and brass carpet flange.

2.11 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
   1. Material requirements.
      a. Galvanized steel: ASTM A123 or ASTM A153.

B. Single Conduit and Outlet Box Support Fasteners:
   1. Material requirements:
      a. Zinc plated steel.
      b. Stainless steel.
      c. Malleable iron.
      d. Steel protected with zinc phosphate and oil finish.

2.12 OPENINGS AND PENETRATONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
   1. See Specification Section 01 73 20 – Openings and Penetrations in Construction.

PART 3 – EXECUTION

3.01 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
   1. NFPA 70.
   2. Manufacturer instructions.

B. Size of Raceways:
   1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
   2. Unless specifically indicated otherwise, the minimum raceway size shall be:
      a. Conduit: 3/4 IN.
      b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
   2. Do not reduce the internal diameter of the conduit when making conduit bends.
   3. Degrease threads after threading and apply a zinc rich paint.
   4. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
   1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
   2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
   3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
   1. See Specification Section 01 73 20 – Openings and Penetrations in Construction.

3.02 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
   1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
   2. Run in straight lines parallel to or at right angles to building lines.
   3. Do not route conduits:
      a. Through areas of high ambient temperature or radiant heat.
      b. In suspended concrete slabs.
   4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
   5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:
   1. As indicated on the Drawings.
   2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
   3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.
   4. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.

5. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with the Project Representative's permission.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:
   1. Between instrumentation and telecommunication: 1 IN.
   2. Between instrumentation and 125 V, 48 V and 24 Vdc, 2 IN.
   3. Between instrumentation and 600 V and less AC power or control: 6 IN.
   4. Between instrumentation and greater than 600 Vac power: 12 IN.
   5. Between telecommunication and 125 V, 48 V and 24 Vdc, 2 IN.
   6. Between telecommunication and 600 V and less AC power or control: 6 IN.
   7. Between telecommunication and greater than 600 Vac power: 12 IN.
   8. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.
   9. Between 125 V, 48 V and 24 Vdc and greater than 600 Vac power: 2 IN.
   10. Between 600 V and less AC and greater than 600 Vac: 2 IN.
   11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
   1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
   1. See Specification Section 01 73 20 – Openings and Penetrations in Construction.

H. New construction:
   1. Sleeves and blockouts:
      a. Set in masonry walls during erection.
      b. Set in concrete walls and floors during forming.
   2. Sleeves not considered to structurally replace the displaced concrete.

I. Conduit embedded in floor slabs or buried under slab-on-grade:
   1. Run in the most direct, practical route.
   2. Not to be installed under equipment pads unless approved by Project Representative.
   3. No crossovers unless approved by the Project Representative.

4. To be placed, backfilled and compacted in the slab subgrade.
5. Secured in place to prevent movement during the backfill and pour.

J. Conduits and accessories embedded in concrete where shown on the Contract Drawings:
   1. In reinforced concrete construction:
      a. Conduit shall not be run in beams.
      b. Place conduit after reinforcing steel has been laid.
      c. The reinforcement steel shall not be displaced by the conduit.
      d. Provide a minimum of 1-1/2 IN of cover over conduit, excluding surface finish.
      e. Conduits parallel to main reinforcement shall be run near the center of the wall.
      f. Conduits perpendicular to main reinforcement shall be run midway between wall or slab supports.

3.03 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
   1. Power wire or cables: All raceway types.
   2. Control wire or cables: All raceway types.
   3. Instrumentation cables: Metallic raceway except non-metallic may be used underground.
   4. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
   1. Dry areas:
      a. RGS.
      b. EMT above 10 FT.
   2. Wet areas:
      a. RGS.
   3. NFPA 70 hazardous areas:
      a. RGS.

C. Permitted Raceway Types Per Routing Locations:
   1. In stud framed walls:
      a. EMT.
   2. In concrete block or brick walls:
      a. PVC-40.
   3. Above acoustical tile ceilings:
      a. EMT.

b. NEMA 1 rated wireway.

4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as dry or wet.
   c. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
   a. PVC-40.
6. Through floor penetrations, see Specification Section 01 73 20:
   a. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as dry or wet.
7. Direct buried conduits and ductbanks:
   a. PVC-80.
   b. 90 degree elbows for transitions to above grade:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
   c. Long sweeping bends greater than 15 degrees:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
8. Concrete encased ductbanks:
   a. PVC-40.
   b. Fiberglass.
   c. 90 degree elbows for transitions to above grade:
      1) RGS wrapped with factory applied weather and corrosion protection tape.
   d. Long sweeping bends greater than 15 degrees:
      1) RGS for sizes 2 IN and larger.

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.
      b. 3 FT to all other equipment.

E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.
      b. 3 FT to motors.
      c. 2 FT to all other equipment.

F. NEMA 1 Rated Wireway:
   1. Surface mounted in electrical rooms.
   2. Surface mounted above removable ceilings tiles of an architecturally finished area.

G. NEMA 3R Wiring Trough:
   1. Surface mounted in exterior locations.

H. NEMA 12 Rated Wireway:
   1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

I. Underground Conduit: See Specification Section 26 05 43 – Electrical: Exterior Underground.

3.04 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:
   1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.

B. Rigid non-metallic conduit and fittings shall be joined utilizing solvent cement.
   1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
   2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.
   3. Underground.

G. Terminate Conduits:
   1. In metallic outlet boxes:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   2. In NEMA 1 rated enclosures:
      a. RGS:
         1) Conduit hub and locknut.
         2) Insulated bushing and two (2) locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   3. In NEMA 12 rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
      b. Use grounding type locknut or bushing when required by NFPA 70.
   4. In NEMA 4 rated enclosures:
      a. Watertight, insulated and gasketed hub and locknut.
   5. In NEMA 7 and NEMA 9 rated enclosures:
      a. Into an integral threaded hub.
   6. When stubbed up through the floor into floor mount equipment:
      a. With an insulated grounding bushing on metallic conduits.
      b. With end bells on non-metallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.05 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Dry or wet and/or hazardous areas:
      a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
   2. Conduit type shall be compatible with the support system material.
      a. Galvanized steel system may be used with RGS and EMT.
      b. Stainless steel system may be used with RGS.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Architecturally finished areas:
      a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
      b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
      c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
   2. Dry or wet and/or hazardous areas:
      a. Material: Zinc plated steel, stainless steel and malleable iron.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   3. Conduit type shall be compatible with the support fastener material.
      a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.
      b. Stainless steel system may be used with RGS.
      c. Non-metallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

C. Conduit Support General Requirements:
   1. Maximum spacing between conduit supports per NFPA 70.
   2. Support conduit from the building structure.
   3. Do not support conduit from process, gas, air or water piping; or from other conduits.
   4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
      a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.

b. Conduit hangers:

1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.

c. Do not use suspended ceiling support systems to support raceways.

d. Hangers in metal roof decks:

1) Utilize fender washers.

2) Not extend above top of ribs.

3) Not interfere with vapor barrier, insulation, or roofing.

5. Conduit support system fasteners:

a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.

b. Do not use concrete nails and powder-driven fasteners.

3.06 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 – Electrical: Basic Requirements and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:

1. Permitted uses of metallic outlet boxes:

a. Housing of wiring devices:

1) Recessed in all stud framed walls and ceilings.

2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.

b. Pull or junction box:

1) Above gypsum wall board or acoustical tile ceilings.

2) Above 10 FT in an architecturally finished area where there is no ceiling.

3) Above 10 FT in dry non-architecturally finished areas.

2. Permitted uses of cast outlet boxes:

a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.

b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.

3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00– Electrical: Basic Requirements.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
    a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
    b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
    a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
    a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
    b. Pull or junction box surface mounted above 10 FT in areas designated as dry in architecturally and non-architecturally finished areas.
3. Permitted uses of NEMA 4 enclosure:
    a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
    a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
    a. Pull or junction box surface mounted in areas designated as Class I hazardous.
        1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
    a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

SECTION 26 05 36
CABLE TRAY

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Cable tray and associated fittings and supports.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 07 84 00 - Firestopping.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 00 - Electrical: Basic Requirements.
   6. Section 26 05 26 - Grounding.
   7. Section 26 05 33 - Raceways and Boxes.
   8. Division 27 - Communications.
   9. Division 28 - Electronic Safety and Security.
   10. Division 40 - Process Integration.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      b. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
      c. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   2. National Electrical Manufacturers Association (NEMA):
      a. VE-2, Metal Cable Tray Installation Guidelines.
   3. Underwriters Laboratories, Inc. (UL).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

5. Building Code:
    a. International Code Council (ICC):
        1) International Building Code and associated standards, 2009 Edition including all amendments, referred to herein as Building Code.

1.03 DEFINITIONS

A. Types of Cable Tray:
1. Ladder: A prefabricated metal structure consisting of two (2) longitudinal side rails connected by individual transverse members of rungs.
2. Ventilated trough: A prefabricated metal structure consisting of two (2) longitudinal side rails and a ventilated bottom with clear openings no greater than 4 IN.
3. Solid-bottom: A prefabricated metal structure consisting of two (2) longitudinal side rails and a bottom with no openings within the cable-bearing surface.
4. Channel: A prefabricated metal structure consisting of a one-piece ventilated or solid bottom channel section not exceeding 6 IN in width.
5. Single-rail: A prefabricated metal structure consisting of one (1) longitudinal rail with transversely connected rungs that project from one (1) or both sides, which may be single- or multi-tier.
6. Wire-mesh: A rigid tray systems constructed from high strength wire spaced parallel with 2 IN longitudinal and 4 IN transverse wire, spot welded at all intersections.

1.04 SYSTEM DESCRIPTION

A. The following is a brief description of the types of the trays to be used.
1. Administration Building: Wire-mesh.

B. Miscellaneous:
1. Cable tray systems are sized on the Drawings.
2. When cable tray system size is not shown on the Drawings or scheduled, the cable tray shall be sized in accordance with the NFPA 70 and the requirements of this Specification Section.
3. Cable tray runs, where shown, are diagrammatic and intended to be used as a guide, unless otherwise indicated on the Drawings.
    a. Site conditions may affect actual routing.
    b. Contractor shall coordinate routing and measurement with other trades and with equipment suppliers to avoid interference with equipment, piping, ductwork, etc.

1.05 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 – Electrical: Basic Requirements for additional requirements.
   2. Fabrication and/or layout Drawings:
      a. Routing, size and fittings.
      b. Seismic location installation details.

C. Quality Assurance Submittals: Cable tray fill calculations.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00 – Electrical: Basic Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wire-mesh cable tray systems:
      a. B-Line.
      b. T.J. Cope.
      c. Husky/Burndy.
      d. Cablofil.
      e. Chalfant.
      f. Niedex.
      g. Thomas & Betts.
      h. Or Approved Equal.
   2. Cable tray conduit and ground clamps and brackets:
      a. B-Line.
      b. P-W Ind.
      c. O.Z. Gedney.
      d. Thomas & Betts.
      e. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 COMPONENTS

A. Wire-Mesh Tray:
   1. Material:
      a. Steel wires and fasteners: ASTM A510 carbon steel hot dipped galvanized after fabrication per ASTM A123 or electroplated per ASTM B633.
   2. Fabrication:
      a. Wires formed into a 2 IN by 4 IN mesh pattern with intersecting wires welded together.
      b. The top of the side rails formed to create a safety system for the cables and installers (e.g., rounded transverse wire ends, top wire T welded to transverse wires).
      c. Fittings (bends, risers, tees, etc.) to be constructed on-site using side action bolt croppers and fastened using spring action couplers or clamps with bolts and nuts.
      d. Useable clear loading depth: Minimum 2 IN.
      e. Useable clear loading width: 12 IN.
      f. UL classified per NFPA 70 as an equipment grounding conductor.

B. Fittings:
   1. Radius of bends: As required for cable layout in tray.
   2. Degrees of arc for elbows: As required for cable tray layout.

2.03 ACCESSORIES

A. Accessories including but not limited to, splice plates, barrier strips, drop outs, box connector, end plate and conduit clamps to be the same material as the tray or other compatible material.

B. Covers and Associated Accessories:
   1. Material: Same base material as tray.

C. Cable Tray Ground Clamps:
   1. Malleable iron or tin-plated extruded aluminum with stainless steel screws.
   2. Serrated edges to bite into and bond to the cable tray system.

D. Support System:
   1. Material: See Specification Section 26 05 00 – Electrical: Basic Requirements for material specifications.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install products in accordance with NEMA VE-2 and as recommended by the manufacturer's instructions unless otherwise indicated on the Drawings.

B. Install cable tray, fittings and accessories, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.

C. Install cable tray systems as close as practical to the locations and elevations shown on the Drawings.
   1. Minor changes (12 IN or less) in location or elevation may be made to avoid interference with piping, ductwork and equipment.
   2. Obtain Project Representative's approval prior to making major changes (greater than 12 IN) in location or elevation.
   3. When cable tray is located adjacent to, beneath or near large piping or major equipment, or terminates at equipment; do not install cable tray until the installation of such piping and equipment is complete.
   4. Insure openings are provided in walls that cable tray will penetrate.
   5. Fire stop penetrations in fire rated walls per Specification Section 07 84 00 - Firestopping.
      a. Use a removable fire stopping system such as pillows.

D. Cable Tray Supports:
   1. Provide supports at required locations to provide the loading capacity per the Contractors fill calculations.
   2. Cantilever bracket type when cable tray is installed adjacent to a wall.
   3. Trapeze type hangers for all other applications.
   4. In seismic locations provide required supports and/or sway bracing per local Building Codes.

E. Permitted prefabricated bracket or trapeze type support system per area designations and tray material:
   1. Dry or wet areas:
      a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
   2. Tray material shall be compatible with the support system material.
      a. Galvanized steel system may be used with zinc coated trays.

F. Whenever cable tray system spans a structural expansion joint provide one (1) of the following:
   1. Expansion connector allowing a minimum of 1 IN straight-line movement of sections.
   2. A 2 IN discontinuity (gap) in the cable tray to allow horizontal and vertical movement.

G. Maintain electrical continuity of the cable tray system.
   1. Bolt connectors to each section or fitting.
   2. Span expansion connectors by a bonding jumper.
   3. Use one (1) of the following to bond conduits to the tray:
      a. Conduits connected to the cable tray system by a one-piece conduit clamp shall be considered bonded to the cable tray system.
      b. Terminate conduits connected to the cable tray system by a bracket and clamp assembly in an insulated grounding bushing and bond to the cable tray system.
   4. Tighten all bolted connections to manufacturer's recommendations to ensure electrical continuity.

H. Cable Tray System Grounding: See Specification Section 26 05 26 - Grounding.

I. Secure cables, in vertical runs of cable tray, with cable clamps or ties as near as practical to the top and bottom of the vertical run and at a maximum of 6 FT spacing over the length of the run.
   1. Plastic wire ties to be UV resistant type.

J. Conduit terminating at a cable tray system:
   1. See Specification Section 26 05 33 – Raceways and Boxes.

K. Use flanged fittings to terminate cable tray systems at switchgear, motor control centers, and other equipment, unless indicated otherwise on the Drawings.

L. Install barrier strips in cable tray systems containing both power and control wiring to physically separate the control cables from the power cables.

3.02 FIELD QUALITY CONTROL

A. Tray Fill Calculations:
   1. Cable tray fill shall not exceed NFPA 70 requirements.
      a. The Contractor shall coordinate the installation of all cables and maintain cable fill calculations and schedule of cables in the trays.

B. Where galvanized steel cable tray is cut, drilled, or where the protective coating has otherwise been damaged during installation, immediately coat the exposed steel surface with a rust-inhibitor and a finish coat of zinc-rich paint.

C. Remove trash and accumulated dirt from the entire cable tray system at the completion of the project and install covers where applicable.

D. Tagging and warning signs:
   1. See Specification Section 10 14 00 – Identification Devices.

END OF SECTION

SECTION 26 05 43
ELECTRICAL: EXTERIOR UNDERGROUND

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits and ductbanks.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 3 - Concrete.
   4. Section 10 14 00 - Identification Devices.
   5. Section 26 05 26 - Grounding.
   6. Section 26 05 33 - Raceways and Boxes.
   7. Section 31 21 33 - Trenching, Backfilling and Compacting for Utilities.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   3. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specification for Underground Enclosure Integrity.

1.03 DEFINITIONS

A. Direct-buried conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   2. Fabrication and/or layout Drawings:
      a. Provide dimensional Drawings of each manhole indicating all specified accessories and conduit entry locations.
      b. Provide cross-sectioned sketch of each concrete encased ductbank.
         1) Dimension spacing between conduits.
         2) Dimension concrete envelope and reinforcing, where applicable.
      c. Provide cross-section sketch of each direct-buried ductbank.
         1) Dimension from grade to direct buried ductbank.
         2) Dimension from direct buried ductbank to other utilities in the route.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Quazite Composolite.
      b. Armorcast Products Company.
      c. Synertech.
      d. Or Approved Equal.
   2. Precast manholes and handholes:
      a. Utility Vault Co.
      b. Oldcastle Precast, Inc.
      c. Lister Industries.
      d. Or Approved Equal.
   3. Manhole and handhole and ductbank accessories:
      a. Neenah.
      b. Unistrut.
      c. Condux International, Inc.

d. Underground Devices, Inc.

e. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 15.
3. Open bottom.
4. Stackable design as required for specified depth.
5. Cover:
   a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
   b. Non-gasketed bolt down with stainless steel penta head bolts.
   c. Lay-in non-bolt down, when cover is over 100 LBS.
   d. One or multiple sections so the maximum weight of a section is 125 LBS.
6. Cover lifting hook: 24 IN minimum in length.

B. Precast Manholes and Handholes:
1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with a 12 IN x 12 IN or 12 IN DIA french drain in the bottom of each manhole.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cable pulling eyes opposite all conduit entrances.
   a. Coordinate exact location with installer.

2.03 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES

A. Cover and Frame:
1. Cast ductile iron: ASTM A536.
2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.
4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.

B. Cable Racks and Hooks:
   1. Material: Heavy-duty non-metallic (glass reinforced nylon).
   2. Hook loading capacity: 400 LBS minimum.
   3. Rack loading capacity: Four (4) hooks maximum.
   4. Hook deflection: 0.25 IN maximum.
   5. Hooks: Length, as required, with positive locking device to prevent upward movement.
   6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
   1. 7/8 IN DIA hot-dipped galvanized steel.
   2. 6000 LB minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 26 05 26 - Grounding.

2.04 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 3 Specifications, Section 03 11 13 - Formwork, Section 03 21 00 - Reinforcement, Section 03 31 30 – Concrete, Materials and Proportioning and Section 03 31 32 – Concrete Finishing and Repair of Surface Defects.

B. Duct Terminators:
   1. Window type.
   2. ABS plastic.
   3. Provide for conduit entrance.
   4. Designed for installation into manhole or handhole walls for a watertight seal.
   5. Sufficient space between terminator walls to allow for placement of rebar and concrete.

C. Conduit: See Specification Section 26 05 33 – Raceways and Boxes.

D. Duct Spacers/Supports:
   1. High density polyethylene or high impact polystyrene.
   2. Interlocking.
   3. Provide 3 IN minimum spacing between conduits.
   4. Accessories, as required:
      a. Hold down bars.
      b. Ductbank strapping.

PART 3 – EXECUTION

3.01 GENERAL

A. Drawings indicate the intended location of manholes and handholes and routing of ductbanks and direct buried conduit.
   1. Field conditions may affect actual routing.

B. Manhole and Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in ductbank routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
   7. Locations are to be approved by the Project Representative prior to excavation and placement or construction of manholes and handholes.

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

D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 31 21 33 - Trenching, Backfilling, and Compacting for Utilities.

3.02 MANHOLES AND HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. For use in areas subjected to occasional non-deliberate vehicular traffic.
   2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
   3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
   4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
   5. Size: As indicated on the Drawings or as required for the number and size of conduits.
   6. Provide cable rails and pulling eyes as needed.

B. Precast Manholes and Handholes:
   1. For use in vehicular and non-vehicular traffic areas.
   2. Construction:
      a. Grout or seal all joints, per manufacturer's instructions.

b. Support cables on walls by cable racks:

1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes and handholes.

a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.

2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.

c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.

1) Drill opening in floor for ground rod.

2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.

3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three (3).

a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.

3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.

4. Install so that the top of cover is 1 IN above finished grade.

a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.

5. After installation is complete, backfill and compact soil around manholes and handholes.

6. Handhole size:

a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.

b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.

7. Manhole size:

a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.

b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.03 UNDERGROUND CONDUITS

A. General Installation Requirements:
   1. Ductbank types per location:
      a. Concrete encased ductbank:
         1) As indicated in the Ductbank Schedule.
      b. Direct-buried conduit(s):
         1) Area/Roadway lighting.
         2) As indicated in the Ductbank Schedule.
   2. Do not place concrete or soil until conduits have been observed by the Project Representative.
   3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT.
      a. Low points shall be at manholes or handholes.
   4. During construction and after conduit installation is complete, plug the ends of all conduits.
   5. Provide conduit supports and spacers.
      a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 3 FT.
         2) 1-1/4 to 3 IN: 5 FT.
         3) 3-1/2 to 6 IN: 7 FT.
      b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
         1) 1 IN and less: 10 FT.
         2) 1-1/4 to 2-1/2 IN: 14 FT.
         3) 3 IN and larger: 20 FT.
      c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
   6. Stagger conduit joints at intervals of 6 IN vertically.
   7. Make conduit joints watertight and in accordance with manufacturer's recommendations.
   8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
      a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
   9. Furnish manufactured bends at end of runs.
      a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.

10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
11. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN.
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
12. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
13. Transition from rigid non-metallic conduit to rigid metallic conduit, per Specification Section 26 05 33 – Raceways and Boxes, prior to entering a structure or going above ground.
    a. Except rigid non-metallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10 14 00 – Identification Devices.
15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:
    1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 – Raceways and Boxes or as detailed on the Drawings.
    2. Install so that top of concrete encased duct, at any point:
        a. Is not less than 24 IN below grade.
        b. Is below pavement sub-grading.
    3. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.

4. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 – Raceways and Boxes for different cabling types.

C. Direct-Buried Conduit(s):
   1. Install so that the top of the uppermost conduit, at any point:
      a. Is not less than 30 IN below grade.
      b. Is below pavement sub-grading.
   2. Provide a uniform minimum clearance of 3 IN between conduits or as required in Specification Section 26 05 33 – Raceways and Boxes for different cabling types.
      a. Maintain the separation of multiple planes of conduits by one of the following methods:
         1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 psi) or concrete per Specification Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities.
         2) Install the multilevel conduits one level at a time.
            a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 21 33 – Trenching, Backfilling, and Compacting for Utilities, to maintain the required separations.

END OF SECTION

SECTION 26 05 48
SEISMIC BRACING SYSTEMS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. The design and installation of seismic bracing and anchorage required for electrical equipment, conduit, cable tray, and bus ducts.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      c. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
   2. Building Code:
      a. International Building Code (IBC) - 2009 Edition including all State of Washington and City of Bellevue amendments.

1.03 SYSTEM DESCRIPTION

A. Contractor is responsible for design and installation of seismic bracing and anchorage systems.

B. Description of Systems:
   1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
   2. Anchorage of floor and roof mounted electrical equipment.

C. Seismic Design Requirements:
   1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit, cable tray, bust duct, designed, constructed, and installed to resist stresses produced by lateral forces.

D. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 LBS or more and all suspended or wall mounted equipment weighing 20 LBS or more.

E. The following components are exempt from the requirements of this Section:
   1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor (I_p) is equal to 1.0.
   2. Electrical components in Seismic Design Categories D, E, and F where I_p = 1.0 and flexible connections between the components and associated ductwork, piping, and conduit are provided and that are mounted at 4 FT (1.22 m) or less above a floor level and weigh 400 LBS (1780 N)or less.
   3. Electrical components in Seismic Design Categories D, E, and F weighing 20 LBS (95 N) or less where I_p = 1.0 and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 LBS/FT (7 N/m) or less.

F. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

G. Installation Inspection:
   1. Certify that seismic bracing system installed is in accordance with approved Shop Drawings.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Seismic control devices.
   2. Fabrication and/or layout Drawings:
      a. Layout and mounting detail Drawings showing system and proposed brace locations for all systems including pre-engineered systems.
      b. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location.
         1) Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
      c. Structural calculations for required lateral force level for each component.
      d. All submittals, including pre-approved systems, shall be signed and sealed by a Washington State Licensed Engineer.

1.05 PROJECT CONDITIONS

A. Seismic (Earthquake) Loads:
   1. Seismic use group: II.
   2. S_s: 1.403.
   3. S_1: 0.725.
   4. Site Class: D.

5. Seismic design category: D.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pre-engineered suspended bracing systems:
      a. International Seismic Application Technology (ISAT) “Engineered Seismic Bracing of Suspended Utilities”.
      b. Unistrut.
      c. Tolco.
      d. B-Line.
      e. Or approved equal.
   2. Custom Engineered systems designed using specified criteria and common building materials.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 EQUIPMENT ANCHORS AND SUPPORTS

A. Drilled-in-place concrete anchors shall have an approved ICBO Evaluation Services Report.

B. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554, 36 ksi.

C. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.

D. Structural steel for supports: ASTM A36.

E. Cold formed metal and connection material: Unistrut.

F. Any details provided are based on assumed equipment and arrangement.
   1. Contractor shall be responsible for design and acquiring approval for support and anchorage of equipment and arrangement which varies from equipment and arrangement assumed in detail provided.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. Every run which requires bracing shall have a minimum of two (2) transverse braces and one (1) longitudinal brace.
   1. A “run” is defined as suspended pipe, conduit, cable tray, bus ductor trapeze rack having a minimum 5 FT straight run length.

B. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

C. Bracing may be omitted from conduit, cable tray and bus duct runs less than 5 FT in length.

D. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 IN (305mm) in length are required.
   1. All unbraced suspended utility systems having 2 IN conduit and larger or systems weighing more then 5 LBS/FT shall be installed with a minimum 6IN clearance to suspended ceiling vertical hanger wires.
   2. The conduit, cable tray, or bus duct shall be installed such that the lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.

E. A longitudinal brace at a 90 degree change in direction may act as a transverse brace if it is located within 2 FT of the change in direction.

F. A transverse brace may act as a longitudinal brace if it is located within 2 FT of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

G. When bracing equipment or a utility system that is suspended from an overhead deck, brace back to the overhead deck or to the supporting structure supporting the deck.
   1. Do not brace to another element of the structure which may respond differently during a seismic event.

H. Obtain approval from the Project Representative prior to attaching any brace elements to structural steel or wood framing.

I. When utilizing cable bracing, tension the cable to remove slack without inducing uplift of the suspended element.
   1. Tension seismic bracing system prior to system start-up and adjust if necessary after equipment start-up.

J. As a general rule, do not mix rigid bracing with cable bracing in the same run.
   1. However, once bracing has transitioned a 90 degree change in run direction, the bracing may switch from rigid to cable or vice versa if required due to a significant change in overhead deck elevation or to provide an implementable bracing scheme in a congested area.

K. Install brace members at an angle of 45 degrees from horizontal within a tolerance of plus 2 1/2 degrees or minus 45 degrees provided the brace length is accounted for in design.
   1. Brace angle may be increased to 60 degrees provided the brace spacing is reduced to 1/2 that required for a 45 degree brace.

L. Seismic bracing may not pass through a building separation joint.
   1. Utility systems that pass through a separation joint must be seismically restrained no greater than 5 FT from the point of connection.

2. Any hardware designed to accommodate seismic movement across the span of the separation joint shall be installed per manufacturer's installation and listing instructions.

M. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

N. Conduit, cable tray, or bus duct constructed of non ductile material (plastic or fiberglass), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials.

O. Where brace elements are through-bolted, the mounting hole in the element is to be no more than 1/16 IN in diameter larger then the bolt or threaded rod.

P. Seismic braces shall directly brace the system and not the hanger.

3.02 SUSPENDED ELECTRICAL SYSTEMS

A. Install seismic bracing for all conduit 2-1/2 IN trade size or greater.

B. All trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering the total weight of the elements on the trapeze.
   1. For the purposes of calculating weight, all conduits are to be treated as full.

C. Brace all trapeze racks which support conduit 2-1/2 IN trade size or larger.
   1. Brace all other conduit rack, cable tray or bus duct trapezes having a minimum weight in excess of 10 LBS/LF.
   2. Include a minimum 10 percent additional capacity for future additions.

D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 IN or less in length form the top of the element to the bottom of the structural attachment of the hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.

E. All vertical risers involving conduit 2-1/2 IN in diameter or larger shall include lateral restraint at maximum 30 FT intervals and at the top and bottom of the riser.

3.03 FLOOR OR ROOF MOUNTED EQUIMENT

A. Provide one (1) anchor on each leg or corner.
   1. Support with a minimum of three (3) 3/8 IN DIA anchors.

B. Friction shall be neglected when designing anchors for shear.

C. Vertical seismic forces, when required, shall be presumed to act concurrently with horizontal seismic forces.

END OF SECTION

SECTION 26 08 13
ACCEPTANCE TESTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Division 26 - Electrical.
   4. Section 40 05 05 - Equipment: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   2. Nationally Recognized Testing Laboratory (NRTL).
   3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Testing firm qualifications: See Specification Section 40 05 05 – Equipment: Basic Requirements.
   2. Field personnel:
      a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
      b. As an alternative, supervising technician may be certified by the equipment manufacturer.
   3. Analysis personnel:
      a. See Specification Section 40 05 05 – Equipment: Basic Requirements.
         As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. See Specification Section 40 05 05 – Equipment: Basic Requirements for electrical equipment and connection testing plan submittal requirements.

C. Quality Assurance Submittals:
   1. Prior to energizing equipment:
      a. Coordinated phasing diagram.
   2. Within two (2) weeks after successful completion of Commissioning Period:
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.
         3) See testing and monitoring reporting requirements in Specification Section 40 05 05 – Equipment: Basic Requirements.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 FACTORY QUALITY CONTROL

A. Provide Division 26 equipment with all routing factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 40 05 05 – Equipment: Basic Requirements.

PART 3 – EXECUTION

3.01 FIELD QUALITY CONTROL

A. General:
   1. See Specification Section 40 05 05 – Equipment: Basic Requirements.
   2. Complete electrical testing in three (3) phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   3. Perform testing in accordance with this Specification Section and NETA ATS.
   4. Provide field setting and programming of all adjustable protective devices and meters to settings provided by the Project Representative.

B. Equipment Monitoring and Testing Plan: See Specification Section 40 05 05 – Equipment: Basic Requirements.

C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 40 05 05 – Equipment: Basic Requirements.

D. Testing and Monitoring Program Documentation: See Specification Section 40 05 05 – Equipment: Basic Requirements.

E. Electrical Equipment and Connections Testing Program:
   1. See Specification Section 40 05 05 – Equipment: Basic Requirements.
   2. See individual Division 26 Specification Sections for equipment specific testing requirements.
   3. Test all electrical equipment.
      a. Perform all required NETA testing.
      b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.02 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchgear and Switchboards:
   1. Perform inspections and tests per NETA ATS 7.1.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

B. Transformers - Small Dry Type:
   1. Perform inspections and tests per NETA ATS 7.2.1.1.

2. Perform the following additional tests:
    a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Project Representative.
4. Record as-left tap connections.

C. Cable - Low Voltage:
1. Perform inspections and tests per NETA ATS 7.3.2.

D. Cable - Optical Fiber:
1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
    a. Optional time domain reflectometer test.
    b. Power attenuation test.
    c. Gain margin test.

E. Low Voltage Power Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.2.
    a. Tests shall include primary current injection testing of all breakers at final settings.
    b. Where short-time or instantaneous settings on large frame breakers are beyond the current capability of field testing, primary injection tests at reduced currents shall be permitted if combined with secondary injection calibration test of trip unit at final settings.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
    a. Shunt trip devices minimum tripping voltage.
4. Record as-left settings.

F. Low Voltage Molded Case Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.1.
2. Components:
    a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
    b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
    c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

G. Metering:
   1. Perform inspections and tests per NETA ATS 7.11.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

H. Grounding:
   1. Perform inspections and tests per NETA ATS 7.13.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

I. Ground Fault Protection:
   1. Perform inspections and tests per NETA ATS 7.14.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following optional tests per NETA ATS:
      a. Control wiring insulation resistance.
   4. Perform the following additional tests for four-wire systems:
      a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
      b. Verify no tripping for unbalanced load on each feeder and each main breaker.
      c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
      d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
      e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

J. Motors:
   1. Perform inspections and tests per NETA ATS 7.15.
   2. See Specification Section 40 05 05 – Equipment: Basic Requirements.

K. Motor Controllers:
   1. Perform inspections and tests per NETA ATS 7.16.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

L. Generators:
   1. Perform inspections and tests per NETA ATS 7.15.2.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3. Perform the following additional tests:
    a. Load and cycle crank test per Specification Section 26 32 14 – Engine Generator: Diesel.

M. Control System Functional Test:
1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
    a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
    b. Verify the correct operation of all sensing devices, alarms and indicating devices.
5. Systems to be tested:
    a. Digital Metering System.
    b. Standby Generator Systems.
    c. Automatic Transfer Switch Schemes.
    d. Low Voltage Lighting Control System.
    e. Central Emergency Lighting Inverter.
    f. Lightning Protection System.
    g. Heat tracing.

END OF SECTION

SECTION 26 09 13
ELECTRICAL METERING DEVICES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Digital metering equipment.
   2. Analog metering equipment.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 - Electrical: Basic Requirements for additional requirements.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cutler Hammer.
   2. Electro Industries.
   3. General Electric Company.
   4. Power Measurement.
   5. Square D Company.
   6. Siemens.
   7. E-MON Energy Monitoring Products.
   8. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 DIGITAL METERING DEVICES

A. General:
   1. Direct reading metered or calculated values.
   2. Microprocessor based.
   3. Integral LED or LCD display.
   4. Current and potential transformers as required.
   5. Integral fusing.
   6. Operating temperature: 0 DegF to 150 DegF.
   7. Standards:
      a. NEMA/ANSI C12.20.
      b. UL 508.

B. Type 'C' High Range Meter:
   1. Display the following minimum electrical parameters (accuracy):
      a. RMS current per phase (+0.2 percent full scale).
      b. RMS voltage line-to-line and line-to-neutral (+0.2 percent full scale).
      c. Real power (W): 3 PH total (+0.4 percent full scale).

d. Apparent power (VA): 3 PH total (+0.4 percent full scale).

e. Reactive power (VAR): 3 PH total (+0.4 percent full scale).

f. Power factor (+1.0 percent).

g. Frequency (+0.04 percent).

h. Percent current individual harmonic and total harmonic distortion (50th).

i. Percent voltage individual harmonic and total harmonic distortion (50th).

j. Watt-hours (0.5 percent).

k. VAR-hours (1.0 percent).

l. VA-hours (0.5 percent).

m. Ampere demand (+0.2 percent full scale).

n. Watt demand (+0.4 percent full scale).

o. VAR demand (+0.4 percent full scale).

p. VA demand (+0.4 percent full scale).

q. Phaser diagram.

2. NEMA/ANSI C12.20, Class 0.2 revenue accuracy.

3. Communication ports and protocols: Meter shall be capable of communicating over Ethernet via Modbus TCP/IP.

4. Supply voltage: 120 Vac.

C. kWh/Demand Meter with Communication:

1. Meter shall be fully electronic with 4-line by 20-character backlit LCD display showing kWh, kW demand (with peak date and time), power factor per phase, real-time load in kW, Amps per phase and Volts per phase.

2. Meter shall utilize 0-2 Vac output current sensors to allow paralleling and/or mounting up to 500 FT from the meter.

a. Sensors shall be of split-core configuration to allow installation without disconnecting cabling, etc.

b. Sensors shall be available from 25 amp to 800 amp.

3. Meter shall provide installation diagnostics on display.

4. Meter shall be enclosed in a heavy-duty JIC steel enclosure suitable for indoor installation.

a. Meter enclosure shall provide a method of locking to prevent unauthorized access.

5. Meter shall be UL/CUL Listed to latest applicable standards for safety.

6. Meter shall meet or exceed ANSI C12 accuracy standards.

7. Meter shall provide non-volatile memory to maintain reading during power outages.
8. Meter shall store interval data for kW and kVAR for up to 36 days in first-in first-out format.
9. Meter shall be capable of daisy-chain or star connection using RS-485 communications.
10. Meter shall be capable of communicating over Ethernet via Modbus TCP/IP.

2.03 ACCESSORIES

A. Communication Cable: As indicated on the Drawings.

B. Software: Power management and control software.
   1. Each meter must connect directly to the BACnet/Modbus backbone and have a unique static IP address.

C. Communication Cable: As recommended by manufacturer.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a complete and functioning system.
   2. Coordinate with the Project Representative on final computer screen layouts, trending requirements and printouts.

B. Meter Types:
   1. Type C meters and kWh/Demand meters: Connected to as indicated on the Drawings.

C. Communication Configuration:
   1. The main breaker meter and feeder breaker meters shall be connected to the nearest facility control system Ethernet switch.

3.02 FIELD QUALITY CONTROL

A. See Section 26 08 13 - Acceptance Testing.

3.03 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Project Representative with 8 HRS of on-site training in the operation and maintenance of the metering system and its components.

END OF SECTION

SECTION 26 09 16
CONTROL EQUIPMENT ACCESSORIES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Control panels and operator stations.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Safety Industrial Control Panels.

B. Miscellaneous:
   1. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:

b. Control panel bill of material.

c. See Section 26 05 00 for additional requirements.

2. Fabrication and/or layout Drawings.

a. Control panel interior and exterior layout.

b. Control panel wiring diagrams.

C. Closeout Submittals:

1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Pilot devices and relays:

a. Idec.

b. Potter & Brumsfield.

c. Time Mark.

d. ATC Diversified Electronics.

e. Or Approved Equal.

2. Contactors:

a. Automatic Switch Company (ASCO).

b. Cutler-Hammer.

c. General Electric Company.

d. Square D Company.

e. Siemens.

f. Allen Bradley.

g. Or Approved Equal.

3. Photocells:

a. Lighting Control and Design.

b. Wattstopper.

c. PLC Buildings.

d. Or Approved Equal.

4. Alarm devices:
   a. Edwards Signaling.
   b. Federal Signal Corp.
   c. Or Approved Equal.
5. Terminal blocks:
   a. Phoenix Contact.
   b. Allen-Bradley.
   c. Or Approved Equal.
6. Enclosures:
   a. Hoffman Engineering Co.
   b. Wiegmann.
   c. B-Line Circle AW.
   d. Adalet.
   e. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 PILOT DEVICES

A. General Requirements:
   1. Standards: NEMA ICS 2, UL 508.
   2. Heavy-duty NEMA 4/13 watertight/oiltight.
   3. Heavy-duty NEMA 4/4X corrosion resistant.
   4. Mounting hole: 30.5 mm.
   5. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
   6. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
   1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
   2. Maintained contact type.
   3. Knob or lever type operators.

C. Pushbuttons:
   1. Non-illuminated type:
      a. Protective boot.
      b. Momentary contact.

c. Standard flush and mushroom operators.

d. Black colored buttons for START or ON and red color for STOP or OFF.

e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.

D. Indicating Lights:
1. Allowing replacement of bulb without removal from control panel.
2. Lamp: LED, 120 V or 24 V as required.
3. Full voltage type.
4. Push-to-test indicating lights.
5. Glass lens.
6. Color code lights as follows:
a. Green: OFF or stopped; valve open.
b. Amber: Standby; auto mode; ready.
c. Red: ON or running; valve closed.

2.03 RELAYS

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.

B. Control Relays:
1. General purpose (ice cube) type:
a. Plug-in housing.
b. Clear polycarbonate dust cover with clip fastener.
c. Coil voltage: 120 Vac or as required.
d. Contacts:
1) 10 amp continuous.
2) Silver cadmium oxide.
3) Minimum of 3 SPDT contacts.
e. Sockets: DIN rail mounted.
f. Internal neon or LED indicator is lit when coil is energized.
g. Manual operator switch.
2. Industrial type:
a. Coil voltage: 120 Vac or as required.
b. Contacts:
1) 10 amp, NEMA A600 rated.
2) Double break, silver alloy.

3) Convertible from normally open to normally closed or vice versa, without removing any wiring.

4) Expandable from 2 poles to 12 poles.

c. Provide contacts for all required control plus two spares.

2.04 CONTACTORS

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.

B. Lighting and Remote Control Switches:
1. Electrically operated, electrically held.
2. Coil voltage: 120 Vac or as required.
3. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
4. Rated for ballasted lighting, tungsten and general use loads.
5. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
6. Auxiliary control relays, as indicated on Drawings or as specified.
7. Auxiliary contacts, as indicated on Drawings or as specified.

C. Definite Purpose:
1. Coil voltage: 120 Vac or as required.
2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
3. Resistive load and horsepower rated.
4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
5. Auxiliary contacts, as indicated on Drawings or as specified.

2.05 PHOTOCELLS

A. Photocells:
1. Weatherproof enclosure.
2. Adjustable turn-on range, initially set at 1.0 footcandles.
   a. Turn-off level approximately three times turn-on.
3. Provide time delay device to eliminate nuisance switching.
4. Voltage, amperage and/or wattage ratings as required for the application.

2.06 ALARM DEVICES

A. Alarm Horns:
1. Vibrating horn type.
2. Heavy-duty die cast housing with corrosion resistant finish.
3. Adjustable volume: 78 to 103 dB at 10 FT.

4. Voltage: 120 Vac or as required.
5. Enclosures/mountings:
    a. NEMA 4 surface mounting in wet areas.
        1) Fixed volume: 97 dB at 10 FT.

B. Alarm Lights:
1. Wall mounted:
    a. Heavy-duty strobe type.
    b. Weatherproof shatter resistant polycarbonate lens and cast base.
    c. Optically designed fresnel lens with color as indicated on Drawings.
    d. Immune to shock and vibration, no moving parts.
    e. Xenon flash tube providing a minimum of 65 single flashes per minute.
    f. Mounting: Wall or corner wall brackets.

2.07 TERMINATION EQUIPMENT

A. General Requirements:
1. Modular type with screw compression clamp.
2. Screws: Stainless steel.
3. Current bar: Nickel-plated copper alloy.
4. Thermoplastic insulation rated for -40 to +90 DegC.
5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
6. End sections and end stops at each end of terminal strip.
7. Machine-printed terminal markers on both sides of block.
8. Spacing: 6 mm.
9. Wire size: 22-12 AWG.
10. Rated voltage: 600 V.
11. DIN rail mounting.

B. Standard-type block:
1. Rated current: 30 A.
2. Color: Gray body.

C. Bladed-type disconnect block:
1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
2. Rated current: 10 A.

3. Color:
    a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
    b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-type block:
1. Electrically grounded to mounting rail.
2. Terminal ground wires and analog cable shields.
3. Color: Green and yellow body.

E. Fuse Holders:
1. Blocks can be ganged for multi-pole operation.
2. Spacing: 9.1 mm.
3. Wire size: 30-12 AWG.
4. Rated voltage: 300 V.
5. Rated current: 12 A.
6. Fuse size: 1/4 x 1-1/4.
7. Blown fuse indication.
8. DIN rail mounting.

2.08 ENCLOSURES

A. Control Panels:
1. NEMA 4 rated:
    a. Seams continuously welded and ground smooth.
    b. No knockouts.
    c. External mounting flanges.
    d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
    e. Cover with oil resistant gasket.
2. NEMA 12 enclosure:
    a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts.
    c. External mounting flanges.
    d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
    e. Flat door with oil resistant gasket.

3. Control panel miscellaneous accessories:
    a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
    b. Interiors shall be white or light gray in color.
    c. Wire management duct:
        1) Bodies: PVC with side holes.
        2) Cover: PVC snap-on.
        3) Size as required.
    d. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
    e. Split covers when heavier than 25 LBS.
    f. Floor stand kits made of same material as the enclosure.
    g. Weldnuts for mounting optional panels and terminal kits.
    h. Ground bonding jumper from door, across hinge, to enclosure body.
4. Standards: NEMA 250, UL 508.

B. Operator Control Stations:
1. NEMA 4/13 rated:
    a. Die cast aluminum body with manufacturers standard finish.
    b. Gasketed die cast aluminum cover with manufacturers standard finish.
    c. Number of device mounting holes as required.

2.09 MAINTENANCE MATERIALS

A. Provide 100 percent replacement lamps for indicating lights.

B. Provide 10 percent replacement caps for indicating lights.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
1. Size as required to mount the equipment.
2. Permitted uses of NEMA 4 enclosure:
    a. Surface mounted in areas designated as wet.
3. Permitted uses of NEMA 12 enclosure:
    a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas.

C. Operator Control Stations:
   1. Permitted uses of NEMA 4/13 enclosure:
      a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas and wet.

3.02 FIELD QUALITY CONTROL

A. See Section 26 05 00.

END OF SECTION

SECTION 26 09 43
LOW VOLTAGE LIGHTING CONTROL SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Low Voltage Lighting Control System.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.
   6. Section 26 09 16 - Control Equipment Accessories.
   7. Section 26 27 26 - Wiring Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 725, Class 1, Class 2, Class 3 Remote-Control, Signaling, and Power-Limited Circuits.
   3. Underwriters Laboratories, Inc. (UL).
      a. UL 508A, Industrial Control Panels.

1.03 SYSTEM DESCRIPTION

A. Install a low voltage switching system consisting of low voltage relay panels, momentary contact switches, intelligent switches, and photocells.

B. All relay panels to be interconnect by a digital communication system.

C. Provide 24 Vdc switching for areas indicated on plans.

D. Switching system shall be complete and conform to NEC Article 725 for Class 2 wiring.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout Drawings.
      a. Schematic and wiring diagrams for all components including, but not limited to, relay panels, relays, low voltage switches and photocells.
      b. One-line diagram of the system configuration.
   3. Certifications.
      a. Proper operation of all system components.

C. Quality Assurance Submittals.

D. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Low voltage switching system components:
      a. Cooper Controls.
      b. Lighting Control and Design (LC&D).
      c. Watt Stopper.
      d. PLC Buildings/PLC Multipoint.
      e. Leviton.
      f. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 COMPONENTS

A. Relay Panels:
   1. Modular relay panels:
      a. Tub: Empty NEMA 1 enclosure that can accept an interior sized to accept up to 8, 12, 24, or 48 mechanically latching relays.
      b. Power supply:
         1) Transformer assembly with two (2) 40VA transformers with separate secondaries.
         2) Transformers include internal overcurrent protection with automatic reset and metal oxide varistor protection against power line spikes.
         3) Supply voltage: 120 or 277 Vac as required, 60 Hz +/- 10 percent.
      c. Cover: Surface or flush as required, with captive screws in a hinged, lockable configuration.
      d. Interior:
         1) Bracket and intelligence board backplane with pre-mounted relays.
         2) Interiors shall be provided with up to 8, 12, 24, or 48 installed and tested relays, as shown in Drawings.
      e. Panel shall be provided with an integral DIN rail mounting bar for easy installation of other system components (such as a time clock and/or photocell controller).
         1) Terminals shall be included in the interior to accept a dataline for the connection of dataline switches to the system, or to allow a dataline to be run between multiple panels for network communications.
      f. Eight (8) channels for grouping relays shall be provided in each interior regardless of size, each with an associated pushbutton to toggle the channel ON/OFF, and a terminal block for a separate dry contact input.
         1) Any number of relays in the panel can be assigned to each channel, with overlapping allowed.
         2) Set up channels via the dataline to main computer, i.e., no hand held programmer or keypad is required.
         3) Provide LED status indication for each channel pushbutton:
            a) RED: All relays within the channel group are ON.
            b) No LED: All relays within the group are OFF.
            c) GREEN: The channel's relays are in a MIXED state (some OFF, some ON).

g. Relays:

1) Momentary-pulsed mechanically latching contactors with plug in connector.

2) Mechanically latching contacts with single moving part design for improved reliability.

3) Characteristics:

a) Coil:

i Magnetically held, momentary coil activation (50 milliseconds).

ii 2.2 VA max per relay to allow up to 20 relays to be controlled in parallel using Class 2 wiring.

iii Split coil: 1/2 for ON, 1/2 for OFF.

b) Power contacts:

i 20 amp tungsten and NEMA electronic ballast rated.

ii Rated for 50,000 ON/OFF cycles at full load.

iii Support #10 - #14 AWG solid or stranded wire.

iv 120, 277 and 347 volt rated.

c) 30 Vac isolated contacts for status feedback and pilot light indication.

d) FCC approved for commercial and residential use.

h. Next to each relay shall be an individual override button and a bi-color LED to indicate status.

i. Panels shall support the “blink warning” function, with LED indication for each relay.

j. Captive screw terminations will be provided for all wiring connections.

k. Each channel button’s dry control contact input terminal shall accept either 2 or 3 wire, maintained or momentary inputs.

1) They shall also accept a 2 wire toggling input.

l. Each channel shall also have an associated 1 amp, 30 Vdc isolated contact which may be used for status feedback or pilot light control.

m. Each panel shall include simple dials for setting a 2 digit panel address.

n. The relay panel shall use an EEPROM to record the channel’s wiring assignments and the current status of all relays, thus insuring a 20 year backup of information in the event of a power failure.

1) Systems that require a chargeable battery with less than 10 year’s life shall not be allowed.

o. The unit shall provide LED status indication of the power supply status.

1) Access to 24 Vac and 24 V rectified power for accessory devices shall be provided within the panel.

p. The panel shall have an integrated DIN rail for mounting dataline control modules.

2. Interior shall use relays with an optional pilot contact to provide individual relay feedback to other control systems.

a. Terminal blocks shall be located next to each relay to allow standard low voltage switching devices to control the relay state.

b. Devices can be either 2 or 3 wire, maintained or momentary inputs.

c. They shall also accept a 2 wire toggling input.

B. Momentary Contact Switches: See Specification Section 26 27 26.

C. System Time Clock:

1. Provide a System Time Clock.

a. System Time Clock can be used to schedule any of the eight (8) global channel groups (A-H) in the relay panel network.

b. Schedules are defined using Occupied versus Unoccupied (after-hours) times to simplify data entry.

2. Network shall include user-selectable intelligent scenarios to handle standard lighting control functions for each channel independently, including:

a. Schedule ON / Schedule OFF.

b. Manual ON / Schedule OFF.

c. Photocell ON / Photocell OFF (with user selectable offsets).

d. Photocell ON / Schedule OFF (with user selectable offsets).

e. Manual ON / Multiple OFF Sweeps using Automatic Control Switch.

3. System Time Clock shall automatically detect the presence of a dataline Photocontrol Module and alter the Astronomic scenarios to Dark, accepting actual light level readings for the following scenarios:

a. Dark ON / Dark OFF.

b. Dark ON / Schedule OFF.

4. Each channel can be assigned a standard time delay from 1-240 minutes (4 HRS).

a. During Occupied hours, the time delays do not take effect.

b. During Unoccupied hours, the time delays will ensure that overridden lights are automatically turned off.

5. Each channel can be assigned an automatic blinking of the lights before they are turned off to allow occupants the opportunity to enter an override without being put in the dark.
6. System Time Clock shall include a switch to change its function from Scheduling mode to Programming mode.
    a. In programming mode, the unit shall be able to wire relays to switch buttons or channels anywhere in the system using simple menus.
7. System Time Clock shall include system diagnostic functions to identify devices anywhere on the network dataline.
8. The System Time Clock will provide a clear eight (8) line, 22-character per line display and a simple user interface.
9. System Time Clock will take into account leap year, daylight savings time, and holidays.
10. The System Time Clock will provide system diagnostics for all components connected to the system.
11. The System Time Clock shall retain memory and time for a minimum of 10 years.

D. Photocontrol Module:
1. A single photocell shall be mounted in an appropriate location for measuring exterior light levels.
    a. The sensor shall connect to a separate Photocontrol Module mounted on the DIN rail inside any panel via a single 20/4 shielded conductor with a maximum distance of 500 FT.
    b. The control unit shall connect to the network dataline at any panel, and draw power from the dataline, so no extra wires are required.
2. The Photocontrol Module shall be designed to integrate seamlessly with either the System Time Clock or the BMS Interface module.
    a. Replacing the astronomic control function on the clock, the Photocontrol module shall measure the actual exterior light level.
    b. Each of the eight (8) global channels shall have the ability to be assigned a different trip level.
3. Real time, 2-line LCD display of actual exterior light level up to 200 fc.
4. Channel set points and parameters programmed via the System Time Clock.
5. Choice of OPERATE or TEST modes, with simulated light level for testing.
6. Control unit detects and broadcasts “Dark” or “Not Dark” states for each channel to the panels.
7. Automatic deadband and five (5) minute time delay to avoid nuisance switching.

8. LEDs for each channel show RED if dark (actual light level below set point); GREEN if above set point, OFF if not programmed.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
   1. Provide all equipment as necessary to provide a compete and functioning system.

B. Switches and/or photocells shall be mounted as indicated on the Drawings.

C. Each low voltage wire shall be labeled clearly indicating which relay panel it connects to.

D. All relays and switches shall be tested after installation to confirm proper operation, and all connected loads shall be recorded on the relay schedule for each panel.

E. The relay panels shall be mounted in electrical rooms as indicated on the Drawings.
   1. The numbered relays in the panel shall be wired to control the power to each load as indicated on the Lighting Relay Panel Schedules.
   2. All power wiring will be identified with the circuit breaker number controlling the load.
      a. If multiple circuit breaker panels are feeding into a relay panel, wires shall clearly indicate the originating panel’s designation.

3.02 FIELD QUALITY CONTROL AND COMMISSIONING

A. Before substantial completion, a factory authorized technician shall commission the entire lighting control system and verify its proper operation. The technician shall then hold a training session with the installing Contractor on the proper installation of all components.

B. Manufacturer shall provide a signed factory certification confirm proper installation and operation of all system components.

C. Acceptance Testing: See Specification Section 26 08 13 – Acceptance Testing and Section 01 95 00 – Commissioning Requirements.

3.03 TRAINING

A. Manufacturer shall provide factory authorized application engineer to train Owner personnel in the operation and programming of the lighting control system (8 HRS of on-site training).

END OF SECTION

SECTION 26 22 13
DRY-TYPE TRANSFORMERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Dry-type transformers, 1000 kVA and less.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 –Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 26 - Grounding.
   6. Section 26 24 13 - Switchboards.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20, Dry-Type Transformers for General Applications.
      c. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 506, Standard for Safety Specialty Transformers.
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.

2. Fabrication and/or layout Drawings.
    a. Nameplate Drawing.
3. Certifications: Sound level certifications.

C. Quality Assurance Submittals.

D. Closeout Submittals:
1. O&M Manual Content: Provide O&M manual documentation in accordance with Section 01 73 00 – Operation and Maintenance Manuals.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Cutler-Hammer.
2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Sola/Hevi-Duty.
6. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated air cooled, two (2) winding type.

B. Cores:
1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:
   1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
   2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as follows:
   1. 1 PH, 2 kVA and below: None.
   2. 1 PH, 3 to 25 kVA: Two (2) 5 percent FCBN.
   3. 1 PH, 25 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.
   4. 3 PH, 3 to 15 kVA: Two (2) 5 percent FCBN.
   5. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

F. Sound Levels:
   1. Manufacturer shall guarantee not to exceed the following:
      a. Up to 9 kVA: 40 dB.
      b. 10 to 50 kVA: 45 dB.
      c. 51 to 150 kVA: 50 dB.
      d. 151 to 300 kVA: 55 dB.

G. Efficiency:
   1. Ventilated, 15 kVA and larger: Energy efficient meeting NEMA TP 1 requirements.

H. Insulating Material (600 V and below):
   1. 3 to 15 kVA units: 185 DegC insulation system with a 115 DegC rise.
   2. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

K. Standards: IEEE C57.96, NEMA ST 20, NEMA TP 1, UL 506, UL 1561.

PART 3 – EXECUTION

3.01 INSTALLATION

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

B. Indoor Locations:
   1. Provide ventilated type for 15 kVA units and above.

2. Mount 9 kVA units and below on wall.
3. Mount 30 kVA units and above on chamfered 4 IN high concrete housekeeping pad or from wall and/or ceiling, at 7 FT above finished floor, using equipment support brackets per Section 26 05 00.
4. Provide rubber vibrations isolation pads.

C. Enclosures: Painted steel in all areas.

D. Ground in accordance with Section 26 05 26 - Grounding.

3.02 FIELD QUALITY CONTROL

A. See Section 26 08 13 - Acceptance Testing.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Low voltage switchboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 09 13 - Electrical Metering Devices.
   6. Section 26 36 00 - Transfer Switches.
   7. Section 26 24 16 - Panelboards.
   8. Section 26 22 13 - Dry-Type Transformers.
   9. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   10. Section 26 43 13 - Low Voltage Surge Protection Devices (SPD).

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 2, Deadfront Distribution Switchboards.
   2. Underwriters Laboratories, Inc. (UL):
      a. 891, Standard for Safety Dead-Front Switchboards.

B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   2. See Specification Section 26 05 00 for additional requirements.

3. Fabrication and/or layout Drawings:
    a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
    b. Front elevation and plan Drawings of the assembly.
    c. Three-line or single line and schematic diagrams.
    d. Conduit space locations within the assembly.
4. Submit Switchboard SB0301 Shop Drawings to the serving utility company (PSE) and obtain approval prior to ordering equipment.

C. Quality Assurance Submittals.
1. Ground fault protection system test report signed by the projects supervising electrical foreman.

D. Closeout Submittals:
1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:
    a. Fabrication and/or layout Drawings updated with as-build conditions.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Eaton Cutler-Hammer.
2. General Electric Company.
3. Square D Schneider Company.
4. Siemens.
5. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 SWITCHBOARDS

A. Ratings:
1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.

2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
3. Service Entrance Equipment rated when indicated on the Drawings.
4. 100 percent rated when 100 percent rated breakers are installed.

B. Construction:
1. Standards: NEMA PB 2, UL 891.
2. Completely enclosed, dead-front, self-supporting metal structure.
3. Vertical panel sections bolted together.
4. Frames bolted together to support and house bus, cables and other equipment.
5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
6. All sections front and rear aligned.
7. Devices front removable and load connections front accessible for mounting switchboard against a wall.
8. NEMA 1 rated enclosure.
9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
1. Material: Tin-plated aluminum or silver-plated copper.
2. Main horizontal bus:
   a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane.
   b. Sufficient size to limit temperature rise to 65 DegC over average air temperature outside the enclosure of 40 DegC.
3. Neutral bus: Fully rated and continuous over length of switchboard.
4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
   a. Individually mounted molded case circuit breaker.
2. Feeder overcurrent protective devices:
   a. Group mounted molded case circuit breaker.
3. See Specification Section 26 28 00 - Overcurrent and Short Circuit Protective Devices for requirements.
4. Factory installed.

5. Means to padlock all main and feeder devices in the open position.

E. Integrally mounted, see Specification Section 26 43 13 – Low Voltage Surge Protective Device.

F. Metering:
   1. Utility:
      a. Separate barriered-off compartment with hinged sealable door.
      b. Bus work with provisions for required current and potential transformers.
   2. Power monitor:
      a. Through cabinet mounting.
      b. See Specification Section 26 09 13 - Electrical Metering Devices for meter requirements.

PART 3 – EXECUTION

3.01 INSTALLATION

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

B. Arrange switchboard as shown on the Drawings.

C. Indoor Locations:
   1. NEMA 1 enclosure.
   2. Install on concrete housekeeping pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

D. Miscellaneous:
   1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
   2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.02 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

B. See Section 26 08 13 - Accepted Testing.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Lighting and appliance panelboards.
   2. Power distribution panelboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   6. Section 26 43 13 - Low Voltage Surge Protection Devices (SPD).

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

2. Fabrication and/or layout Drawings:

    a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

C. Closeout Submittals:
1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:

    a. Panelboard schedules with as-built conditions.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Eaton Cutler-Hammer.
2. General Electric Company.
3. Square D Schneider Company.
4. Siemens.
5. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.
3. Panelboards rated 480 Vac: Short circuit rating as indicated in the panel schedule.
4. Service Entrance Equipment rated when required or indicated on the Drawings.

C. Construction:
1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
2. Multi-section panelboards: Feed-through or sub-feed lugs.
3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Enclosure:
   1. Boxes: Code gage galvanized steel, furnish without knockouts.
   2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
   3. Lighting and appliance panelboard:
      a. Trims supplied with hinged door over all circuit breaker handles.
      b. Trims for surface mounted panelboards, same size as box.
      c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
      d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
      e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
      f. Clear plastic cover for directory card mounted on the inside of each door.
      g. NEMA 3R or NEMA 12 rated: Door gasketed.
   4. Power distribution panelboard:
      a. Trims cover all live parts with switching device handles accessible.
      b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
      c. Clear plastic cover for directory card mounted front of enclosure.
      d. NEMA 3R or NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.

F. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.

2. Branch overcurrent protective devices:

   a. Mounted molded case circuit breaker.

3. See Section 26 28 00 for overcurrent and short circuit protective device requirements.

4. Factory installed.

G. Integral surge protective device: Provide surge suppression in each panel as per Specification Section 26 43 13.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

C. Provide NEMA 1, NEMA 3R or NEMA 12 rated enclosure as indicated on the Drawings.

D. Provide each panelboard with a typed directory:
   1. Identify all circuit locations in each panelboard with the load type and location served.

   2. Mechanical equipment shall be identified by Project Representative-furnished designation if different than designation indicated on the Drawings.

   3. Room names and numbers shall be final building room names and numbers as identified by the Project Representative if different than designation indicated on the Drawings.

END OF SECTION

SECTION 26 24 19
MOTOR CONTROL EQUIPMENT

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Separately mounted motor starters (including those supplied with equipment).
   2. Manual motor starters.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.
   6. Section 26 09 16 - Control Equipment Accessories.
   7. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. International Electrotechnical Commission (IEC).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
      b. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
   4. International Electrical Testing Association (NETA):
      a. ATS, Acceptance Testing Specification Electrical Power Distribution Equipment and Systems.

B. Miscellaneous:
   1. Verify motor horsepower loads, other equipment loads, and controls from approved Shop Drawings and notify Project Representative of any discrepancies.
   2. Verify the required instrumentation and control wiring for a complete system and notify Project Representative of any discrepancies.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout Drawings:
      a. Separately mounted combination starters:
         1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.
         2) Schematic and connection wiring diagrams.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Allen-Bradley.
   2. Eaton Cutler Hammer.
   3. General Electric Company.
   4. Square D Schneider Company.
   5. Siemens.
   6. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Enclosure:
   1. NEMA 4 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.
   2. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:
   1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
   2. Circuit breaker and MCP operators includes a separate TRIPPED position.
   3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
   4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
   5. Padlockable in the OFF position.

D. External mounted overload relay pushbutton.

E. Control Devices:
   1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.
   2. The following devices are the minimum required unless otherwise indicated on the Drawings:
      a. Three-position switch (HAND-OFF-AUTO).
      b. Red ON indicator light.
      c. Green OFF indicator light.
   3. Devices will be accessible with the door closed.

F. Control Power Transformer:
   1. 120V secondary.
   2. Fused on primary and secondary side.
   3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:
   1. Motor circuit protector.
   2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
   3. Factory installed.

2.03 MOTOR STARTERS

A. Standards:
   1. NEMA ICS 2.
   2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:
   1. NEMA full size rated contactor.
      a. NEMA half sizes and IEC contactors are not permitted.
   2. Double-break silver alloy contacts.
   3. Overload relays:
      a. Ambient compensated, bimetallic type with interchangeable heaters, 24 percent adjustability, single phase sensitivity, an isolated arm contact and manual reset.
   4. Interlock and auxiliary contacts, wired to terminal blocks:
      a. Holding circuit contact, normally open.
      b. Overload alarm contact, normally open.
      c. Normally open auxiliary contact, for remote run status.
      d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.
      e. Two (2) additional normally open spare field replaceable auxiliary contacts.

2.04 MANUAL MOTOR STARTERS

A. Standards:
   1. NEMA 250, NEMA ICS 2.
   2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
   1. Horsepower rated, for ON/OFF control.
   2. Horsepower rated, for ON/OFF control and thermal overload protection.
      a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
   1. NEMA 1 rated:
      a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. With or without concentric knockouts.
   2. NEMA 4 rated:
      a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
      b. No knockouts, external mounting flanges.
   3. NEMA 4X rated:
      a. Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges.
   4. NEMA 12 rated:
      a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
      b. No knockouts, external mounting flanges.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.

C. Overload Heaters:
   1. Size for actual motor full load current of the connected motor.

D. Combination and Manual Starter Enclosures:
   1. Permitted uses of NEMA 1 enclosure:
      a. Surface or flush mounted in architecturally finished areas.
      b. Surface mounted above 10 FT in areas designated as dry in architecturally and non-architecturally finished areas.
   2. Permitted uses of NEMA 4 enclosure:
      a. Surface mounted in areas designated as wet.
   3. Permitted uses of NEMA 4X enclosure:
      a. Surface mounted in areas designated as wet and/or corrosive.

4. Permitted uses of NEMA 12 enclosure:
    a. Surface mounted in areas designated as dry.

3.02 FIELD QUALITY CONTROL

A. See Specification Section 26 08 13 - Acceptance Testing.

END OF SECTION

SECTION 26 26 13
PACKAGE POWER SUPPLY

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Package power supply consisting of a transformer and panelboard.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 26 - Grounding.
   6. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96, Loading Dry-Type Distribution and Power Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
      c. ST 20, Dry-Type Transformers for General Applications.
      d. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
   3. Underwriters Laboratories, Inc. (UL):
      a. 67, Standard for Safety Panelboards.
      b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout Drawings:
      a. Nameplate Drawing.
      b. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. General Electric Company.
   2. Square D Schneider Company.
   3. Eaton Cutler-Hammer.
   4. Siemens.
   5. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 PACKAGED POWER SUPPLY

A. General:
   1. Standards: IEEE C57.96, NEMA PB 1, NEMA ST 20, UL 67 and UL 1561.
   2. Package power supply includes a main primary circuit breaker, an encapsulated dry-type transformer and a secondary panelboard with main circuit breaker.

B. Ratings:
   1. Single or three (3) phase as indicated on the Drawings.
   2. KVA and voltage ratings as indicated on the Drawings.
   3. Suitable for use as service entrance equipment.

C. Transformer:
   1. Non-ventilated, air cooled, two (2) winding type.

2. Core and coil assembly encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock resistant seal.
3. Cores:
    a. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
    b. Magnetic flux densities are to be kept well below the saturation point.
4. Coils: Continuous wound with electrical grade aluminum and grounded to the enclosure.
5. Insulation system: 185 DegC with a 115 DegC rise.
6. Taps: Two (2) 5 percent FCBN.
7. Sound levels:
    a. Manufacturer shall guarantee not to exceed the following:
        1) 9 kVA and less: 40 dB.
        2) 10 to 30 kVA: 45 dB.

D. Efficiency:
1. 15 kVa and larger: Energy efficient meeting NEMA TP 1 requirements.

E. Panelboard and Protective Devices:
1. Bus: Aluminum.
2. Factory installed wiring between primary breaker and transformer, secondary breaker and transformer and distribution section.
3. 480 Vac primary circuit breaker: 14,000 amp minimum interrupting rating.
4. 240 Vac or less secondary circuit breaker: 10,000 amp minimum interrupting rating.
5. Feeder breakers:
    a. Plug-in type with 10,000 amp minimum interrupting rating.
    b. See Section 26 28 00 for additional requirements.

F. Enclosure:
1. Main, secondary and feeder circuit breakers enclosed with a padlockable hinged door.
2. Wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
3. Totally enclosed, non-ventilated, NEMA 3R, steel finished with a rust inhibitor primer and manufacturer's standard paint.

PART 3 – EXECUTION

3.01 INSTALLATION

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

B. Ground in accordance with Section 26 05 26 or as indicated on the Drawings.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Light switches.
      b. Receptacles.
      c. Device wallplates and coverplates.
      d. Occupancy sensors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 33 - Raceways and Boxes.
   6. Section 26 24 19 - Motor Control Equipment.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout Drawings:
      a. Floor plan showing occupancy sensor location and coverage.
      b. Wiring diagram of occupancy sensor system.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Light switches and receptacles:
      a. Bryant.
      b. Cooper Wiring Devices.
      c. Hubbell.
      d. Leviton.
      e. Pass & Seymour.
      f. Crouse-Hinds.
      g. Appleton Electric Co.
      h. Killark.
      i. Or Approved Equal.
   2. Occupancy sensors:
      a. Cooper Controls.
      b. Lighting Design and Control (LD&C).
      c. Watt Stopper.
      d. PLC Buildings.

e. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 LIGHT SWITCHES

A. General requirements unless modified in specific requirements paragraph of switches per designated areas or types:
   1. Toggle type, quiet action, Industrial Specification Grade.
   2. Self grounding with grounding terminal.
   3. Back and side wired.
   4. Solid silver cadmium oxide contacts.
   5. Rugged urea housing and one-piece switch arm.
   6. Rated 20 A, 120/277 Vac.
   7. Switch handle color: Ivory.
   8. Types as indicated on the Drawings:
      a. Single-pole.
      b. Double-pole.
      c. 3-way.
      d. 4-way.
      e. Keyed.
      f. Momentary contact.
   9. Standards: UL 20, UL 514A, NEMA WD 6.

B. Architecturally Finished Areas:
   1. Wallplate:
      a. Ivory colored high impact thermoplastic or nylon.
      b. Single or multiple gang as required.

C. Dry Non-architecturally Finished Areas:
   1. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

D. Wet Non-architecturally Finished Areas:
   1. Coverplate:
      a. Gasketed zinc plated malleable iron or aluminum with stainless steel screws utilizing rocker, front mounted toggle or pull type switch.
      b. Single or multiple gang as required.

E. Hazardous Areas:
   1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
   2. Switch enclosed in separate sealing chamber.
      a. Sealing chamber has prewired factory sealed pigtail leads.
   3. Coverplate:
      a. Zinc plated malleable iron or copper free aluminum with stainless steel screws utilizing rocker or front mounted toggle type switch.
      b. Single or multiple gang as required.
   4. Standards: UL 894.

2.03 RECEPTACLES

A. General requirements unless modified in specific requirements paragraph of receptacles per designated areas:
   1. Straight blade, Industrial Specification Grade.
   2. Brass triple wipe line contacts.
   3. One-piece grounding system with double wipe brass grounding contacts and self grounding strap.
   4. Back and side wired.
   5. Rated 20 A, 125 Vac.
   6. High impact nylon body.
   7. Receptacle body color:
      a. Normal power: Ivory.
      b. Generator or UPS power: Red.
   8. Types as indicated on the Drawings:
      a. Normal: Self grounding with grounding terminal.
      b. Ground fault circuit interrupter: Feed-through type with test and reset buttons.
   9. Duplex or simplex as indicated on the Drawings.
   10. Configuration: NEMA 5-20R.
   11. Standards: UL 498, UL 514A, UL 943, NEMA WD 1, NEMA WD 6.

B. Architecturally Finished Areas:
   1. Wallplate: Ivory colored high impact thermoplastic or nylon.

C. Dry Non-architecturally Finished Areas:
   1. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

D. Wet Non-architecturally Finished Areas:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

E. Exterior Locations:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

F. Special Purpose Receptacles:
   1. NEMA configuration as indicated on the Drawings.
   2. Coverplate: See requirements per area designations herein.

2.04 MISCELLANEOUS WIRING DEVICES

A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 26 24 19.

2.05 OCCUPANCY SENSORS

A. Low Voltage Passive Infrared Ceiling Sensor:
   1. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
   2. Analog and digital processing to provide immunity to RFI and EMI.
   3. Temperature compensated, dual element sensor and a multi-element lens with a minimum field of view of 110 degrees.
   4. Daylight filter or compensation for short wavelength infrared wave from the sun.
   5. Cover up to 300 SF at normal mounting heights.
   6. System voltage: 24 Vdc through power pack.
   7. Load ON-OFF control through power pack.
   8. Adjustable time delay set at 30 minutes
   9. Adjustable sensitivity set at maximum.
   10. Adjustments and mounting hardware under a removable cover.
   11. Parallel wiring of multiple sensors to allow coverage of large areas.

B. Passive Infrared Wall Switch:
   1. Self contained control system that replaces a standard toggle switch.
      a. Latching air gap relay switching mechanism, compatible with electronic ballasts, compact fluorescent and inductive loads.
   2. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
   3. Analog and digital processing to provide immunity to RFI and EMI.
   4. Temperature compensated, dual element sensor and a multi-element Fresnel lens.

5. Cover up to 300 SF for walking motion, with a field of view of 180 degrees.
6. System voltage: 120 Vac or 277 Vac.
7. No minimum load.
    a. 0 to 800 watts fluorescent or 1/6 HP at 120 Vac, 60 Hz.
    b. 0 to 1200 watts fluorescent or 1/3 HP at 277 Vac, 60 Hz.
8. DIP switch to control the following functions:
    a. Built-in light level feature adjustable from 8 to 180 foot candles.
    b. AUTOMATIC-ON or MANUAL-ON operation.
    c. Time delay adjustable from 30 seconds to 30 minutes.
    d. High/low sensitivity adjustments.
9. Adjustments and mounting hardware under a removable, tamper resistant cover.
10. Normal operation: OFF and AUTO.

C. Ultrasonic Ceiling Sensor:
1. Detection of Doppler shifts in transmitted ultrasound.
2. Ultrasonic sensing is volumetric in coverage with a frequency of 32 kHz and automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled areas.
3. Temperature and humidity resistant, 32 kHz tuned ultrasonic receivers.
    a. Receivers have less than a 6 dB shift in the humidity range of 10 percent to 90 percent and less than a 10 dB shift in the temperature range of -20 to 60 DegC.
    b. Time delay adjustable from 15 seconds to 30 minutes.
    c. High/low sensitivity adjustments.
    d. Cover 360 degrees and hallway and corridor sensors shall cover up to 90 LF.
    e. Additional single-pole, double-throw isolated relay with normally open, normally closed, and common outputs rated at 1 amp for 24 Vdc.
        1) The isolated relay is for use with HVAC control, data logging and other control options.

D. Power Pack:
1. Self contained transformer and relay module.
2. Dry contacts capable of switching:
3. 20 amp ballast at 277 Vac, 60 Hz.
4. 24 Vdc, 100 mA output.
5. Capable of parallel wiring without regard to AC phases on primary.

6. Used as a stand alone, low voltage switch or wired to sensor for auto control.
7. Low voltage Teflon coated leads, rated for 300 V, suitable for use in plenum applications.

PART 3 – EXECUTION

3.01 INSTALLATION

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

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.

C. See Specification Section 26 05 33 for device outlet box requirements.

D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

F. Occupancy Sensors:
   1. Locations and quantity of sensors shown on the Drawings are diagrammatic and indicate only the rooms and spaces to be provided with sensors.
   2. Verify sensor type, quantity, location, aiming and sensitivity with manufacturer's recommendations.
   3. All controlled spaces shall be tested to insure 90 to 100 percent coverage of the controlled space.
      a. If test fails, Contractor shall adjust sensitivity, re-aim, relocate, and/or add sensor(s) as required at no cost to Owner.
   4. Power supplies and slave units if required shall be located above accessible ceilings.

END OF SECTION

SECTION 26 28 00
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.
   2. Low voltage fuses.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 08 13 - Acceptance Testing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
      b. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
   2. National Electrical Manufacturers Association (NEMA):
      a. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 248-1, Low-Voltage Fuses - Part 1: General Requirements.
      b. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
      c. 248-8, Low-Voltage Fuses - Part 8: Class J Fuses.
      d. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      e. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
      f. 1053, Standard for Ground-Fault Sensing and Relaying Equipment.

g. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

C. Quality Assurance Submittals:

D. Miscellaneous Submittals:
   1. Ground fault protection system test reports signed by the projects supervising electrical foreman.
   2. Reports:
      a. Short circuit study report.
      b. Protective coordination study report.
      c. As-left condition of all circuit breakers that have adjustable settings.

E. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 ARC FLASH STUDY AND REPORT

A. Perform arc flash hazard study after the short circuit and protective device coordination study has been completed.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Circuit breakers:
      a. Cutler-Hammer.
      b. General Electric Company.

c. Square D Company.

d. Siemens.

e. Or Approved Equal.

2. Fuses:

a. Bussmann, Inc.

b. Littelfuse, Inc.

c. Gould Shawmut.

d. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 CIRCUIT BREAKERS

A. Molded Case Type:

1. General:

a. Standards: NEMA AB 1, UL 489.

b. Unit construction.

c. Over-center, toggle handle operated.

d. Quick-make, quick-break, independent of toggle handle operation.

e. Manual and automatic operation.

f. All poles open and close simultaneously.

g. Three (3) position handle: On, off and tripped.

h. Molded-in ON and OFF markings on breaker cover.

i. One-, two- or three-pole as indicated on the Drawings.

j. Current and interrupting ratings as indicated on the Drawings.

k. Bolt on type.

2. Thermal magnetic type:

a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.

b. Frame size 150 amp and below:

1) Non-interchangeable, non-adjustable thermal magnetic trip units.

c. Frame sizes 225 to 400 amp (trip settings less than 400A):

1) Interchangeable and adjustable instantaneous thermal magnetic trip units.

d. Ground Fault Circuit Interrupter (GFCI) Listed:

1) Standard: UL 943.

2) One- or two-pole as indicated on the Drawings.

3) Class A ground fault circuit.

4) Trip on 5 mA ground fault (4-6 mA range).

e. Ground Fault Equipment Protective Circuit Interrupter (GFEPCI) Listed:

1) Standard: UL 1053.

2) Trip on 30 mA ground fault (6-50 mA range).

f. HACR listed: Heating, air conditioning and refrigeration applications.

3. Solid state trip type:

a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.

b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):

1) Standard rating.

2) Interchangeable current sensor or rating plug.

3) Adjustable long time pick-up setting.

a) Adjustable from 50 to 100 percent of the current sensor or rating plug.

4) Adjustable short time pick-up setting.

5) Adjustable instantaneous pick-up.

6) Fixed ground fault pick-up, when indicated on the Drawings.

c. Frame size 1600 amp and above:

1) 100 percent rated.

2) Interchangeable current sensor or rating plug.

3) Adjustable long time pick-up setting.

a) Adjustable from 50 to 100 percent of the current sensor or rating plug.

4) Adjustable long time delay setting.

5) Adjustable short time pick-up setting.

6) Adjustable instantaneous pick-up setting.

7) Adjustable ground fault pick-up setting, when indicated on the Drawings.

8) Adjustable ground fault delay setting, when indicated on the Drawings.

4. Motor circuit protector:

a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.

b. Sized for the connected motor.

2.03 ARC FLASH HAZARD LABELS

A. Provide labels on all electrical equipment and weatherproof labels for equipment mounted outdoors.

B. Information on each equipment Arc Flash Hazard warning label shall include:
   1. Flash Protection Boundary distance
   2. Hazard/Risk Category level (0-4) defined by NFPA 70E 2009.
   3. Required Protective Clothing and PPE.
   4. Shock Hazard when enclosed equipment is exposed.
   5. Equipment name and field marked location.

2.04 FUSES

A. UL Class J Fuses:
   1. Standard: UL 248-1 and UL 248-8.
   2. Dual-element time-delay and current limiting rejection type.
   3. Ratings: 600 V, 0-600 amps and 200,000 RMS AIC symmetrical.

B. UL Class RK-5 Fuses:
   1. Standard: UL 248-1 and UL 248-12.
   2. Dual-element time-delay and current limiting rejection type.
   3. Ratings: 250 and 600 V, 1/10-600 amps and 200,000 RMS AIC symmetrical.

C. UL Class CC Fuses:
   1. Standard: UL 248-1 and UL 248-4.
   2. Single-element fast-acting and current limiting rejection type.
   3. Ratings: 250 and 600 V, 1/10-30 amps and 200,000 RMS AIC symmetrical.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
   1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
      a. Frame sizes 250 amp and less with trip setting less than 250A shall be thermal magnetic type.

b. Frame sizes 400 amp and larger shall be solid state trip type.

c. Frame sizes 400 amp and above shall include integral ground fault protection, when indicated on the Drawings.

d. Motor circuit protectors sized for the connected motor.

E. Fuses:
1. UL Class J: Use for feeder devices 600 amps and smaller.

2. UL Class RK-5: Use for motor feeder and branch circuit devices.

3.02 FIELD QUALITY CONTROL

A. Coordinated Power System Protection:
1. Prepare a study to demonstrate that the equipment and system constructed within the scope of these Contract Documents, meet the specified requirements for equipment ratings, coordination and protection.

2. Perform the studies in accordance with IEEE 242 and IEEE 399.

3. Include the name of the software developer, software package and software version number in the computer generated studies.

4. System short circuit study report:

a. Begin the study at the main service electrical gear and extend down the system through all buses.

1) Perform a balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study.

b. Prepare a one-line diagram to show the electrical system buses, transformers and all sources of fault current including generators and motors.

c. Utilize manufacturer's data for the actual proposed equipment (e.g., transformer impedance).

d. Coordinate the available utility fault current with the power utility company.

e. Show input data in tabular form in the report and/or on the one-line diagram.

1) Input data shall include but is not limited to:

a) Utility fault current or MVA and X/R ratio.

b) Bus voltages.

c) Conductor sizes and type of conduit.

d) Generator and motor sizes and contributions.

e) Transformer sizes and impedances.

f. Show available fault current at each bus in tabular form in the report and/or on the one-line diagram.

g. Perform studies for both normal power and emergency/standby power scenarios.

5. System protective coordination study report:
   a. Begin the study at the main service electrical gear and extend down the system through all buses as required to ensure a coordinated power system.
   b. Demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions.
      1) Where necessary, an appropriate compromise shall be made between system protection and service continuity.
      2) Consider system protection and service continuity to be of equal importance.
   c. Prepare a one-line diagram to show the electrical system buses, transformers and protective devices.
   d. Utilize manufacturer's data for the actual proposed protective devices.
   e. Summarize the coordination study, conclusions and recommendations.
      1) As a minimum, include the following:
         a) The manufacturer's information used to prepare the study.
         b) Assumptions made during the study.
         c) Recommended taps and settings of all adjustable devices in tabulated form.
         d) Composite coordination time-current curves on log-log paper showing:
            i That the settings for each protective device will provide protection and selectivity.
            ii Identify each curve.
            iii Cable and equipment damage points.
            iv Circuit interrupting device operating and interrupting times.
            v One-line sketch of the part of the system being investigated.
            vi Include as many curves as possible on a graph while maintaining readability.
         e) Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
         f) Advise the Project Representative of potential coordination problems discovered during the study and include recommendations to resolve the problem.

g) Submit the report for approval 90 days prior to equipment energization.

B. Adjustable Circuit Breakers:
   1. Set all circuit breaker adjustable taps as defined on the Drawings, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

C. Ground Fault Protection System:
   1. Single source system:
      a. Main breaker using the residual sensing method system.
      b. Main and feeder breakers: Utilize four (4) individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

D. Testing:
   1. See Specification Section 26 08 13 - Acceptance testing.
   2. Adjustable circuit breakers:
      a. Test and verify all circuit breaker trip functions using a test set provided by the manufacturer for that purpose for circuit breakers 1200 A and above.

END OF SECTION

SECTION 26 28 16
SAFETY SWITCHES

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a table that associates safety switch model number with connected equipment tag number.
      c. See Specification Section 26 05 00 for additional requirements.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton Cutler-Hammer.
   2. General Electric Company.
   3. Square D Schneider Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Crouse-Hinds.
   7. Killark.
   8. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.
   5. Quick-make/quick-break operating mechanism.
   6. Deionizating arc chutes.
   7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
   8. Clear line shields to prevent accidental contact with line terminals.
   9. Operating handle:
      a. Red and easily recognizable.
      b. Padlockable in the OFF position
      c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
   1. Horsepower rated of connected motor.
   2. Voltage and amperage: As indicated on the Drawings.

3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
    1. Neutral kits.
    2. Ground lug kits.
    3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

D. Enclosures:
    1. NEMA 1 rated:
        a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
        b. With or without knockouts, hinged and lockable door.
    2. NEMA 3R rated:
        a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
        b. With or without knockouts, hinged and lockable door.
    3. NEMA 4 rated:
        a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
        b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
    4. NEMA 4X rated (metallic):
        a. Body and cover: Type 304 or 316 stainless steel.
        b. No knockouts, external mounting flanges, hinged and gasketed door.
    5. NEMA 12 rated:
        a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
        b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
    1. Fuses.
    2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in architecturally finished areas.

D. Permitted uses of NEMA 3R enclosure:
   1. Surface mounted in exterior location for HVAC equipment only.

E. Permitted uses of NEMA 4 enclosure:
   1. Surface mounted in areas designated as wet.

F. Permitted uses of NEMA 4X metallic enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

G. Permitted uses of NEMA 12 enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

SECTION 26 28 17
SEPARATELY MOUNTED CIRCUIT BREAKERS

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Separately mounted circuit breakers.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 489, Standard for Safety Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. Provide a table that associates equipment model number with equipment tag number.
      c. See Section 26 05 00 for additional requirements.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton Cutler Hammer.
   2. General Electric Company.
   3. Square D Schneider Company.
   4. Siemens.
   5. Appleton Electric Company.
   6. Crouse-Hinds.
   7. Killark.
   8. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 COMPONENTS

A. NEMA 1 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. With or without knockouts, hinged or unhinged cover.
   3. Breaker is front operable and padlockable in the OFF position.
   4. Suitable for service entrance.

B. NEMA 4 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

C. NEMA 4X rated:
   1. Body and cover: Type 304 or 316 stainless steel.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

D. NEMA 12 rated:
   1. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   2. No knockouts, external mounting flanges, hinged and gasketed door.
   3. Front operating handle padlockable in the OFF position and interlocked to prevent door from opening when the breaker is ON.
   4. Suitable for service entrance.

E. Standards: UL 489.

F. Overcurrent and short circuit protective devices:
   1. Molded case circuit breaker.
   2. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
   3. Factory installed.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Permitted uses of NEMA 1 enclosure:
   1. Surface or flush mounted in areas designated dry in architecturally finished areas.

C. Permitted uses of NEMA 4 enclosure:
   1. Surface mounted in areas designated as wet.

D. Permitted uses of NEMA 4X enclosure:
   1. Surface mounted in areas designated as wet and/or corrosive.

E. Permitted uses of NEMA 12 enclosure:
   1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

SECTION 26 32 14
ENGINE GENERATOR: DIESEL

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Engine generator set and accessories.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.
   5. Section 26 05 48 - Seismic Bracing Systems.
   6. Section 40 05 13 - Piping and Pipe Fittings: Basic Requirements.
   7. Section 40 05 23 - Valves: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Environmental Protection Agency (EPA):
      a. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   3. National Fire Protection association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 702, Optional Standby Systems.
   4. Underwriters Laboratories, Inc. (UL):
      a. 142, Standard for Steel Above Ground Tanks for Flammable and Combustible Liquids.
      b. 2200, Standard for Stationary Engine Generator Assemblies.
   5. Factory Mutual Insurance Company (FM):
      a. 7-88, Property Loss Prevention Data Sheets.
   6. International Fire Code, 2009:
      a. Section 604.

b. Chapter 27 as adopted and amended by the City of Bellevue.

B. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and installation of the unit.

1.03 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:
   1. Optional standby power during a utility power outage, NFPA 70, Article 702.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
      c. Engine/generator performance curves.
      d. Unit sizing calculations.
   2. Fabrication and/or layout Drawings.
      a. Dimensional plan and elevation Drawings.
      b. Wire interconnection Drawings.

C. Quality Assurance Submittals:
   1. Test reports:
      a. Factory test reports.
   2. Unit installation, startup and operational statement.
   3. Field Quality Control test reports.
   4. Test reports: Sound attenuating enclosure test measurements.

D. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.05 SITE CONDITIONS

A. Ambient air temperature:
   1. Minimum: 16 DegF.
   2. Maximum: 96 DegF.

B. Altitude: 322 FT above sea level.

C. Seismic (Earthquake) forces: See Specification Section 26 05 48.

1.06 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Engine generator unit:
      a. Caterpillar.
      b. Cummins Onan.
      c. Kohler.
      d. Or Approved Equal.
   2. Silencers:
      a. Maxim.
      b. GT Exhaust Systems.
      c. Nelson.
      d. Cowl.
      e. Hapco.
      f. Or Approved Equal.
   3. Battery charger:
      a. Manufacturer's standard.
   4. Governor:
      a. Manufacturer's standard.
   5. Radiator:
      a. Manufacturer's standard.
   6. Vibration isolators:
      a. Caldyne.
      b. Mason Inds.
      c. Ace.
      d. Korfund Dynamics.
      e. Or Approved Equal.

7. Day tank:
    a. Pryco.
    b. Simplex Access Controls.
    c. Tramont.
    d. Ace Tank.
    e. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 EQUIPMENT

A. Emissions Requirements:
1. A single units emissions shall meet all Federal, State and Local government requirements, including but not limited too:
    a. Environmental Protection Agencies (EPA) New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart IIII.
    b. EPA standby rating, meet US EPA Emissions Regulations for tier 3, as follows:
        1) Oxides of Nitrogencombined with Hydrocarbons limit (NOx+HC)=4.0.
        2) Carbon Monoxide limit CO= 3.5.
        3) Particulate matter limit PM= 0.20 includes any visible smoke and soot.
2. Performance and Configuration Requirements:
    a. The Unit shall be capable of providing standby power without over or under loading the Unit.
3. Deviations from the indicated size on the Drawings based on the manufacturer's calculation shall be brought to the attention of the Project Representative.

2.03 COMPONENTS

A. Engine Generator Unit General:
1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.
2. Mount unit on skid suitable for installation on concrete foundation.
3. Base rating on operation at rated RPM when equipped with all operating accessories.
4. Standards: UL 2200.

B. Engine:
   1. Four-cycle, full compression ignition, single acting, solid-injection unit, either vertical or V-type pistons naturally aspirated or turbo charged with after cooling.
   2. Fuel supply: No. 2 Diesel.
   3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.
   4. Capable of operating at idle or light loads for extended periods of time.

C. Injection Pumps and Valves:
   1. Type not requiring adjustment in service, which may be individually removed and replaced.
   2. Individual injection pump and valve for each cylinder.
   3. Fuel injection pumps: Positive action, constant-stroke, actuated by cam driven by gears from engine crankshaft.
   4. Fuel lines between injection pumps and valves: Heavy seamless steel tubing.
   5. Flexible fuel line connectors for supply and return connections at pump.

D. Oil Pump:
   1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
   2. Spray cool and lubricate pistons.
   3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
   4. Filter elements accessible and easily removable.
   5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
   6. Equip filter system with spring-loaded by-pass valve.
   7. Oil cooler: Water-cooled, engine-mounted.

E. Fuel System:
   1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump.
   2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
   3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
   4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.

F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 percent of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.

G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

H. Electric Starting System:
   1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
   2. Controls to provide automatic cranking of engine when generator is called to start.
   3. Prevent excessive cranking which could damage cranking motor.
   4. Automatic stop controls.
   5. Starter motors with positive-engagement feature.

I. Cooling System:
   1. Capacity for cooling engine at the specified operating conditions.
   2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
   3. Unit mounted radiator.
      a. Core guard flexible duct adapter.
      b. Site glass at top of unit.
      c. Engine driven blower fan.
      d. Low water level cutoff switch.
   4. Provide fan guards.

J. Heater:
   1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
   2. 208 V, single phase.

K. Silencer:
   1. Suitable type for critical grade silencing.
   2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.

L. Engine Instruments and Controls:
   1. Engine-mounted instruments:
      a. Oil pressure gage.
      b. Water temperature gage.
      c. Run time meter.
      d. Battery voltage meter.

2. Automatic cycle cranking and over-crank protection.
3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.
4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.
5. Three (3) NO auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.
    a. Contacts shall close when generator is started.

M. Fuel Day Tank:
1. Double wall sub-base day tank mounted underneath engine generator unit.
2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.
3. Tank connections: Fuel level gage, fuel lines to generator, fill, vent, drain and pressure relief.
4. Manual overfill protection.
5. Fuel level continuous monitoring transmitter.
6. Low level warning with contacts for remote alarm.
    a. Set to alarm at 50 percent of capacity.
7. Critical low level shutoff with contacts for remote alarm.
8. Leak detection alarm with contacts for remote alarm.
9. Capacity: 24 HRS at full load.
10. Standards: UL142, FM 7-88.Tank constructed shall have integral secondary containment as UL 142 listed
11. Normal atmospheric vent shall not be less than 12 ft above adjacent grade, nor located for trapped vapors under eaves, and at least 5 feet from building openings or property lines per IFC 3404.2.7.3.3.
12. Tank vents shall not be manifolded per IFC 3404 2.7.3.5.
13. Emergency vent shall be labeled indicating opening pressure and flow rate per NFPA 30: 4.2.5.2.
14. The tank emergency vent shall not vent inside weather housing, IFC 3404 2.7.4.2.
15. Filling, emptying, and vapor recovery openings shall be located outside the weatherproof housing, not less than 5 FT from building openings or lot lines per IFC 3404, 2.7.5.2.

16. Fuel fill tube shall be installed to minimize static electricity by terminating within 6 inches of the tank bottom per IFC 3404, 2.7.5.5.
17. Spill container with a capacity of not less than 5 gallons shall be provided for fill connection. Fill connections shall be positive no leak design. Equipped with a manual drain valve that drains into the main tank, per IFC 3404 2.9.6.8.
18. Overfill prevention valve shall be provided set at 95% of capacity or sooner. An audible or visual alarm notifying fuel level is at 90% of tank capacity or sooner, per 3404 2.9.6.6 and 2.7.5.8.
19. Provide label that shows fill location, procedure, tank calibration, and verbiage for signs prohibiting open flames and no smoking per IFC 3404.5, 3404.2.3.
20. Monitor for liquid in the secondary containment shall be provided per IFC 2704 2.2.5.

N. Batteries:
1. Lead acid type.
2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.

O. Battery Charger:
1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 Vac input.
3. Malfunction alarm contacts (minimum): Low and high battery voltage, weak battery and charger failure.
4. Enclosure: NEMA 1 rated.

P. Generator:
1. Brushless, 6-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
2. Minimum continuous standby ratings:
    a. As indicated on the Drawings, substantiated by manufacturer's standard published curves and conform to NEMA MG 1 Specification.
    b. Special ratings or maximum ratings are not acceptable.
3. Rated to serve up to 50 percent non-linear load without exceeding rated temperature rise.
4. Minimum efficiency: 92 percent at 50 to 110 percent of nominal standby rating, less than 30 percent instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other future units connected in parallel.

5. Stator and rotor: 125 DegC temperature rise with minimum Class F insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
6. Directly connect stator to engine flywheel housing.
7. Drive rotor through semiflexible driving flange to ensure permanent alignment.
8. Self ventilating with suitable blower, air inlet and outlet openings.
9. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
10. Generator drive free from critical torsional vibration within operating range.
11. Provide generator mounted main circuit breaker:
    a. Solid state molded case type.
    b. Ratings as indicated.

Q. Voltage Regulator:
1. SCR type, to maintain 2 percent voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 percent including cross-current compensation to provide maximum of 5 percent unbalance in kVA load sharing between this unit and possible future generators.
2. Automatic protection against short circuits on system.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of plus or minus 5 percent from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

R. Generator Instruments and Controls:
1. Generator mounted NEMA 1 type, illuminated vibration isolated instrument and control panel(s).
2. AC voltmeter and phase selector switch.
3. AC ammeter and phase selector switch.
4. Frequency meter.
5. Kilowatt load meter.
6. Run-off-auto engine, start-stop control switch.
7. Emergency stop.
8. Run time meter.
9. Governor control rheostat.

10. Voltage level adjustment rheostat.
11. Cool down time delay 0-15 minute adjustable.
12. Cycle cranking control.
13. Minimum red shut down indicating lights as follows:
    a. Overcrank.
    b. Overspeed.
    c. Low lubricating oil pressure.
    d. High engine water temperature.
14. Minimum amber alarm indicator lights as follows:
    a. Control switch not in auto position.
    b. Low engine water temperature (less than 70 DegF).
    c. Low fuel in day tank.
    d. Day tank leak.
    e. Battery charger malfunctioning.
    f. Low battery voltage.
15. Minimum amber prealarm indicator lights as follows:
    a. High engine water temperature.
    b. Low lubricating oil pressure.
16. Common dry contact and audible alarm to indicate when one (1) or more alarm or prealarm conditions exist.

S. Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the seismic zone of the Project.

2.04 ACCESSORIES

A. Provide interposing relays (24 Vdc to 120 Vac) as required for interfacing with customer's 120 Vac monitoring system.

B. Generator remote annunciator panel:
   1. Flush mounted enclosure with flush plate.
   2. Circuits:
      a. 24 Vdc powered from starting batteries.
      b. Verify circuit voltage to match battery voltage.
   3. Provide red and green signal lamps, buzzer, silencing switch, lamp test switch, relays, solid-state components, and engraved function identifications.

4. Annunciator functions:
    a. Green light "ON" to indicate generator is operating to supply power to load.
    b. Separate red light for each shutdown or alarm condition and amber light for each prealarm condition and common buzzer with silence/ acknowledge switch.
    c. Shut down indicating lights as follows:
        1) Overcrank.
        2) Overspeed.
        3) Low lubricating oil pressure.
        4) High engine water temperature.
    d. Alarm indicator lights as follows:
        1) Control switch not in auto position.
        2) Low engine water temperature (less than 70 DegF).
        3) Low fuel in day tank.
        4) Fuel in day tank rupture basin.
        5) Battery charger malfunctioning.
        6) Low battery voltage.
    e. Prealarm indicator lights as follows:
        1) High engine water temperature.
        2) Low lubricating oil pressure.

C. Provide communication module inside generator controller to be compatible with facility SCADA PLC modbus TCP/IP protocol.

D. Generator set non-walk-in sound attenuating, weatherproof, self-contained, freestanding generator containment.
    1. Attenuate engine-generator produced sound to an A-weighted sound level of 75 dB(A) at 23 FT from enclosure.
    2. Construction:
        a. Aluminum frame and exterior panels.
        b. Structurally stable in 100 mph wind.
        c. Support roof load of 40 PSF.
        d. Fiberglass or mineral wool insulation to provide minimum R11 insulation in side walls and roof for thermal transmission, sound attenuation material can be in addition to or include the thermal insulation.
        e. Enclosure shall be approved for installation in local seismic zone.
    3. Exterior shall be mill prepainted in color selected by Project Representative.

4. Resist intake of blown sand or rain through intake air assembly.
5. Easy access to all major generator and engine control components.
6. Enclosures mounted directly to sub-base fuel tank.
7. Enclose exhaust system.
8. Anchor bolts for casting into concrete base for attaching enclosure to pad.
9. Motorized dampers for control of air intake and discharge openings.
10. Electric unit heaters to maintain internal temperature at 50 DegF and interlock so unit heaters shut off when generators are running.
11. Coordinate the enclosure with the engine generator furnished to assure physical clearances, sound attenuation, airflow and pressure drop through the system.
12. Space for mounting electrical panel for serving loads inside enclosure to include but not be limited to lights, unit heaters, engine block heaters, battery chargers, ventilation fans.

2.05 SOURCE QUALITY CONTROL

A. Individually test each prime mover.
   1. Apply derating factors for the proposed site to test data.
   2. Continuously test for a period no less than 4 HRS.
   3. Test procedure shall be as follows:
      a. Start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating at rated power factor in one (1) step.
      b. Observe and record the cranking time(s) required to start and run for each prime mover.
      c. Observe and record the time required to come up to operating speed for each prime mover.
      d. Record voltage and frequency overshoot for each prime mover.
      e. Record voltage, frequency and amperes.
      f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

2.06 MAINTENANCE MATERIALS

A. Spare Parts: Provide manufacturer's recommended spare parts.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions and Specification Section 26 05 48.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DegF.

C. Provide fuel for a full day tank.

D. Install all wiring to engine in conduit.
   1. Control wiring on engine may be factory installed in high temperature loom.

E. Provide control wiring in conduit between generator control panel, remote annunciator panel(s) and remote devices as described under generator instrument and controls paragraph and remote annunciator paragraph of this Specification.

F. Mount on concrete pad utilizing vibration/seismic isolators, see structural drawings for pad detail.

G. Sound attenuating engine generator enclosure:
   1. Field test installation under load.
   2. Use a precision sound measuring instrument meeting ANSI S1.4 Type 1.
   3. Provide measurements to Project Representative.

3.02 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-startup adjustments and installation checks.
   3. Conduct initial startup of equipment and perform operational checks.
   4. Provide Project Representative written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
   5. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.

B. Provide two (2) load tests and one (1) cycle crank test.
   1. Tests one (1) and two (2) shall be for continuous period of no less than 2 HRS each.
   2. Project Representative shall be notified seven (7) days prior to testing.
   3. Test number one:
      a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
      b. Observe and record the time delay on engine start.
      c. Observe and record the cranking time(s) required to start and run for each prime mover.

d. Observe and record the time required to come up to operating speed for each prime mover.

e. Record voltage and frequency overshoot for each prime mover.

f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.

g. Record voltage, frequency and amperes.

h. Record oil pressure, water temperature where applicable and battery charge rate at 5-minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.

i. Return normal power to facility, record time delay on retransfer to normal for each switch and cooldown time delay for each prime mover.

4. Test number two:

   a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating in one (1) step.

      1) Unity power factor is acceptable for on-site testing

   b. Observe and record the cranking time(s) required to start and run for each prime mover.

   c. Observe and record the time required to come up to operating speed for each prime mover.

   d. Record voltage and frequency overshoot for each prime mover.

   e. Observe and record time required to achieve steady-state condition.

   f. Record voltage, frequency and amperes.

   g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

5. Cycle crank test:

   a. Perform test for each prime mover.

      1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.

      2) Put control switch into "run" position to cause prime mover to crank.

   b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.

      1) Upon starting and running of the prime mover, further cranking shall cease.

      2) Two (2) means of cranking termination shall be utilized so that one (1) will act as a backup to the other to prevent inadvertent starter engagement.

3) Cranking limiter time shall be 75 seconds for cycle crank.

6. Furnish load banks of required ratings necessary for tests.
7. Record engine fuel consumption by means of test equipment.
8. Test all safeties specified for generator instruments and controls and generator remote annunciator panel as recommended by manufacturer and as required to verify proper operation.
9. Contractor shall be responsible for fuel and all consumables use during the test.

END OF SECTION

SECTION 26 36 00
TRANSFER SWITCHES

PART 1 – GENERAL

1.01 GENERAL

A. Section Includes:
   1. Automatic transfer switches.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 00 - Electrical: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittals process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.
   2. Submit Transfer Switch Shop Drawings to the serving utility company (PSE) and obtain approval prior to ordering equipment.

C. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 26 05 00.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Automatic transfer switches:
      a. Automatic Switch Company.
      b. Kohler.
      c. Onan.
      d. Russelectric.
      e. Zenith Products.
      f. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 AUTOMATIC TRANSFER SWITCH

A. Construction:
   1. Electrically operated mechanically held, double throw, air-break type.
   2. Silver-surface main contacts and protect by arcing contacts.
   3. Switch shall have provisions for visual inspection of switch blades and contacts.
   4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
   5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.
   6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
   7. Ratings:
      a. Continuous duty in both normal and emergency.

b. Three-phase, three-pole, four-wire.

c. Voltage and current ratings as indicated on the Drawings.

d. Short circuit withstand rating equal to or greater than the normal source electrical gear.

8. Standards: UL 1008.

B. Operation:

1. Microprocessor based control module.

2. Open transition.

3. Red and green indicating lights with fuses, identification nameplates, and test switch on front to simulate normal power failure at switch.

4. Engine starting contacts and all other auxiliary contacts and accessory devices for functions to be performed. Output contact (N/O or N/C) for engine-start signals.

5. Supervisory voltage relays on each phase of normal source and single phase supervisory voltage and frequency relay for emergency source.

a. Normal source voltage sensing.

1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.

2) Adjustable dropout from 75-98 percent of pickup setting, factory set 85 percent.

b. Emergency source voltage and frequency sensing:

1) Adjustable pickup from 85-100 percent of rated voltage, factory set 90 percent.

2) Fixed voltage dropout at 85 percent of pickup setting.

3) Adjustable pickup from 90-100 percent of rated frequency, factory set 95 percent.

4) Fixed frequency dropout at 88 percent of pickup setting.

6. Time delays:

a. Engine start, adjustable from 0 to 10 seconds, factory set at 4 seconds, to avoid unnecessary starting caused by short time outages.

b. Transfer to generator, adjustable from 0 to 120 seconds, factory set at 10 seconds.

c. Retransfer to normal, adjustable from 2 to 30 minutes, factory set at 15 minutes to avoid erratic operation caused by short time reestablishment of normal source.

1) Automatically bypassed when emergency source fails and normal source is available.

d. Generator cool down, adjustable from 0 to 60 minutes, factory set at 10 minutes.

7. Exerciser timer:
    a. Enable and disable function.
    b. Selectable to exercise with or without transferring load.
    c. Adjustable exercise duration from 1 minute to 24 HRS, factory set at 15 minutes.
    d. Adjustable day of the week exercise setting, factory set for Monday.
8. In-phase monitor:
    a. Compare the phase relationship and frequency difference between the normal and emergency sources and permit transfer the first time the sources are within 15 electrical degrees and only if transfer can be accomplished within 60 electrical degrees as determined by monitoring the frequency differences.
    b. In-phase transfer accomplished if both sources are within 2 Hz of rated frequency and 70 percent or more of rated voltage.

C. Enclosure:
1. NEMA 1 rated.
2. Body and cover: Sheet steel finished with a rust inhibiting primer and manufacturers standard paint inside and out.
3. No knockouts, hinged and lockable door.

D. Switch-Position Indication: Indicate source to which load is connected.
1. Source-Available Indication: Supervise sources via transfer switch normal- and emergency-source sensing circuits.
2. Normal Power Indication: Indicate "Normal Source Available."
3. Emergency Power Indication: Indicate "Emergency Source Available."

E. Interface of ATS Controls with Facility SCADA PLC:
1. ATS Controls shall provide indication of switch status and be equipped with alarm diagnostics.
2. Four auxiliary contacts, two contacts closed when switch is in normal position and two contacts closed when switch is in emergency position. Output signals for remote indication of normal and emergency source acceptability.
3. Local/remote communications capability for interfacing via Modbus TCP/IP communication. Internet enabled monitoring and control.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in one-line diagram.

C. Mounting of automatic transfer switches:
   1. Wall-mounted or floor mounted on 4 IN high concrete pad.

3.02 FIELD QUALITY CONTROL

A. Automatic Transfer Switch Testing:
   1. Simulate power outage by opening normal source overcurrent device.
      a. Verify engine generator starts and switch transfers in the specified time.
   2. Close normal source overcurrent device to simulate the return of normal power.
      a. Verify the switch retransfers and engine generator shuts down in the specified time.
   3. Perform a manual transfer and retransfer.
   4. Verify the indicator lights function properly.

END OF SECTION

SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Contractor shall provide all material, design and installation requirements for a complete:
      a. Lightning protection system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Section 26 05 26 - Grounding.
   5. Section 26 05 33 - Raceways and Boxes.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Lightning Protection Institute (LPI):
      a. 175, Standard of Practice for the Design - Installation - Inspection of Lightning Protection Systems.
   2. National Fire Protection Association (NFPA):
      a. 780, Standard for the Installation of Lightning Protection Systems.
   3. Underwriters Laboratories, Inc. (UL):
      a. 96A, Standard for Installation Requirements for Lightning Protection Systems.

1.03 DEFINITIONS

A. Classification of Buildings per NFPA 780:
   1. Class I: Any commercial, industrial, or residential building less than 75 FT in height.

1.04 SYSTEM DESCRIPTION

A. Provide a complete lightning protection system on the following:
   1. Transfer Station Building (including HHW Building).
   2. Administration Building.

1.05 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
      c. Include data sheets that include manufacturer's name and product model number. Clearly identify all optional accessories.
      d. Acknowledgement that products submitted are in compliance with LPI or UL.
      e. Manufacturer's delivery, storage, handling and installation instructions.
      f. Equipment installation details.
   2. Fabrication and/or layout Drawings:
      a. Plan Drawing showing type, size, and locations of all lightning protection hardware. Roof penetration details.
      b. Verification that the installation shall comply with the requirements of, and shall qualify for the UL Master Label Certificate.

C. Quality Assurance Submittals: UL Master Label Certificate.

D. Closeout Submittals:
   1. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:
      a. Product data and as-built layout Drawings.
      b. Requirements for, and frequency of, periodic inspections.

1.06 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Construction Agents Northwest-Erico Inc., Eritech Lighting Protection.

2. A-C Lightning Security, Inc.
3. Harger Lightning Protection.
4. Heary Brothers.
5. National Lightning Protection (NLP).
6. Robbins Lightning Protection Company.
7. Thompson Lightning Protection, Inc.
8. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 MATERIALS

A. Standards: NFPA 780, UL 96A.

B. Material for air terminals, main conductors and bonding conductors: Copper or aluminum.

C. Size of air terminals, main conductors and bonding conductors: In accordance with Tables 3-1.1(a) and 3-1.1(b) of NFPA 780.

D. Ground rods: In accordance with Specification Section 26 05 26.

E. Material for conductor fasteners, connector fittings, bonding fittings, conductor splicers and thru-wall or thru-roof assemblies: Cast bronze, brass or copper with bolt pressure connectors.

F. Material for bolts, nuts, and screws: Stainless steel.

G. Raceways: In accordance with Specification Section 26 05 33.

PART 3 – EXECUTION

3.01 INSTALLATION

A. General:
1. Design and installation standards: LPI 175, NFPA 780, UL 96A.
2. Lightning protection material selected shall be compatible with the material of construction for the structure being protected.
3. Components shall be adhesively fastened to the roof system unless specifically noted otherwise.
    a. Do not mechanically fasten to metal roof panels or penetrate roof membrane without written consent of the roofing manufacturer and the Project Representative.
    b. Seal all penetrations in accordance with roofing manufacturer's recommended details.

B. Structures and/or Buildings:
1. The protection system shall utilize Class I or Class II materials as defined by NFPA 780.

2. The system shall include:
    a. Roof mounted air terminals.
    b. Interconnecting conductors.
    c. Downleads:
        1) Conductors encased in rigid non-metallic conduit concealed within the exterior wall.
        2) Metal structural steel members.
    d. Ground terminations.
    e. Bonding of other grounded structure/building systems.
3. Connect down leads to ground ring per Specification Section 26 05 26 and the Drawings.
4. Connection to grounding electrode system shall be made in accordance with Specification Section 26 05 26.

3.02 FIELD QUALITY CONTROL

A. Installation shall be performed in accordance with UL and NFPA.

B. The completed installation shall qualify for and receive the UL Master Label Certificate.

C. Provide a nameplate, attached to the structure, which includes the name and address of the Contractor responsible for the installation of the lightning protection system.

END OF SECTION

SECTION 26 43 13
LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Type 1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), integrally mounted.
   2. Type 3 SPD - Medium exposure locations (switchboard, panelboard and motor control center), integrally mounted.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Division 26 - Electrical.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. Military Standard:
      a. MIL-STD-220B, Method of Insertion-Loss Measurement.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Safety Transient Voltage Surge Suppressors (3rd Eddition).

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

1.03 DEFINITIONS

A. Clamping Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Standard catalog cut sheet.
      b. Electrical and Mechanical Drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      c. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
         1) Data in the Product Data Sheet heading:
            a) SPD Type Number per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
            c) Name of the nationally recognized testing laboratory that preformed the tests.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
         4) Date of signature.

C. Quality Assurance Submittals.
   1. Manufacturer's qualifications.
   2. Testing procedures and testing equipment data.

D. Closeout Submittals:
   1. Extended Warranty: Provide two exectued copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.
   2. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.05 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty period for Work of this Section five (5) years commencing on the date of Substantial Completion.

PART 2 – PRODUCTS

2.01 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, NEMA LS 1, MIL-STD 220B, UL 1283, UL 1449.

2.02 TYPE 1 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to SB0301.
   2. Integrally mounted in switchgear, switchboards or MCCs.
   3. Hybrid solid-state high performance suppression system.
      a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   4. Do not connect multiple SPD modules in series to achieve the specified performance.
   5. Designed for parallel connection.
   6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   7. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 percent deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

		IEEE C62.41		
System Voltage	**Test Mode**	**C High V & I Wave**	**B Combination Wave**	**UL 1449**
L-L < 250 V	L-L	1470 V	1000 V	800 V
L-N < 150 V	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V	L-L	2700 V	2000 V	1800 V
L-N > 150 V	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.03 TYPE 3 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to SB0302, HP0302, HP0201, HP0401.
   2. Integrally mounted in a switchboard, panelboards or motor control centers.
   3. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.

4. Do not connect multiple SPD modules in series to achieve the specified performance.
5. Designed for parallel connection.
6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
7. Device monitor:
    a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
    b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 120,000 A per phase, 60,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

I. SPD Protection:
1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41 B Comb. Wave	IEEE C62.41 B3 Ring Wave	UL 1449
L-L < 250 V	L-L	1000 V	700 V	800 V
L-N < 150 V	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V	L-L	2000 V	1400 V	1800 V
L-N > 150 V	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.04 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
   1. Integral unit level and/or component level fusing.
   2. Neutral and ground shall not be bonded during testing.
   3. 6 IN lead lengths.
   4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
   1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
   2. Single pulse surge current capacity test.
   3. Repetitive surge current capacity testing.
   4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 – EXECUTION

3.01 INSTALLATION

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

B. Type 1 and 3 SPD:
   1. Connected in parallel to the equipment.

2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
3. Provide leads that are as short and straight as possible.
4. Maximum lead length: 12 IN.
5. Minimum lead size: #2 stranded AWG or bus bar.
6. Connect leads to the equipment to be protected by one (1) of the following means:
    a. Through a circuit breaker or molded case switch mounted in the equipment.
    b. Use manufacturer recommended circuit breaker size.
    c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

END OF SECTION

SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building lighting fixtures.
      b. Exterior building and site lighting fixtures.
      c. Lamps.
      d. Ballasts.
      e. Light poles.
      f. Lighting control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 10 14 00 – Identification Devices.
   4. Division 3 - Concrete.
   5. Section 26 05 00 - Electrical: Basic Requirements.
   6. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
   7. Section 26 09 16 - Control Equipment Accessories.
   8. Section 26 09 43 - Low Voltage Lighting Control System.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
      a. ANSI/IESNA RP-7-01, Lighting Industrial Facilities.
      b. NECA/IESNA 502-1999 (R2006), Standard for Installing Industrial Lighting Systems (ANSI).
      c. NECA/IESNA 501-2000 (R2006), Standard for Installing Exterior Lighting Systems (ANSI).
   2. Certified Ballast Manufacturers (CBM).
   3. Federal Communications Commission (FCC):
      a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.

4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
5. National Electrical Manufacturers Association (NEMA):
    a. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
    b. LE 4, Recessed Luminaires, Ceiling Compatibility.
6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
    a. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.
    b. C82.4, Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
    c. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.
7. National Fire Protection Association (NFPA):
    a. 70, National Electrical Code (NEC).
    b. 101, Life Safety Code.
8. Underwriters Laboratories, Inc. (UL):
    a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
    b. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
    c. 924, Standard for Emergency Lighting and Power Equipment.
    d. 935, Standard for Fluorescent-Lamp Ballasts.
    e. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
    f. 1598, Luminaires.
    g. 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.
9. United States Department of Energy (USDOE):
    a. EPAct, the National Energy Policy Act.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
1. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. Identify fixtures by Fixture Schedule number.

c. Fixture data sheet including:

1) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.

2) Fixture effective projected areas for pole mounted fixtures.

d. Pole data shall include:

1) Pole wind loading.

2) Anchor bolt template.

e. UL nameplate data for fixtures used in Class 1 Division 1 and 2 areas.

f. See Specification Section 26 05 00 for additional requirements.

1.04 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Lighting fixtures: See Fixture Schedule.
2. Lamps:

a. Osram/Sylvania.

b. General Electric.

c. Philips.

d. Venture.

e. Or Approved Equal.

3. Ballasts: Fixture manufacturer's standard.
4. Emergency ballasts:

a. Bodine.

b. Exitronix.

c. Or Approved Equal.

5. Emergency transfer devices:
    a. Bodine.
    b. Exitronix.
    c. Or Approved Equal.
6. Poles: Fixture manufacturer's standard.

B. Submit request for substitution in accordance with Specification Section 01 60 00.

2.02 GENERAL REQUIREMENTS

A. All lighting fixtures and electrical components:
    1. UL labeled.
    2. Fixtures complete with lamps and ballasts.
    3. Rated for area classification as indicated on the Drawings.
        a. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and lamp combination shall not exceed the auto-ignition temperature of the atmosphere in which the fixture is used.

B. Provide all recessed fixtures with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
    1. Provide recessed fixtures with trim gaskets cemented in proper position.

C. Provide standard plaster frame for all recessed lighting fixtures installed in plaster walls or ceilings.
    1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

D. No live parts normally exposed to contact.

E. When intended for use in wet areas: Mark fixtures "Suitable for wet locations."

F. When intended for use in damp areas: Mark fixtures "Suitable for damp locations" or "Suitable for wet locations."

2.03 LIGHT FIXTURES

A. Fluorescent:
    1. UL 1598.
    2. UL 844 for hazardous locations.
    3. NEMA LE 4 for recessed locations.
    4. Lenses: As indicated in Fixture Schedule, with the following minimums:
        a. Troffer: 100 percent virgin acrylic, conical shaped, female 0.1875 IN, square based prisms, aligned 45 degrees to the length and width, 0.125 IN nominal thickness.

5. Finish:
    a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
    b. Manufacturer's standard color or special color specified in Fixture Schedule.
6. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.

B. High Intensity Discharge:
1. UL 1598.
2. Finish:
    a. Manufacturer's standard polyester, acrylic enamel or epoxy powder coating applied after fabrication.
    b. Manufacturer's standard color or special color specified in Fixture Schedule.
3. Prewired and provided with lamps that are properly mated to the ballast operating characteristics.
4. Provided with safety chain.

C. Exit Signs and Emergency Lighting Units:
1. UL 924, NFPA 101.

D. LED:
1. Optical system controls light above 90 degrees.
2. UL 1598.
3. UL 8750.
4. Construction:
    a. Rugged, die-cast, single piece aluminum housing.
    b. Housing completely sealed against moisture and environmental contaminants.
5. Finish:
    a. Exterior parts protected by zinc-infused thermoset powder coat finish for resistance to corrosion and weathering.

2.04 LAMPS

A. Fluorescent:
1. T8 (265 mA) instant or rapid-start medium bipin lamps.
    a. Correlated color temperature of 3500 degrees Kelvin.
    b. Minimum color rendering index (CRI) of 80.
    c. Minimum initial lumen ratings for each lamp type shall be:
        1) 1300 lumens for 24 IN, 17 watt F17T8 lamp.

2) 2400 lumens for 48 IN, 25 watt F32T8 lamp.

3) 36,000 HRS rated on 3 HRS switching cycle.

2. T5 instant or rapid-start 4 pin (2G11 base) compact fluorescent lamps.
   a. Correlated color temperature of 3500 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 80.
   c. Minimum initial lumen ratings for each lamp type shall be:
      1) 1250 lumens for 10.5 IN, 18 watt F18BX lamp.
      2) 1800 lumens for 12.8 IN, 24 or 27 watt F27BX lamp.
      3) 2850 lumens for 16.5 IN, 36 or 39 watt F39BX lamp.
      4) 3150 lumens for 22.5 IN, 39 watt F39BX lamp.
3. T4 twin-tube, quad-tube, and/or triple twin-tube compact fluorescent lamps.
   a. Correlated color temperature of 3500 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 80.
   c. Minimum initial lumen ratings for preheat 2-pin twin-tube lamps with a G23 or GX23 base shall be:
      1) 580 lumens for 6.5 IN, 9 watt CF9TT lamp.
      2) 800 lumens for 7.1 IN, 13 watt CF13TT lamp.
   d. Minimum initial lumen ratings for rapid-start 4-pin quad-tube lamps with a G24q-1, G24q-2 or G24q-3 base shall be:
      1) 900 lumens for 5.2 IN, 13 watt CF13QT lamp.
      2) 1160 lumens for 5.8 IN, 18 watt CF18QT lamp.
      3) 1700 lumens for 6.5 IN, 26 watt CF26QT lamp.
   e. Minimum initial lumen ratings for rapid-start 4-pin triple twin-tube lamps with a GX24q-2 or GX24q-3 base shall be:
      1) 1120 lumens for 4.6 IN, 18 watt CF18TTT lamp.
      2) 1610 lumens for 5.2 IN, 26 watt CF26TTT lamp.
      3) 2200 lumens for 5.8 IN, 32 watt CF32TTT lamp.
      4) 3200 lumens for 6.3 IN, 42 watt CF42TTT lamp.

B. High Intensity Discharge (HID) Lamps:
   1. Metal halide lamps:
      a. Metal halide lamps shall be pulse-start type.
         1) If used in an open luminaire, the lamp shall be rated for use in an open fixture and incorporate a protective arc tube shroud design.
      b. Clear lamps:
         1) Correlated color temperature of 4000 degrees Kelvin.

2) Minimum color rendering index (CRI) of 65.

c. Minimum initial lumen ratings for metal halide lamps with a medium base in a vertical position shall be:

1) 3200 lumens for 50 watt, ED-17 (ANSI M110) clear lamp.

2) 5600 lumens for 70 watt, ED-17 (ANSI M98) clear lamp.

3) 8500 lumens for 100 watt, ED-17 (ANSI M90) clear lamp.

4) 14250 lumens for 150 watt, ED-17 (ANSI M102) clear lamp.

5) 17500 lumens for 175 watt, ED-17 (ANSI M137) clear lamp.

d. Minimum initial lumen ratings for metal halide lamps with a mogul base in a vertical position shall be:

1) 42000 lumens for 400 watt, ED-28 or ED-37 (ANSI M135) clear lamp.

C. LED:

1. High Efficiency nominal 4000k.
2. 65 CRI LEDs.
3. Lumens per watts (LPW): Typical 82.
4. 60,000 HRS of performance (L85) at 77 DegF.

2.05 BALLASTS

A. Fluorescent High Frequency Electronic Ballasts:

1. UL 935.
2. "High Frequency" electronic operating lamps at a frequency of 20 KHz or higher without visible flicker.
3. Power factor: Greater than 90 percent.
4. Input current total harmonic distortion (THD) of less than 20 percent.
5. Lamp current crest factor: Less than 1.7, in accordance with lamp manufacturer's recommendations and NEMA/ANSI C82.11.
6. Instant start with lamps wired in parallel.
7. Support a sustained short to ground or open circuit of any output leads without damage to the ballast.
8. Ballast Factor: Greater than 0.85 per NEMA/ANSI C82.11.
9. Audible noise rating: Class A or better.
10. Operation in ambient temperatures up to 40 DegC (105 DegF) without damage.
11. Light output to remain constant for a line voltage fluctuation of +5 percent.
12. Meet the requirements of the FCC 47 CFR 18, for non-consumer equipment for EMI and RFI.
13. Meet NEMA/ANSI C82.11 standards regarding harmonic distortion.

14. Meet IEEE C62.41 Cat. A for transient protection.
15. Comply with all applicable state and federal efficiency standards.
16. UL listed, Class P.
17. Contain no Polychlorinated Biphenyls (PCB's).

B. Fluorescent Emergency Ballasts:
   1. UL 924, NFPA 101.
   2. High temperature, 24 Watt-hour, maintenance-free nickel cadmium battery with charger.
   3. Charging indicator light (LED) to monitor the charger and battery.
   4. Double-pole test switch.
   5. Light one (1) lamp for 90 minutes in 1, 2 and 3-lamp fixtures.
      a. Light two (2) lamps for 90 minutes in 4-lamp fixtures.
   6. Dual input voltage (120/277V), 4 Watts input.
   7. Compatible with the install lamp type.
   8. Initial lumen output: 975 to 1400.
   9. Contain no Polychlorinated Biphenyls (PCB's).

C. High Intensity Discharge Ballasts:
   1. NEMA/ANSI C82.4, UL 1029.
   2. Metal halide:
      a. Input voltage variation: +10 percent.
      b. Maximum lamp regulation spread: 20 percent.
      c. Minimum power factor: 90 percent.
      d. Starting current: Not greater than operating current.
      e. Maximum input voltage dip: 40 percent.
      f. Crest factor: 1.5 to 1.8.
      g. Types:
         1) Lead-type regulators: Constant wattage autotransformer (CWA) and pulse start.
         2) Lag-type regulators: Magnetic regulator and pulse start.
      h. Contain no Polychlorinated Biphenyls (PCB's).
   3. Ballasts for interior use:
      a. Encased and potted type.
      b. Audible noise rating of B or better.
      c. Built-in automatic resetting thermal protection switch.

4. Ballasts for exterior use:
    a. Starting temperature: -20 DegF.

D. LED Standard and Dimming Drivers:
1. 120-277 V.
2. 50-60 Hz.
3. Power factor better than 90 percent.
4. Total Harmonic Distortion less than 20 percent.
5. Expected driver life is over 60,000 HRS, to match light engine life.
6. Integral surge protection.

2.06 POLES

A. As scheduled or noted on the Drawings.

2.07 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 percent of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 percent of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Coordinate fixture types with ceiling construction.
1. Provide mounting hardware for the ceiling system in which the fixture is to be installed.

B. Fasten lighting fixtures supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted fixtures.
1. Do not support fixture from conduit system.
2. When fixtures are supported from outlet boxes, install per NFPA 70.
3. Supports for fixtures mounted on exterior walls shall not be attached to exterior face of the wall.

D. Provide pendant fluorescent, compact fluorescent, and/or HID fixtures with swivel hangers which will allow fixture to swing in any direction but will not permit stem to rotate.
1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.

2. Swivel hangers for fixtures in mechanical equipment areas: Shock absorbing type.
3. Secure HID fixtures with safety chain.

E. Pendant mounted, open, industrial fluorescent fixtures:
1. Not in continuous rows, shall be supported by conduit or by approved chains:
   a. Hardwired to ceiling mounted junction box.
2. In continuous rows, shall be rigidly supported with conduit and fasten fixtures to each other or mount on continuous metal channel per Specification Section 26 05 00.
   a. Hardwired to ceiling mounted junction box.
   b. Provide reflector alignment clips.

F. Locate fixtures in accordance with reflected ceiling plans.

G. Locate in exact center of tile when indicated.
1. Relocate misplaced fixtures and replace damaged ceiling materials.

H. Mount lighting fixtures at heights indicated in Specification Section 26 05 00 or per fixture schedule or as indicted on the Drawings.

I. Install exterior fixtures so that water can not enter or accumulate in the wiring compartment.

J. Where indicated provide two-level control of three (3) and/or four (4) lamp fluorescent fixtures.
1. Provide two (2) ballasts per fixture and control inside lamp(s) in each fixture by one (1) switch or set of switches and the outside two (2) lamps by a second switch or group of switches.

K. Ground fixtures and ballasts.

L. Provide bird deterrents for pendant fluorescent light fixtures on TS tipping floor.

3.02 POLE INSTALLATION

A. Drawings indicate the intended location of light pole.
1. Field conditions may affect actual location.
2. Coordinate location with all existing or new utilities and pavement.

B. Steel Poles:
1. Mounted on cast-in-place foundations, as detailed on the Drawings.
   a. Concrete and reinforcing steel, in accordance with Division 3 Specification Sections.
2. Protect pole finish during installation.
   a. Repair damage to pole finish with manufacturer approved repair kit.

C. Ground poles as indicated on the Drawings.

D. Conductors:
   1. See Specification Section 26 05 19 for required underground conductors.
   2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to fixture, #12 AWG minimum.

E. Overcurrent and Short Circuit Protection:
   1. Protect each phase with a UL Class CC fuse:
      a. Size: Three (3) times load current.
      b. Standard: UL 248-4.
   2. Fuseholder:
      a. Watertight, in-line and break-a-way style.
      b. Accept up to a 30 A, 600 V fuse.
      c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
      d. Conductor terminal: Adequate size for the installed conductors.

F. Provide bird deterrents for pole mounted light fixtures. Refer to Section 10 29 00 – Bird Control Device.

3.03 LIGHTING CONTROL

A. See Specification Section 26 09 16 and Specification Section 26 09 43 for lighting control equipment: LCP0201 (Transfer Building Lower Level), LCP0301 (Administration Building and Transfer Building Ground Level) and LCP0401 (Household Hazardous Waste Building).

B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

C. Fueling facility canopy mounted fixtures.
   1. Major equipment:
      a. Lighting control panel, LCP0601.
      b. Electrically held lighting contactor.
         1) Mounted in control panel.
         2) Quantity of contactors and number of poles as required.
         3) Auxiliary contact.
      c. Photocell mounted on roof.
      d. Three-position (HOA) switch panel mounted.
      e. Red panel mounted indicator light.
   2. Sequence of operation:
      a. When the HOA switch is in the HAND position:
         1) Contactor is energized and the exterior lights are ON.

2) Contactor auxiliary contact is energized and the indicator light is ON.

b. When the HOA switch is in the OFF position:

1) Contactor is de-energized and the exterior lights are OFF.

2) Contactor auxiliary contact is de-energized and the indicator light is OFF.

c. When the HOA switch is in the AUTO position:

1) Contactor is energized and de-energized according to the light level as seen by the photocell.

2) Contactor auxiliary contact is energized and de-energized according to the light level as seen by the photocell.

3.04 ADJUST AND CLEAN

A. See Specification Section 01 70 00.

B. Replace all inoperable lamps with new lamps prior to final acceptance.

C. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION

SECTION 27 05 00
PASSIVE TELECOMMUNICATION SYSTEM

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for data and telephone signal distribution.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Building Industry Consulting Service International (BICSI).
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568B-1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
      b. 568B-2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
      c. 568B-3, Optical Fiber Cabling Components Standard.
      d. 569A, Commercial Building Standard for Telecommunications Pathways and Spaces.
      e. 606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
      f. J-STD-607, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

B. Qualifications:
   1. Contractor shall have a Registered Communications Distribution Designer (RCDD) on staff and a BICSI Certified Technician supervising each work crew on site.
      a. Bidding Contractors are pre-selected prior to bid based on Telecommunications Infrastructure installation experience.

b. The Contractor shall include three (3) references of similar scope jobs completed in the last two (2) years.

2. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten (10) years documented experience.

1.03 SYSTEM DESCRIPTION

A. The telecommunications passive infrastructure shall consist of the all passive components and ancillary equipment and devices, as required to complete the intended function of the voice and data system.
   1. All components required for the above shall be provided for a fully tested operational system per the latest TIA/EIA/ANSI Standards.

B. The Contractor shall provide and install all passive components per this Specification for the Passive Telecommunication System.

C. Active equipment including switched hubs, routers, data switch(es) for fiber/copper shall be provided by others under a separate contract.
   1. Patch cords connected to active equipment shall be installed by others.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification.
      b. See Section 26 05 00 – Electrical: Basic Requirements for additional requirements.
   2. Fabrication and/or layout Drawings.
      a. Rack layouts.
   3. Labeling scheme.

C. Quality Assurance Submittals:
   1. Test reports:
      a. Test procedures.
      b. Cable test results.
   2. Contractor and manufacturer qualifications.

D. Closeout Submittals:
   1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least one (1) year prior to installation.
   1. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.

2.02 UNSHIELDED TWISTED PAIR CABLE SYSTEM

A. Horizontal Voice and Data Cable:
   1. Category 6.
   2. Cable shall be label-verified.
   3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
   4. Conductors shall be solid untinned copper 24 AWG.
   5. Cable shall be rated CMP per NFPA 70.

B. Outside Plant Cable:
   1. Same as horizontal cable except gel filled with UV resistant jacketed suitable for installation underground.

C. Connecting Hardware.
   1. Connecting and cross-connecting hardware shall be the same category as the cable it serves.
   2. Telecommunications outlets.
      a. General wall and desk outlet plates shall come equipped with two (2) modular jacks, with the top jack labeled "voice" and the bottom jack labeled "data".
      b. Modular jacks shall be the same category as the cable they terminate.
      c. Modular jack pin/pair configuration shall be T568B.
      d. Modular jacks shall be unkeyed.
      e. Wallplates:
         1) High impact thermoplastic or nylon.
         2) Color: Ivory.
   3. Patch panels:
      a. 48-port modular jack (2U maximum), with rear mounted type 110 insulation displacement connectors.
      b. Mounted in a 19 IN rack.

c. Jack pin/pair configuration shall be T568B.

d. Jacks shall be unkeyed.

e. Panels shall be labeled with alphanumeric x-y coordinates.

4. Patch cords:

a. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.

b. Cable shall be label-verified.

c. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

d. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.

e. Patch cords shall be unkeyed.

f. Patch cords shall be factory assembled.

5. Terminal blocks:

a. Wall mounted or rack mounted wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings.

1) Blocks shall be type 110 or 66 which meet the requirements for Category 6 or as shown.

b. Blocks shall be mounted on standoffs and shall include cable management hardware.

c. Insulation displacement connectors shall terminate 22 or 24 GA solid copper wire as a minimum, and shall be connected in pairs so that horizontal cable and connected jumper wires are on separate connected terminals.

6. Standards: TIA/EIA/ANSI 568B Series.

2.03 FIBER OPTIC CABLE SYSTEM

A. Multimode:

1. Multimode fiber optic backbone cable shall be FDDI 62.5/125 micrometer multimode graded index optical fiber cable.

2. Numerical aperture for each fiber shall be a minimum of 0.275.

3. Cable construction shall be loose-tube all-dielectric buffered suitable for installation in underground conduit.

4. Individual fibers shall be color coded for identification.

5. Cable shall be imprinted with fiber count and aggregate length at regular intervals.

B. Connectors:
   1. Connectors shall be ST type with ceramic ferrule material with a maximum insertion loss of 0.5 dB.
   2. Connectors shall be field installable.
   3. Connectors shall utilize adhesive for fiber attachment to ferrule.
   4. Standards:
      a. TIA/EIA/ANSI 568B Series.
      b. ICEA S-83-596.

2.04 EQUIPMENT RACKS

A. Floor mounted equipment racks shall be welded steel or aluminum relay racks with uprights to mount equipment 19 IN and as indicated on the Drawings.
   1. Uprights shall be 3 IN deep channel, 1-1/4 IN wide, drilled and tapped 12-24 in a 1/2 IN pattern.
   2. Racks shall be provided with a standard top crossmember, and predrilled base plate to allow floor fastening.
   3. Open frame equipment racks shall be 7 FT in height and clear coated.

B. Wall Mounted Open Frame:
   1. Wall mounted open frame equipment racks shall be steel or aluminum relay racks to mount equipment 19 IN wide with standoff brackets for wall mounting.
   2. Uprights shall be drilled and tapped 12-24 in a 1/2 IN pattern.
   3. Standoff brackets shall be of sufficient length for a 6 IN clearance between rack and wall.
   4. Wall mounted open frame racks shall be hinged.

C. Cable Guides.
   1. Cable guides shall be specifically manufactured for the purpose of routing cables, wires and patch cords horizontally and vertically 19 IN equipment racks.
   2. Cable guides shall consist of ring or bracket-like devices mounted on rack panels for horizontal use or individually mounted for vertical use.
   3. Cable guides shall mount to racks by screws and/or nuts and lockwashers.

2.05 LABELING AND COLOR CODING

A. Labels shall be developed by the contractor and approved by the Project Representative.
   1. Labels shall be machine printed on opaque or clear tape, stenciled onto adhesive labels.

B. Cable and Jacks:
   1. Voice: White.
   2. Data: Blue.

2.06 TELEPHONE TERMINAL CABINETS

A. Factory painted or galvanized steel NEMA 1 enclosure with hinged door.
   1. Used to house building entrance protector and terminal blocks.

2.07 EQUIPMENT MOUNTING BACKBOARD

A. Plywood backboards shall be provided, sized as shown, painted with white or light colored paint.

2.08 TELECOMMUNICATIONS OUTLET BOXES

A. Electrical boxes for telecommunication outlets shall be 4-11/16 IN square by 2-1/8 IN deep with minimum 3/8 IN deep single or two gang plaster ring as required.
   1. Provide a minimum 1 IN conduit.

PART 3 – EXECUTION

3.01 INSTALLATION

A. System components and appurtenances shall be installed in accordance with NFPA 70, manufacturer's instructions and as shown.

B. Necessary interconnections, services, and adjustments required for a complete and operable signal distribution system shall be coordinated with the local telephone company.

C. Components shall be labeled in accordance with TIA/EIA/ANSI 606.

D. Penetrations in fire-rated construction shall be firestopped.

E. Wiring shall be installed in accordance with TIA/EIA/ANSI Standards.
   1. Wiring, and terminal blocks and outlets shall be marked in accordance with TIA/EIA/ANSI 606.

F. Cables shall not be installed in the same cable tray, utility pole compartment, or floor trench compartment with ac power cables.
   1. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

G. Horizontal Distribution Cable:
   1. The rated cable pulling tension shall not be exceeded.
   2. Cable shall not be stressed such that twisting, stretching or kinking occurs.
   3. Cable shall not be spliced.

4. Copper cable not in a wireway shall be suspended a minimum of 8 IN above ceilings by cable supports no greater than 60 IN apart.
5. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
6. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 IN shall be maintained when such placement cannot be avoided.
7. Cables shall be terminated; no cable shall contain unterminated elements.
8. Minimum bending radius shall not be exceeded during installation or once installed.
9. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

H. Telecommunications Outlets:
1. Faceplates: As a minimum each jack shall be labeled as to its function and a unique number to identify cable link.
2. Cables:
   a. Unshielded twisted pair cables shall have a minimum of 6 IN of slack cable loosely coiled into the telecommunications outlet boxes.
   b. Minimum manufacturers bend radius for each type of cable shall not be exceeded.

I. Terminal Blocks:
1. Terminal blocks shall be mounted in orderly rows and columns.
2. Adequate vertical and horizontal wire routing areas shall be provided between groups of blocks.
3. Industry standard wire routing guides shall be utilized.

J. Unshielded Twisted Pair Patch Panels:
1. Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 10 percent spares.
2. Cable guides shall be provided above, below and between each panel.

K. Equipment Racks:
1. Open frame equipment racks shall be bolted to the floor.
2. Cable guides shall be bolted or screwed to racks.
3. Racks shall be installed level.
4. Ganged racks shall be bolted together.
5. Wall mounted racks shall be secured to the mounting surface to prevent fully loaded racks from separating from the mounting surface.

L. Rack Mounted Equipment: Equipment to be rack mounted shall be securely fastened to racks by means of the manufacturer's recommended fasteners.

3.02 TERMINATION

A. Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles.
   1. Manufacturer's minimum bending radius shall not be exceeded.
   2. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.
   3. Unshielded Twisted Pair Cable:
      a. Each pair shall be terminated on appropriate outlets, terminal blocks or patch panels.
      b. No cable shall be unterminated or contain unterminated elements.
      c. Pairs shall remain twisted together to within the proper distance from the termination as specified in the TIA/EIA/ANSI 568B Series.
      d. Conductors shall not be damaged when removing insulation.
      e. Wire insulation shall not be damaged when removing outer jacket.

3.03 GROUNDING

A. Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with TIA/EIA/ANSI J-STD-607.
   1. Equipment racks shall be connected to the electrical safety ground.

3.04 LABELING

A. All cables will be labeled using color labels on both ends per TIA/EIA/ANSI 606.

B. All workstation and patch panel connections will be labeled using color coded labels per TIA/EIA/ANSI 606.

3.05 TESTING

A. Testing shall conform to the TIA/EIA/ANSI Standards for Category 6 test parameters.
   1. All test data sheets shall be downloaded from the tester, printed out and provided to the Project Representative.
   2. A CD ROM shall be provided to the Project Representative with all test results.
   3. Tester shall be capable of testing parameters for the warranted system.

B. Materials and documentation to be furnished under this Specification are subject to inspections and tests.
   1. All components shall be terminated prior to testing.

2. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

C. Unshielded Twisted Pair Tests:
   1. All metallic cable pairs shall be tested for proper identification and continuity.
   2. All opens, shorts, crosses, grounds, and reversals shall be corrected.
   3. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet.
   4. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room.
   5. These tests shall be completed and all errors corrected before any other tests are started.

D. Category 6 Circuits:
   1. All Category 6 circuits shall be tested using a test set that meets the Class II accuracy requirements of TIA/EIA/ANSI 568B Series.
   2. Testing shall use the Basic Link Test procedure of TIA/EIA/ANSI 568B Series.
   3. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.

E. Fiber Optic Cable:
   1. Unless stated otherwise, tests shall be performed from both ends of each circuit.
   2. Connectors shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist.
   3. Each circuit leg and complete circuit shall be tested for insertion loss at 850 and 1300 using a light source similar to that used for the intended communications equipment.
   4. High-resolution optical time domain reflectometer (OTDR) tests shall be performed from one end of each fiber.
   5. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80 percent of the X-axis.

END OF SECTION

SECTION 27 52 13
CENTRAL EMERGENCY LIGHTING INVERTER

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Central emergency lighting inverter.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 26 05 00 - Electrical: Basic Requirements.
   4. Section 26 08 13 - Acceptance Testing.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electric Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 101, Life Safety Code.
   3. Underwriters Laboratories, Inc. (UL):
      a. 924, Standard for Emergency Lighting and Power Equipment.

1.03 SYSTEM DESCRIPTION

A. An on-line uninterruptible power supply for the emergency operation of HID and LED, emergency lighting loads.
   1. The system shall provide full light output for a minimum of 1.5 HRS.

1.04 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Descriptive bulletins.

c. Installation instructions.

d. See Specification Section 26 05 00 - Electrical: Basic Requirements for additional requirements.

2. Fabrication and/or layout Drawings:

a. Cabinet outline Drawings indicating dimensions, weights, heat loss, input/output connection locations and required clearances.

b. Wiring diagrams.

C. Closeout Submittals:

1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.05 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Myers Power Products.
2. Controlled Power Company.
3. LightGuard.
4. Lithonia Lighting.
5. PowerClone.
6. Or Approved Equal.

B. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 COMPONENTS

A. Standards: UL 924.

B. Electrical Characteristics:

1. System configuration:

a. On-line (Double conversion): 0 ms transfer time for HID and non-HID lighting loads.

2. System capacity:

a. As indicated on the Drawing.

b. When normally off system is utilized, the unit shall have the capacity for the required amount of inrush current expected from luminaire ballasts.

3. Input and output:
   a. Voltage: As indicated on the Drawings.
   b. Number of phases: As indicated on the Drawings.
   c. Frequency: 60 Hz.
4. Total Harmonic Distortion:
   a. Less than 3 percent with linear load.
   b. Less than 5 percent with non-linear load.
5. System efficiency:
   a. On-line: Over-all efficiency, input to output, at least 85 percent with the battery fully charged and the inverter supplying full-rated load.

C. Rectifier and/or Battery Charger:
1. Solid-state equipment.
2. Controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging.
3. Battery charger voltage: 2 percent RMS maximum.

D. Inverter:
1. Solid-state equipment.
2. Controls to convert DC power from the rectifier or battery to regulated AC power for supporting critical load.

E. Maintenance Bypass Switch:
1. An external or internal, wrap around, make-before-break switch for complete isolation of the inverter output terminals.

F. Battery:
1. Maintenance free, sealed lead calcium.
2. 90 minutes of run time at full load.
3. Battery charger to recharge fully discharged batteries within 24 HRS.

G. Input Protection:
1. Input circuit breaker.
2. Overload capacity:
   a. 100 percent continuous.
   b. Minimum of 115 percent for 5 minutes.

H. Output Distribution:
1. Normally ON 20A circuit breakers with neutral and ground buses, quantity per Schedule.

I. Display, Alarm and Testing Functions:
   1. Supervision and display panel:
      a. Microprocessor controlled.
      b. Alphanumeric display and optional indicator lights.
      c. Touch pad.
      d. Control, programming and data logging functions.
   2. Alphanumeric display or in combination with indicating lights shall display, at a minimum:
      a. Input voltage.
      b. Output voltage.
      c. Battery voltage.
      d. Battery current.
      e. Output current.
      f. Output VA.
      g. On AC power.
      h. On battery power.
      i. Battery charging.
      j. On bypass.
      k. System temperature.
      l. System fault.
   3. Audible alarm for alarm conditions.
      a. High and low battery charger voltage.
      b. High and low AC input voltage.
      c. Near low and low battery voltage.
      d. Load reduction fault.
      e. High ambient temperature.
      f. Inverter fault
      g. Output fault and overload.
   4. Common output contact for remote monitoring of alarm conditions.
   5. RS232 diagnostic interface.
   6. Programmable self-diagnostics test with user selectable battery test intervals.

J. Enclosure:
   1. Minimum of 14 GA steel.
   2. Free standing.

3. NEMA 1.
4. Forced air cooling as required by manufacturer.
5. Factory-applied paint coating system.

2.03 PERFORMANCE

A. Normal Operation:
   1. On-line system shall supply power to the load from the AC source through the rectifier and/or inverter.
   2. Battery charger to maintain a ripple free float charge on the batteries.

B. Emergency Operation:
   1. Upon the failure or unacceptable AC power, supply power to the load to be derived from the batteries through the inverter.
   2. An on-line system shall have no break or interruption of power to the load on failure or restoration of AC power.

C. Automatic Restart:
   1. If the power outage exceeds 90 minutes and the batteries are fully discharged, the unit may shut down, but automatically restart once the AC power returns to power the load and recharge the batteries.

D. Automatic Battery Testing:
   1. The unit shall automatically test the batteries at the programmed intervals.
   2. The test data shall be logged into the data logger.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions, NFPA 70 and NFPA 101.

B. Arrange as shown on the Drawings.

3.02 SCHEDULE

Unit Identification Tag	CELS0301
Unit Type	On-Line
Voltage In	480/277
Voltage Out	480/277
Number of Phases	3
Total connected VA	13,474
HID connected VA	5,304
Rated VA	16,700
Qty of ON Output CB	10

Unit Identification Tag	CELS0301
Qty of OFF Output CB	
Qty of TIMED Output CB	

3.03 FIELD QUALITY CONTROL

A. See Specification Section 26 08 13 – Acceptance Testing.

B. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.04 TRAINING

A. Provide 4 HRS of on-site training in the operation and maintenance of the central emergency lighting inverter and its components.

END OF SECTION

SECTION 28 16 00
INTRUSION DETECTION

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. The Contractor shall provide, install, and program a functionally complete, integrated Digital Alarm Communicator System (DACS) per Manufacturer's guidelines, codes described, within these Specifications.
   2. PRO-COMM is the sole source remote monitoring service provider for King County Solid Waste Division (KCSWD). Contractor to hire PRO-COMM to provide field services for commissioning and startup of the intrusion detection system.
   3. The Contractor shall implement keyswitch connection at existing Scalehouse DACS manufactured by Radionics model D7112 integrated security and fire control panel. This keyswitch will allow KC Electronic Security System to disarm existing and new DACS as per Section 28 34 00 – Electronic Detection, Alarm and Access Control.
   4. Work included under this Section:
      a. System and its components.
      b. System wiring (low voltage).
      c. Mounting accessories.
      d. System programming.
      e. Warranty, service and training.

B. Related Sections:
   1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 01 - General Requirements.
   3. Section 01 09 05 – Reference Standards.
   4. Section 07 70 00 – Finish Hardware.
   5. Section 08 11 00 – Metal Doors and Frames and Borrowed Light Frames.
   6. Section 27 05 00 – Passive Telecommunication System.
   7. Section 28 34 00 - Electronic Detection, Alarm and Access Control.

1.02 SYSTEM DESCRIPTION

A. The DACS specified herein shall include a Digital Alarm Communicator Transmitter (DACT), built-in telephone line monitor, up to 1000 event memory logger, real time clock, calendar, test timer, battery charging / voltage supervision circuitry, battery lead supervision, diagnostics displays, time / event-based scheduling system, lightning / EMI protection circuits, and the associated optional modules and components for a complete DACS. Refer to Article 2.02 Materials for detailed hardware requirements and Specifications. The following describes the general functional requirements of the DACS:

1. The DACS shall support the connection and reporting of intrusion detection to a remote Digital Alarm Communicator Receiver (DACR).
2. The DACS shall be capable of segregating the points (i.e., a detector or group of detectors zoned together) into separate, independent "areas."
3. The DACS shall be "modularly" expandable using hard-wired address identification modules.
4. The DACS shall have electrically supervised detection loops and power supplies (mains and battery(s)). This supervision shall be programmable for the purposes of reporting this information to the DACR.
5. The DACS shall be capable of monitoring and switching to active telephone lines when trying to establish communications with the DACR and transmitting a report.
6. The DACS shall be capable of reporting and communicating alarm or trouble event data by reporting to one, two, three or four off-site remote DACRs via dial-up analog telephone lines.
7. The DACS shall be capable of sending (manually or automatically) test and status reports to remote DACRs.
8. The DACS shall be programmable locally. Programming shall be accomplished via a portable programmer. Users shall be capable of changing their own user passcode from the Alarm Command Center (ACC) and managers shall be capable of changing the user passcodes and authority assignments by area of other users from the ACC.
9. The DACS shall annunciate alarm, trouble, service reminders, and other relevant system status messages in custom English text at the ACC.
10. The DACS shall be capable of executing diagnostics and testing functions locally or remotely.
11. The DACS shall be capable of controlling relays and automatically executing system functions based on a time/ event scheduling program. The program can be hour, day of week or day of month based. Each scheduled event can be exclusive of one of four holiday date definitions that can include one to 365 selected Julian dates. The following functions can be executed:
    a. Arm / Disarm a specific area.
    b. Bypass / Unbypass a point.
    c. Activate / Deactivate a relay.

d. Send a test report.

e. Adjust system clock for daylight savings time.

12. The DACS shall be capable of listening to calls answered by other devices on the premises side of the phone line and determining if a special tone is being sent from the incoming call (Remote Account Manager) and intercepting the call for Remote Account Manager sessions.

B. System Interface Requirements:

1. Grounding: The Contractor shall properly earth ground the DACS to prevent electrostatic charges and other transient electrical surges from damaging the DACS panel.

2. Primary power: The Contractor shall provide a 16.5 VAC to power the DACS panel using a class two, plug-in transformer. This power circuit shall be properly rated to continuously power all points and functions indefinitely in full alarm condition.

3. Primary power supervision: When the primary power source fails, the system can be configured to report an "AC Fail" message to a commercial central station. The transmission delay of this message is programmable from 5 seconds to 86 minutes with an optional 6 HR to 12 HR transmission delay. The message can also be programmed to "tag-along" with another message transmitted to the central station. The system will always display a loss of primary power on the ACC and may be configured to provide additional audible warning.

4. Secondary power (standby battery): The Contractor shall provide adequate battery power as defined by the relevant application criteria, (UL 864 and UL 985 for alarm installations or NFPA 72 chapters for fire applications). Appropriate battery chargers shall be provided consistent with the battery back-up capacity. The most current accepted version of NFPA 72 and any applicable local codes or AHJ requirements must be met accordingly.

5. Secondary power supervision: When the secondary power source experiences an 85 percent depletion of its standby capacity, the system can be configured to report a "Low Battery" message to a commercial central station. The system will always display a low battery condition on the ACC and may be configured to provide additional audible warning.

6. Wiring: The Contractor shall provide cables consistent with the manufacturer's recommendations. The following general guidelines shall be followed for wiring installation:

a. Wiring shall be appropriately color-coded with permanent wire markers. Copper conductors shall be used.

b. All signal cables provided under this contract shall be Class II, plenum-rated cable where required. Where subject to mechanical damage, wiring shall be enclosed in metal conduits or surface metallic raceway.

c. Data wires shall not be enclosed in conduit or raceways containing AC power wires.

d. Where EMI may interfere with the proper operation of the DACS circuits, twisted/shielded cable shall be used.

7. The DACS shall be protected from EMI and lightning surges.

8. Telephone interface: The DACS shall be equipped with a phone line monitor and shall interface with the phone lines via RJ-31X jacks for supervision of the telephone line connection to the DACS panel. When a telephone line is determined to be out of service by the DACS panel, the event will be annunciated locally on the ACC and transmitted to the central station. The transmission delay of this message is programmable from ten (10) to two-hundred forty (240) seconds. A telephone line switching modules shall be used to interface to a second telephone line. This interface shall conform to FCC rules part 15 and 68.

9. Functional criteria programmed into system memory shall be backed up by battery power. Additionally, the number of system programmers shall be severely restricted via the use of program locking features and passwords.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product Data:
      a. Specification sheets (cut sheets) of all proposed equipment.
      b. Equipment list identifying:
         1) Model number of each unit.
         2) Quantities of each type of device.
      c. Specification compliance: A letter, responding to Specification sub-sections individually, indicating exceptions, substitutions, and alternates. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to the substituted equipment) per Section 01 60 00 - Product Requirements.
   2. Shop Drawings:
      a. Drawings: Shop Drawings to provide details of proposed system and the work to be provided. These include point-to-point Drawings of systems, wiring diagrams of individual devices and point programming.
   3. Permits: The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the Project Representative in obtaining the relevant alarm permits.
   4. Samples.

C. Quality Assurance Submittals:
   1. Design Data.
   2. Test Reports.

D. Closeout Submittals:
   1. "As-built": Upon completion of installation, the Contractor shall prepare "as-built" Drawings of the system. These "As-builts" shall be Drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
      a. Additionally, final point-to-point wiring diagrams of each type of device shall be included in the "as-builts."
      b. "As-builts" shall be submitted to the Project Representative for approval prior to the system acceptance walk-through.
   2. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.04 QUALITY ASSURANCE

A. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
   1. National codes: NEC, NFPA, UBC, BOCA, SBCCI.
   2. Approvals and listings: UL, FM, (ANSI CP-01, CSFM, NYC-MEA, when applicable).
   3. Local Authorities Having Jurisdiction.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00 – Product Requirements.

1.06 MAINTENANCE

A. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).

B. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

C. The Contractor shall correct any system defect within six (6) HRS of receipt of call from the Project Representative during the warranty period.

D. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

1.07 COMMISSIONING

A. The Work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Security Panel:
   1. Bosch Security Systems, G-series.
   2. Honeywell Security Systems, Vista 20p.
   3. Or approved equal.

B. Door Contacts:
   1. Bosh.
   2. Honeywell.
   3. Corbin Rosswin.
   4. Or approved equal.

2.02 MATERIALS

A. DACS: The DACS shall be provided, at minimum, with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
   1. Enclosure.
   2. Lock and key.
   3. D7412GV2 DACT with removable terminal blocks and single screw mounting bracket.
   4. Faceplate shield and metal bracket covering rear of D7412GV2 circuit assembly.
   5. Power transformer.
   6. Manuals.

2.03 ACCESSORIES

A. System Accessories:
   1. D8103: universal enclosure.
   2. ISC-BDL2-WP12G: Wall mount motion detector.
   3. 1078W: 1 IN drilled frame door contact.
   4. D9127U: Addressable Interface POPIT Module.

B. Power Supply:
   1. D126: Standby Battery (12 V, 7 Ah) sealed lead-acid standby and auxiliary rechargeable power supply.
   2. D1640: Transformer, 16.5 VAC, 40 VA.

C. Communication Accessories:
   1. D161: 7 FT phone cords.
   2. D166: RJ-31X Phone Jack.

3. D928: Dual telephone line switcher module: Alternates event transmission to Central Station between primary and secondary phone lines. Module transmits over other phone line when first phone line is determined to be inoperable. Periodically tests phone line for usage and integrity and reports to central station when phone line is faulty. Remembers faulty line and transmits over operational line.

D. LCD Keypad Devices:
   1. D1260B: Alarm Command Center (ACC) - Built-in multi-tone sounder. Displays status is in custom English text on 20-character display.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify conditions are satisfactory to receive Work of this Section. Do not commence Work until unsatisfactory conditions have been corrected.

B. Beginning Work constitutes acceptance of conditions.

3.02 PREPARATION

A. Field Measurements: Verify on job before beginning Work.

3.03 INSTALLATION

A. Install all equipment and materials in accordance with the "current" recommendations of the manufacturer. The work shall also be in accordance with:
   1. Installation criteria defined in these specifications and in the construction documents.
   2. Factory Representative can be the Security System manufacturer certified Dealer.
   3. Approved submittals.
   4. Applicable requirements of referenced standards.

3.04 CONSTRUCTION

A. The Contractor shall provide the following services as part of the Contract:
   1. Supervision of sub-contractors.
   2. Coordination of other Contractors for system-related work (electrical contractor, finish hardware contractor, Project Representative, and General Contractor).
   3. Attending site construction/coordination meetings.
   4. Keeping updated construction Drawings at the construction site.
   5. Meeting construction deadlines per the construction schedule.

3.05 ADJUSTING

A. Operational Testing: The Contractor shall perform thorough operational testing and verify that all system components are fully operational.

B. Hard-copy System Printout: The Contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.

C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.
   1. This form shall include separate sections for each device/panel/unit as well as a column indicating the manufacturer's performance allowance/margin, a column indicating the result of the testing performed by the Contractor (pass/fail), and an empty column for recording findings during the walk-through.

3.06 DEMONSTRATION

A. The Contractor shall certify completion in writing and schedule the commissioning walk-through. The Contractor shall provide all the tools and personnel needed to conduct an efficient commissioning process.

END OF SECTION

SECTION 28 23 00
VIDEO SURVEILLANCE INFRASTRUCTURE

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Conduits and cables for video surveillance system.
   2. Power over Ethernet environmental enclosures.
   3. Camera support hardware, labeling and identification.

B. Related Sections include but not necessarily limited to:
   1. Division 00 – Bidding Requirements, Contract forms, and Conditions of the Contract.
   2. Division 01 – General Requirements.
   3. Section 26 05 00 – Electrical: Basic Requirements.
   4. Section 26 05 33 – Raceways and Boxes.

1.02 SYSTEM DESCRIPTION

A. All cameras and mounting hardware will be obtain by the Project Representative and delivered to the site for installation by the Contractor.

B. Cameras within the Recycling and Transfer Station will be installed, adjusted and focused by the Contractor with assistance by the Project Representative.

C. Cameras exterior to the transfer Building will be installed, adjusted and focused by the Contractor with assistance by the Project Representative.

D. All cameras and mounting hardware will be marked and labeled per Project Representative Instructions.

E. The raceways, boxes for Power Over Ethernet injectors, and cabling for video surveillance system will be provided by the Contractor.

F. The Power Over Ethernet injectors will be provided by the Project Representative and installed by the Contractor.

1.03 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 – Submittal Procedures for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Conduit fittings.
         2) Support systems.
      b. See Specification Section 26 05 00 – Electrical: Basic Requirements for additional requirements.

2. Fabrication and/or layout Drawings:
   a. Identify dimensional size of enclosure boxes to be used.
   b. Seismic location installation details.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 26 05 00 – Electrical: Basic Requirements.

PART 2 – PRODUCTS

2.01 MANUFACTURED UNITS

A. Cabling:
   1. Horizontal voice and data cable:
      a. Category 6 per TIA/EIA/ANSI 568.
      b. Cable shall be label-verified.
      c. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
      d. Conductors: No. 24 AWG solid untinned copper or as indicated on the Drawings.
      e. Rated CMP per NFPA 70.
   2. Conform to NFPA 262 and NFPA 70 Type ITC.

B. Raceways:
   1. Comply with Section 26 05 33 – Raceways and Boxes requirements.

C. Cameras:
   1. Cameras provided by the Project Representative and installed and adjusted by the Contractor per this section System Description.
   2. See Drawings for camera's locations.

D. Cameras mounting hardware:
   1. Cameras mounting hardware provided by the Project Representative and installed by the Contractor.

E. Power over Ethernet Injector:
   1. Enable–IT 360.
   2. Injector provided by the Project Representative and installed by the Contractor in NEMA 4, 14 IN high x 12 IN wide x 6 IN deep enclosure.

PART 3 – EXECUTION

3.01 PREPARATION

A. Field Measurements: Verify all measurements on job site before beginning Work.

3.02 INSTALLATION

A. Install system in accordance with applicable codes and regulations, manufacturer's written instructions, the Project Representative directions, and this Section.

B. Penetrations in fire-rated construction shall be firestopped.

C. Wiring shall be installed in accordance with TIA/EIA/ANSI Standards.

D. Cables shall not be installed in the same cable tray, conduit, utility pole compartment or junction or pull box with ac power cables.

E. Cables not installed in conduit or wireways shall be properly secured and neat in appearance and, if installed in plenums or other spaces used for environmental air, shall comply with NFPA 70 requirements for this type of installation.

F. The rated cable pulling tension shall not be exceeded.

G. Cable shall not be stressed such that twisting, stretching or kinking occurs.

H. Cable shall not be spliced.

I. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 IN shall be maintained when such placement cannot be avoided.

J. Cables shall be terminated; no cable shall contain unterminated elements.

K. Minimum bending radius shall not be exceeded during installation or once installed.

L. Cable ties shall not be excessively tightened such that the transmission characteristics of the cable are altered.

3.03 TESTING

A. Testing shall conform to the TIA/EIA/ANSI Standards for Category 6 test parameters.
   1. All test data sheets shall be downloaded from the tester, printed out and provided to the Project Representative.
   2. A CD ROM shall be provided to the Project Representative with all test results.
   3. Tester shall be capable of testing parameters for the warranted system.

B. Materials and documentation to be furnished under this Specification are subject to inspections and tests.
   1. All components shall be terminated prior to testing.
   2. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the cameras distribution system conforms to the requirements, and that the required equipment, systems, and documentation have been provided.

END OF SECTION 28 23 00

SECTION 28 31 00
FIRE DETECTION AND ALARM

PART 1 – GENERAL

1.01 SUMMARY

A. Provide all material, labor, equipment, design and services necessary to perform the complete installation of the building fire detection and alarm system as indicated on the Drawings and described in the Specifications, except where specifically excluded herein.

B. This Section of the Specifications includes the furnishing, installation, and connection of the microprocessor controlled, addressable reporting fire alarm equipment required to form a complete coordinated system ready for operation, for all portions of the Transfer Station including attached canopies, buildings and spaces.
   1. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, fire alarm control panel, auxiliary control devices, annunciators, and wiring as shown on the Drawings and specified herein.

C. The fire alarm system shall comply with requirements of the 2009 International Fire Code, NFPA 72 National Fire Alarm Code and FM Global Loss Prevention Data Sheets, except as modified and supplemented by this Specification.
   1. The system shall be electrically supervised and monitor the integrity of all conductors.

D. The existing Scale House is excluded.

1.02 SCOPE OF WORK

A. Provide separate analog addressable, detection, monitoring and control system for a complete fire alarm system throughout all buildings as required by the Fire Code and described herein.

B. Provide a complete fire detection alarm and control system as specified herein and as indicated within the Contract Documents.
   1. Provide features, performance, regulatory compliance, and other items as specified herein.

C. The system includes, but is not limited to, control units, power supplies, digital alarm communicating transmitter, remote annunciators, initiating devices, notification appliances, and outputs for specified fire, life safety and control functions.
   1. The system also includes batteries, relays, fire alarm termination cabinets, conduit, wiring, and other equipment for a complete and operating system.

D. Devices shown on the plan Drawings illustrate the minimum intended protection for that space or area.
   1. Device layouts shall conform to the more restrictive of the Drawings, applicable codes, or Authorities Having Jurisdiction (AHJ) requirements.

E. Provide complete detailed engineering including, but not limited to, interconnecting wiring, raceway layout, panel design, and battery calculations.

F. Provide code-required submittals to AHJ.

G. Thoroughly review the Drawings to ascertain the necessity for additional detection, control or annunciation devices.

H. Design Basis Information:
   1. Provide design, materials, equipment, installation, inspection, and testing of an addressable reporting, microprocessor controlled fire detection and alarm system in accordance with the requirements of this Specification and Drawings.

I. Basic Performance:
   1. Alarm, trouble and supervisory signals from all intelligent addressable reporting devices shall be wired as Class B Signaling Line Circuits (SLCs).
   2. Initiation Device Circuits (IDCs) shall be wired Class B.
   3. Notification Appliance Circuits (NAC) shall be wired Class B.
   4. All pathways shall comply with NFPA 70, National Electrical Code and provide Pathway Survivability Level 1.
   5. Built-in Horn Strobe Synchronization w/ selective silence.
   6. Digitized electronic signals shall employ check digits or multiple polling.
   7. A single ground or open on the system SLC shall not cause system malfunction, loss of operating power or the ability to report an alarm.
   8. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

J. Basic System Functional Operation:
   1. When a fire alarm condition is detected and reported by one of the system initiating devices the following functions shall immediately occur:
      a. The System Alarm LED shall flash.
      b. A local piezo electric signal in the control panel shall sound.
      c. An 80-character, backlit LCD display shall indicate all information associated with the Fire Alarm condition, including the type of alarm point and its location within the protected premises.
      d. History storage equipment shall log the information associated with each new Fire Alarm Control Panel condition, along with time and date of occurrence.
      e. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated System Outputs (alarm Notification Appliances and/or Relays) shall be activated.

K. Provide a remote annunciator in the lobby of the Administration Building for the fire alarm system.

L. System Supervision: Provide electrically supervised, microprocessor-based system, with analog/addressable supervised two-wire Class B SLCs, IDCs and NACs.
   1. Occurrence of single ground or open condition in initiating device, notification appliance, or signaling line circuit places system in "trouble" mode.
      a. Occurrence of single ground or open condition on alarm initiating circuit or on signaling circuit does not disable that circuit or control panel from transmitting "alarm."
      b. Each circuit includes individual supervisory and alarm function and is to be so arranged that a fault condition in circuits will not affect the proper operation of other circuits.
   2. Component or power supply failure places system in "trouble" mode.
   3. Fire sprinkler supervisory switch or duct-mounted smoke detector activation puts system in “supervisory” mode.

M. Alarm Sequence of Operation:
   1. Activation of a manual fire alarm box, automatic smoke detector, or fire suppression system causes system to enter “alarm” mode including the following operations:
      a. Provide local English language annunciation of device location, address and condition, and audible and visual alarm signal at control panel and remote annunciators.
      b. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible alarm signal, visual signal remains displayed until initiating alarm is cleared.
      c. Transmit “alarm” signal to off-premises equipment, i.e., to the Project Representative’s selected vendor. Provide necessary connections to digital alarm communicator transmitter.
      d. Activate fire alarm notification appliances.
      e. Transmit signal to fire/smoke dampers.
      f. Transmit signal to initiate shutdown of air handling equipment.

N. Supervisory Sequence of Operation:
   1. Fire sprinkler tamper or supervisory pressure switch activation or duct-mounted smoke detector activation causes system to enter "supervisory" mode including the following operations:
      a. Provide local English language annunciation of device location, address and condition, and audible and visual supervisory signal at control panel and remote annunciators.
      b. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible supervisory signal, visual signal remains displayed until initiating supervisory is cleared.
      c. Transmit "supervisory" signal to off-premises equipment.

d. Transmit signal to shut down air associated air handling unit and close fire/smoke dampers (duct smoke detector only).

O. Trouble Sequence of Operation:
   1. System trouble, including single ground or open of supervised circuit, or power or system failure, causes system to enter "trouble" mode including the following operations:
      a. Provide local English language annunciation of device location, address and condition, and audible and visual trouble signal at control panel and remote annunciators.
      b. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible trouble signal, visual signal remains displayed until initiating trouble is cleared.
      c. Transmit "trouble" signal to off-premises equipment.

P. System Reset:
   1. Key-accessible control function returns the system to normal, non-alarm state, if initiating circuits have cleared.
   2. Reset to be located on both the main fire alarm control panel and the remote annunciators.

Q. Lamp Test:
   1. Manual "lamp test" function causes the annunciation lamps to illuminate at fire alarm control and remote annunciator panels.
   2. Provide "lamp test" function at each annunciator panel.

R. Addressing: Provide each initiating device with its own discrete analog address.

S. Power Requirements:
   1. The control panel and remote power supplies receive 120VAC via a dedicated circuit per NFPA requirements.
   2. Loss of normal and emergency power automatically causes the system to transfer to battery power.
      a. Indicate battery power operation by a yellow lamp and audible annunciation at the control panel and remote annunciator panels.
      b. Upon return of 120VAC power, unit recharges batteries to full capacity and maintains battery on float charge.
   3. Provide storage batteries of sufficient capacity to operate the fire alarm system under normal supervisory condition for twenty-four (24) HRS and operate alarm signals for five (5) minutes at the end of the standby period.
      a. Provide trickle charge adequate capacity to maintain the battery fully charged with automatic rate charge.
      b. Provide batteries in a locking cabinet manufactured for the purpose.
      c. Do not install cabinets or equipment below the battery cabinet.
      d. Do not locate battery and charging system cabinets in ceiling space.

1.03 RELATED SECTIONS

A. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

B. Section 01 09 05 – Reference Standards.

C. Section 01 33 00 – Submittal Procedures.

D. Section 01 43 00 – Quality Assurance and Control.

E. Section 01 73 00 - Operation and Maintenance Manuals.

F. Section 01 60 00 – Product Requirements.

G. Section 01 78 00 – Closeout Procedures.

H. Section 01 81 30 – Sustainability Requirements.

I. Section 07 84 00 – Firestopping.

J. Section 21 13 00 – Fire-Suppression Sprinkler Systems.

K. Section 21 30 00 – Fire Pump.

L. Section 26 05 33 – Raceway and Boxes.

M. Section 28 16 00 – Intrusion Detection.

N. Additional Sections of the Specifications may be required to provide a fully functional system.
   1. Refer to the Specifications index.

1.04 CODES AND STANDARDS

A. Applicable provisions of the most recent adopted edition of the following standards shall apply to the work of this Section, except as modified herein, and are hereby made a part of these Contract Specifications to the extent required:
   1. International Code Council: www.iccsafe.org.
      a. International Building Code (IBC), 2009 edition, including Washington State and City of Bellevue Amendments.
      b. International Fire Code (IFC), 2009 edition, including Washington State and City of Bellevue Amendments.
      c. International Mechanical Code (IMC), 2009 edition, including Washington State and City of Bellevue Amendments.
   2. City of Bellevue Code Amendments: www.Bellevuewa.gov.
   3. National Fire Protection Association (NFPA): www.nfpa.org.
      a. NFPA 70 - 2008, National Electric Code.
      b. NFPA 72 - 2010, National Fire Alarm Code.
   4. FM Global: www.fmglobal.com.
      a. FM Global Approval Guide.
      b. FM Global Property Loss Prevention Data Sheet 5-40, Fire Alarm Systems.

c. FM Global Property Loss Prevention Data Sheet 5-48, Automatic Fire Detection.

5. Underwriters Laboratories, Inc. (UL) www.ul.com.
   a. UL Fire Protection Equipment Directory.
   b. UL 38 Manually Actuated Signaling Boxes.
   c. UL 268 Smoke Detectors for Fire Protective Signaling Systems.
   d. UL 268A Smoke Detectors for Duct Applications.
   e. UL 346 Waterflow Indicators for Fire Protective Signaling Systems.
   f. UL 464 Audible Signaling Appliances.
   g. UL 521 Heat Detectors for Fire Protective Signaling Systems.
   h. UL 864 Control Units for Fire Protective Signaling Systems.
   i. UL 1971 Visual Notification Appliances for the hearing impaired.
6. Revised Code of Washington (RCW) http://apps.leg.wa.gov/rcw.
   a. RCW Section 19.28 – Electricians and Electrical Installations.
7. Washington Administrative Code (WAC) http://apps.leg.wa.gov/wac.
   a. WAC Chapter 296-46B - Electrical safety standards, administration, and installation.
8. American National Standards Institute (ANSI): www.ansi.org.
9. Institute of Electrical and Electronics Engineers (IEEE) www.ieee.org.

1.05 DEFINITIONS AND ACRONYMS

A. Approved or Approval: Use of the word "approved" or "approval" in this Section shall require the approval or acceptance from the AHJ and Project Representative.

B. AHJ: For purposes of code compliance, the AHJ for this installation will be the City of Bellevue.

C. Fire Alarm Installer: The firm authorized by the fire alarm manufacturer to install the system equipment.

D. Listed: Use of the word "listed" for fire protection equipment, components, etc. in this Section shall mean listed by UL and approved for fire protection.

E. Shop Drawings or Working Plans: As used in this Section refer to construction documents (including Drawings and calculations) prepared pursuant to requirements in NFPA 72 for obtaining approval of AHJ.

F. Other definitions for fire protection systems are included in referenced I-Codes and NFPA standards.

G. ADA: Americans with Disabilities Act.

H. AH: Ampere-Hour.

I. ATP: Acceptance Test Procedure.

J. CPU: Central Processing Unit.

K. EOL: End of Line.

L. FACP: Fire Alarm Control Panel.

M. FSD: Fire Smoke Damper.

N. IDC: Initiation Device Circuit.

O. LCD: Liquid Crystal Display.

P. LED: Light-Emitting Diode.

Q. NAC: Notification Appliance Circuit.

R. POPIT: Point of Protection Input Transponder.

S. POPEX: Point of Protection Expansion Module.

T. SLC: Signal Line Circuit.

1.06 GENERAL REQUIREMENTS

A. Give necessary notices, obtain permits and pay taxes, fees and other costs, including utility connections or extensions for the work.
   1. File necessary Drawings, prepare documents and obtain necessary approvals of governmental departments having jurisdiction.
   2. Include all costs associated with notices, permits, taxes, fees, utility connections or extensions, government approvals and other related costs in original bid.
   3. Obtain required certificates of inspection for work and deliver to the Project Representative before request for acceptance and final payment for the work.

B. Comply with laws, ordinances, rules, regulations and lawful orders of any public authority bearing on the performance of the work.
   1. If the Contractor observes that any of the Contract Documents are at variance therewith in any respect, he shall promptly notify the Project Representative in writing and any necessary changes shall be accomplished by appropriate modification.
   2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to the Project Representative, he shall assume full responsibility, and shall bear all costs.

C. The work of this Section requires system design performed by the Contractor, assisted by the fire alarm installer.

D. The design work shall not be delegated to a third party.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Equipment shall be manufactured by an ISO 9001 Certified Company.
   1. Firms who's equipment and devices shall be of a make and type listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

2. The name of the manufacturer, part numbers and serial numbers shall appear on all major components.
3. All devices, components and equipment shall be the products of the same manufacturer, unless otherwise approved.
4. All devices, components and equipment shall be new, standard products of the manufacturer's latest design and suitable to perform the functions intended.
5. All components and equipment within the scope of the FM Global Approval Guide shall be listed by FM Global for the purpose for which they are used and shall bear their listing mark.
6. All components and equipment within the scope of the UL Testing Laboratory Service shall be listed by the Underwriters' Laboratories for the purpose for which they are used and shall bear their listing mark.

B. Designer's Qualifications: The fire alarm system shall be designed by a NICET Level 3 or 4 fire alarm technician.
   1. The designer is responsible for understanding the construction of the building to take into consideration ceiling heights, ceiling construction Design and installation shall meet the standards and requirements of the Project Representative's insurance company, FM Global, referenced codes and standards, and AHJ's review comments.

C. Installing Contractor's Qualifications:
   1. Fire alarm installer shall be authorized in writing by the fire alarm manufacturer to install the system equipment.
   2. Firms qualified to install and alter fire alarm systems, equipment, specialties, and accessories, and repair and service equipment in accordance with NFPA.
   3. A qualified firm is one who is a Licensed Fire Alarm Contractor per the Fire Alarm Licensing requirements in the State of Washington and that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the AHJ.
      a. Submit evidence of qualifications to the Project Representative upon request.

D. Service Organization Qualifications: Offer an annual maintenance contract including complete service and equipment costs for maintenance of complete system.
   1. Five (5) years experience minimum serving fire alarm systems.
   2. Provide for 24 HR emergency service.

E. Fire Alarm Contractor shall participate in preparation of the MEP Coordination Shop Drawing submittal specified in Section 01 33 00 – Submittal Procedures.

1.08 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from AHJ for fire protection systems specified.
   1. The fire alarm work shall comply with all requirements of the codes and regulations of AHJ and local and state authorities.
   2. The Fire Alarm Contractor shall develop and coordinate Drawings with other design disciplines in order to obtain a fire alarm system permit prior to the start of work.
      a. The Contractor shall field verify all dimensions and device locations and modify the Drawings as necessary prior to installation.
   3. Any materials shown or specified in the Drawings and Specifications shall be furnished and installed by the Contractor.
      a. Materials reasonably implied and usually included under good industry practice and/or for proper and safe completion and operation of the work described herein, shall also be furnished by the Contractor.
      b. The Drawings and/or Specifications, when more stringent than NFPA, IFC or the local authority requirements, shall take precedence.

B. The fire alarm system shall be designed in accordance with the IFC, NFPA, and FM Global Loss Prevention Data Sheets.

1.09 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Shop Drawings, calculations, and product data shall be submitted and approved by the AHJ prior to submittal to the Project Representative.
      a. FM Global review and approval: Direct submittals to Plan Review, FM Global, 601 – 108th Ave NE, Suite 1400, Bellevue, WA 98004. Phone: 425-709-5064.
      b. City of Bellevue review, approval and permit: Direct submittals to Development Services, 10900 NE 4th St, Bellevue, WA 98004.
      c. Contractor is responsible for making changes to system design as required to satisfy requirements of AHJ and is responsible for obtaining installation permit for system including paying all fees.
      d. Allow sufficient time for review assuming at least a second round of submittals to the AHJ.
      e. All comments and requirements of FM Global and the City of Bellevue shall be incorporated and revised Drawings submitted to the Project Representative.

2. Shop Drawings:
    a. Sufficient information, clearly presented, shall be included to determine compliance with Drawings and Specifications.
        1) Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
    b. Submit floor plans drawn with AUTOCAD to same scale as the Contract Drawings, showing equipment hardware location, wiring and mounting details.
        1) Submit detailed 1:100 (1/8 IN) scale (minimum) working Drawings conforming to IFC 907 and NFPA 72.
    c. Each sheet shall have a symbol key with device catalog number, description, dimensions, back box size and mounting requirements.
    d. Point-to-point wiring indicating the quantity and gage of the conductors and size of conduit/raceway used.
    e. Wiring connection diagrams for components being connected to the system and interfaces to associated equipment.
    f. Show remote annunciator(s) layout, configurations, and terminations.
    g. Provide detailed fire alarm riser diagram.
    h. Provide device address and notification appliance circuit number with end-of-line device.
    i. Complete sequence of operation.
3. Calculations:
    a. Provide calculations for the battery stand-by power supply taking into consideration the power requirements of all alarms, initiating devices and auxiliary components under full load conditions.
    b. Submit battery calculations for each battery backed fire alarm control unit.
    c. Submit voltage drop calculations for each notification appliance circuit, indicating conductor run length and size. Ten (10) percent voltage drop maximum and 20 percent spare current capacity per circuit.
    d. Allowable voltage drop for a device shall not exceed 4.4 volts as required per NFPA 72 – 2010, Section 10.14.1.
4. Manufacturers Data Sheets:
    a. Submit manufacturer’s product data, including installation and testing instructions. Provide for all materials and equipment proposed for use on the system (e.g. detection devices, notification devices, FACP, relays, etc.).
    b. Include listing information and installation instructions in data sheets.
    c. Where more than one item appears on a manufacture's catalog sheet, indicate the item or items to be used.

C. Quality Assurance Submittals:
   1. Comply with provisions of Section 01 43 00 – Quality Assurance and Control and the requirements of this Section.
   2. Do not begin installation without approval from AHJ and FM Global.
   3. Manufacturer's written Acceptance Test Procedure (ATP).
      a. At the time "As-Built" Drawings and maintenance/operations manuals are submitted, the installing Contractor shall submit an "Acceptance Test Procedure" describing procedures to be used to test the control system(s).
      b. The Test Plan shall include a step-by-step description of all tests to be performed and shall indicate the type and location of test apparatus to be employed.
      c. Submit, prior to final acceptance, a letter confirming that inspections have been completed and the system is installed and functioning in accordance with the Specifications.
      d. Include manufacturer representative's certification of installation.
   4. Certification of acceptance of installation by AHJ.

D. Closeout Submittals:
   1. Provide record Drawings (as-built Drawings), testing and maintenance instructions in accordance with the requirements in Section 01 78 00 - Closeout Procedures.
   2. Submittals shall include, but not be limited to, the following:
      a. Record Documentation:
         1) Include As-built Shop Drawings, calculations for the installed system.
         2) One complete set of reproducible as-built Drawings shall indicate installed location of components including all initiating devices, notification devices, panels, and other system specialty components.
         3) Also include corrections noted during the site observation process and reflect revisions, addenda, and construction change directives implemented on the project.
      b. Material and Testing Certificate:
         1) Upon completion of the fire alarm system installation provide a copy of a completed Material and Testing Certificate as indicated in NFPA 72.

3. O&M Manual Content: Provide O&M manual documentation in accordance with Section 01 73 00 – Operation and Maintenance Manuals. Include the Following:

    a. Manufacturer's operation and maintenance manual containing cut sheets, manufacturer's operation and maintenance manual, troubleshooting guide, operating instructions, spare parts list, program printout, and data file servicing requirements, inspection data, and owner's manuals for each type of fire protection specialty specified. Provide on CD-ROM, and Record Drawings.

    b. Maintenance Material:

        1) Provide two (2) copies of NFPA 72 National Fire Alarm Code to be delivered to Project Representative's maintenance personnel.

    c. Commissioning Data:

        1) Submit system commissioning data (in a format recommended by the manufacturer and per the instructions provided by the manufacturer) within 30 days of completion of the installation.

4. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

1.10 EQUIPMENT DEVIATIONS

A. Specific manufacturers and model numbers are noted to indicate a standard of design and are not intended to be restrictive.

B. Where the term "or approved equal" is used, alternative and/or substitute products shall be submitted for review, in accordance with Section 01 60 00.
    1. Where the term "or equal" is used, Contractor shall use a product that is equal to that specified.

    2. The Project Representative shall determine if two products are "equal".

C. When submitting an alternative and/or substitute product, Contractor shall include complete product literature of original specified item.

D. Provide redesign to any part of the work resulting from the use of equipment and material other than specified or indicated on the Drawings.
    1. Obtain approval of redesign from the Project Representative.

    2. Redesign cost and additional construction cost resulting from the redesign shall be at the Contractor's expense.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of Section 01 60 00 - Product Requirements, and the following:
    1. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

    2. Handle fire alarm system components carefully to avoid damage to components, enclosures, and finish.

    3. Store fire alarm system components in a clean, dry space and protect from weather.

1.12 PROJECT SITE CONDITIONS

A. Be responsible for work and equipment until finally inspected, tested and accepted; protect work against theft, injury or damage; and carefully store material and equipment received on site which are not immediately installed.
   1. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

B. The Contractor is advised that the Drawings are diagrammatic in nature and are not intended to show all details.

C. At the completion of each portion of work, all waste material, rubbish, equipment, and surplus material shall be removed from the site.
   1. Contractor is responsible for the daily clean up of their work.

D. Protect work from damage and deterioration until completion and acceptance by Project Representative.

1.13 EXTENDED WARRANTY

A. In accordance with Section 01 78 00 - Closeout Procedures, provide an Extended Warranty for the Work of this Section:
   1. Warranty Period for Work of this Section is two (2) years commencing on the date of Substantial Completion.
      a. Provide warranty against defects in materials and workmanship, and agreeing to repair or replace components that fail during the Warranty Period.

PART 2 – PRODUCTS

2.01 GENERAL

A. All equipment and components shall be new, and the current model of a manufacturer regularly engaged in the production of such materials and equipment, as listed under MANUFACTURERS.
   1. Where two or more pieces of equipment are required to perform interrelated functions, they shall be products of one manufacturer.

B. All materials necessary to make the installation complete in every detail shall be furnished and installed whether or not specifically shown on the Drawings or specified herein.

C. Unless otherwise indicated, all materials, appliances, equipment and devices shall be tested and listed in the latest publication of Approval Guides for Underwriters Laboratory and FM Global for the service intended.

D. All equipment and components shall be installed in strict compliance with manufacturers' recommendations.
   1. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

E. All Equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings).
   1. Fasteners and supports shall be adequate to support the required load.

F. Product Marking:
   1. Each item shall be furnished with legible markings indicating: name brand and manufacturer, manufacturing process, and markings as required per Standards.

G. Spare parts and special tools shall be provided to the Project Representative prior to final acceptance.

2.02 MANUFACTURERS

A. Available Fire Alarm Manufacturers:
   1. Subject to compliance with requirements of the Specifications and Drawings, manufacturers offering fire alarm systems that may be incorporated in the work include the following:
      a. Fire Alarm Control System:
         1) Silent Knight, Inc. www.silentknight.com.
         2) No Approved Equal.
      b. Notification Appliances:
         1) Wheelock, Inc. www.wheelockinc.com.
         2) Gentex, Inc. www.gentex.com.
         3) Or Approved Equal.
      c. Initiating Devices:
         1) Silent Knight, Inc. www.silentknight.com.
         2) No Approved Equal.

2.03 FIRE ALARM CONTROL PANEL (FACP)

A. Provide Silent Knight Model 5820XL control panel. Panel shall be located in Mechanical Room 03-108.

B. Multiprocessor Based: Configurable as an analog/addressable, point identified system.

C. System will be capable of displaying the analog value of each initiating device, the address and condition of fire alarm monitoring points.

D. CPU continuously monitors the communications and data processing cycles of the microprocessor.
   1. On CPU failure the system generates an audible and visual trouble signal on the control panel and remote annunciators.

E. House the CPU in the fire alarm cabinet with sufficient space to allow maximum system expansion and to enclose the alphanumeric display.

F. Retain basic life safety software in field programmable non-volatile memory.
   1. Provide the CPU with a capacity of a minimum of twenty (20) percent spare.

G. Equip the CPU with software to provide a control-by-event feature, whereby the receipt of an alarm point is programmed to operate the control points within the system.
   1. Provide control-by-event actions for life safety functions in a programmable non-volatile memory.
   2. CPU software programming for control of systems defined in this Section is installed as a part of this Section.
   3. Reprogram the support system prior to acceptance, if required by the Project Representative.

H. System shall be capable of addressing and operating smoke detectors, manual pull stations, open contact devices and addressable auxiliary control relays on the same communication loop.

I. Program Software:
   1. The field configuration program provides the programmable operating instructions for the system. Store the resident program in non-volatile memory.
   2. Perform the programming at the location of the FACP.
      a. Program the system without shutting the system down.
      b. Programming is done off line.
      c. Update and maintain a hard copy and a CD-ROM copy of the program at the site.
      d. Make system programming software available to the Project Representative, at an additional cost, allowing the user to reprogram system points, add system points, add or change point descriptions and update the data file.
   3. Programmed control point activation includes selective control of HVAC, door holder release, and fire safety and auxiliary functions.
   4. Devices meet criterion specified under System Components.
   5. Verification and display of sensitivity of each addressable smoke detector can be read using the operating software.
      a. Replace devices with readings outside of the allowed value at time of system check out.

J. Control Panel Display Modules:
   1. Provide keyboard display module 80-character backlit LCD.
   2. Each alarm/trouble condition appears in English language with the description and location of the alarm/supervisory/trouble.
   3. The alarm/supervisory/trouble may be acknowledged, silenced and the system reset from the control panel or the remote annunciator(s).

K. Digital Alarm Communicator Transmitter (DACT):
   1. Electrically supervised, capable of transmitting alarm, supervisory and trouble signals over telephone lines to off-premises receiver.

2. Signal transmitter interfaces fully with receiver station of local fire department or Project Representative's selected vendor.

3. Verify requirements and provide call sequence and message as directed by Project Representative and the AHJ.

L. Auxiliary Relays:
1. Provide sufficient SPDT auxiliary relay contacts for each function in this portion of the Specifications and for equipment interconnections required under Electrical and Mechanical Specifications.

M. Auxiliary Switches: Provide auxiliary equipment control switches with labeled status indicating lights for each switch.

2.04 CONDUIT AND WIRE

A. Conduit:
1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

2. Conduit shall not enter the FACP, or any other remotely mounted Control Panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.

3. Conduit shall be 3/4 IN minimum.

B. Wire:
1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system.

C. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes.

2.05 POWER SUPPLY AND BATTERIES

A. Power:
1. Adequate and reliable primary and 24 HR minimum standby sources of energy shall provide power supply(s), adequate to serve control panel modules, remote annunciators, addressable devices, notification appliances, and other connected devices.

a. The Power Supply shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.

b. It shall provide a minimum of 6.0 amps of usable Notification Appliance power.

c. It shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.

d. It shall be power-limited using fuse-less, quick-acting electronic circuitry meeting the latest UL requirements.

e. The system shall be powered from a UL1481 listed regulated power supply of nominal 24V DC.

f. It shall provide a battery charger for 24 HRS of standby using dual-rate charging techniques for fast battery recharge.

g. The power supply shall be provided with battery backup that transfers automatically from AC to battery in the event main AC power is interrupted.

B. Batteries:
1. Where batteries are used for secondary supply, they shall comply with this Section.
2. The secondary power supply shall have sufficient capacity to operate the system under quiescent load (system operating in a non-alarm condition) for a minimum of 24 HRS and, at the end of that period, shall be capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for 5 minutes.
3. Provide sealed, maintenance-free, rechargeable lead acid, lead-calcium, or gel-cell batteries.
4. The batteries are to be completely maintenance free.
a. No liquids are required.
b. Fluid level checks refilling, spills and leakage shall not be required.

2.06 SYSTEM COMPONENTS

A. Provide remote control/indication and test switches for system or equipment testing or control accompanied by English language labeled indicator lamps (i.e. for duct-mounted smoke detectors, projected beam type smoke detector, and the like).

B. Programmable Electronic Sounders (Horns):
1. The strobes shall meet or exceed the latest requirements of NFPA 72, and UL standard 217 and UL 464.
2. They shall be flush wall and ceiling mount as shown on the plans.
3. They shall operate on 24 VDC nominal.
4. The electronic sounders shall be field programmable without the use of special tools, to provide slow whoop, continuous, or interrupted tones (Temporal Pattern).
5. The electronic sounders shall provide a sound pressure level of 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level, in accordance with IFC 907. The minimum sound pressure levels shall be 90 dBA in machine and equipment areas and 60 dBA in all other occupancies.

C. Visible Notification Appliances (Strobes):
1. The strobes shall meet or exceed the latest requirements of NFPA 72, ANSI 117.1, and UL standard 1971.
2. They shall be flush wall and ceiling mount as shown on the plans.
3. The candela rating shall be 75 cd minimum unless otherwise indicated on Drawings.
4. They shall operate on 24 VDC nominal.

5. They shall meet the requirements of the ADA (Americans with Disabilities Act) as well as UL Standard 1971.

D. Audible/Visible Combination Appliances (Horn/Strobes):
   1. The horn-strobes shall meet or exceed the latest requirements of NFPA 72, ANSI 117.1 and UL 1971.
   2. They shall be flush wall and ceiling mount as shown on the plans.
   3. They shall meet the applicable requirements of Section A listed above for audibility.
   4. They shall meet the requirements of Section B listed above for visibility.

E. Addressable Manual Pull Box:
   1. Addressable Manual Stations shall be provided to connect to the FACP Signaling Line Circuit (SLC) Loops.
   2. Manual Stations shall provide address-setting means using decimal switches.
      a. Addressable manual stations that use binary address setting methods, such as a dip switch, are much more difficult to install and are subject to installation error, and are not allowable substitutes.
   3. Manual Stations shall, on command from the Control Panel, send data to the panel representing the state of the manual switch.
      a. Manual Fire Alarm Stations shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
   4. Manual Stations shall be constructed of LEXAN (or polycarbonate equivalent) with clearly visible operating instructions provided on the cover.
      a. The word FIRE shall appear on the front of the stations in raised letters, 1.75 IN or larger.
   5. Manual Stations shall be suitable for surface mounting, or semiflush mounting as shown on the plans, and shall be installed in accordance with ADA and local codes.

F. Addressable Photoelectric Detectors:
   1. Smoke detectors shall be analog/addressable rate-compensating panel adjustable sensitivity with self-compensating circuitry.
      a. Visual indication of detector actuation. LED source, multiple cell. 360 degree smoke entry, functional test switch, two- wire operation, 900 SQ FT coverage, insect screen, vandal resistant locking feature.
   2. The detectors shall connect with two wires to the FACP Signaling Line Circuit.
      a. Up to 318 addressable detectors may connect to two separate SLC loops.
   3. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density.

4. The detectors shall be low profile ceiling-mount and shall include a twist-lock base.
5. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
    a. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel.
6. The detectors shall provide address-setting means on the detector head using decimal switches.
    a. Because of the possibility of installation error, systems that use binary jumpers on dipswitches to set the detector address are not acceptable.
    b. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector.
7. The detectors shall provide an alarm and power LED.
    a. The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel.
    b. The LED is placed into steady illumination by the control panel indicating that an alarm condition has been detected.
    c. An output connection shall also be provided in the base to connect an external remote alarm LED.

G. Addressable Photoelectric Detectors with Fixed Thermal Sensor:
1. Smoke detectors shall be addressable and shall connect with two wires to the FACP Signaling Line Circuit.
    a. Up to 318 addressable detectors with fixed thermal sensors (135 DegF or 190 DegF) may connect to two SLC loops.
2. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density.
3. The detectors with fixed thermal sensors shall alarm at a fixed temperature of 135 DegF or 190 DegF as noted on Drawings or required by space use.
4. The detectors shall be ceiling-mount, white low profile detectors and shall include a twist-lock base.
5. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
    a. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel.
6. The detectors shall provide address-setting means on the detector head using decimal switches.
    a. Because of the possibility of installation error, systems that use binary jumpers on dipswitches to set the detector address are not acceptable.

b. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable.

c. The detectors shall also store an internal identifying code that the control panel shall use to identify the type of detector.

7. The detectors shall provide an alarm and power LED.

a. The LED shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel.

b. The LED is placed into steady illumination by the control panel indicating that an alarm condition has been detected.

c. An output connection shall also be provided in the base to connect an external remote alarm LED.

H. Addressable Ionization Smoke Detectors:

1. Smoke Detectors shall be low profile addressable and connect with two wires to the FACP Signaling Line Circuit.

a. Up to 318 addressable detectors may connect to two SLC loops.

2. The detectors shall use the dual-chamber ionization principal to measure products of combustion.

3. The detectors shall be low profile ceiling-mount and shall include a twist-lock base.

4. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.

a. Such a test may be initiated at the detector itself, by activating a switch, or may be activated remotely on command from the control panel.

5. The detectors shall provide address-setting means on the detector head using decimal switches.

a. Because of the possibility of installation error, systems that use binary jumpers or dipswitches to set the address are not acceptable.

b. They shall also store an internal identifying code that the control panel shall use to identify the type of detector.

6. The detectors shall provide an alarm and power LED.

a. The LED shall flash under normal conditions.

b. The LED is placed into steady illumination by the control panel, indicating that an alarm condition has been detected.

c. An output connection shall also be provided in the base to connect a remote alarm LED.

I. Heat Detectors:
   1. A 120V, normally closed contact, thermally actuated fire detector/device rated at least 50 degF above the highest anticipated operating environment temperature shall be located directly above the hydraulically operated equipment, as noted on Drawings.
   2. Electrical contractor to make final connection to Hydraulic Power Unit Controller.

J. Duct-Mounted Analog Smoke Detectors:
   1. Analog/addressable photoelectric type, auxiliary relay contacts rated at 5 amps each at 120VAC.
   2. Duct sampling tubes extending width of duct, visual indication of detector actuation, direct housing mount.
   3. Detector powered from control panel, power on indicator light.
   4. Detector rated for air velocity, humidity, and temperature of duct.

K. Waterflow Switches:
   1. Verify requirements, locations, and quantities with sprinkler design.
      a. Switches are to be provided under Section 21 13 00 – Fire-Suppression Sprinkler Systems and wired under Division 28, unless specifically noted otherwise.
      b. Provide each switch with an addressable module.
   2. Flow switches shall be integral, mechanical, non-coded, non-accumulative retard type.
   3. Flow switches shall have an alarm transmission delay time that is conveniently adjustable from 0 to 60 seconds.
   4. Flow switches shall be located a minimum of one (1) FT from a fitting that changes the direction of the flow and a minimum of three (3) FT from a valve.

L. Sprinkler Control Valve Supervisory Switches:
   1. Each valve controlling sprinkler system water supplies (riser, isolation valve, Post Indicator Valve (PIV), DCVA isolation valve, etc.) shall be equipped with a supervisory switch. Verify requirements, locations, and quantities with sprinkler design.
      a. Switches are to be provided under Section 21 13 00 – Fire-Suppression Sprinkler Systems and wired under Division 28, unless specifically noted otherwise.
      b. Provide each switch with an addressable module.
      c. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.

M. Addressable Monitor Module:
   1. Addressable Monitor Modules shall be provided to connect one supervised IDC (zone) of conventional Alarm Initiating Devices (any N.O. dry contact device) to the FACP Signaling Line Circuit (SLC) Loop.

2. The Monitor Module shall mount in a 4 IN square, 2-1/8 IN deep electrical box.
3. The IDC (zone) shall be wired for Class B operation.
    a. The Monitor Module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the FACP shall use to identify the type of device.
    b. Modules that use binary jumpers or dip-switches are subject to installation errors and are not acceptable.
    c. An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the Monitor Module shall be available in a miniature package and shall be no larger than 2-3/4 IN wide x 1-1/4 IN high x 1/2 IN deep (Fire-Lite Alarms model MMF-301).
    a. This version does not support Style D operation or include an LED.

N. Addressable 2-Wire Smoke Detector Monitor Module:
1. Addressable 2-Wire Smoke Detector Monitor Modules shall be provided to connect one supervised IDC (zone) of two-wire conventional smoke detectors to the FACP Signaling Line Circuit (SLC) Loop.
2. The Monitor Module shall mount in a 4 IN square, 2-1/8 IN deep electrical box.
3. The Monitor Module shall provide terminal connections for a resettable external supply voltage to provide power to the IDC (zone) of two-wire smoke detectors.
4. The IDC (zone) shall be wired for Class B operation.
    a. The Monitor Module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the FACP shall use to identify the type of device.
    b. Modules that use binary jumpers or dip-switches are subject to installation errors and are not acceptable.
    c. An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.

O. Addressable Dual-Circuit Monitor Module:
1. Addressable Dual-Circuit Monitor Modules shall be provided to connect two supervised IDCs (zones) of conventional Alarm Initiating Devices (any N.O. dry contact device) to the FACP Signaling Line Circuit (SLC) Loop.
2. The- Monitor Module shall mount in a 4 IN square, 2-1/8 IN deep electrical box.

3. The IDCs (zones) shall be wired for Class B operation only.
    a. The Monitor Module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the FACP shall use to identify the type of device.
    b. Modules that use binary jumpers or dip-switches are subject to installation errors and are not acceptable.
    c. An LED shall be provided that shall flash under normal conditions, indicating that the Monitor Module is operational and in regular communication with the control panel.

P. Addressable Control Module:
1. Addressable Control Modules shall be provided to supervise and control the operation of one conventional NAC of compatible, 24 VDC powered, polarized Audio/Visual appliances or audio speakers.
2. The Control Module shall mount in a standard 4 IN square, 2-1/8 IN deep electrical box or to a surface mounted backbox.
3. The NAC shall wire in a Class B fashion.
    a. Each Control Module shall support up to 1 Amp of Inductive or 2 Amps of Resistive Audible/Visual signals.
4. Audio/Visual power shall be provided by a separate supervised power Loop from the main FACP or from a supervised, UL listed Remote Power Supply.
5. The Control Module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the Control Panel shall use to identify the type of device.
    a. Modules that use binary jumpers or dip-switches are subject to installation errors and are not acceptable.
    b. An LED shall be provided that shall flash under normal conditions, indicating that the Control Module is operational and is in regular communication with the control panel.
6. A magnetic test switch shall be provided to test the module without opening or shorting its NAC circuit wiring.

Q. Addressable Relay Module:
1. Addressable Relay Modules shall be provided to allow a compatible control panel to switch discrete contacts by code command.
2. The Relay Module shall mount in a standard 4 IN square, 2-1/8 IN deep electrical box or to a surface mounted backbox.
3. The Relay Module shall provide two isolated sets of Form-C contacts for fan shutdown and other auxiliary control functions.

4. The Relay Module contact ratings shall support up to 1 Amp/30 VDC of Inductive load or 2 Amps/30VDC (coded) of Resistive load (up to 3 Amps in non-coded applications).
    a. The relay coil shall be magnetically latched to reduce wiring connection requirements and to insure that 100 percent of all auxiliary relays or may be energized at the same time on the same pair of wires.
5. The Control Module shall provide address-setting means using decimal switches and shall also store an internal identifying code that the Control Panel shall use to identify the type of device.
    a. Modules that use binary jumpers or dip-switches are subject to installation errors and are not acceptable.
    b. An LED shall be provided that shall flash under normal conditions, indicating that the Control Module is operational and is in regular communication with the control panel.
6. A magnetic test switch shall be provided to test the module without opening or shorting its NAC circuit wiring.

R. Isolator Module:
1. Isolator Modules shall be provided to automatically isolate wire-to-wire short circuits on a SLC loop.
    a. The Isolator Module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop.
    b. At least one Isolator Module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the Isolator Module shall automatically open-circuit (disconnect) the SLC loop.
    a. When the short circuit condition is corrected, the Isolator Module shall automatically reconnect the isolated section of the SLC loop.
3. The Isolator Module shall not require any address setting, and its operations shall be totally automatic.
    a. It shall not be necessary to replace or reset an Isolator Module after its normal operation.
4. The Isolator Module shall mount in a standard 4 IN deep electrical box or in a surface mounted backbox.
    a. It shall provide a single LED that shall flash to indicate that the Isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

S. Serial, LED-Type, Remote Annunciation:
1. The annunciator shall communicate with the FACP via an EIA 485 (ACS mode) communications loop and shall annunciate all zones in the system.
    a. Up to 32 annunciators may be connected to the EIA 485 communications loop.

2. The annunciator shall need no more than four wires to connect to the FACP.

3. The annunciator shall provide a red Alarm LED per zone, and a yellow Trouble LED per zone.

   a. The annunciator will also have an "ON-LINE" LED, local piezo sounder, local acknowledge/lamp test switch, and custom zone/function identification labels.

4. The annunciator switches may be used for System control such as, Global Acknowledge, Global Signal Silence, and Global System Reset.

T. Serial, LCD-Type, Remote System Display:

1. The annunciator shall communicate with the FACP via an EIA-485 (Terminal Mode) communications loop and shall include a 80-character, backlit, LCD display which mimics the integral FACP LCD display.

   a. Up to 32 annunciators may be connected to the EIA-485 communications loop.

2. The annunciator shall require no more than four wires on the communication loop (two for communication, two for supervision) and two additional wires for power.

3. In addition to the LCD, English language display, the annunciator shall also include a Power LED, Alarm LED, Trouble LED and Supervisory LED.

4. A local piezo sounder shall also be included on the annunciator.

5. Switches for Acknowledge/Lamp Test, Silence, Drill and Reset shall be included on the annunciator protected from unauthorized usage by a key switch (keyed alike to the host FACP).

2.07 ANNUNCIATORS

A. Alphanumeric Remote Annunciator with Controls:

1. Back lit LCD alphanumeric annunciator 80 characters long.

2. Provide under locking cover a test switch, alarm and trouble buzzer, buzzer silence switch and buzzer silence message and reset switch, flush mount with finished cover, vandal-resistant UV stabilized Lexan (or approved) overlay and required modules, control panel, etc., to drive annunciator.

3. Self-contained, suitable for wet location where located exterior.

4. Verify locations shown on Drawings with Project Representative and AHJ during permitting.

B. Provide framed floor plan of facility adjacent to each annunciator panel identifying room names/numbers, device/addresses or fire zone number and listing as utilized on the annunciator panel, as required by local AHJ.

1. Check with the local fire department for size and approved mounting location.

C. Provide fire/smoke damper control/monitoring.

1. Provide required smoke detectors, relays, wiring, and the like.

2. Provide spot type smoke detector(s), listed for releasing service, and install within 5 FT of the dampers per the IBC.

3. Verify requirements, locations and quantities with Division 23 prior to bidding.

PART 3 – EXECUTION

3.01 GENERAL

A. Installation shall be in accordance with the applicable codes and regulations (NEC, NFPA 72, local and state codes, etc.) as shown on the Drawings and detailed in this Section, and as recommended by the equipment manufacturer.

B. Requirements prior to installation:
   1. Do not order, fabricate, or install any material prior to receipt of all approvals as stipulated in Part 1 of this Section.

C. Standards and requirements:
   1. Perform all installation work in accordance with the reference standards without exception, and as required by the AHJ.

D. Changes to the Work:
   1. Install all equipment as shown on the approved Shop Drawings.
   2. Carefully note any minor deviations on the Record Drawings as outlined in Part 1 of this Section.
   3. Before making significant deviations from the approved Drawings, obtain written approval from the Project Representative and the AHJ.

E. Coordination of Work:
   1. Carefully coordinate work with other trades so that unnecessary offsets and revisions to the approved Drawings are avoided.
   2. Failure to coordinate does not relieve Contractor from meeting performance standards.

F. All equipment shall be installed and identified in accordance with the noted Codes and Standards and the manufacturer's guidelines and design manuals.
   1. Comply with manufacturer's instructions, including technical bulletins and product catalog data.
   2. Retain manufacturer's written installation instructions at the project site.

G. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.
   1. Smoke detectors shall not be installed prior to the system programming and test period.
   2. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

H. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

3.02 EXAMINATION

A. Electrical, Mechanical, Structural and Architectural Drawings of the building and systems shall be reviewed by the Fire Alarm Contractor and its work shall be arranged to avoid interferences.
   1. Refer to MEP Coordination requirements in Section 01 33 00 – Submittal Procedures.

B. Verify conditions are satisfactory to receive work of this Section.
   1. Do not commence work until unsatisfactory conditions have been corrected.

C. Beginning work constitutes acceptance of conditions.

D. Coordinate with other trades to confirm that subsequent construction activities do not involve procedures that will damage installed materials.
   1. Materials damaged during construction shall be replaced at the Contractor's expense.

3.03 PREPARATION

A. Field Measurements: Verify on job before beginning work.

B. Protect surrounding areas and surfaces from damage prior to beginning work.

C. Deliver material to job site in original non-broken factory packaging, with manufacturer's labels.

3.04 INSTALLATION

A. All equipment shall be installed and identified in accordance with the noted Codes and Standards and the manufacturer's guidelines and design manuals.

B. All work shall be in accordance with local, state and national codes (IBC, NEC, etc.) and as recommended by the manufacturer of the fire alarm system.

C. Coordination of work:
   1. Device locations indicated on the Drawings are approximate and require Contractor field coordination for exact placement.
      a. Minor adjustments shall be made to properly coordinate device placement, excepting that minimum device listed spacing is not exceeded.
      b. Similar devices shall, where possible, be mounted in consistent rows, at common elevations and shall be placed symmetrically, and in common relation to repetitive building features.
      c. Review Architectural plans, details and elevations and avoid device location conflicts with casework, windows, relites, bulletin boards, appliances, light fixtures, and similar items.
   2. Ensure that all equipment supplied will fit in locations designated on plans and in the Specifications.

3. Smoke detectors at control panel and equipment locations:
    a. Provide smoke detector within five (5) FT of all control panel equipment per NFPA code requirements.
    b. This detector may also serve as an area detection device.

D. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes.
    1. This circuit shall be labeled at the Main Power Distribution Panel as FIRE ALARM. FACP Primary Power wiring shall be minimum 12 AWG.
    2. The Control Panel Cabinet shall be grounded securely to either a cold water pipe or grounding rod.

E. Duct-Mounted Smoke Detectors:
    1. Provide duct-mounted smoke detectors on air systems with air quantities of 2000 cfm or more. Coordinate with Division 23.
    2. Install duct-mounted smoke detector(s) on return side of air duct.
    3. Coordinate installation location and mounting of duct/smoke detectors with sheet metal installer; electrically connect and provide remote indicator lights where the detector is located above a suspended ceiling or in non-readily accessible areas.
    4. Provide control wiring from duct-mounted detector auxiliary relay contacts to air handling equipment controller.
        a. Connect to controller so that when duct-mounted smoke detector is activated, the air handling equipment is shut down.
    5. Provide duct-mounted smoke detectors rated for air velocity, temperature, and humidity of duct.
        a. Verify quantities, locations, and requirements with Division 23 Drawings and mechanical system installer.
    6. Where duct-mounted smoke detectors are mounted in inaccessible building void spaces provide access hatch. Provide access hatch with fire rating equivalent to rating of wall, ceiling, or shaft being penetrated.

F. Fire/Smoke Dampers and Smoke Dampers:
    1. Connect control and power wiring to dampers per manufacturer's instructions.
    2. Verify quantities, location and requirements of dampers with Division 23 Drawings and Specifications, and mechanical system installer.
    3. If damper is installed within a duct, provide smoke detector within 5 FT of damper with no air inlets or outlets between the damper and detector.
    4. If damper is installed within an unducted opening, provide smoke detector located within a 5 FT horizontal radius of the damper to control the damper.
    5. Provide control wiring, transformers and power connections for an operable damper and detection system.

3.05 SYSTEM AND CONTROL WIRING

A. In accordance with manufacturer's instructions, provide wiring, conduit and outlet boxes required for the erection of a complete system as described herein, as shown on Drawings, and as required by AHJ.

B. All system wiring shall be furnished and installed by the Contractor.

C. All wiring shall be installed by qualified individuals, in a neat and workmanlike manner, to conform to the National Electrical Code, Article 760, except as otherwise permitted for limited energy circuits, as described in NFPA 72 current edition.

D. Wiring shall be in accordance with local, state and national codes (e.g., IBC, IFC, NFPA, NEC Article 760, etc.) and as recommended by the manufacturer of the fire alarm system.

E. All wiring shall be installed in minimum 3/4 IN electrical metallic tubing (EMT), or conduit, and must be installed and kept separate from all other building wiring.

F. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

G. Conduit:
   1. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
   2. Wiring for 24 volt control, alarm notification, emergency communication and similar power limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits.
   3. Conduit shall not enter the FACP, or any other remotely mounted Control Panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
   4. Runs of conduit and wiring shall be straight, neatly arranged, properly supported, and installed parallel and perpendicular to walls and partitions.

H. Wire:
   1. Provide complete conduit system for wiring. Provide Type FPL power-limited fire alarm cable.
   2. Provide final connections between equipment and the wiring system approved by manufacturer.
   3. At junction boxes and termination points, provide identification tags on wires and cables.
   4. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
   5. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG for Notification Appliance Circuits.

6. Wiring must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.
7. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
8. Wiring used for the multiplex communication loop shall be twisted and shielded and installed in conduit unless specifically accepted by the fire alarm equipment manufacturer.
    a. The system shall permit use of IDC and NAC wiring in the same conduit with the communication loop.
9. All field wiring shall be completely supervised.
10. Color coded wire shall be used.

I. Terminal Boxes, Junction Boxes and Cabinets:
    1. All boxes and cabinets shall be UL listed for their use and purpose.

J. All system components shall be securely supported independent of the wiring.

K. All wires shall be tagged at all junction points and shall be free from shorts, earth connections (unless so noted on the system drawings), and crosses between conductors.

L. Final terminations between the control panel and the system field wiring shall be made under the direct supervision of a factory trained representative.

M. The complete system electrical installation, and all auxiliary components, shall be connected to earth ground in accordance with the National Electrical Code.

N. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto an NFPA Class B Signaling Line Circuit (SLC).

O. Initiation device circuits (IDCs) shall be wired per NFPA Class B.

P. Notification appliance circuits (NACs) shall be wired per NFPA Class B.

Q. All pathways shall comply with NFPA 70, National Electrical Code and provide Pathway Survivability Level 1.

3.06 FIELD PROGRAMMING

A. The system and its respective devices (i.e. smoke detectors and modules) shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.

B. All programming shall be accomplished through the standard FACP built-in keypad, as well through using a PC keyboard or through the video display terminal.

C. All field-defined programs shall be stored in non-volatile memory and shall not be lost if AC mains and/or battery is lost.

D. System programming shall be backed up on a computer diskette.
   1. This system back-up shall be capable of download to a replacement FACP system should the system be damaged due to fire or other event.

E. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed.
   1. Two levels of password protection shall be provided in addition to a key-lock cabinet.
   2. One level is used for status level changes such as zone disable or manual on/off commands.
   3. A second (higher-level) is used for actual change of program information.

F. Program edit shall not interfere with normal operation and fire protection.
   1. If a fire condition is detected during programming operation, the system shall exit programming and perform fire protection functions as programmed.

G. A special program check function shall be provided to detect common operator errors.

H. An Auto-Program (self-learn) function shall be provided to quickly program initial functions within several seconds.
   1. During this operation, smoke detectors connected to the Signaling Line Circuit shall be automatically installed without labor intensive operator key commands and using additional electronic equipment to program each individual detector.

I. For flexibility, an optional off-line programming function, with batch upload/download, shall also be available.

J. Fit a suitable, listed guard on the circuit breakers in the power panels feeding the control panel, such that the circuit breaker cannot be manually turned off, but fixed so the breaker can trip and requiring the removal of a screw to remove the guard.
   1. Separate breakers shall be provided for each control panel main power and trouble circuits.

3.07 CLEANING

A. Clean smoke detectors showing degraded alarm threshold levels, as recommended by the manufacturer prior to project close-out.

B. Clean equipment cabinets and enclosures to remove all trimmings, debris, dirt, dust and foreign materials.

C. Clean the outside surfaces of devices and equipment as recommended by the manufacturers.

3.08 PROTECTION

A. Retain protective dust-covers over spot-type smoke detectors until painting and dust-producing work within that area is completed.
   1. Remove during construction only as required for testing and AHJ approval, replacing when such demonstration is complete.

3.09 INSTALLERS

A. Delegated Design Responsibility:
   1. The fire detection and alarm system is in detail a bidder-design system, excepting that specific device layouts and Specification requirements shown within the Contract Documents, and therein-exceeding code minimum requirements, shall be included as indicated on the Contract Documents.

B. Rough-in preparation for devices may be performed by licensed electricians performing Division 26 work.
   1. Wiring, terminations, device mounting, testing, trouble-shooting and programming shall be performed only by factory authorized and trained fire alarm system installers as furnished by a UL (UUJS) listed signal subcontractor.

C. Terminate fire alarm conductors in control and annunciator panels on terminal strips.
   1. Connect wiring neatly and secure to cabinet with nylon cable straps.
   2. Set up termination of cabling so that sections of the system may be isolated or shorted out for servicing.
   3. Maximum of two conductors under each terminal strip connection.

D. From fire alarm controlled relays, make connection to motor controls and related equipment as required for fan system control.
   1. Provide relays UL listed for the purpose.

3.10 FIELD QUALITY CONTROL

A. Upon completion of the installation, subject the system to final inspection and testing and when necessary corrections have been accomplished, advise Project Representative who will schedule a final inspection test with the Project Representative.
   1. Ensure the connections to the fire alarm system have been in service for at least 10 days of trouble/alarm free operation prior to the final inspection.
   2. Furnish instruments, labor and materials required for the tests and a qualified technician to conduct the tests.
   3. Correct deficiencies found at no cost and retest system as necessary, prior to final acceptance.

B. Upon completion of the installation of fire alarm equipment, provide to Project Representative a signed, written statement substantially in the form as follows:
   1. "The undersigned having been engaged as the Contractor on the facility confirms that the fire alarm equipment was installed in accordance with the Drawings, Specifications, wiring diagrams, instructions, directions provided by manufacturer, and requirements of the governing authorities."

C. The entire system shall be tested in accordance with the Acceptance Test Procedure (ATP) to demonstrate and certify proper system operation.

D. The system shall be tested by qualified personnel in accordance with requirements of NFPA 72 – 2010, Chapter 14, FM Global and the City of Bellevue.

3.11 COMMISSIONING

A. The work of this Section shall include the Contractor's labor and materials for participation in the Commissioning Activities (Cx) as a Commissioning Team Member (CxT) as required by Section 01 95 00 – Commissioning Requirements.

B. The completed system shall be reviewed and tested by qualified personnel to meet the approval of the AHJ.
   1. Only listed equipment and devices shall be used in the systems.
   2. Fire alarm manufacturer's factory trained and authorized/certified service technicians shall be used for commissioning.

C. To determine that the system has been properly installed and will function as specified, the testing outlined in the 2010 edition of NFPA 72, Chapter 14 shall be followed, in addition to those detailed in this document.

D. All necessary instrumentation, equipment, materials and labor shall be provided by the Contractor.

E. All testing shall be in accordance with this section, referenced standards and the approved Acceptance Test Procedure.
   1. The tests shall demonstrate that the operational and installation requirements of this Specification have been met.
   2. All tests shall be conducted in the presence of the Project Representative and shall not be conducted until the Acceptance Test Procedure has been approved.

F. Before the systems are accepted, all system components and equipment shall be thoroughly cleaned.
   1. Remove temporary labels and protective coverings.
   2. Remove foreign materials including dust and dirt, and excess adhesive using materials and methods in accordance with manufacturer's written instructions.

G. City of Bellevue Fire Inspector and FM Global representative shall be invited to witness all operational tests.

H. Submit completed Contractor's Material and Test Certificate or suitable record of all inspection and testing as required by NFPA 72 -2010, Chapter 14.

I. System Checks:
   1. Check the system to ensure the following features are operational and programmed in accordance with the Specification.
      a. Detector address.
      b. Display address.
      c. Time and date.
      d. Time delays.

e. Display buttons operable (Mode, Silence, Reset, Isolate).

f. Referencing.

g. Units set to U.S.

2. Check to ensure that all ancillary warning devices operate as specified.

3. Check interconnection with FACP to ensure correct operation.

J. Visual Inspection:

1. Final device placement shall be considered satisfactorily complete when all devices are installed in accordance with their listing or approval and Contractor's approved Shop Drawings.

2. The Contractor may be required to relocate or add additional devices if proper coverage is not provided due to unforeseen or modified architectural conditions.

3. Inspect wiring interconnection to ensure each component is correctly wired in accordance with the manufacturer's requirements.

4. Check system configuration settings to ensure all features are programmed in accordance with this Specification.

K. Operational Testing:

1. Perform operational testing of system components in accordance with manufacturer's instructions to determine correct operation of system.

a. Before energizing the cables and wires, check for correct connections and test for proper connection, short circuits, ground faults, continuity, and resistance to ground.

b. Test the Normal (standby) state, Trouble (supervisory) state and alarm state of all devices.

2. Tests include the following:

a. Operation of each signal initiating device (smoke detectors, heat detectors, pull stations, fire/smoke rated doors, process and facilities control sequences).

b. Operation of each notification appliance (alarm horn and alarm strobe).

c. Operation of features of the system under normal operation.

d. Operation of supervisory features of the system.

e. Operation of features of the systems on standby power with primary power off.

f. Documentation by download of control panel memory.

L. Functional Testing:

1. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

2. The installed system shall be proven capable of satisfactorily responding to an appropriate system performance test selected from those detailed in NFPA 72.
3. Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.
4. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc. shall function as required and designed.
5. Perform functional testing of smoke detectors in accordance with manufacturer's instructions after operational testing is completed to determine correct alarm operation of detectors.
6. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
7. Verify activation of all flow switches.
8. Open initiating device circuits and verify that the trouble signal actuates.
9. Open and short signaling line circuits and verify that the trouble signal actuates.
10. Open and short Notification Appliance Circuits and verify that trouble signal actuates.
11. Ground all circuits and verify response of trouble signals.
12. Check presence and audibility of tone at all alarm notification devices.
13. Check installation, supervision, and operation of all addressable smoke detectors using the Walk Test.
14. Each of the alarm conditions that the system is required to detect should be introduced on the system.
    a. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
15. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures.
    a. This is intended to address such items as verifying the controls performance by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.
16. Replace system components that do not pass test procedures specified.
    a. Then retest to demonstrate compliance.
    b. Repeat procedure until satisfactory results are obtained.
17. Report test results promptly and in writing to Project Representative.
18. Report test results promptly and in writing to AHJ when required.

M. Punch List:
1. Should the results of the inspection/test not be satisfactory to the Project Representative or Fire Department representatives, deficiencies will be recorded on a punch list and delivered to Contractor.

2. Make corrections within two weeks of receipt of the punch list, no exceptions, at the Contractor's expense; a re-inspection/test will be made.

N. A set of reproducible as-built installation Drawings, operation and maintenance manuals, and a written sequence of operation shall be provided to Project Representative.

O. Certificate of Completion:
   1. Using the manufacturer's standard form, prepare and submit a completed commissioning report.

P. Final Approval:
   1. After the fire alarm system has been completely installed, tested and all punch list items corrected, obtain acceptance of the system by the City of Bellevue and the FM Global Representative.
   2. Submit the certification of acceptance by both agencies to the Project Representative.
   3. Deliver a completed Contractor's Material and Test Certificate to the Project Representative upon satisfactory completion of the work.

Q. Upon acceptance by the Project Representative, the completed system(s) shall be placed into service.
   1. Remove all keys from manual pull stations, control panels, and all other key-operated devices when agent becomes operational.
   2. Deliver keys to Project Representative.

3.12 TRAINING

A. At the direction of Project Representative the equipment supplier of the system will provide a factory trained representative to demonstrate the operation of the fire alarm system equipment and to instruct the Project Representative's personnel in its operation.
   1. Provide names and date of instruction prior to final acceptance.

B. Provide sixteen (16) HRS of on-site training for operations and maintenance staff including:
   1. Two (2) four (4) HR days of operations training during which staff will be trained on the functional operation of the fire alarm system including the following:
      a. Zone by zone description and reporting of the system.
      b. Actions to be taken for supervisory and trouble alarms.
      c. Actions to be taken for alarm condition.

C. One (1) eight (8) HR day of maintenance training covering requirements of NFPA 72.

3.13 OPERATION AND MAINTENANCE

A. Maintenance and testing shall be on a semi-annual basis or as required by the local AHJ.
   1. A preventive maintenance schedule shall be provided by the Contractor that shall describe the protocol for preventive maintenance.

2. The schedule shall include:

    a. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, water flow switches and all accessories of the fire alarm system.

    b. Each circuit in the fire alarm system shall be tested semi-annually.

    c. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

B. Prior to final acceptance, the installing Contractor shall provide complete operation and maintenance instruction manuals, four (4) copies for each system, to the Project Representative.
    1. All aspects of system operation and maintenance shall be detailed, including wiring diagrams of all circuits, a written description of the system design, sequence of operation and Drawing(s) illustrating control logic and equipment used in the system.

    2. Checklists and procedures for emergency situations, troubleshooting techniques, maintenance operations and procedures shall be included in the manual.

END OF SECTION

SECTION 28 31 50
HAZARDOUS GAS DETECTION AND ALARM

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes the following:
   1. Gas detection system operation.
   2. Gas detection equipment.

1.02 REFERENCES

A. Comply with the requirements of Section 01 09 05 – Reference Standards and as listed herein. The following is a list of standards referenced in this Section:
   1. National Fire Protection Association (NFPA).
   2. NFPA 70 – National Electric Code (NEC).
   3. American Standards for Testing and Materials (ASTM).
   4. International Electrical Testing Association Inc. (NETA).
   5. National Electrical Manufacturer's Association (NEMA) Standards.
   6. Underwriter's Laboratories, Inc. (UL).
   7. Washington Administrative Code (WAC).
   8. Revised code of Washington (RCW).
   9. Washington State Chief Electrical Inspector's Approved list for Nationally Recognized Testing Laboratories (NRTL).
   10. National Electrical Contractors Association (NECA).
   11. International Organization for Standardization (ISO).

1.03 DEFINITIONS

A. CO: Carbon Monoxide.

1.04 SYSTEM DESCRIPTION

A. General:
   1. Furnish, install and place in operating condition a toxic gas monitoring system suitable for detecting various toxic gases. Possible toxic gases to be monitored include: Carbon monoxide, nitrogen dioxide and carbon dioxide. The system shall be installed in accordance with the Drawings and as specified herein complete with all accessories necessary for proper operation.
   2. Products used in the work of this Section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of satisfactory production acceptable to the Project Representative. The manufacturer shall have an ISO 9001:2000 Registered Quality Control System in place and approved.

B. Operation:
   1. The electrochemical sensor/transmitters shall have a minimum of 90 day calibration interval.
   2. The gas sensor module must be able to be calibrated without opening the enclosure (non-intrusive calibration) using a magnetic wand to activate four keys.
   3. Utilizing the integral display and magnetic wand activated keys, the sensor module must have a menu-driven procedure for calibration, set-up, maintenance and alarm reset.
   4. There shall be a high and low level alarm and trouble alarm for each sensor. The type of alarm shall be annunciated on the controller display panel using the scrolling display.
   5. Sensor module will have user selectable ranges.
   6. Sensor/transmitter shall be a 3-wire device operating between 10 and 30 VDC.
   7. Operating temperatures shall be: Operating temperature for all toxic gas sensor modules shall be plus 4 DegF to plus 122 DegF.
   8. Operating ranges shall be:
      a. Up to 0 to 10 PPM (User adjustable) the Nitrogen Dioxide gas sensor modules.
      b. Up to 0 to 500 PPM (User adjustable) the Carbon Monoxide gas sensor modules.
      c. Up to 0 to 1000 PPM (User adjustable) for Carbon dioxide modules.

C. Interconnectivity:
   1. Sensor module shall include multiple interface/connectivity capabilities, including:
   2. 4-20 mA output including:
      a. User-selectable values for output during calibration and trouble conditions
      b. Interface testing during set-up confirming 4mA and 20 mA matching between the module and the interface device.
   3. Integral High and Low alarm relays (SPDT type):
      a. A minimum of 8 Amps to enable interface to control devices.
      b. Shall be field-selectable through non-intrusive means, without use of an external remote control unit. Selectable features include:
         1) Alarm level.
         2) Latching/Non-Latching.
         3) Sentry control or Module control.

D. Sensor/Transmitter Display:
   1. There will be a local display indicating the gas type being monitored, sensor number, unit of measure and the concentration of gas present. The display shall be a scrolling display.
   2. The display will indicate any current alarm condition and any appropriate diagnostic and fault codes and conditions.
   3. Module number must be settable using an analog selector to allow module number to be selected without power applied to the sensor module.

E. Sensor Enclosure: Enclosures shall have a NEMA 4X rating in 316 Stainless Steel.

F. Calibration:
   1. Calibration shall be single-person, auto-adjusting without any manual adjustments required and without exposing circuit electronics to the atmosphere.
   2. Provide calibration kit to Project Representative. Calibration kit shall consist of cylinders of calibration gas plus pressure and flow regulator for delivery of the calibration gas to the sensor.

1.05 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product Data:
      a. Complete descriptive data (cut sheets) including UL listing, FM approval (for the specified application) for system components.
   2. Shop Drawings:
      a. A symbol key with device catalog number, description, dimensions, back box size and mounting requirements.
      b. Detailed riser diagram.
      c. Point to point wiring indicating the quantity and gage of the conductors and size of conduit/raceway used.
      d. Wiring connection diagrams for components being connected to the system and interfaces to associated equipment.

C. Closeout Submittals:
   1. Extended Warranty: Provide two executed copies of the Extended Warranty required by this Section in accordance with the provisions of Section 01 78 00 – Closeout Procedures.

2. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals. Include the following:
    a. Provide manuals containing cut sheets, manufacturer's operation and maintenance manual, troubleshooting guide, operating instructions, spare parts list, program printout, and data file on CD-ROM, and Record Drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00 – Product Requirements.

1.07 EXTENDED WARRANTY

A. In accordance with the provisions of Section 01 78 00 – Closeout Procedures, provide an Extended Warranty for the Work of this Section.
    1. Warranty Period for Work of this Section is two (2) years commencing on the date of Substantial Completion.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Products used in the work of this section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of satisfactory production acceptable to the Project Representative.

B. Provide product of one of the following:
    1. Sierra Monitor Corporation.
    2. Mine Safety Appliance Company (MSA).
    3. Federal Signal Corporation.
    4. Allen – Bradley.
    5. Edwards Signaling.
    6. Or approved equal.

2.02 ACCEPTABLE PRODUCTS

A. Central installed systems:
    1. Multi-zone monitoring panel:
        a. Sentry 5000-02 Model.
        b. MSA 5300-N-4-02-M Model.
        c. Or approved equal.
    2. Toxic Gas Sensor module:
        a. 5100-04-IT-A1-02.
        b. 5100-12-IT-A1-02.
        c. Ultima X Series.
        d. Or approved equal.

3. Strobe Light:
    a. Model LP3P.
    b. Model 57EDF Series.
    c. Or approved equal.
4. Industrial Horn:
    a. 855HBA10AD.
    b. 870 Series.
    c. Or approved equal.

B. Provide all appurtenances required to complete the gas detection system indicated on Drawings.

PART 3 – EXECUTION

3.01 EXAMINATION

A. Verify conditions are satisfactory to receive Work of this Section. Do not commence Work until unsatisfactory conditions have been corrected.

B. Beginning Work constitutes acceptance of conditions.

3.02 INSTALLATION

A. Install system in accordance with applicable codes and regulations, manufacturer's written instructions, and this Section.

3.03 CLEANING

A. Provide any adjustments or cleaning necessary to the system upon completion of construction to facilitate delivery of a fully functional and operational system to Project Representative upon building occupancy.

END OF SECTION 28 31 50

SECTION 28 34 00
ELECTRONIC DETECTION, ALARM AND ACCESS CONTROL

PART 1 – GENERAL

1.01 ELECTRONIC DETECTION AND ALARM

A. Simplex Grinnell is the sole source Electronic Security System (ESS) Software House Certified Dealer and Installer selected by King County. Contractor to hire Simplex Grinnell under this Contract. Contact person: Steven R. Burger, District Operations Manager, Tel: 206-291-1452, Fax: 206 291-1500, Address: 9520 10th Avenue South, Suite #100, Seattle, WA 98108, Email: sburger@simplexgrinnell.com.

B. The following security systems will coexist at this facility:
   1. Existing KCSWD intrusion detection system Bosch security panel at the Scalehouse. Monitors man entry doors not controlled by ESS.
   2. New KCSWD intrusion detection system panel to be located at the new Administration Building Telephone/Data Rm 03-107. Refer to Section 28 16 00 for details.
   3. New KCSWD ESS as per this Section.

C. Provide all material, labor, equipment, design and services necessary to perform the complete installation of the Facility ESS.
   1. At existing Scalehouse provide disarm switch toggle key switch option at existing Bosh security panel, wire it to ESS for this system to disarm it.
   2. At new administration building provide Security Panel as per Section 28 16 00 - Intrusion Detection with key switch option. ESS to disarm it.
   3. Refer to Electronic Security System Equipment Schedule in this Section, Part 2, Paragraph 2.07.
   4. Contractor to coordinate among suppliers and installers to provide complete and functional Electronic Security System including interface with automated gate controllers, specifically North Truck Gate automatic vehicle identification (AVI). Refer to Section 32 31 13 - Fence and Automated Gates for automated gates and long RFID Specifications.

D. Equipment and materials shall be selected from the Materials and Equipment List in Division 28 or the current Facilities Building Standards for Division 28 Security Equipment and Material whichever is most recent.

E. The Facilities Management Division Security Unit's Systems Manager or their designee will provide all security system base System programming.

F. Device Specifications and requirements may be changed at any time by Project Representative. Contractor shall provide equipment and material current and specified at the time notice to proceed is given. Owner shall not accept any Contractor provided equipment no longer listed on the Facilities Building Standards at the time of notice to proceed for each separate work order. Contractor is responsible for reviewing and complying with the most current Facilities Building Standards and ensuring compliance for each work order prior to ordering equipment and materials or beginning work.

G. System design and operation principals shall adhere to design principles specified herein.

H. Access to the readers shall not be obstructed when manual presentation is required.

I. The installation of electric locking hardware shall not compromise the fire rating of a door or door frame.

1.02 ELECTRONIC ACCESS CONTROL

A. At card access door locations indicated; exterior doors shall be monitored from the access control system using a door position monitor or each operating door panel and shall be equipped with request to exit devices from the access control system shunting the door position switch on free exit.

B. Each card access controlled door unit shall be equipped with the following:
   1. Inbound and/or outbound card reader as specified.
   2. Door contact for each separate operable door panel.
   3. REX device for each operable single or dual panel door group.
   4. Electric strike or lock.

C. Locking hardware shall be appropriate for the application:
   1. Use of magnetic door locks (mag locks) pose significant security concerns. Mag locks shall be used only when other locking methods are not practical.

1.03 QUALITY ASSURANCE

A. Comply with the requirements of Section 01 09 05 – Reference Standards and as listed herein.

B. Provide the following quality assurances:
   1. Possess all applicable Contractors' licenses.
   2. Provide a complete working installation of all systems with all equipment called for in proper operating condition.
   3. Documents do not undertake to show or list every item to be provided. When an item not shown or listed is necessary for proper installation and operation of the equipment and systems; provide, install and test/certify the item at no increase in contract price.

4. This Specification contains a combination of prescriptive and performance requirements. The Contractor is responsible for fully implementing the functions described in the Specifications and shown on the Drawings. This will require the Contractor to perform work selecting system components, integrating system functions, and integrating the various security systems with each other and with equipment provided and installed by other Sections.
5. Electronic Security System and equipment shall conform to the referenced industry standards specified in each Section of Division 28, as applicable.
6. All equipment supplied shall be listed by a nationally recognized test laboratory where applicable.
7. All equipment and accessories shall be the product of a manufacturer regularly engaged in its manufacture.
8. All items of a given type shall be the products of the same manufacturer.
9. All items shall be of the latest technology. No discontinued models or near end of life products are acceptable.
10. The manufacturer, or their authorized representative, shall confirm that within 4 travel hours of the project site there is an agency approved by the Project Technical Representative which:
    a. Stocks a full compliment of parts.
    b. Offers service during normal working hours as well as emergency service on all equipment to be furnished.
    c. Will supply parts and service without delay and at reasonable cost.
11. Contractor shall be capable of performing service or maintenance work on these specified or accepted systems.
12. Contractor shall be factory-certified where such certification is available or required.

C. All equipment, systems, and materials furnished and installed under this section shall be installed in accordance with the applicable standards of:
    1. National codes: UBC, BOCA, SBCCI.
    2. Local Authorities Having Jurisdiction.
    3. Reference standards listed herein.

1.04 REFERENCE STANDARDS

A. ADA, Americans with Disabilities Act.

B. ASCII, American Standard Code for Information Interchange.

C. ASTM, American Society for Testing and Materials.

D. EIA, Electronic Industry Association.

E. IEEE C 2, National Electric Safety Code (NESC).

F. NEMA, National Electrical Manufacturers' Association.

G. NFPA, National Fire Protection Association.

H. NEC, National Electrical Code.

I. OSHA Standard 29 CFR 1910.268, Occupational Safety and Health Administration.

J. TIA/EIA 568B, Commercial Building Telecommunications Cabling Standard.

K. TIA/EIA 569A, Commercial Building Standard for Telecommunications Pathways and Spaces.

L. TIA/EIA 606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.

M. TIA/EIA 607, Commercial Building Grounding and Bonding.

N. UL, Underwriters Laboratories, Inc.

O. FM, Factory Mutual.

P. SIA, Security Industrial Association, ANSI/SIA Standard CP-01.

Q. WAC, Washington Administrative Code.

1.05 SYSTEM DESCRIPTION

A. Provide and install security electronics equipment.

1.06 SUBMITTALS

A. Submittal Procedures: See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. Approval Submittals:
   1. Product Data:
      a. Specification sheets (cut sheets) of all proposed equipment.
      b. Equipment list identifying:
         1) Model number of each unit.
         2) Quantities of each type of device.
      c. Specification compliance: A letter, responding to Specification sub-sections individually, indicating exceptions, substitutions, and alternates. The Contractor shall submit requests for substitutions (as well as all relevant technical data pertaining to the substituted equipment) per Section 01 60 00 - Product Requirements.
   2. Shop Drawings:
      a. Drawings: Shop Drawings to provide details of proposed system and the work to be provided. These include point-to-point Drawings of systems and wiring diagrams of individual devices.
   3. Permits: The Contractor shall be responsible for identifying requirements for permits from the local police department for the installation of the alarm system specified herein and shall assist the Project Representative in obtaining the relevant alarm permits.
   4. Samples.

C. Quality Assurance Submittals:
   1. Design Data.
   2. Test Reports.

D. Closeout Submittals:
   1. "As-built": Upon completion of installation, the Contractor shall prepare "as-built" Drawings of the system. These "As-builts" shall be Drawings of each floor plan indicating exact device locations, panel terminations, cable routes and wire numbers as tagged and color-coded on the cable tag.
      a. Additionally, final point-to-point wiring diagrams of each type of device shall be included in the "as-builts."
      b. "As-builts" shall be submitted to the Project Representative for approval prior to the system acceptance walk-through.
   2. O&M Manual Content: Provide O&M manual documentation as required by Section 01 73 00 – Operation and Maintenance Manuals.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with Section 01 60 00 - Product Requirements.

B. Ship equipment in original packages to prevent damage or entry of foreign matter. All handling shall be in accordance with manufacturers' recommendations. Provide protective covering during construction.

C. Replace, at no expense to Owner, equipment and material damaged during storage and installation as directed by the Project Representative.

D. Products delivered to the job site in racks and consoles shall be protected from dust, dirt, and foreign matter. All racks and consoles shall be protected from dents, bumps and scratching.

1.08 MAINTENANCE

A. System maintenance and repair of system or workmanship defects during the warranty period shall be provided by the Contractor free of charge (parts and labor).

B. Periodic testing of the system shall be carried out on a monthly or quarterly basis to ensure the integrity of the control panel, the sensing devices, and the telephone lines.

C. The Contractor shall correct any system defect within six (6) HRS of receipt of call from the Project Representative during the warranty period.

D. Extended service/maintenance agreements shall be offered by the Contractor for up to four years after the warranty expires. The agreement shall be renewable monthly, quarterly, or yearly.

1.09 COMMISSIONING

A. The Work of this Section shall include the Contractor’s labor and materials for participation in the Commissioning Activities (CX) as a Commissioning Team Member (CxT) as required by Section 01 95 00 - Commissioning Requirements.

1.10 WARRANTY

A. Defective items covered by warranty shall be corrected immediately. Warranty remains in effect until all defective items have been corrected.

B. Warranty repairs shall begin within twenty-four hours following notification that a repair is needed. As determined by the Project Representative, repairs involving minimum risk may be permitted to begin outside of this time period.

C. Before proceeding with any warranty-related testing, maintenance or repair, coordinate with the Project Representative notification of the testing or maintenance with the affected building occupants to prevent an unnecessary response.

1.11 COORDINATION

A. Coordinate equipment locations for all security devices with the work specified in other sections to ensure that security devices can be supported and installed as indicated.

B. Security Systems and Equipment Design Guidelines.

C. Security systems and equipment shall be designed so that it is capable of performing its intended functions under the following conditions:
   1. At 85 percent and at 110 percent of the nameplate primary (main) and secondary (standby) input voltage(s).
   2. At ambient temperatures of 0 DegC (32 DegF) and 49 DegC (120 DegF).
   3. At a relative humidity of 85 percent and an ambient temperature of (30 DegC) 86 DegF.

D. Equipment intended for use in damp, wet or exterior environments shall be listed for its use.

E. All Security Electronic System additions shall be compatible with and an extension of the existing King County Integrated Enterprise Security Control System. Communication connections from new panels to the existing Control System shall be provided using one of the following technologies:

F. Over the King County Security System Intranet (KCWAN).

G. Direct connection to King County Primary Server Security local Security LAN in the King County downtown buildings complex.

H. Whenever possible, one discrete zone, input, output, reader, etc., shall be dedicated to each device. If more than one device resides on a loop/zone, the area covered by all zoned devices, it shall not exceed the area that one person can maintain under surveillance from a single location by either CCTV observation or direct observation.

PART 2 – PRODUCTS

2.01 GENERAL

A. At the present time, the following is a list of currently approved systems, equipment and/or components to be used for this Contract; however, King County may review systems, equipment and components that the Contractor feels are equal to, or better than, the approved selected equipment; however, acceptance or rejection will be at the sole discretion of King County.
   1. Submit request for substitution in accordance with Specification Section 01 60 00 – Product Requirements.

2.02 SYSTEMS

A. Software:
   1. Tyco Inc. – Software House Cure.
   2. No substitutions permitted.

B. Hardware:
   1. Media Converters / Connectors:
      a. Allied Telesis AT-MC converters.
   2. Netgear HUB FS108 8 port.
   3. Netgear HUB FS524 24 port rack mount.
      a. Belkin Omniview16 port KVM.
   4. Network Patch Cord:
      a. Lcom RJ45-RJ45 Cat5e Black - TRD855BLK-xx.
      b. Lcom RJ45-RJ45 Cat5e Blue - TRD855-BL-xx.
   5. DB-9 Patch Cable:
      a. Lcom Dsub DB-9 CS2N9MM-xx.
   6. Controllers:
      a. Access Control – Software House:
         1) iStar Pro.
         2) iStar Edge.
         3) iStar Ex.
         4) DCM-2 RM4e door controller.
      b. Add on boards / cards - Software house:
         1) i-8 8 input card.
         2) r-8 8 output card.
   7. Power Supplies:
      a. Software House apS power supply - SWH controllers.
      b. Altronix Access Control 24vdc, FACP interface, PTC protection.
         1) Class 2 Rated PTC protected power limited outputs.

2) Provides power for Fail-Safe and/or Fail-Secure locking devices.
3) Fire Alarm Panel or Access Control System trigger inputs.
4) NO or NC supervised trigger input and/or polarity reversal trigger.
5) LED's to indicate condition of each power output.
6) Power & input trigger LED's.
7) Filtered and electronically regulated outputs.
8) Short circuit and thermal overload protection.
9) Built-in charger for sealed lead acid or gel type batteries.
10) Zero voltage drop upon transfer to battery backup.
11) Automatic switch over to stand-by battery when AC fails.
12) AC fail, low battery, and battery presence supervision.
13) AC input and DC output LED indicators.
14) Cam lock.
15) Will fit two (2) 12VDC/12AH batteries.

8. Readers / Transmitters:
   a. RP40 multiCLASS Wall_mount, Black.
   b. RP15 multiCLASS Mullion_mount Reader, Black.
9. Door Monitoring / Control:
   a. Bosch DS 150i Request to Exit Sensor.
   b. Sentrol wired Door Contacts.
   c. Ademco wired Door Contacts.
   d. Air Products and Controls MR101-MR201 UL Interface relay.
   e. Rutherford Controls 909 (S and F) remote door unlock switch.
   f. Alarm Controls TS-32 Emergency Door Release Button.

2.03 WIRE AND CABLE

A. Contractor shall provide all wire/cable for all devices as required and follow the manufacturers' recommendation for cabling. Wire and cable sizes, number of conductors, shielding, or other data listed in this specification or shown on Drawings are a guide to the correct product required to achieve a working system and represent minimum acceptable equipment.

B. Cables are to be shielded plenum rated and as shown on Drawings to preclude any outside noise or interference from entering the cable and degrading system performance.

C. When required a separate centrally located Access/Security/CCTV contiguous wire/cable riser shall be installed between all floors with dedicated terminal/routing cabinets on each floor. Conduits shall be of 2 IN DIA or greater. A maximum of 50 percent of riser rated wire fill capacity shall be used.

D. Data cable shall be Category 6. Category 6 cables shall be plenum rated.

E. The shield of the coaxial cable shall be braided, 100 percent copper material with an efficiency rating (ER) of 95 percent or better. Reverse foil over copper braid with a 100 percent ER shall also be acceptable. The dielectric shall have an impedance of 75Ω. The center core shall be 100 percent copper with an outer diameter that matches the inner diameter of the center tit of the BNC connector that is to be installed. In installations where the coaxial cable will flex (i.e.; pole to pole) a stranded center core shall be used. In installations where the coaxial cable will be fixed (i.e.; inside conduit), a solid center core shall be used. All connections shall be made with three piece, crimp BNC connectors only. The only acceptable connector shall be a three piece, crimp connector consisting of a separate center tit, jacket sleeve and main body that snaps onto the center tit and under the crimp sleeve and cable shield.

F. Mini coax may be used for interconnection between devices within the control cabinet or rack.

G. A splice intended to be soldered shall be joined mechanically before being soldered. Each splice and joint should be covered with insulation equivalent to that of the conductors or with not less than two layers of electrical tape. A splice located in an area of dampness shall be treated with a listed sealant or equivalently treated.

H. Electrical connections to device manufacturer's supplied leads shall be either:
   1. Soldered and heat shrink wrapped or;
   2. Crimped with a listed insulating crimp connector.

I. Unless specifically allowed by the manufacturers wiring Specifications, low voltage\electronic premises security system wiring shall be spaced at least 2 IN from conductors of any light and power circuits, unless one of the circuits is in metal raceway.

J. Conductors shall be connected to devices and to fittings so that tension is not transmitted to joints or terminals.

K. Wires and cables shall not be placed in such a manner as to prevent access to equipment.

L. Unless specific unique wiring instructions are provided by the manufacturer, wire or cable ends at the point of connection to a device shall have the outside protective sheathing removed so that the ends of the internal insulated conductors will extend at least 2 IN. The wires or cables shall be cut so that, including its stripped end, the wires or cables will extend at least 6 IN beyond the finished surface at the point of device installation.

M. The stripped portion of the conductor shall have the same number of conductors as the un-stripped portion. Unused portions of striped wire shall be wound back around the un-striped portion and secured with electrical tape.

N. Circuit identifications shall be within the control panel and enclosures used for wiring connections. Circuit identifications shall not be visible to the public.

O. Circuit identifications shall be at all field terminations.

P. Strain relief shall be provided for wiring leaving control panels and junction boxes not utilizing conduit.

Q. Unless specific unique wiring instructions are provided by the manufacturer or designer, there shall be a 6 IN service loop at control panels and enclosures used for wiring terminations. Service loops shall be mechanically protected.

R. Unless specific unique wiring instructions are provided by the manufacturer or designer, there shall be a 6 IN service loop at field terminations.

2.04 CONDUIT

A. Runs shall not contain more than 225 degrees of bends.

B. Runs shall not exceed 100 FT in length between junction boxes.

C. All conduits for the security communication are 1 IN minimum in diameter with no looping between outlets.

D. A bushing is required to be placed at each end of any conduit that is used for placing communications wiring. The Contractor will be required to insure these bushings are in place prior to pulling wire and not place them after the fact. If upon inspection it is noted that the bushings are not in place or it appears that the bushings were placed after the cable was pulled (split bushing), the Contractor will be directed to remove the wiring that was placed, destroy that wiring, and re-pull the wiring with the appropriate bushings in place.

2.05 FASTENERS

A. Manufacturers' recommendations for equipment mounting shall be used for equipment and device installation. In the absence of manufacturers' instructions, the following minimum requirements shall be used:

B. Wood fasteners shall penetrate a minimum of 2 IN into the surface.

C. In concrete lead anchors or expansion bolts with at least (60 LB) pull out strength.

D. In steel use bolts long enough to accommodate a lock-washer and nut.

2.06 POWER SUPPLIES

A. All power supplies shall be provided with normal dedicated AC power plus battery or UPS backup.

B. As a result of conditions, such as temperature, device inrush requirements, tolerances, environmental factors, and incremental system growth; power supplies shall be rated at 150 percent of calculated maximum quiescent load. The power supplies shall be sized to provide adequate power for simultaneous use of all associated devices, such as readers, RTE motion detectors, locks, controllers and so forth. Power calculations need not take into account simultaneous inrush current.

C. Under maximum quiescent load (system functioning in a non-alarm condition), the secondary power supply shall have sufficient capacity to operate a protected premises security system for a minimum of twenty-four hours and at the end of that period shall be capable of operating all alarm sounding, visual, access control and other devices for 15 minutes, under maximum alarm load. The secondary supply capacity required above shall include the load of all premises security related equipment, functions, or features which are not automatically disconnected upon transfer of operating power to the secondary supply.

D. When primary power is lost or incapable of providing the minimum voltage required for proper operation, the secondary supply shall automatically supply the energy to the system without loss of signals, or cause transmission of an alarm.

E. The secondary supply shall consist of one of the following:
   1. A storage battery dedicated to the premises security system arranged in accordance with 3c.
   2. A dedicated branch circuit of an automatic starting engine driven generator arranged in accordance with 3c. and storage batteries dedicated to the premises security system with 15 minutes full system backup capacity.

F. Operation of secondary power shall not affect the required performance of an electronic premises security system. The system shall produce the same alarm and trouble signals and indications (excluding the ac power indicator) when operating from the standby power source as are produced when the unit is operating from the primary power source.

G. Where a UPS is employed in a positive means for disconnecting the input and output of the UPS system while maintaining continuity of the power supply to the load shall be provided.

H. Supervision means appropriate for the batteries and charger employed shall be provided to detect a failure of battery charging and initiate a trouble signal.

2.07 ELECTRONIC SECURITY SYSTEM EQUIPMENT SCHEDULE

A. Per Card Reader Location:

# CR	Room / Door	Part #	Equipment Description	Controller / Reader / input #
	Admin Bld	STAR016W-64A	iStar Controller 16 door 1 GCM, 2 ACM (Requires 100Mb Ethernet connection to KC Wan Port)	iStar #1 10.1.55.2
	Ground Level	AS0063-00	Power Supply apS with battery, 120 VAC	
	03-107 Telephone Data Room Head end	AL1024ULACMCB	Power Supply Altronix 24vdc power supply w/ FA interface 10amp 8 PTC Outputs	
		FS108	Network Netgear 8 port Hub	KC WAN Port - FMD Security Vlan
		AS0074-000	R8x2 output module, Link hardwire Disarm ckt to Bosch Panel input	
			Link hardwire Door Alarm for each door alarm to Bosch Panel input	
		RM-CAN	Small metal enclosure with tamper switch	
		1076CW	GE Magnetic Door Contact Switch	
	03-107 Telephone Data Room	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
1	**Door 03-009**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		N / A	24vdc Locks	
	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
2	**03-109 Mechanical Room, West Entry**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-012	N / A	24vdc Locks	
	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
3	**03-109 West Hall Entry**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-013	N / A	24vdc Locks	
	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
4	**03-110A Electrical Room West Ext. Entry**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-014	N / A	24vdc Locks	
	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
5	**03-110B Electrical Room Hall Entry**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-015	N / A	24vdc Locks	
	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
6	**03-100 Lobby room**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-001	N / A	24vdc Locks	

	Admin Bld	1076CW	GE Magnetic Door Contact Switch	
	Ground Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
7	**03-104 North Vestibule**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
	Door 03-006	N / A	24vdc Locks	
	Transfer Building	1076CW	GE Magnetic Door Contact Switch	
	Lower Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
	02-008 Break Room	RM-DCM-2	SoftwareHouse w/Rm4e Personality Module +can	
8	**Door 02-019**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		N / A	24vdc Locks	
	Transfer Building	1076CW	GE Magnetic Door Contact Switch	
	Lower Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
	02-013 Employee Area Room	RM-DCM-2	SoftwareHouse w/Rm4e Personality Module +can	
9	**Door 02-021**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		N / A	24vdc Locks	
	Transfer Building	1076CW	GE Magnetic Door Contact Switch	
	Lower Level	DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
	02-007 Man door to Maint. Area	RM-DCM-2	SoftwareHouse w/Rm4e Personality Module +can	
10	**Door 02-018**	6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		N / A	24vdc Locks	

# CR	Room / Door	Part #	Equipment Description	Controller / Reader / input #
	Main Gate	N / A	Gate position contact switch dry contact.	
		N / A	Gate Rex loop sense aux contact.	
		RM-DCM-2	SoftwareHouse w/Rm4e Personality Module +can	
		N / A	NEMA 4X Enclosure.	
11		6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		VE-GNP-SS	Gooseneck	
		VE-5X5-PNL-SS	Backbox	
		N / A	Gate control dry contact input.	
	Scale house	RM-DCM-2	SoftwareHouse w/Rm4e Personality Module + can	
		eFlow4N	Power Supply Altronix 24vdc power supply w/ FA interface 4amp 8 Outputs	
	Scale House Door	1076CW	GE Magnetic Door Contact Switch	
		DS 150i	Reader DS 150i REX PIR Access Control 12-24v	
12		6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		*	Hardwire to Bosch input for disarm Ckt to input #2 RM4e-Scalehouse	
		N / A	24vdc Locks	
	North Truck Gate	N / A	Gate position contact switch dry contact.	
		N / A	Gate Rex loop sense aux contact.	
		RM-DCM-2	SoftwareHouse w/Rm4e Personality Module +can	
		N / A	NEMA 4X Enclosure.	
13		6125CKD0000	Reader RP40 MultiClass Wall Switch Reader	
		VE-GNP-SS	Gooseneck	
		VE-5X5-PNL-SS	Back Box	
		N/A	RFID Weigand Reader.	

B. Electronic Security System Wiring Schedule.

Signal	From	To	Belden #	Gauge	# Prs	Shielded	Max Length
Comm	iSTAR	RM-4	9841[a]	24	1	Yes	4000 ft. (1219 m.)
Power	iSTAR	RM-4	8442 8461	22/18	1	No	Limited by voltage drop
RTE	RM-4E	Switch	8442 8461	22/18	1	No	2000 ft. (610 m.)
DSM	RM-4E	Contact	8442 8461	22/18	1	No	2000 ft. (610 m.)
Reader data	RM-4E	Wiegand Read Head	9942 9260 Alpha wire 5386C	22 20 18	3	Yes	200 ft. (61 m.) 300 ft. (91 m.) 500 ft. (152 m.)

a. For plenum or underground applications, use Manhattan M63995 or 2 pair only, 150 ohm, 8.8 pf/ft or Belden 89182 for 1 pair 22 AWG, 100 ohm 12.95 pf/ft. Control and supervised input cables must be shielded for FCC Class B operation.

C. Electronic Security System Wiring Type and Length:
   1. R/8, RM readers and I/8 Modules wiring requirements:
      a. Data line to iStar – twisted pair, shielded 24 AWG Belden #9841. Maximum distance is 4000 FT.
      b. Power line to iStar – twisted pair, 18 AWG, Belden # 8461 or 22 AWG Belden # 8422.
      c. RS 485 communication requires low capacitance cable.
      d. Use shielded twisted pair cable for input and output circuits that extend from the unit. Ground the shield at one end only, usually the circuit end.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Systems shall be complete and operational in all respects.

B. Building ESS Contractor shall coordinate conduit usage with Electrical Contractor. All wiring shall be in conduit unless shown otherwise on the Drawings.

C. Installation personnel shall be supervised by persons who are certified, qualified and experienced in the installation, inspection, and testing of premises security systems.

D. Furnish and install all wiring and components recommended by submitted system manufacturers for optimum system performance at no additional cost to the Owner.

E. Connect low voltage power to ESS as required. Coordinate as required all 120 Vac connections with electrical contractor.

F. Circuit disconnecting means shall have a blue marking, shall be accessible only to authorized personnel, and shall be identified as “PREMISES SECURITY CIRCUIT.”

G. The location of the circuit disconnecting shall be permanently identified at the building's security control unit.

H. All security equipment, junction boxes, terminal cans, etc. shall be installed utilizing tamper proof mounting hardware. Provide a minimum of 2 driver bits or hand tools for each type of security fastener provided.

I. Furnish and install all additional security system components required to complete the installation as designed to match existing installation including, but not limited to, termination enclosures, terminal blocks, control relays, etc.

J. Provide any additional, console components and raceway systems to support all equipment installed as part of the work.

K. All equipment and wiring within racks, terminal cabinets, consoles, etc., shall be neatly wired and clearly identified as to type of equipment and system. Label identically each end of each cable, including splice points. Note locations of any splices on as-built Drawings.

L. Head end equipment shall be rack mounted.

M. Separate equipment rack space in a secure MDF, IDF, or Security Electronics room shall be provided for all Security/Access Control/CCTV/ Intercom head end and interface equipment.

N. Security Head end equipment shall located in a room cooled to a minimum of 68 and a maximum of 72 DegF. The room must be on separate HVAC zone or drop with thermostat control and not included with heating/cooling of adjacent rooms.

O. Security Head end equipment room shall not be a pass through for any other room, used for pipe chase, clean outs, or any other object which reduces the useable interior dimension of the room and used for roof or crawlspace access hatches.

P. Each rack enclosure will be provided with a UPS rated at 150 percent of calculated equipment load. If room space is shared or common with other functional areas racks shall be fully enclosed and lockable.

Q. Control units, sub-controls and devices that are used to interconnect control units to protection devices shall be located within the area being protected by the system. If the enclosures for such equipment are not located in such an area shall be protected by one of the following methods:
   1. That is continuously under the notice of assigned personnel.
   2. Located in an area that is only accessible to authorized personnel.
   3. Supervised to annunciate tampering.

R. Wall mounted equipment such as controller panels, enclosures, and power supplies shall not be located above ceilings or in difficult to access locations. Wall mounted equipment shall be mounted on finished 3/4 IN fire retardant plywood backboards installed vertically with fire brand showing. Equipment shall be mounted between 2 and 7 FT above the finished floor.

S. Install all 3/4 IN fire retardant plywood backboards vertically with fire brand showing. Locate and mount all equipment racks, wire management, terminating hardware (copper, coax and fiber), ladder rack (including waterfalls), grounding of the ladder racks and frame and all labeling. This applies to all MDFs, IDFs, and Security Electronics Control rooms in the building.

T. Initiating devices shall be located in such a manner to prevent unintentional operation by employees and others with access to the equipment. Fixed in place duress alarm initiating devices shall be installed within four (4) FT of the workstation and accessible from their normal work position to the individuals responsible for utilizing the device. Holdup alarm initiating devices shall be mounted at a height that is accessible from their normal work position. Duress alarm initiating device shall be located so that it cannot be observed by the public.

U. When manual presentation of access credentials is required for a vehicle, the reader shall be readily accessible from the operator's position of vehicles common to the site.

3.02 AS-BUILT DRAWINGS, COMPUTER SOFTWARE AND ACCESS CODES

A. Maintain a complete set of contract drawings of the work order. As work is installed, carefully draw on prints, in colored pencil, correct location of work including depth of underground runs, if any, with dimensions from permanent walls, walks, etc. Wiring diagrams and details shall be included. Transfer this as-built information to reproducible drawings and updated CAD disks in AutoCAD format.

B. Provide all software and current files, printed ladder-logic files and access codes for all programmable equipment.

C. Submit the above to the Project Representative prior to final acceptance of the project by the Owner.

3.03 TRAINING OF OWNER'S PERSONNEL

A. On-site training classes in the proper use and maintenance of all Division 28 equipment, shall be conducted at dates and times requested by the Project Representative.

3.04 PROGRAMMING

A. The Contractor has no responsibility for base programming. All programming will be provided by the Project Representative or their designee. The Contractor shall assist and help coordinate any programming questions asked by the Project Representative.

3.05 COMMISSIONING, ACCEPTANCE TESTING AND REPORTS

A. Provide two separate, distinct types of tests, as follows:
   1. Pre-Functional Performance Test which ensures that all equipment, wiring, and systems are installed in accordance with the Specifications, Drawings and manufacturers' requirements.
   2. Functional Performance Test which ensures that all equipment and systems operate in accordance with design intent. These are dynamic tests which test the systems through all possible modes of operation.

B. Provide a written testing plan in compliance with NFPA standard 730 / 731 and the Owner's testing standards describing proposed duration and schedule for performing pre-functional performance test and functional performance test in spreadsheet format listing each and every device, cable/wire and software point to be tested.

C. Perform systems tests using personnel who have attended a manufacturer's training school for installation and testing of the systems as described above.

D. Upon completion of the installation of all Division 28 security systems and equipment, perform 100 percent testing and submit pre-functional reports, including but not limited to the following information in spreadsheet format:
   1. A complete list of all equipment installed, including serial numbers of major components.
   2. Certification that all equipment is properly installed and functional and conforms to the Specifications and Drawings.
   3. Test reports of all inputs and outputs, devices and equipment.

4. Test technician's name, company and dates of test.

E. Following review and approval of the test report by the Project Representative perform a functional test of all Division 28 equipment in the presence of the Project Representative. Test shall include performance tests of each device, switch, control unit, monitor panel, controller and all other Division 28 equipment and materials.

F. At a minimum, perform tests to demonstrate that:
   1. All systems are free from grounding and open circuits.
   2. Each alarm-initiating device consistently functions as specified and produces the specified alarm actions.
   3. An abnormal condition of any circuit or device required to be electrically supervised will result in activating the specified trouble or tamper alarm signal.
   4. Systems operate properly during and while on emergency generator power.
   5. Alarm signals are audibly and visually indicated at the monitor.
   6. The system is operable under specified trouble conditions.
   7. All software functions properly as specified, and all equipment is fully programmed.

END OF SECTION