Jefferson County Department of Public Works

Port Hadlock UGA Sewer System/
Water Reclamation Facility and
Influent Pipeline

Technical Specifications

Volume 3 - Divisions 26 - 33

December 2013
PORT HADLOCK UGA SEWER SYSTEM / WATER RECLAMATION
FACILITY AND INFLUENT PIPELINE DESIGN

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SECTION 260500 – COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Scope

1. This Section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other sections, but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations.

2. The Contractor shall examine all Drawings and Specifications to determine actual locations, sizes, materials, and ratings of all equipment provided by others.

3. Items of Work shown on drawings and not specified, or mentioned in the specifications and not shown on the drawings, shall be considered required as if they had been both specified and show on the Drawings. In the event of conflicting specified or drafted requirements the more stringent requirement shall govern. Any work or material omitted from the description of the work but which is clearly implied shall be furnished by the Contractor as though specifically stated. The Drawings and Specifications contemplate a finished piece of Work of such character and quality as described in and reasonably inferred from them, and fitting with the Work of other Contractors and the Owner. The Contractor agrees that the failure to show details or repeat on any drawings the figures or notes given on another shall not be cause for additional charges or claims.

4. When record drawings are provided with the contract drawing set, they constitute the best available information pertaining to the relevant systems at the time of design. Their accuracy is specifically not guaranteed and they are provided only for the Contractor’s convenience. It is the Contractor’s responsibility to field-verify these record drawings prior to use. Actual field conditions are specifically and entirely the responsibility of the Contractor. Deviation of the record drawings provided from actual field conditions shall not constitute a basis for any increase in time allowed for completion or compensation for the Contractor.

5. The Contractor shall notify the Engineer in writing of perceived discrepancies, errors, or omissions in the Contract Documents prior to bid. The Engineer shall provide clarification to resolve these issues prior to bid. The Contractor shall resolve their questions regarding the perceived inconsistency, errors, or omissions in the Contract Documents prior to bid. Failure of the contractor to resolve his questions prior to bid shall result in the residual issues of the aforementioned kind providing no basis of claim for an increase in compensation for the Work or the time allowed for the completion of the contract and the Engineer’s interpretation shall govern.

B. Definitions

1. Provide: Furnish and install complete and ready to use for its intended purpose.

2. Contractor: The party who furnishes and installs all tools, materials, and equipment to complete the work shown and implied in the drawings and these Specifications. This
includes the Prime Contractor, the Electrical Contractor, Control System Integrator, and all other Contractors and Subcontractors.

3. Control System Integrator / System Integrator / Integrator: The party that furnishes all control components and designs, the detailed control wiring diagrams, and layout and assembly of the custom control panels. See Division 40.

4. Control System: All equipment, instruments, and wiring for control and monitoring of all operating equipment. This shall also include custom control panels, packaged control panels, and control equipment furnished with other systems and mechanical equipment. All sensing, transmitting, indicating, control and recording of all functions as specified and shown shall also be included in the control system.

5. Elementary or Schematic or Control Diagram: Shows, by means of graphic symbols, the electrical connections and functions of a specific circuit arrangement. The schematic diagram shows all circuit functions without regard to the actual physical size, shape, or location of the component devices or parts.

6. Single-Line Diagram / One-Line Diagram: Shows, by means of lines and graphical symbols, the course of the electrical distribution system and the components, devices, or parts used therein.

7. Wiring Diagram or Connection Schematic: Includes all of the devices in a system and shows their physical relationship to each other, including terminals and interconnecting wiring in assembly. This diagram shall be (a) in a form showing interconnecting wiring only by terminal designation (wireless diagram), or (b) a panel layout diagram showing the physical location of devices plus the elementary diagram.

8. Interconnection Diagram: Shows all external connections between terminals of equipment and outside points, such as motors and auxiliary devices. References shall be shown to all connection diagrams that interface to the interconnection diagrams. Interconnection diagrams shall be of the continuous line type. Bundled wires shall be shown as a single line with the direction of entry / exit of the individual wires clearly shown. Each wire identification as actually installed shall be shown. The wire identification for each end of the same wire shall be identical. All devices and equipment shall be identified. Terminal blocks shall be shown as actually installed and identified in the equipment complete with individual terminal identification. All jumpers, shielding and grounding termination details not shown on the equipment connection diagrams shall be shown on the interconnection diagrams. Wires or jumpers shown on the equipment connection diagrams shall not be shown again on the interconnection diagram. Signal and DC circuit polarities and wire pairs shall be shown. Spare wires and cables shall be shown.

9. Arrangement, Layout, or Outline Drawings: Shows the physical space and mounting requirements of a piece of equipment. Diagrams may also indicate ventilation requirements and space provided for connections or the location to which connections are to be made.

1.2 GENERAL DESCRIPTION OF WORK

A. The Contractor shall provide all labor, material, tools, equipment and services required to complete the furnishing, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical equipment, devices and components as indicated and implied by the plans and these Specifications. General descriptions include:

1. Complete the procurement, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical devices, components, accessories and equipment
that is not shown or specified but which is nonetheless required to make the systems shown and specified function properly.

2. Complete the wiring to, connection to, adjustment and calibration of, and testing of furnished electrical components.

3. Install all equipment so it shall be readily accessible for maintenance. Installations shall have electrical clearances in accordance with NEC and shall be installed in locations that will provide adequate cooling.

4. Check electrical equipment prior to installation so that defective equipment is not installed. Acceptance testing for electrical equipment shall be performed as discussed in Section 260800.

5. Provide field services of qualified technicians to supervise and check out the installation of the equipment, to supervise and check out interconnecting wiring, to conduct start-up of operation of the equipment, and to correct any problems that occur during start-up.

6. Provide circuit breakers, conduit, wire and installation for all items that require electrical power.

7. The Contractor shall provide all permits, licenses, approvals and other arrangements for work on this project and all fees shall be paid for by the Contractor. The Contractor shall include these fees in the bid price.

1.3 PROJECT DESCRIPTION

A. General

1. In general, the project shall consist of all electrical, control, and telemetry construction required to make a complete and operating system. The following is a description of the work anticipated by the Electrical Contractor. The Electrical Contractor shall coordinate with the Control System Integrator during bid to establish exact division of responsibility.

B. Overview

1. Provide electrical and control systems to support construction of a 0.5mgd wastewater reclamation facility.

2. The facility consists of an influent gravity sewer, influent pump station, two membrane bio-reactor treatment trains, a treatment equipment building, an Administration Building, effluent percolation pond and associated site development which is an old gravel quarry.

3. The electrical room within the treatment building will house all of the main electrical equipment. This includes the utility metering compartment, service entrance disconnect, automatic transfer switch, distribution switchboard, panelboards for local 480Y/277, 208Y/120 and 240 volt loads, active harmonic filter and motor control center. Additionally the room will house the main SCADA (supervisory control and data acquisition) control panel, MBR control panels, and ultraviolet light control panels. The administration building, and influent pump station will be supplied by a 480-volt, 3-phase, 4-wire feeder originating in the treatment building. The administration building will also be provided with a step-down transformer to provide the required 208Y/120-volt AC power for the building.
1.4 TEMPORARY OPERATION AND CONSTRUCTION POWER

A. The Contractor shall provide a separately metered temporary power service for construction power. The temporary service shall provide:

1. Power for operation of all equipment during testing
2. Power for operation of all equipment including lighting and HVAC equipment until certificate of occupancy is obtained

B. All coordination with the utility and associated construction costs for temporary construction power shall be paid for by the Contractor. The Contractor shall pay the for the energy costs as billed by the utility on the construction power meter.

1.5 THERMAL (TEMPERATURE) RATINGS OF EQUIPMENT TERMINATIONS

A. All materials shall conform to the National Electrical Code Article 110-14C. Wiring and circuit breakers on this project are designed for 75°C operation above 100 amperes; 60°C for 100 amperes and below. All products furnished on this project shall have electrical terminations rated for 60°C for amperages of 100 amperes and below, and rated for 75°C for amperages above 100 amperes.

B. These requirements cover all electrical equipment provided under this Contract.

1.6 STANDARDS AND CODES

A. References: This section contains references to the following documents. They are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. National Electrical Code (NEC)
2. Underwriters' Laboratories, Inc. (UL)
3. National Electrical Manufacturers Association (NEMA)
4. Canadian Standards Association (CSA)
5. Electrical Testing Laboratories (ETL)
6. International Electrical Testing Association (NETA)
7. National Electrical Contractors Association (NECA)
8. Factory Mutual (FM)
9. NFPA 820 – Standards for Fire Protection in Wastewater Treatment and Collection Facilities
10. Washington State Administrative Code (WAC)

B. Identification of Listed Products

1. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.
2. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of
Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

3. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.7 SITE FAMILIARIZATION

A. The Contractor shall become familiar with all features of the site which may affect the execution of the work prior to submitting a bid. The Contractor shall take all field measurements necessary for the work and shall assume full responsibility for their accuracy. The Contractor shall take full responsibility for locating and avoiding all substructures and utilities. Any damage to existing equipment or utilities shall be repaired or replaced by the Contractor at the Contractor's expense.

1.8 AREA CLASSIFICATIONS

A. The following classification of areas shall be used as a reference in determining application of material covered by this Section unless specifically shown otherwise on the drawings. Areas that fall under two or more of the following classifications shall conform to the minimum requirements of all of the area classifications listed for that area.

1. Outdoor and Damp Areas: Vaults, all outdoor areas
   a. Raceways shall be galvanized rigid steel (GRS), or aluminum. Conduit entrances shall be threaded and fittings shall have gasketed covers. Threaded fastening hardware and rods shall be stainless steel. Raceway supports such as channel, clamps, and brackets shall be stainless steel or aluminum. Panels, boxes, and enclosures shall be NEMA 4X - aluminum, stainless steel or FRP (or as shown on the drawings). Enclosures shall be mounted 1 inch from walls to provide an air space unless specifically shown otherwise. Device boxes shall be cast, copper free aluminum.

2. Hazardous Locations:
   a. Class I / Div I, Group D
      1) Raceways to be GRS or aluminum.
      2) Explosion-proof boxes.
      3) Electrical equipment to include UL listing for hazard classification.
      4) Conduit Seals for all raceways entering hazardous area.
      5) Intrinsically safe wiring methods.
   b. Class I / Div 2, Group D
      1) Raceways to be GRS or aluminum.
      2) Explosion-proof boxes.
      3) Electrical equipment to include UL listing for hazard classification.
4) Conduit Seals for all raceways entering hazardous area.
5) Intrinsically safe wiring methods.

3. Corrosive Areas:
   a. Includes defined classified areas within the Headworks, Membrane Tanks, and Influent Pump Station. Also includes non-classified area of Treatment Facility within WAS Pump Room 103.
   b. PVC-coated GRS raceway, couplings, condulets, and boxes.
   c. Enclosures, hardware and fasteners to be marine-grade 316SS.
   d. NEMA 4X minimum.
   e. Devices to be identified for marine-duty use, or as otherwise required for area hazard classification.

4. Below Grade Areas:
   a. Conduits shall be Schedule 80 PVC, or concrete encased Schedule 40 PVC, as indicated on the drawings.

5. General Purpose Areas: All other areas not described above
   a. Raceways shall be GRS. Raceways concealed in walls or ceilings for general purpose lighting and receptacle circuits may be EMT. Exposed boxes and enclosures shall be NEMA 12. Concealed boxes and enclosures may be NEMA 1. Boxes poured in concrete shall be cast copper free aluminum.

1.9 ELECTRICAL SUBMITTALS

A. Electrical submittals shall be submitted, bound in a three-ring binder, labeled with the project name and Contractor's name, and Project Manager’s name. An index sheet shall be provided showing each product being submitted. Submittals shall be provided with section tabs per the electrical specifications by section and paragraph or equipment. Each equipment submittal sheet shall be labeled with the individual equipment name and number.

B. Submittals shall include:
   1. Manufacturer’s name, address, and telephone number
   2. Trade name, catalog model or number, nameplate data and size
   3. Layout dimensions, capacity, project specification and paragraph reference
   4. Local manufacturers representative (if applicable) name, address and telephone number

C. Submittals shall be largely complete prior to the first submittal. Long lead items may be submitted separately. Each item shall be clearly marked and provided with adequate sales and technical information to clearly show conformance with all aspects of the specification. Packages not provided as described above or largely incomplete shall be returned to the Contractor, without review or comment.

D. The Contractor shall ensure that the material being proposed conforms to the Contract requirements. In the event of any variance, the Contractor shall state specifically which portions vary and shall request a variance in writing.
E. The Contractor shall certify that all furnished equipment can be installed in the spaces allocated by stating on each item:

1. “This equipment can be installed in the spaces allocated.”

F. The Contractor shall provide shop drawings on 11” x 17” sheets (maximum), and shall be scaled using standard engineering or architectural scales. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment.

G. Failure to submit a specified item does not relieve the Contractor from meeting the requirements of the Specification.

H. The Engineer will review the original submittal and one re-submittal on each item. Subsequent submittal reviews shall be conducted at the Contractor's expense. The Contractor shall be billed at the Engineer's current hourly rates for these subsequent submittal reviews.

1.10 PROJECT RECORD DRAWINGS

A. The contractor shall maintain one set of record drawings at the job showing any deviations in the electrical systems from the original design.

B. Markings shown on the drawings shall conform with the following color coding (marked with pencil):

1. Red - Additions, changes in routing, etc., showing placement different than shown on the original drawings
2. Green - Deletions, modifications in routings etc., deleting lines depicting placements different than shown on the original drawing
3. Black - Dimensional data showing exact placement of concealed or buried equipment, raceways, etc.

1.11 CORRECTION OF WORK

A. All work, all materials, whether incorporated in the work or not, all processes of manufacture, and all methods of construction shall be at all times and places subject to the inspection of the Engineer, who shall be the final judge of the quality and suitability of the work, materials, processes of manufacture, and methods of construction for the purposes for which they are used. Should they fail to meet his approval they shall be forthwith reconstructed, made good, replaced, and/or corrected, as the case may be, by the Contractor at his own expense. Rejected material shall immediately be removed from the site. If, in the opinion of the Engineer, it is undesirable to replace any defective or damaged materials or to reconstruct or correct any portion of the work injured or not performed in accordance with the Contract Documents, the compensation to be paid to the Contractor hereunder shall be reduced by such amount as in the judgment of the Engineer shall be equitable.
1.12 GUARANTEE

A. The Contractor shall guarantee all work and all components thereof, excluding lamps, for a period of 1 year from date of acceptance of the installation. The Contractor shall remedy any defects in workmanship and repair or replace any faulty equipment which shall appear within the guarantee period without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. General

1. Equipment and materials shall be new and free from defects. All material and equipment of the same or a similar type shall be of the same manufacturer throughout the work. Standard production materials shall be used wherever possible.

B. Equipment Finish

1. Unless otherwise specified, electrical equipment and materials shall be painted by the manufacturer.

C. Galvanizing

1. Where specified, galvanizing shall be in hot dipped.

2.2 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall prepare and assemble detailed operation and maintenance (O&M) manuals in accordance with the project general requirements and other requirements in other specification sections. The manuals shall be bound in a 3 ring binder and tabbed with an index. The O&M manual format shall follow the submittal data specified in Section 260500. The manuals shall include, but not be limited to, the following:

1. Catalog data and complete parts list for all equipment and devices
2. All cut sheets of equipment and components
3. Preventative maintenance procedures
4. Trouble-shooting
5. Calibration
6. Testing
7. Replacement of components
8. Automatic mode operation
9. Manual mode operation
10. System schematics / shop drawings and record drawing.
11. As-built wiring diagrams of cabinet and enclosure contained assemblies
12. As-built wiring diagrams of overall system
13. Listing of recommended spare parts
14. Listing of recommended maintenance tools and equipment
PART 3 - EXECUTION

3.1 GENERAL

A. Delivery and handling

1. Equipment, devices, components, and other electrical products and materials shall be delivered to site in Manufacturer’s point of origin packing materials.
2. Inspect all materials at time of receipt to ensure materials are undamaged due to shipping or handling.

B. Storage and Installation Environment

1. The Contractor shall store all electrical equipment in a dry environment free from dust, moisture, sprays or vapors which may be detrimental to their new condition. After installation of equipment, the Contractor shall take care to protect all equipment from all dust, moisture, paint and other spray, harmful vapors.
2. Equipment shall not be installed in indoor areas until the area is covered, dry and finished to the point that other work will not create dust, vapors, or moisture. Equipment with integral heaters and fans shall not be installed until power is available at the location, and the heater and fan shall be energized within 6 hours of the equipment being installed.

C. Housekeeping

1. The premises shall be kept free of accumulated materials, rubbish and debris at all times. Surplus material, tools and equipment must not be stored at the job site. Upon completion of the project, all equipment and fixtures shall be cleaned and in proper condition for their intended use.
2. Lamps and fluorescent tubes shall be cleaned and defective units replaced at the time of final acceptance.

3.2 TESTS

A. The Contractor shall conduct testing for installed feeder cables and motors in accordance with Sections 260519. Transformers shall be in accordance with Section 262200.

B. Functional testing shall be performed in accordance with the requirements of Section 260800. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energization of equipment, the Contractor shall perform a functional checkout of the control circuit. Checkout shall consist of energizing each control circuit and operating each control, alarm or malfunction device and each interlock in turn to verify that the specified action occurs. The Contractor shall submit a description of the proposed functional test procedures prior to the performance of the functional checkout.

C. The Contractor shall verify motors are connected to rotate in the correct direction. Verification may be accomplished by momentarily energizing the motor, provided the Contractor confirms that neither the motor nor the driven equipment will be damaged by reverse operation.
3.3 FINAL ACCEPTANCE

A. Prior to final acceptance, the Engineer will perform one or more site observation trips to develop a “punch list” of items deemed incomplete. The Electrical Contractor and Control System Integrator shall be present while these inspections are taking place and shall be available for opening cabinets and operating and adjusting the system as is necessary for the Engineer to verify all equipment is installed and operates to the requirements of the contract documents.

B. The Contractor shall complete all items of work, including wire markers, nameplates, final tests and final test reports prior to requesting final acceptance inspections. All equipment shall be checked for proper operation and all signals verified for correct calibration and wiring. Fixtures shall have been cleaned, and burned out or defective lamps shall have been replaced.

3.4 TRAINING

A. The Contractor shall provide training in accordance with the specific requirements in other sections of these Specifications. In addition to training required in other Sections of the Specifications, the Contractor shall conduct specifically organized training sessions in the overall operation and maintenance of the electrical system for personnel employed by the Owner. The training sessions shall be conducted to educate and train the personnel in operation and maintenance of all components of the electrical system outside the training requirements in the other sections of these Specifications. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components
6. Equipment operation

B. At least two training sessions, each at least four (4) hours in duration, shall be conducted at the facility after start-up of the system. The Contractor shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the Owner at least one (1) week prior to the time of the training.

END OF SECTION 260500
SECTION 260519 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies conductors and cables rated to 600 volts used for power, lighting, receptacle, signal, and control circuits.

1.2 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS

A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. With the exception of lighting, communication, paging, security and receptacle circuits, the type, size and number of conductors shall be as specified on the drawings or schedules. Lighting and receptacle circuit conductors are unscheduled and shall be sized by the Contractor in accordance with the NEC to limit voltage drop to 3 percent. Number and types of communication, paging, and security cables shall be as required for the particular equipment provided.
2.2 LIGHTING AND RECEPTACLE BRANCH CIRCUIT CONDUCTORS

A. Lighting conductors shall be stranded except for 12 AWG which shall be solid. Minimum conductor size shall be 12 AWG.

B. Conductors shall be provided with the following characteristics:

   1. Voltage: 600 volts
   2. Conductor: Bare soft annealed copper, Class B stranded per ASTM-8; solid per ASTM B-3
   3. Insulation: THWN/THHN, 90 degree C dry, 75 degree C wet polyvinylchloride (PVC)
   4. Jacket: Nylon
   5. Flame resistance: UL 83
   6. Manufacturer: Okonite; Southwire; or equal

2.3 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

A. Single Conductor:

   1. Single conductor cable shall be stranded and shall be used in conduits for power and control circuits.
   2. Conductor shall be provided with the following characteristics:

      a. Voltage: 600 volts
      b. Conductor: Uncoated, soft annealed copper, Class B stranded per ASTM B-8
      c. Insulation: Power: THHN/THWN, 90 degrees C continuous rating, wet or dry (as specified)
      d. Control: THHN/THWN, 90m degrees C continuous rating, wet or dry
      e. Flame resistance: UL 83
      f. Manufacturer: Okonite, Southwire; Anaconda; or equal

B. Multiconductor Cable:

   1. Multiconductor cable shall be used for power and control circuits routed in cable tray. Cables shall be UL labeled, Type TC, designed for cable tray installation in accordance with NEC 340. The type of insulation, number of conductors, and size of conductor shall be as specified.
   2. Power Cable: Multiconductor power cable shall contain three or four conductors, as specified, plus an equipment grounding conductor.

      a. Conductors shall be provided with the following characteristics:

         1) Voltage: 600 volts
         2) Conductors: Annealed copper, stranded, per ASTM B8
         3) Insulation: RHH/ RHW or THHN/THWN, 90 degrees C dry, 75 degrees C wet, (PVC) with a nylon jacket, ICRA S-61-402 (as specified)
         4) Jacket: Polyvinylchloride (PVC)
         5) Flame resistance: UL 1277
         6) Manufacturer: Okonite, Okoseal-N; or equal
b. Variable Frequency Drive Cable:
   1) 600-volt rated minimum with helical symmetrical design within an overall jacket and specifically designed for VFD motor service.
   2) Approved for Tray Cable (TC) application
   3) Conductors: Tinned copper, stranded, per ASTM B8
   4) Insulation: XLPE, 90 degrees C dry, 90 degrees C wet.
   5) Shield: 2 overlapped copper tape shields helically-wound with 100% coverage.
   6) Ground: three symmetrical bare copper ground conductors
   7) Over-Jacket: Polyvinylchloride (PVC)
   8) Flame resistance: IEEE 383, 210, 000 Btu/hr.
   9) Manufacturer: Belden Classic Symmetrical VFD Cable, or Approved Equal.

c. Control Cable: Unless otherwise specified multi conductor control cables shall be 14 AWG.
   1) Voltage 600 volts
   2) Conductors: Annealed copper, stranded, per ASTM B8
   3) Insulation: THHN/THWN, 90 degrees C dry, 75 degrees C wet, cross-linked polyethylene (XLP), (CSPE) per ICEA S-66-524
   4) Jacket: Polyvinylchloride (PVC)
   5) Flame resistance: IEEE 383, 210, 000 Btu/hr.
   6) Manufacturer: Rome Cable Corp., 3625, or equal

2.4 SIGNAL CABLES

A. General
   1. Signal cable shall be provided for instrument signal transmission, alarm, communication and any circuit operating at less than 100 volts. Cables shall be color coded black and white for pairs or black, white and red for triads. Circuit shielding shall be provided in addition to cable shielding. Circuits for signals specified in paragraph 409000, Part 1.1.C.15, Paragraphs a and b, shall be provided in compliance with the instrument manufacturer’s recommendations.

B. Single Circuit
   1. Cable shall consist of one pair or triad, 18 AWG conductors with 15 mils of 90 degree C polyvinylchloride (PVC) insulation, 4 mils nylon conduit or jacket, twisted on a 2-inch lay, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with 18 AWG 7-strand tinned copper drain wire and a 45 mil PVC jacket overall. Cable shall be UL listed, Type TC, rated 600 volts. Cable shall be Okonite, Okoseal N TYPE P-OS, or equal.

C. Multiple Circuit
   1. Cable shall consist of four or more pairs or triads which are made up of 18 AWG conductors with 15 mils of 90 degree C PVC insulation, 4 mils nylon jacket, twisted on a
staggered lay 1-1/2 to 2-1/2 inches, and covered with a 100 percent 1.35 mil aluminum-Mylar tape shield with 22 AWG 7-strand tinned copper drain wire. Overall cable shield shall be 2.35 mil aluminum-Mylar tape with a 20 AWG 7-strand tinned copper drain wire. Cable shall be UL listed, Type TC, 600 volts. Cable shall be Okonite, Okoseal-N Type SP-OS, or equal.

D. Thermocouple Extension

1. Extension cable shall be provided for the type of thermocouple circuit specified. Conductors shall be 16 AWG, solid alloy, with 15 mils of 90 degree C flame-retardant polyvinylchloride insulation, twisted and covered with 100 percent 2.35 mil aluminum polyester tape and a 20 AWG, 7-strand, tinned-copper drain wire and a 35 mil, flame-retardant PVC jacket overall. Cable shall be approved for cable tray installation and shall be Okonite P-OS, Type PLTC, or equal.

E. Telephone System Cable

1. Inter-building cables shall be premium grade, REA Type PE-39, gopher resistant telephone exchange area type cable. Cable shall be single jacketed, filled telephone cable, designed for direct burial or installed in ducts.
   2. Conductors shall be solid annealed copper. Insulation shall be heat-stabilized, moisture resistant, low loss dielectric, high density polyethylene per REA PE-200 or polypropylene per REAL PE-210. Pairs shall be twisted to minimize cross-talk, assembled into layer and group cables. The interstices between pairs shall be filled with a filling compound which deters moisture migration. The filling compound shall be formulated to meet or exceed the requirements of the latest issue of REA PE-39.
   3. The cable shall include an overall shield. The shield shall consist of an 8 mil corrugated copper or 6 mil corrugated copper alloy shield applied longitudinally. The outer jacket shall be black, low density molecular weight polyethylene which shall be resistant to abrasion, weathering, moisture, corrosion and environmental cracking.
   4. Pair protectors shall include three-element fail-short gas tubes, Cook Electric Type 9X, or equal. Protectors shall be rated at 400 Vdc and shall be self-restoring. An external spark gap shall be provided for backup protection in accordance with Underwriters Laboratory 497, 4th Edition.

2.5 PORTABLE CORD

A. Portable cord shall be UL listed, Type SO for 10 AWG and smaller. Cords with conductors larger than 10 AWG shall be UL listed, Type G. Cords shall contain an equipment grounding conductor. Cable characteristics shall be as follows:

1. Conductors: Flexible rope stranded per ASTM B189 and B33. Conductors shall be coated except ground conductors may be uncoated.
2. Insulation: Insulation shall be ethylene propylene (EPR) as per ICEA S-68-516 and rated for continuous operation at 90 degrees C.
3. Jacket: Heavy-duty neoprene as per ICEA S-68-516
4. Manufacturer: Okonite
2.6 CONNECTORS

A. Pre-insulated Connectors for splices and taps in conductors 10 AWG and smaller shall be Ideal Industries "Wing Nut" or 3M Company "SCOTCHLOCK", or equal. For 8 AWG and larger conductors shall be T&B compression connectors, or equal. Compress using manufacturers recommended die and tools.

B. Waterproof silicone filled “wing nut” type connectors or spade/lug type terminations and terminals and coat with liquid insulation shall be used for all connections of wire to cord to removable equipment provided with integral cords (such as floats, transmitters, limit switches, etc.) in junction boxes in underground handholes or outdoor junction boxes. Insulators shall be Thomas and Betts multi splice insulator MSLT112-4, or equal.

2.7 SPLICE INSULATION

A. Splice insulation shall be equal or greater than the insulation level of the conductor used.

B. All permanent splices that are underground or in damp or corrosive environments shall be insulated with cast epoxy type insulation which covers the jacket of all cords and the insulation on all wire. Epoxy splice shall be Scotch #3570 or equal.

2.8 WIRING SCHEDULE

A. Refer to cable schedule for description of conductors required.

2.9 MOTOR TERMINAL SPLICING INSULATION

A. Motor terminal splice insulation in the motor connection box shall be provided which will withstand constant vibration and abrasion without degrading the insulation of the splice. A product shall be used that is specifically designed for the purpose of motor terminations in accordance with the following:

1. Motor splices in general purpose areas: bolted splice with a TY-RAP boot type insulator, Thomas and Betts Splice insulator Series MSC, or equal. Splices using wire larger than 8 AWG may be heat shrinkable motor connection stub splices, Raychem, MCK-V series, or equal.

2. Motors in outdoor, damp, or corrosive environments: waterproof motor stub insulator, Thomas and Betts multi splice insulator MSLT112-4, or equal. Splices using wire larger than 8 AWG may be heat shrinkable motor connection stub splices, Raychem, MCK-V series, or equal.

2.10 SHIELDED POWER CABLE

A. Cables shall be certified RHW-2, rated 1000V at 90 degrees C for wet or dry locations, with XLPE conductor insulation and overall PVC jacket. Listed UL 1277 type TC-ER with ground. Shielding shall be a tinned copper braid and tinned copper drain wire. Belden 29500 series or equal.
2.11 WIRE MARKERS

A. Field installed wire markers shall be T&B SMS pre-printed clip-on markers, or equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Each power and control conductor shall be identified at each terminal to which it is connected.

B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, tale or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed in the raceway.

3.2 600 VOLT CONDUCTOR AND CABLE

A. Conductors in panels and electrical equipment, 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.

B. Slack shall be provided in junction and pull boxes, handholes and manholes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required.

C. Solid wire shall not be lugged, nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.

D. All splices and terminations are subject to inspection by the Engineer prior to and after insulating. Terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated and sealed with factory-engineered kits. Bolt connection area shall be kept free of mastics and fillers to facilitate rapid stripping and re-entry. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer’s tolerances.

E. In-line splices and tees, where approved, shall be made with tubular compression connectors and insulated as specified for motor terminations, except that conductors 10 AWG and smaller may be spliced using self-insulating connectors. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits. Terminations at devices with 120 volt pigtail leads shall be made using self-insulating tubular compression connectors.
F. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self insulating tubular compression connectors.

G. In the case where multiple field located instrumentation and control devices require parallel or series wiring configuration, it shall be done at one location in one junction box or marshalling enclosure with terminals. Interconnection of instrumentation and control devices shall not be done within conduit bodies (i.e. LBs, condulets, etc.)

H. Provide shielded power cable for leads extending from VFDs to motors, where indicated.

3.3 SIGNAL CABLES

A. Circuit runs shall be of individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.

B. Shields shall not be used as a signal path, except for coaxial cable circuits operating at radio frequencies.

C. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.

D. Spare circuits shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run. Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.

E. Cable for paging, telephone, and security systems shall be installed and terminated in compliance with the manufacturer’s recommendations.

3.4 PORTABLE CORD

A. Portable cord feeding permanent equipment, such as pendant cords, pumps, cranes, hoists and portable items shall have a wire mesh cord grip of flexible stainless steel wire to take the tension from the cable termination. Connection of portable cords to permanent wiring shall be accomplished with the use of terminals. In-line taps and splices shall be used only where specified.

3.5 COLOR CODING

A. Wiring shall conform to the following color code, unless otherwise specified.

B. Insulation on phase conductor sizes 8 AWG and smaller shall be colored, 6 AWG and larger may have black insulation with plastic tape of the appropriate color from the table below.
C. Insulation on the grounded conductor (neutral) sizes 6 AWG and smaller shall be colored; 4 AWG and larger may have black insulation with plastic tape of white or gray in accordance with the table below.

<table>
<thead>
<tr>
<th>Description</th>
<th>208Y/120V</th>
<th>480Y/277V</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A (Left, Top, Front)</td>
<td>Black</td>
<td>Brown</td>
<td>--</td>
</tr>
<tr>
<td>Phase B (Center, Center, Center)</td>
<td>Red</td>
<td>Orange</td>
<td>--</td>
</tr>
<tr>
<td>Phase C (Right, bottom, Back)</td>
<td>Blue</td>
<td>Yellow</td>
<td>--</td>
</tr>
<tr>
<td>Neutral</td>
<td>White</td>
<td>Gray</td>
<td>White</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>120 VAC Control</td>
<td>--</td>
<td>--</td>
<td>Red</td>
</tr>
<tr>
<td>120 VAC Control</td>
<td>Neutral</td>
<td>--</td>
<td>White</td>
</tr>
<tr>
<td>DC Control (+)</td>
<td>--</td>
<td>--</td>
<td>Purple</td>
</tr>
<tr>
<td>DC Control (-)</td>
<td>--</td>
<td>--</td>
<td>Gray</td>
</tr>
<tr>
<td>External Source</td>
<td>--</td>
<td>--</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

D. All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block (with energization indicator light) upon entering the enclosure. The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

E. All wiring in industrial machines and equipment shall be in accordance with NFPA 79. Notify owner of any deficiencies noted during installation.

3.6 TERMINAL MARKING

A. All terminals in instrument and relay compartments, motor control centers, in control panels, instrument panels, field panels and control stations, as well as connections to mechanical equipment shall have reference number and letter in accordance to the following.

1. h = Control power hot
2. n = neutral
3. g = ground
4. x = PLC input
5. y = PLC output
6. ax = PLC signal/analog input
7. ay = PLC signal/analog output
8. c = control
9. p = power
10. s = signal
3.7 WIRE BENDING RADIUS

A. The radius of bends in all non-shielded wire (conductors and cables) shall not be less than eight (8) times the outside diameter of the wire. Shielded or lead covered wire shall not be bent to a radius less than twelve (12) times the diameter of the wire. Any wire installed with bends less than the allowed diameter and which the Engineer deems has caused that insulation to be damaged, shall be removed and new wire shall be installed.

3.8 GENERAL TESTS

A. Conductor Tests
   1. Following the completion of installation, the following conductors shall be tested:
      a. All 480 volt power feeders scheduled in Conduit and Cable Schedule.
      b. Service conductors and feeder conductors
      c. All new grounding; measure ground resistance at each ground rod.

B. The Contractor shall perform voltage, current and resistance tests as required to complete the Electrical System Test Report form provided at the end of this section. Test reports shall be submitted to the Engineer prior to final acceptance by the Owner. The Contractor shall inform the Engineer of scheduled testing a minimum of 5 days prior to the testing. Testing shall not take place unless the Engineer is present to witness the testing.

C. The Contractor shall undertake all such corrective measures if the test results indicate corrective measures are required. No additional compensation will be paid for corrective measures.

D. Test Scope
   1. The Contractor shall provide all material, equipment, labor and technical supervision to perform tests and inspections as specified herein.
   2. It is the intent of these tests to assure that all electrical equipment as supplied and installed by the Contractor is operational within the industry and manufacturer's tolerances and is installed in accordance with the design documents.
   3. The tests and inspection shall determine the suitability for energization.

E. Visual and Mechanical Inspections
   1. Inspect exposed section for physical damage.
   2. Verify cable is supplied and connected in accordance with specifications and one line diagram, and that phases are labeled correctly.

F. Electrical Tests
   1. Perform insulation resistance test on each cable in reference to ground and adjacent conductors in the same raceway.
   2. Perform continuity test to ensure proper cable connection.

G. Test Values
   1. Insulation resistance tests shall be performed at 1000 volts DC for one-half minute.
2. Minimum megger readings at 20 degrees C shall be one megohm.
3. The maximum acceptable reading for an individual ground rod shall be 25 ohms as required by the NEC and measured by the three rod method. The composite ground electrode shall have a maximum acceptable reading of 15 ohms.

END OF SECTION 260519

ATTACHMENT: ELECTRICAL SYSTEM TEST REPORT - 600V CABLE
SERVICE DESCRIPTION:
nominal voltage, phase to phase
phase to neutral - single or three phase-
number of conductors

SERVICE CONDUCTORS:
phase size and insulation type
neutral size and insulation type
ground size and insulation type

SERVICE DISCONNECT DESCRIPTION:
circuit breaker or disconnect switch
size (amps)
fuse (amps)

MEASURED CONDITIONS

Operating Load Voltage Volts
Vab_______ Vbc_______ Vca_______
Van_______ Vbn_______ Vcn_______

Operating Load Feeder Current  Amps
Ia_________ Ib_________ Ic_________

Conductor Insulation  Megohms
a-b_______ b-c_______ c-a_______

Resistance (record the indicated measurement for each of the following circuits:)
Megohms
a-g_______ b-g_______ c-g_______

1. Service Feeder
2. Pump Feeders
PROCEDURE:
To measure ground resistance, two additional temporary grounds, consisting of short rods 2 or 3 ft long, shall be driven in the ground at least 20 ft. away from the rod being tested. A direct-reading ground resistance tester shall then be connected to the three ground rods by means of insulated leads. The battery operated ground resistance tester reads the resistance of the ground rod being tested directly in ohms. The ground rod location / designation and its measured ohm value shall be recorded in chart below.

<table>
<thead>
<tr>
<th>GROUND ROD LOCATION / DESIGNATION</th>
<th>OHM VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>*</td>
</tr>
<tr>
<td>2.</td>
<td>*</td>
</tr>
<tr>
<td>3.</td>
<td>*</td>
</tr>
<tr>
<td>COMPOSITE GROUND</td>
<td>*</td>
</tr>
</tbody>
</table>

* Ohm value of a single ground rod shall not exceed 15 Ohms. If additional ground rod(s) are added, the "composite" ground electrode shall have a maximum acceptable reading of 15 Ohms which shall be recorded in chart above.
SECTION 260526 – GROUNDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product Specified, noted or otherwise shown.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:

1. Instructions for periodic testing and inspection of grounding features at test wells and grounding connections for separately derived systems located at the Intake PS, Control Bldg., High Head PS and the Maintenance Bldg. based on NETA MTS.

   a. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

   b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 467 for grounding and bonding materials and equipment.
PART 2 - PRODUCTS

2.1 CONDUCTORS

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

B. Bare Copper Conductors:

3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches by 24 in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

D. Underground - Soft drawn bare stranded copper wire, sized as noted on the drawings.

E. Installed in raceway with other insulated power conductors – provide with insulation similar to other conductors in the raceway. Insulation to be green color.

F. Exposed condition – 600-volt green-colored insulated copper conductors THHN/THWN-2.

G. Bonding conductors for moving parts such as vault lids, enclosure doors, engine-generator units and similar applications:

1. Flat tinned-copper braid with one-hole terminal ends for installation over threaded grounding studs.
2. Overall length of braided strap shall be measured and adjusted to allow for 20-percent additional installed length beyond maximum movement of the lid, hinge, or other moving part. Avoid excessive length beyond this allowance.
3. For removable lids, allow enough length for removal and placement of lid next to vault without the need to remove grounding hardware.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Products:

1. Cable to Bus-bars: cast silicon bronze single-hole or two-hole spade-type hy-press compression lugs system.
2. Cable to Equipment lugs: As provided per equipment Manufacturer.
3. Cable to piping systems: Two-piece bronze grounding pipe-clamp sized for pipe.
4. Cable to Earth Electrode Rod: Bronze mechanical clamps within inspection wells, exothermic welded connections where concealed below grade.
5. Cable to building steel: Exothermic welding.
6. Cable to structural rebar: Exothermic welding.
7. Metal Raceway: insulated-throat bonding bushings with integral screw clamps

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

2.4 ISOLATED ROOM GROUND BUS
   A. Main Grounding Bus:
      1. 4-inch-wide x 1/4-inch-thick copper bus bar mounted on 2000-volt insulators.
      2. Length shall be 20 inches or per plans whichever is longer.
      3. ANSI EIA/TIA standard hole-pattern.
   B. Telecommunications Room Grounding Bus:
      1. 2-inch-wide x 1/4-inch-thick tin-plated copper bus bar mounted on 600-volt insulators.
      2. Length shall be 12 inches, or per plans whichever is longer.
      3. Listed BICSI/TIA-607-B
      4. ANSI EIA/TIA standard hole-pattern.
      5. Basis of Design: Panduit GB2B0306TPI-1 Series, includes accessory hardware kit.

PART 3 - EXECUTION

3.1 APPLICATIONS
   A. Provide equipment grounding conductor installed in raceways with all feeders and branch circuit wiring, including those for lighting and receptacles.
   B. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
   C. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
      1. Bury at least 24 inches below grade.
2. Duct-Bank Grounding Conductor: Provide as shown in drawing details.

D. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

F. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.
3.3 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including heaters, dampers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, and Heat-Tracing Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

   1. For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

   2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-4-by-12-inch grounding bus.

   3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

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

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:
   1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
   2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
   3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building.
   1. Install copper conductor not less than No. 4/0 AWG for ground ring and for taps to building steel.
   2. Bury ground ring not less than 24 inches from building's foundation.
3.5 LABELING

A. Comply with requirements in Section 16075 "Electrical Identification" for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.

   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.6 FIELD QUALITY CONTROL

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

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Tests and Inspections:

   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

   3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.

      a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

      b. Perform tests by fall-of-potential method according to IEEE 81.

   4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

G. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Manhole Grounds: 10 ohms.

H. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Hangers and supports for electrical equipment and systems.
      2. Construction requirements for concrete bases.
   B. Related Sections include the following:
      1. Section 260548 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

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

1.4 PERFORMANCE REQUIREMENTS
   A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
   C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.
1.5 ACTION SUBMITTALS

A. Product Data: For the following:
   1. Structural channel metallic support systems.
   2. Nonmetallic slotted support systems.
   3. Hardware fittings and fasteners

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.
   3. Nonmetallic slotted channel systems. Include Product Data for components.
   4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Atkore International.
g. Wesanco, Inc.
h. Or Substitution: Permitted.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Stainless Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Material: Fully annealed Marine-grade 316SS.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Atkore International.
   g. Wesanco, Inc.
   h. Or Substitution: Permitted.
3. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Fabco Plastics Wholesale Limited.
   d. Seasafe, Inc.
   e. Or Substitution: Permitted.
2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except fasteners which shall be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.
D. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

E. Conduit and Cable Supports:

1. Conduit Supports
   a. Hot-dip galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit supports for PVC or epoxy coated rigid steel and PVC conduit systems shall be one hole PVC or epoxy coated clamps or PVC conduit wall hangers.
   b. Conduit supports in all exterior and corrosive areas shall be aluminum, stainless steel, or fiberglass, or as shown on the plans. All hardware shall be stainless steel.

2. Ceiling Hangers
   a. Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber’s perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

3. Racks
   a. Racks shall be constructed from framing channel. Galvanized channels and hanger rods shall be steel, hot dip galvanized, 1.5 oz. / sq. ft. after fabrication. Field cuts shall be re-galvanized by the Galv-A-Weld process or by GAL-VAN-IZE as manufactured by LAWSON Products Inc., or equal. Channels attached directly to building surfaces shall be 14 gauge minimum thickness, 1-5/8 inch deep. Channel section shall be sufficient to limit deflection to 1/360 of span.
   b. Framing channels in all exterior and corrosive areas shall be aluminum, stainless steel, or fiberglass, or as shown on the plans. All hardware shall be stainless steel. Channel section shall be sufficient to limit deflection to 1/360 of span. Framing channel shall be as manufactured by Unistrut or equal.

F. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

G. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

   1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

1) Cooper B-Line, Inc.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti, Inc.
4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
5) MKT Fastening, LLC.
6) Or Substitution: Permitted.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.


2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with structural channel support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.
D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.
3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Provide metal dowels for securing concrete bases to floor surfaces. Prepare concrete floor surface with bonding agent prior to placing housekeeping pads.

D. Anchor equipment to concrete base.

   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529
SECTION 260533 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies raceways for electrical conductors including fittings and supports. Raceways shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems. Raceways consist of conduits, tubing, and tray systems. For the purpose of this specification, conduit and tubing is described collectively as conduit.

1.2 RELATED SECTIONS
A. Section 260500 – Common Work Results for Electrical Systems
B. Section 260529 – Hangers and Supports for Electrical Systems
C. Section 260548 – Vibration and Seismic Controls for Electrical Systems
D. Section 260553 – Identification for Electrical Systems

1.3 STANDARDS AND CODES
A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.
B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.
C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.4 SUBMITTALS
A. The Contractor shall submit catalog data showing material information and conformance with Specifications in accordance with the “Submittals” requirements of section 260500.
PART 2 - PRODUCTS

2.1 GENERAL

A. Material

1. All materials shall be new, free from defects, of current manufacture, of quality specified or shown. Each type of material shall be of the same manufacturer throughout the work.

B. Unscheduled Raceway

1. With the exception of lighting, communication, paging, security and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules. Lighting and receptacle raceway are unscheduled and shall be sized by the contractor in accordance with the NEC. Minimum size shall be 3/4 inch for exposed and 1 inch for embedded raceway.

2. The number and size of communication, paging, and security raceways shall be as required for the particular equipment provided subject to the minimum sizes specified above.

3. The type of raceway shall be in accordance with Part 2.2.A “Application” specified herein.

C. Scheduled Raceway

1. The size of raceway shall be as specified on the drawings or schedules. Except as specifically noted to the contrary on drawings or schedules, raceway types shall be as specified in Part 2.2.A “Application” specified herein.

2.2 RACEWAY

A. Application:

1. All conduits shall be Galvanized Rigid Steel (GRS) or aluminum, unless otherwise noted or specifically allowed in Section 260500, Part 1.8 “Area Classification.”
2. All connections to vibrating equipment or motors shall be liquidtight flexible metallic conduit.
3. PVC installed above grade shall be UV resistant Schedule 80.
4. Underground power, control and telephone conduits shall be concrete encased, schedule 40 PVC. (All sweeps and risers for transition from below grade to above grade shall be PVC coated, GRS), unless indicated otherwise.
5. Underground conduits serving non-critical loads such as site lighting, signs, etc. shall be PVC schedule 80.

B. Rigid Steel Conduit

1. Rigid conduit shall be steel, hot dipped galvanized. Final conduit terminations shall be by means of threaded hubs or double locknuts and insulating grounding type bushings.

C. Liquid Tight Flexible Metallic Conduit

1. Flexible conduit shall be interlocking single strip, hot dipped galvanized and shall have a polyvinyl chloride jacket extruded over the outside to form a flexible watertight raceway.

D. Nonmetallic Conduit

1. Nonmetallic conduit shall be rigid PVC, Schedule 40 or 80. Fittings shall be of the same material as the raceway and installed with solvent cement per the manufacturer's instructions. Conduit, fittings and solvent cement shall all be manufactured by the same manufacturer.

E. PVC Coated Rigid Steel Conduit

1. Conduit shall be hot dip galvanized, then coated with urethane inside and outside, then covered with 40 mil PVC coating.

F. Aluminum Conduit

1. Aluminum conduit shall be rigid ANSI C80.5, threaded.

G. Electrical Metallic Tubing (EMT)

1. EMT shall be UL 797 and ANSI C80.3, steel tubing, hot-dip galvanized. EMT fittings shall be ANSI/NEMA FB 1, steel, raintight, insulated throat, compression type.

2.3 FITTINGS AND BOXES

A. Material

1. Materials for fittings and boxes shall be chosen to satisfy the requirements of Section 260500, Part 1.8 “Area Classification.” All screws, nuts, bolts, and other hardware used with fittings and boxes shall be stainless steel unless installed in general purpose areas.
B. Unions

1. All unions of the type designated as UNF and UNY and shall be suitable for use in moist atmospheres. Unions shall be of cast ferrous alloy, electroplated with zinc.

C. Locknuts

1. All locknuts used in general purpose areas shall be extra heavy steel electroplated with zinc for sizes ¾ inch to 2 inches. Locknuts larger than 2 inches shall be of malleable iron, electroplated with zinc. Locknuts used in damp and outdoor areas shall be stainless steel. Locknuts in corrosive areas shall be FRP.

D. Bushings

1. All bushings shall be steel or malleable iron threaded type electroplated with zinc or hot-dip galvanized. Bushings shall have a molded-phenolic or nylon insulating collar.
   
   a. Grounding Bushings: Grounding-type bushings shall have a projecting portion drilled for the size grounding cable used and shall be provided with a clamp or set screw for securing the cable. In addition, a set screw shall be provided to securely lock the bushing to the conduit. Grounding bushings shall be GEDNEY Type IBC-L-BC, or T&B No. 3870 through 3880, or T&B BG Series, or equal.
   
   b. Bushed Openings: Bushings for protection of cables passing through metal boxes or troughs shall all be phenolic type and shall be OZ Type ABB, or equal.
   
   c. Hubs for connection of conduit to boxes shall be of zinc. Hubs for use in damp or corrosive areas shall be non metallic or aluminum to match the raceway. The hubs shall provide a liquidtight connection to the box and an insulating bushing for the wiring. Hubs shall be Thomas and Betts bullet type, or equal.

E. Liquidtight Flexible Metallic Conduit Connectors:

1. Connectors for liquidtight flexible metallic conduit shall be electroplated zinc malleable iron. An O-ring gasket and an approved grounding insert shall be part of the unit. Where applicable, 45 degree and 90 degree fittings may be used. Liquid-tight connectors shall be by O.Z. GEDNEY, or equal.

F. Expansion Fittings

1. Expansion fittings in exposed runs shall be weatherproof type and shall be provided with an external bonding jumper. The expansion fittings shall allow for 4 inch longitudinal movement and shall be designed so that when completely assembled the end of each conduit entering the fitting is bushed. Fittings shall be O.Z. GEDNEY Type EX, or equal.

2. Deflection fittings in embedded runs shall be of the watertight type and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for 3/4 inch movement in any direction. Fittings shall be O.Z. GEDNEY Type DX, or equal.
G. Junction Boxes
   
1. Junction boxes, device boxes, fixture support boxes, oblong, round and rectangular conduit fittings (condulets) shall be of the same material as required by the area classification for the raceway. Junction boxes for use in general purpose areas shall be zinc electroplated cast ferrous alloy. Integrally cast threaded hubs or bosses shall be provided for all conduit entrances and shall provide for full 5 thread contact on tightening. Drilling and threading shall be complete before finishing. Boxes shall be Crouse-Hinds type FS, FD, or approved equal.

2. Cover plates shall be of similar cast ferrous alloy material and finish. Full body neoprene gaskets shall be provided with all covers and shall fastened with stainless steel screws.

3. NEMA 12 boxes shall be of heavy gauge sheet steel, or cast metal. All NEMA 12 boxes shall be provided with a 5 mil thick light gray thermo-epoxy finish, and designed so that moisture will drain away from the gasketed cover joint. Covers for sheet steel boxes shall have turned edges, ground smooth to form a tight seal against the gasket when the cover is closed.

2.4 CONDUIT SCHEDULE
   
A. Refer to conduit schedule for raceway sizing and routing description.

2.5 CONDUIT TAGS
   
A. Refer to Section 260553 for requirements.

2.6 HANDHOLES AND MANHOLES
   
A. Handholes

1. Handholes shall be precast concrete with checker plate, galvanized, traffic covers designed for H-20 loading. Dimensions shall be as specified on the drawings. Handholes shall be provided with precast solid concrete slab bottoms with sumps. Handholes shall be construction of 3000 psi reinforced concrete.

B. Manholes

1. Manholes shall be precast concrete, 3000 psi strength at 28 days, with reinforcing and cover designed for H-20 bridge loading. Wall thickness shall be 6 inches minimum. Necking and shaft shall have 36-inch minimum clear opening. Manhole cover and frame shall be Class 30B gray cast iron per ASTM A48 with machine finished flat bearing surfaces.

2. Duct entries shall be no less than 14 inches above floor and below ceiling. Cables supports, clamps or racks shall be provided. Floor shall slope 2 percent in all directions to a sump. Sump shall be a minimum of 12 inch diameter or as detailed.

2.7 DUCT BANKS
   
A. Concrete used for duct banks shall be min. 2000 P.S.I. with red oxide added.
2.8 UNDERGROUND MARKING TAPE (DETECTABLE TYPE)
   A. Refer to Section 260553 for specifications.

2.9 FIRESTOPS
   A. Firestops and seals shall be Flamemastic 77, Vimasco No. 1-A, or equal, and shall be applied in accordance with manufacturer’s recommendations. Products which are affected by water are not acceptable.

PART 3 - EXECUTION

3.1 CONDUIT
   A. General
      1. The Contractor shall limit the number of directional changes of the conduit to a total not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction. Bends and offsets shall be avoided where possible but, where necessary, shall be made without flattening or kinking, or shall be factory preformed bends. Turns shall be made with case metal fittings or conduit bends. Welding, brazing or otherwise heating of conduit is not acceptable.
      2. Where required for pulling cable and as necessary to meet the requirements of the previous Paragraph, the Contractor shall provide cast junction or pull boxes. Pull boxes used for multiple conduit runs shall not combine circuits fed from different MCCs, switchboards, or switchgear.
      3. Conduit entering NEMA 1 type sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the box or cabinet and shall have an insulating grounding or bonding bushing constructed over the conduit end. Conduit entering all other boxes shall be terminated with a threaded hub. Cast boxes and nonmetallic enclosures shall have threaded hubs. Joints shall be made with standard couplings or threaded unions. Metal parts of nonmetallic boxes and plastic coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of conduit shall be cut square, reamed and threaded with straight threads.
      4. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box. Where conduit comes from above, it shall be run down beside the enclosure and a tee conduit and drip leg shall be installed.
      5. When new conduit is added to areas which are already painted, the conduit and its supports shall be painted to match the existing facilities. Where new conduit is used to replace existing conduit, the existing conduit and supports shall be removed, resulting blemishes shall be patched and repainted to match original conditions. Similarly, if existing conduits are to be reused and rerouted, resulting blemished shall be corrected in the same manner.
B. Conduit Support

1. Exposed conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling. No conduit shall be routed within 6 inches of any object operating above 30 degrees C.

2. Where three or more conduits are located in a parallel run, they shall be spaced from the wall using framing channel. Support systems shall be galvanized steel unless otherwise specified.

3. Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors. Individual conduit supports shall use cast-in-place anchors, die-cast, rust-proof alloy or expansion shields. Wooden plugs, plastic inserts or gunpowder-driven inserts are not acceptable as a base to secure conduit supports.

4. Refer to Section 260548 “Vibration and Seismic Controls for Electrical Systems”, and Section 260529 “Hangers and Supports for Electrical Systems” for additional requirements.

C. Conduit Encasement or Embedment (Structures and Duct Banks)

1. Conduit constructed in concrete which is in contact with the earth shall be separated from the earth by at least 3 inches of concrete unless otherwise shown on the drawings. Clearances equal to the nominal conduit diameter, but not less than 2 inches, shall be maintained between conduits encased in slabs.

2. Expansion fittings shall be provided whenever embedded conduit crosses building expansion joints, between two adjacent structures, and between a duct bank and structure.

3. Plastic conduit spacers shall be located 5 feet on centers. The spacers shall be secured to the conduits by wire ties. The duct bank shall be securely anchored to prevent conduit flotation while the concrete is being placed. Conduit runs shall be watertight.

4. The ends of conduits shall be protected from damage during construction by using plastic plugs. A 1/4 inch hole shall be drilled in the lower portion of the plug to provide drainage.

5. All raceways installed under this contract that are without conductors, shall be provided with a nylon pull rope. These raceways include raceways identified as “spare”(X conduit identifier).

6. Conduits shall be thoroughly swabbed inside immediately upon completion of pouring concrete. After the concrete has set, but before backfilling, a mandrel having a diameter equal to the nominal conduit inside diameter minus 1/2 inch, and not less than 4 inches long, shall be pulled through each conduit. The mandrel shall be lead covered or painted to indicate any protrusion on the inside of the conduit.

D. Conduit Penetrations

1. Unless otherwise specified, conduit routed perpendicular through floors, walls or other concrete structures shall pass through cast-in-place openings wherever possible. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure’s integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Unless otherwise protected, conduits that rise vertically through the floor shall be protected by a 3 1/2-inch high concrete pad with a sloping top.
2. Conduits entering manholes and handholes shall be horizontal. Conduits shall not enter through the concrete bottom of handholes and manholes.

3. Wherever conduits penetrate outdoor concrete walls or ceilings below grade, the Contractor shall provide a watertight seal as manufactured by O.Z. Gedney Co., Type CSM Series; Thunderline Corp., Link Seal; or equal.

4. Wherever conduits enter buildings or structures below grade, seal the conduit opening (after installation of conductors and cables), with conduit sealing material, to prevent water from entering the structure, enclosure, etc. Sealing compound to be a pliable, removable putty-type compound listed for the application.

E. Conduit Separation

1. Signal conduits shall be separated from AC power or control conduits. The separation shall be a minimum of 12 inches for metallic conduits and 24 inches for nonmetallic conduits.

F. Conduit Seals for Hazardous or Corrosive Areas

1. Each conduit passing from a hazardous or corrosive area into a non-hazardous or non-corrosive area shall be provided with a sealing fitting which may be located on either side of the boundary. The seal shall be located at the boundary in accordance with the NEC.

2. Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized case ferrous alloy. Sealing compound shall be hard type, Chico A, or equal, UL listed for explosion-proof sealing fittings. Sealing compound shall be non-hardening type for corrosive areas. Provide reducing bushings and larger seals as required to meet NEC 25% fill.

3.2 MANHOLES AND HANDHOLES

A. Manholes and handholes shall be set plumb to limit the depth of standing water to a maximum of 2 inches. Manhole covers, unless otherwise specified, shall be set at grade.

3.3 RACEWAY NUMBERING

A. Each conduit shall be provided with a number tag at each end and in each manhole and/or pullbox. Trays shall be identified by stencils at intervals not exceeding 50 feet, at intersections, and at each end.

END OF SECTION 260533
SECTION 260548 – SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Restraint channel bracings.
   2. Restraint cables.
   4. Mechanical anchor bolts.
   5. Adhesive anchor bolts.

B. Related Requirements:
   1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
      a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
      b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.
   1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.
      a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
3. Seismic and Wind-Restraint Details:
   a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
   b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
   c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
   d. Preapproval and Evaluation Documentation: an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.3 INFORMATIONAL SUBMITTALS
   A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints.
   B. Qualification Data: For professional engineer and testing agency.
   C. Welding certificates.
   D. Field quality-control reports.

1.4 QUALITY ASSURANCE
   A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
   B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
   C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.
   E. Comply with NFPA 70.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:
   1. Basic Wind Speed: 85 mph.
   2. Occupancy Category: III.
   3. Minimum 10 lb/sq. ft. multiplied by maximum area of electrical component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC:C.
   2. Assigned Occupancy Category as Defined in the IBC:III.
      a. Component Importance Factor: 1.0
      b. Component Response Modification Factors:
         1) Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing.: 6.0
         2) Communication equipment, computers, instrumentation, and controls: 2.5
         3) Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials: 2.5
         4) Lighting fixtures: 2.5
         5) Electrical conduit, bus ducts, and rigidly mounted cable trays: 2.5
         6) Suspended cable trays: 6.0
         7) Other electrical components: 1.5
      c. Component Amplification Factor:
         1) Motor control centers, panel boards, switch gear, instrumentation cabinets, and other components constructed of sheet metal framing: 2.5
         2) Communication equipment, computers, instrumentation, and controls: 1.0
         3) Generators, batteries, inverters, motors, transformers, and other electrical components constructed of high deformability materials: 1.0
         4) Lighting fixtures: 1.0
         5) Electrical conduit, bus ducts, and rigidly mounted cable trays: 1.0
         6) Suspended cable trays: 2.5
         7) Other electrical components: 1.0
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.852
   4. Design Spectral Response Acceleration at 1.0-Second Period: 0.516

2.2 RESTRAINT CHANNEL BRACINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Unistrut products or comparable product by one of the following:
   1. Cooper B-Line, Inc.; a Division of Cooper Industries.
   2. Hilti, Inc.
3. Mason Industries, Inc.
4. Unistrut; Atkore International.
5. Or Substitution: Permitted.

B. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Kinetics Noise Control, Inc.
2. Loos & Co., Inc.
3. Vibration Mountings & Controls, Inc.
4. Or Substitution: Permitted.

B. Restraint Cables: ASTM A 492 stainless-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following: Cooper B-Line, Inc.; a Division of Cooper Industries.

2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.
4. TOLCO; a brand of NIBCO INC.
5. Or Substitution: Permitted.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
2.5 MECHANICAL ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
4. Mason Industries, Inc.
5. Or Substitution: Permitted.

B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.6 ADHESIVE ANCHOR BOLTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper B-Line, Inc.; a Division of Cooper Industries.
2. Hilti, Inc.
4. Mason Industries, Inc.
5. Or Substitution: Permitted.

B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners as required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
   1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
   2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post-connection testing has been approved), and with at least seven days' advance notice.
   4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
   5. Test to 90 percent of rated proof load of device.

B. Seismic controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE


B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

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

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for vinyl tape Raceway System Identification Carrying Circuits at 600 V or Less:
   1. 480Y/277V Distribution Feeders: Purple on white field
   2. 208Y/120V Distribution Feeders: Blue on white field.
   3. Motor Circuits: Magenta on white field
   4. Lighting, Receptacle and equipment branch circuits: Black on white field.
   5. Life-safety circuits: Red with white background

C. Colors for Raceways Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER CONCEALED HIGH VOLTAGE WIRING."

D. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

E. Tape and Stencil for Raceways Carrying Circuits More Than 600 V: 4-inch wide black stripes on 10-inch centers diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

F. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

G. Write-On Tags: Tyvek plastic weatherproof tag, 3-1/4”L x 1-5/8”H x 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Colors for vinyl tape identified Cables Carrying Circuits at 600 V and Less:
   1. 480Y/277V Distribution Feeders: Purple on white field
   2. 208Y/120V Distribution Feeders: Blue on white field.
   3. Motor Circuits: Magenta on white field
   4. Lighting, Receptacle and equipment branch circuits: Black on white field.
   5. Life-safety circuits: Red with white background

C. Colors for Cables Carrying Circuits at More Than 600 V:
   1. Black letters on an orange field.
   2. Legend: "DANGER HIGH VOLTAGE WIRING."

D. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

F. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted, 3-mil thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the cable diameter such that the clear shield overlaps the entire printed legend.

D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

E. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
A. Write-On Tags: Tyvek plastic weatherproof tag, 3-1/4”L x 1-5/8”H x 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

C. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeve, 2 inches long, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Self-Adhesive, Self-Laminating Polyester Labels: Preprinted 3-mil- thick flexible label with acrylic pressure-sensitive adhesive that provides a clear, weather- and chemical-resistant, self-laminating, protective shield over the legend. Labels sized to fit the conductor diameter such that the clear shield overlaps the entire printed legend.

C. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeve with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

E. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

F. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

G. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
   2. Labels for Tags: Self-adhesive label, machine-printed with permanent, waterproof, black ink recommended by printer manufacturer, sized for attachment to tag.
2.5 FLOOR MARKING TAPE

A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

2.6 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Description:
   1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
   2. Overall Thickness: 5 mils.
   3. Foil Core Thickness: 0.35 mil.
   5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.7 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 7 by 10 inches.
D. Metal-Backed, Butyrate Warning Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.
   3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:
   1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
   2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES." Therein adjusting the stated distance per NEC minimum requirement based on voltage and conditions of installation.
   3. Arc Flash and Shock Hazard Warning labels: “WARNING – ARC FLASH AND SHOCK HAZARD APPROPRIATE PPE REQUIRED.” Include available fault current, specific boundary limit distances, boundary energy levels and specific PPE requirements for each piece of equipment within each boundary area.

2.8 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
   1. Engraved legend with black letters on white face.
   2. Punched or drilled for mechanical fasteners.
   3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.9 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.


E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.10 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
   3. Temperature Range: Minus 40 to plus 185 deg F.

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
   2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
   3. UL 94 Flame Rating: 94V-0.
   4. Temperature Range: Minus 50 to plus 284 deg F.
   5. Color: Black.

2.11 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers where NEMA rating of enclosure allows. Fasten to enclosure surfaces with a durable epoxy compound where NEMA rating would be otherwise compromised by the use of screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.
B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
   1. Outdoors: UV-stabilized nylon.
   2. In Spaces Handling Environmental Air: Plenum rated.

J. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.

K. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil 4-inch-wide black stripes on 10-inch centers over orange background that extends full length of raceway or duct and is 12 inches wide. Stencil legend "DANGER CONCEALED HIGH VOLTAGE WIRING" with 3-inch-high black letters on 20-inch centers. Stop stripes at legends. Apply to the following finished surfaces:
   1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
   2. Wall surfaces directly external to raceways concealed within wall.
   3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
B. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels. Install labels at 30-foot maximum intervals.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20A, and 120V to ground: Identify with self-adhesive vinyl tape applied in bands. Install labels at 30-foot maximum intervals.

D. Junction and Pull Boxes: Identify the covers of each junction and pull box with self-adhesive vinyl labels identifying the wiring system legend and system voltage. System legends shall be as follows:

1. Unscheduled Raceways: Indicate Voltage, Panel Source and Circuits contained within.
2. Scheduled Raceways: Indicate Voltage, Source Equipment and Identification Tag indicated on the Conduit and Cable Schedules.

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
   a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Colors for 480/277-V Circuits:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
   d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

F. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use write-on tags.

G. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

H. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use machine-printed self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
I. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.

J. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

L. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.
   2. Install underground-line warning tape for both direct-buried cables and cables in raceway.

M. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   2. Identify system voltage with black letters on an orange background.
   3. Apply to exterior of door, cover, or other access.
   4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
      a. Power transfer switches.
      b. Controls with external control power connections.

O. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

P. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for life-safety system power transfer.

Q. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power,
lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
   b. Outdoor Equipment: Stenciled legend 4 inches high.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
   d. Where possible, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure. Use durable epoxy adhesive for enclosures that cannot use mechanical fasteners.
   e. Panelboard index cards shall be durable heavy-duty pre-printed card-stock form with type-written circuit index matching the physical arrangement of circuits within the panel. Insert in holder on back-side of door designated for this purpose. Index cards for outdoor panelboards shall be fully laminated.

2. Equipment to Be Labeled:
   a. Identification labeling of some items listed below may be required by individual Sections or by NFPA 70.
   b. For the following items, provide two labels; one indicating the equipment identification per the One-line Diagrams, and one label indicating the voltage, phase, and power source “FED FROM” equipment identification.

   1) Panelboards
   2) Switchgear
   3) Switchboards
   4) Motor-control centers
   5) Substations

   c. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
   d. Emergency system boxes and enclosures.
   e. Access doors and panels for concealed electrical items.
   f. Enclosed switches.
   g. Enclosed circuit breakers.
   h. Enclosed controllers.
   i. Variable-speed controllers.
   j. Push-button stations.
   k. Power transfer equipment.
   l. Contactors.
   m. Remote-controlled switches, dimmer modules, and control devices.
   n. Battery-inverter units.
o. Battery racks.
p. Power-generating units.
q. Monitoring and control equipment.
r. UPS equipment.

END OF SECTION 260553
SECTION 260800 – COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies the acceptance testing of electrical materials, equipment and systems. The Contractor shall provide all labor, tools, material, power, and other services necessary to provide the specified tests.

B. The testing specified in this section shall be performed by a Testing Agency (testing firm) independent of the Contractor. The Contractor shall obtain the services of the Testing Firm and allow time within their construction schedule for tests to take place, and any corresponding corrections to be made.

1.2 TESTING COSTS

A. All costs for testing equipment and personnel shall be paid for by the Contractor. Work associated with coordination by the Contractor such as opening panels, disconnecting and re-terminating wire and cables etc., for the testing to be performed, shall also be responsibility of the Contractor.

1.3 CONTRACTORS REQUIREMENTS

A. The Contractor shall be responsible to inform the Testing Firm and the Engineer when equipment is on site or installed, whichever is appropriate, for the equipment to be tested.

B. The Contractor shall provide support to the Testing Firm for equipment that may need adjustment or operation. The Contractor shall open panels, disconnect equipment, and perform any other work necessary as directed by the Testing Firm to properly test the equipment.

1.4 TESTING CRITERIA

A. All tests of equipment listed in Part 3 of this section will be conducted in accordance with the National Electrical Testing Association.

1.5 APPLICATION

A. Requirements for testing in accordance with this section are specified in this and other related sections of Division 26. Where testing in accordance with this section is required, the required tests, including correction of defects where found, and retesting, shall be completed prior to energizing material, equipment, or systems.
PART 2 - PRODUCTS

2.1 TESTING EQUIPMENT AND MATERIALS

A. Test instruments shall be calibrated to references traceable to the National Bureau of Standards and shall have a current sticker showing date of calibration, deviation from standard, name of calibration laboratory and technician, and date recalibration is required.

2.2 PRODUCT DATA

A. Functional Checkout procedures shall be provided in accordance with Section 260500. The Contractor shall provide proposed functional test procedures 45 days prior to performing functional checkout tests.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall inform the Testing Firm and the Engineer when equipment and systems are ready for testing. The Contractor shall coordinate the time a minimum of five (5) days in advance of when testing is to take place, for the Testing Firm to schedule test equipment with the Engineer. The Contractor shall provide the necessary space and support equipment for the testing.

B. At conclusion of the testing, the Contractor shall perform necessary work to return the equipment to operation, if applicable.

C. Equipment that does not pass initial testing shall be repaired or replaced by the Contractor at no additional cost to the Owner. Repaired or replaced equipment shall be re-tested. The Contractor shall inform the Testing Firm and the Engineer the repair or replacement has been completed. If the equipment fails to meet the specified criteria a second time, all subsequent testing and Engineer witnessing shall be at the Contractor’s expense until the equipment performs as specified.

3.2 ACCEPTANCE TESTS

A. Confirm equipment installed matches submitted and approved equipment

B. Verify equipment installed is in new condition and undamaged

C. Verify secure mounting and proper alignment of operating components

D. Verify electrical connection provided matches rated voltage and phasing of equipment nameplate

E. Verify that overcurrent protective devices does not exceed MOCP listed on the equipment Nameplate
F. Review documentation to ensure factory testing and subsequent field testing has been performed and documented for each applicable electrical equipment item. Factory and Field Testing requirements are listed within individual specification sections.

G. Perform thermal imaging testing for equipment lugs, terminations, and windings to identify any potentially abnormal hot-spots which may require correction.

H. Directly perform equipment-specific tests listed under Part 3.3, Equipment to Be Tested.

I. Observe Contractor adjustment and calibration activities; provide report.

J. Observe Contractor-performed high-potential testing of cables, equipment, and windings; provide report.

K. Actuate available operator interface controls (following properly documented safe operating procedures), to confirm equipment and processes are properly controlled by the operator interface. Confirm that available emergency shut-down controls are properly located and operate as intended.

3.3 EQUIPMENT TO BE TESTED

A. Conduct Acceptance Tests on the equipment listed.

1. Motors 5HP and above
   a. Verify correct motor rotation and alignment
   b. Verify applicable winding and bearing temperature elements are operating. Provide resistance measurements for TDR’s.
   c. Verify moisture sensors are working properly

2. Grounding and Bonding systems
3. Conductors
4. Power Quality Meters
5. Engine-Generator Set
6. Automatic Transfer Switch
7. Fuel inventory control and leak detection systems
8. Lighting Control Systems
9. Transformers
10. Outlets

   a. Test for mis-wired devices

11. Overcurrent Protective Devices
12. Motor Control Centers
13. Variable Frequency Drive Harmonics

a. System harmonics shall be tested for voltage and current harmonics in accordance with the requirements of IEEE-519 to verify compliance with the requirements outlined in Section 262923. VFDs shall be tested using both utility and stand-by power sources.

END OF SECTION 260800
SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes PC-based computer and software for monitoring of electrical power system.

B. Related Sections:

   1. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for sub-metering.

1.2 ACTION SUBMITTALS

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

   1. Attach copies of approved Product Data submittals for products (such as switchboards and switchgear) that describe power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

B. Shop Drawings: For power monitoring and control equipment. Include plans, elevations, sections, details, and attachments to other work.

   1. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components.
   2. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Other Informational Submittals: System installation and setup guides, with data forms to plan and record options and setup decisions.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data:

   1. Operating and applications software documentation.
   2. Software licenses.
3. Hard copies of manufacturer's specification sheets, operating specifications, design
guides, user's guides for software and hardware, and PDF files on CD-ROM of the hard-
copy submittal.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Software Backup: On a magnetic media or compact disc, complete with Owner-selected
      options.
   3. Device address list and the set point of each device and operator option, as set in
      applications software.

C. Software Upgrade Kit: For Owner to use in modifying software to suit future power system
   revisions or power monitoring and control revisions.

D. Software licenses and upgrades required by and installed for operating and programming digital
   and analog devices.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by
   a qualified testing agency, and marked for intended location and application.

1.6 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two
   years.

B. Upgrade Service: Update software to latest version at Project completion. Install and program
   software upgrades that become available within two years from date of Substantial Completion.
   Upgrading software shall include the operating systems. Upgrade shall include new or revised
   licenses for use of software.

   1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow
      Owner to upgrade computer equipment if necessary.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton IQ Data Plus
   or comparable product by one of the following:

   2. General Electric Company; GE Consumer & Industrial.
   3. Landis+Gyr Inc.
   5. Schneider Electric - Power Management Operation.
6. Or Approved Equal.

2.2 COMMUNICATION COMPONENTS AND NETWORKS

A. Network Configuration: High-speed, multi-access, open nonproprietary, industry standard communication protocol; LANs complying with EIA 485, 100 Base-T Ethernet, and Modbus TCP/IP.

2.3 POWER MONITORS

A. Enclosure and equipment to comply with conditions listed in 260500 – Area Classification.

B. RMS Real-Time Measurements:
   1. Current: Each phase, neutral, average of three phases, percent unbalance.
   2. Voltage: Line-to-line each phase, line-to-line average of three phases, line-to-neutral each phase, line-to-neutral average of three phases, line-to-neutral percent unbalance.
   3. Power: Per phase and three-phase total.
   4. Reactive Power: Per phase and three-phase total.
   5. Power Factor: Per phase and three-phase total.
   6. Frequency.
   7. THD: Current and voltage.
   8. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
   9. Incremental Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).
   10. Conditional Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute).

C. Demand Current Calculations, per Phase, Three-Phase Average and Neutral:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Peak.

D. Demand Real Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
   5. Peak.
   6. Coincident with peak kVA demand.
   7. Coincident with kVAR demand.

E. Demand Reactive Power Calculations, Three-Phase Total:
   1. Present.
   2. Running average.
   3. Last completed interval.
   4. Predicted.
5. Peak.
6. Coincident with peak kVA demand.
7. Coincident with kVAR demand.

F. Average Power Factor Calculations, Demand Coincident, Three-Phase Total:

1. Last completed interval.
2. Coincident with kW peak.
3. Coincident with kVAR peak.
4. Coincident with kVA peak.

G. Power Demand Calculations: According to one of the following calculation methods, selectable by the user:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:
   a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
   b. Fixed block that calculates demand at end of the interval.
   c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.
3. Demand Calculation Initiated by a Synchronization Signal:
   a. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.

H. Sampling:

1. Current and voltage shall be digitally sampled at a rate high enough to provide accuracy to 63rd harmonic of 60-Hz fundamental.
2. Power monitor shall provide continuous sampling at a rate of 128 samples per cycle on all voltage and current channels in the meter.

I. Minimum and Maximum Values: Record monthly minimum and maximum values, including date and time of record. For three-phase measurements, identify phase of recorded value. Record the following parameters:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Current per phase.
4. Line-to-line voltage unbalance.
5. Line-to-neutral voltage unbalance.
6. Power factor.
7. Displacement power factor.
8. Total power.
9. Total reactive power.
10. THD voltage L-L.
11. THD voltage L-N.
12. THD current.
13. Frequency.

J. Harmonic Calculation: Display and record the following:

1. Harmonic magnitudes and angles for each phase voltage and current through 31st harmonic. Calculate for all three phases, current and voltage, and residual current. Current and voltage information for all phases shall be obtained simultaneously from same cycle.
2. Harmonic magnitude reported as a percentage of the fundamental or as a percentage of rms values, as selected by user.

K. Current and Voltage Ratings:

1. Designed for use with current inputs from standard instrument current transformers with 5-A secondary and shall have a metering range of 0-10 A.
2. Withstand ratings shall not be less than 15 A, continuous; 50 A, lasting over 10 seconds, no more frequently than once per hour; 500 A, lasting 1 second, no more frequently than once per hour.
3. Designed for use with voltage inputs from standard instrument potential transformers with a 120-V secondary.

L. Accuracy at full-scale for meters that are circuit-breaker accessories shall not be less than the following:

1. Current: Plus or minus 2.5 percent.
2. Voltage: Plus or minus 1.5 percent.
3. Energy, Demand, and Power: Plus or minus 4.0 percent.
4. Frequency: Plus or minus 1 Hz.

M. Waveform Capture:

1. Capture and store steady-state waveforms of voltage and current channels; initiated manually. Each capture shall be for 3 cycles, 128 data points for each cycle, allowing resolution of harmonics to 31st harmonic of basic 60 Hz.
2. Store captured waveforms in internal nonvolatile memory; available for PC display, archiving, and analysis.

N. Input: One digital input signal.

1. Normal mode for on/off signal.

O. Outputs:

1. Operated either by user command sent via communication link, or set to operate in response to user-defined alarm or event.
2. Closed in either a momentary or latched mode as defined by user.
3. Each output relay used in a momentary contact mode shall have an independent timer that can be set by user.
4. One digital KY pulse to a user-definable increment of energy measurement. Output ratings shall be up to 120-V ac, 300-V dc, 50 mA, and provide 3500-V rms isolation.

5. Output Relay Control:
   a. Relay outputs shall operate either by user command sent via communication link or in response to user-defined alarm or event.
   b. Normally open and normally closed contacts, field configured to operate as follows:

   1) Normal contact closure where contacts change state for as long as signal exists.
   2) Latched mode when contacts change state on receipt of a pickup signal; changed state is held until a dropout signal is received.
   3) Timed mode when contacts change state on receipt of a pickup signal; changed state is held for a preprogrammed duration.
   4) End of power demand interval when relay operates as synchronization pulse for other devices.
   5) Energy Pulse Output: Relay pulses quantities used for absolute kWh, absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
   6) Output controlled by multiple alarms using Boolean-type logic.

P. Onboard Data Logging:

1. Store logged data, alarms, events, and waveforms in 800 KB of onboard nonvolatile memory.

2. Stored Data:
   a. Billing Log: User configurable; data shall be recorded every 15 minutes, identified by month, day, and 15-minute interval. Accumulate 24 months of monthly data, 32 days of daily data, and between 2 and 52 days of 15-minute interval data, depending on number of quantities selected.
   b. Custom Data Logs: Three user-defined logs holding up to 96 parameters. Date and time stamp each entry to the second and include the following user definitions:

   1) Schedule interval.
   2) Event definition.
   3) Configured as "fill-and-hold" or "circular, first-in first-out."

   c. Alarm Log: Include time, date, event information, and coincident information for each defined alarm or event.
   d. Waveform Log: Store captured waveforms configured as "fill-and-hold" or "circular, first-in first-out."

3. Default values for all logs shall be initially set at factory, with logging to begin on device power up.

Q. Alarms.

1. User Options:
   a. Define pickup, dropout, and delay.
b. Assign one of four severity levels to make it easier for user to respond to the most important events first.
c. Allow for combining up to four alarms using Boolean-type logic statements for outputting a single alarm.

2. Alarm Events:
   a. Over/undercurrent.
   b. Over/undervoltage.
   c. Current imbalance.
   d. Phase loss, current.
   e. Phase loss, voltage.
   f. Voltage imbalance.
   g. Over kW demand.
   h. Phase reversal.
   i. Digital input off/on.
   j. End of incremental energy interval.
   k. End of demand interval.

R. Control Power: 90- to 457-V ac or 100- to 300-V dc.

S. Communications: Local plug-in connections shall be for RS-232 and 100 Base-T Ethernet.

2.4 LOW-VOLTAGE WIRING

A. Comply with Section 260519 "Low-Voltage Conductors" and Section 271500 "Communications Horizontal Cabling."

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.
   1. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
   2. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
   3. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

PART 3 - EXECUTION

3.1 CABLING

A. Comply with NECA 1.

B. Install cables and wiring according to requirements in Section 271500 "Communications Horizontal Cabling."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
3.2 IDENTIFICATION
A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
B. Label each power monitoring and control module with a unique designation.

3.3 GROUNDING
A. Comply with IEEE 1100, "Recommended Practice for Powering and Grounding Electronic Equipment."

3.4 FIELD QUALITY CONTROL
A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
B. Tests and Inspections:
   1. Electrical Tests: Use caution when testing devices containing solid-state components.
   2. Continuity tests of circuits.
   3. Operational Tests: Set and operate controls at workstation and at monitored and controlled devices to demonstrate their functions and capabilities. Use a methodical sequence that cues and reproduces actual operating functions as recommended by manufacturer. Submit sequences for approval. Note response to each test command and operation. Note time intervals between initiation of alarm conditions and registration of alarms at central-processing workstation.
      a. Coordinate testing required by this Section with that required by Sections specifying equipment being monitored and controlled.
      b. Test LANs according to requirements in Section 271500 "Communications Horizontal Cabling."
      c. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of calculated battery operating time.
      d. Verify accuracy of graphic screens and icons.
      e. Metering Test: Load feeders, measure loads on feeder conductor with an rms reading clamp-on ammeter, and simultaneously read indicated current on the same phase at central-processing workstation. Record and compare values measured at the two locations. Resolve discrepancies greater than 5 percent and record resolution method and results.
      f. Record metered values, control settings, operations, cues, time intervals, and functional observations and submit test reports printed by workstation printer.
C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
D. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

E. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

F. Remove and replace malfunctioning devices and circuits and retest as specified above.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain systems.

1. Train Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Include troubleshooting, servicing, adjusting, and maintaining equipment. Provide a minimum of 4 hours' training.

2. Training Aid: Use approved final versions of software and maintenance manuals as training aids.

END OF SECTION 260913
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Photoelectric switches.
   2. Standalone daylight-harvesting switching controls.
   3. Indoor occupancy sensors.
   4. Outdoor motion sensors.
   5. Lighting contactors.

B. Related Requirements:
   1. Section 262726 "Wiring Devices" for wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.
   2. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 OUTDOOR PHOTOELECTRIC SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC; TORK Products
4. Tyco Electronics; ALR Brand

B. Description: Solid state, with DPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
3. Time Delay: Fifteen second minimum, to prevent false operation.
5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper or comparable product by one of the following:

1. Cooper Industries, Inc.
2. Hubbell Building Automation, Inc.
4. Lithonia Lighting; Acuity Lighting Group, Inc.

B. System Description: Control scheme is closed-loop type. Sensing the combined daylight and electrical lighting levels, then adjusting the indoor electrical lighting levels to achieve a target illumination level within the daylighted zone. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:
   a. When no daylight is present (target level)
   b. When significant daylight is present

2. System programming is done with two hand-held, remote-control tools.
   a. Initial setup tool
   b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level

C. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with separate controller unit, to detect changes in lighting levels that are perceived by the eye.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Sensor Output: 0- to 10-V dc to operate electronic dimming ballasts. Sensor is powered by controller unit.
3. Power Pack: Sensor has 24-V dc, Class 2 power source, as defined by NFPA 70.
4. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.

2.3 INDOOR OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper or comparable product by one of the following:

1. Bryant Electric; a Hubbell company
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
5. Lightolier Controls
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products
9. RAB Lighting
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
4. Power Pack: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
5. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
7. Bypass Switch: Override the "on" function in case of sensor failure.
8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
C. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Watt Stopper or comparable product by one of the following:

1. Bryant Electric; a Hubbell company
2. Cooper Industries, Inc.
3. Hubbell Building Automation, Inc.
5. Lightolier Controls
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Lutron Electronics Co., Inc.
8. NSi Industries LLC; TORK Products
9. RAB Lighting
10. Sensor Switch, Inc.
11. Square D; a brand of Schneider Electric

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
3. Switch Rating: Not less than 800-VA fluorescent at 120 V, 1200-VA fluorescent at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic
3. Switch Type: As noted on drawings
4. Voltage: Match the circuit voltage dual-technology type.
5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
6. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
7. Concealed "off" time-delay selector at 30 seconds, and 5, 10, and 20 minutes.
8. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.

2.5 TIME CLOCK

A. Time clock shall have 24 hour dial with day-omitting device. Time clock shall be powered by self starting synchronous motor. Contacts shall be rated minimum 10 amperes at 120 volts. On/Off trips shall make possible a minimum ON period of twenty minutes and a minimum of 2 hours between one OFF period and the next. Enclosure shall be rated NEMA 3R, weatherproof. Time clock shall be TORK 7000 series or equal.

2.6 LIGHTING CONTACTORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Square D or comparable product by one of the following:

1. Allen-Bradley/Rockwell Automation
2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
3. Eaton Corporation
4. General Electric Company; GE Consumer & Industrial - Electrical Distribution; Total Lighting Control
5. Square D

B. Description: Electrically operated and electrically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation
3. Switch: Hand-Off-Auto (H-O-A)
4. Enclosure: Comply with NEMA 250
5. Provide with control and pilot devices as indicated on drawings, matching the NEMA type specified for the enclosure.

2.7 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 Low-voltage Electrical Power Conductors and Cables.

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 Low-voltage Electrical Power Conductors and Cables.
C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 Low-voltage Electrical Power Conductors and Cables.

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

B. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Section 260519 "Conductors and Cables." Minimum conduit size is 1/2 inch.

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Electrical Identification."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.
3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate lighting control devices and perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.

END OF SECTION 260923
SECTION 262200 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies dry-type transformers rated 600 volts and less used for power distribution, lighting and control purposes.

1.2 MATERIALS

A. All materials shall be new, free from defects, of current manufacture, of quality specified or shown. Each type of material shall be of the same manufacturer throughout the work.

1.3 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.4 EQUIPMENT SIZE

A. Electrical equipment shall fit in the space provided on the plan drawings or as specified. Equipment heights shall not exceed those shown or specified. Larger equipment shall not be considered equivalent or acceptable.

1.5 SUBMITTALS

A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.
PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Reference drawings for transformer size and windings. Transformers shall conform to ANSI/IEEE C57.12.01 and ANSI/ UL 506. The voltage, frequency, number of phases and KVA rating shall be as specified. Transformers shall be General Electric, Square D, Eaton: Cutler-Hammer, or equal.

2.2 INSULATION

A. Transformers 2 KVA and less shall be designed not to exceed 80 degrees C temperature rise. Transformers greater than 2 KVA and less than 15 KVA shall be designed not to exceed 115 degree C temperature rise. Transformers 15 KVA and above shall have a Class 220 insulation system in accordance with NEMA ST20.

2.3 COILS

A. Transformer coils shall be copper. Transformer coils 15 KVA and above shall be impregnated with varnish. Transformer coils 10 KVA and below shall be encapsulated.

2.4 WINDING CONFIGURATION

A. Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and enclosure. Single-phase transformers shall be the four winding type.

2.5 TRANSFORMER TAPS

A. Transformers 15 KVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

2.6 TERMINAL COMPARTMENTS

A. Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for cable specified.

2.7 ENCLOSURES

A. Transformers rated 15 KVA and smaller shall be provided with weatherproof, non-ventilated enclosures.
B. Indoor transformers rated greater than 15 KVA shall be provided with drip proof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.8 MOUNTING

A. Transformers 15 KVA and below shall be suitable for wall mounting. Transformers greater than 15 KVA shall be floor mounting type.

2.9 SOUND LEVELS

A. The sound levels shall not exceed the following values:

<table>
<thead>
<tr>
<th>KVA</th>
<th>dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-9</td>
<td>40</td>
</tr>
<tr>
<td>10-50</td>
<td>45</td>
</tr>
<tr>
<td>51-150</td>
<td>50</td>
</tr>
<tr>
<td>151-300</td>
<td>55</td>
</tr>
<tr>
<td>301-500</td>
<td>60</td>
</tr>
<tr>
<td>501-700</td>
<td>62</td>
</tr>
<tr>
<td>701-1000</td>
<td>64</td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.1 INSTALLATION

A. Transformers shall include internal "rubber-in-shear" isolation mounts selected per manufacturer's recommendations or shall be installed with "KORFUND" or equal external vibration isolators. Wall mounting shall be allowed on masonry. Mounting hardware shall be per manufacturer's instructions. Transformers with enclosures designed for floor mounting where suspended from above shall be suspended on a trapeze constructed of a minimum of two horizontal structural channels hung from threaded rod attached to structural slab with inserts. Channel rod and inserts shall be sized for not less than 500% load safety factor. Transformer raceway connections shall be flexible metal conduit as specified herein-before for equipment subject to vibration.

3.2 CONNECTION

A. Transformers shall be considered "grounded neutral separately derived systems" and neutral shall be grounded accordingly to the building ground grid utilizing a direct connection.

3.3 IDENTIFICATION

A. The transformer shall be identified with nameplates as specified in Section 260500.
B. The nameplate shall state the following:

EXAMPLE

Rating: 480V – 208Y/120V, 3ø
Primary Source: Primary Breaker at Panel 340007

END OF SECTION 262200
SECTION 262413 – SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies low-voltage service entrance switchboards for power distribution.

1.2 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical
B. Section 260519 – Low-voltage Electrical Power Conductors and Cables
C. Section 260548 – Seismic Controls for Electrical Systems
D. Section 260553 – Identification for Electrical Systems
E. Section 260800 – Commissioning of Electrical Systems
F. Section 260913 – Electrical Power Monitoring and Control
G. Section 262800 – Low-voltage Circuit Protective Devices
H. Section 264300 – Surge Protection for Low-Voltage Electrical Distribution Systems

1.3 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.
1.4 EQUIPMENT SIZE

A. Electrical equipment shall fit in the space provided on the plan drawings or as specified. Equipment heights shall not exceed those shown or specified. Larger equipment shall not be considered equivalent or acceptable.

1.5 SUBMITTALS

A. General:
   1. Submit materials in accordance with Section 260500.

B. Product Data:
   1. Technical data sheets for all components with the complete part number of the component clearly designated with all required options as specified in Part 2. Provide at a minimum one tab section for each product listed in Part 2 of this section.

C. Shop Drawings: Shop Drawings shall be provided on 11” x 17” sheets (maximum) and shall be scaled using standard engineering or architectural scales. Submit the following:
   1. Bill of materials showing quantity, manufacturer, catalog number, and the supplier name and phone number for all components of the switchboard.
   2. Descriptive text schema for wire markers, labels and other identification products specified in Section 260553.
   3. Layout drawings showing dimensioned views of general line-up arrangement, equipment elevations, plan view layout, conduit and cable entry areas, and anchoring points.
   4. Scaled arrangement drawings of all panel-front and internal-mounted instruments, switches, devices, and equipment indicated. Show all mounting details required. Deviations from approved arrangements require resubmittal and approval prior to installation.
   5. System wiring diagrams for each unit in the entire switchboard including but not limited to: instruments, relays, switches, indicating lights, breakers, terminal strips, and similar items. Where applicable, diagrams shall indicate the terminals for remote devices as shown on the wiring diagrams in the contract drawings. Wire and terminal numbers shall be included on the schematic diagrams. Relay contacts shall be indicated for type and number available for each relay used.
   6. Information on ratings and sizes of all equipment such as instrument transformers, fuses, breakers, etc.
   7. Connection diagrams showing physical wiring layout within each unit.
   8. Power flow diagrams showing bus arrangement and ratings.

D. Utility Coordination: Submit and obtain approval of the CT-Section to Utility Company prior to submitting final Shop Drawings to the Owner. Utility Contact information:

1. Kevin Streett, Electrical Superintendent, Jefferson Co. PUD
2. Phone: (360) 385-8360
3. Cell: (360) 302-0022
4. E-mail: kstreett@jeffpud.org
E. Operation and Maintenance Materials
   1. Operating and Maintenance Instruction materials
   2. Start-up and Inspection reports
   3. Spare Parts Receipt

F. Draft copy of intended Test Forms and written test procedures. Requirement applies to factory and field testing activities; segregate activities for each.

G. Demonstration Materials:
   1. Outline of field demonstration Agenda.
   2. Copy of written materials proposed for use in conjunction with field demonstrations.
   3. Completed minutes of demonstration activities including sign-in sheet of attendees

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: The size of the switchboard and arrangements shown on the drawings are based on Pow-R-Line C switchboards manufactured by Eaton / Cutler-Hammer.

B. Approved Manufacturers:
   2. Square-D.
   4. Or Approved Equal.

C. The equipment of the proposed Manufacturer must fit within the space allocations shown on the Bid Document plans.

D. Use the same Manufacturer for production of Panelboards and Switchboards.

2.2 SERVICE ENTRANCE SWITCHBOARD

A. Service entrance equipment shall be switchboard construction and shall contain the C.T. space and molded case circuit breakers indicated on the drawings. C.T. space shall be designed per the serving utilities requirements.

B. The switchboard shall be of the general purpose indoor construction type for bottom, top or rear feed as required. The switchboard shall be designed so that an additional pull section is not required. The switchboard size shall not exceed the space provided as shown on drawings.

C. The switchboard shall be dead-front style with front-only accessibility required for installation and service. The switchboard framework shall be code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Switchboard construction shall include a lifting means.
D. All sections of the switchboard shall be front and rear aligned with depth as shown on the drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

E. The switchboard shall meet all applicable UL, NEMA, NEC and local code requirements for service entrance equipment.

F. Furnish a barrier to separate the utility CT compartment complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC and local code requirements.

G. Switchboard shall be braced for a minimum available fault current as shown on the plans.

H. The switchboard shall contain neutral and ground busses with provisions for grounding and bonding.

I. Switchboard shall be designed and tested to withstand seismic conditions of this site. Refer to Section 260548 – Vibration and Seismic Controls for Electrical Systems for site-specific requirements.

Enclosure shall meet the NEMA environmental listing requirements identified under Section 260500, Part 1.8 “Area Classification”.

J. In addition to the Manufacturer’s standard nameplate data, identification products shall be applied per Section 260553 – Electrical Identification.

1. Provide Equipment Identification Label
2. Provide identification for loads being served by overcurrent protective devices
3. Provide warning labels as required
4. Provide label indicating suitability for service entrance use
5. Provide identification for devices and instruments
6. Provide label for serviceable components concealed behind doors and removable panels
7. Indicate overcurrent protective device ratings or settings as applicable
8. Apply NRTL label as listed and approved

2.3 DISTRIBUTION SWITCHBOARD

A. The switchboard shall be of the general purpose indoor construction type for bottom, top or rear feed as required. The switchboard shall be designed so that an additional pull section is not required. The switchboard size shall not exceed the space provided as shown on drawings.

B. The switchboard shall be dead-front style with front-only accessibility required for installation and service. The switchboard framework shall be code gauge steel, rigidly welded and bolted together to support all cover plates, bussing and component devices during shipment and installation. Switchboard construction shall include a lifting means.
C. All sections of the switchboard shall be front and rear aligned with depth as shown on the drawings. All protective devices shall be group mounted. Devices shall be front removable and load connections front accessible enabling switchboard to be mounted against a wall.

D. Switchboard shall be braced for a minimum available fault current as shown on the plans.

E. The switchboard shall contain neutral and ground busses with provisions for grounding and bonding.

F. Switchboard shall be designed and tested to withstand seismic conditions of this site. Refer to Section 260548 – Vibration and Seismic Controls for Electrical Systems for site-specific requirements.

Enclosure shall meet the NEMA environmental listing requirements identified under Section 260500, Part 1.8 “Area Classification”.

G. In addition to the Manufacturer’s standard nameplate data, identification products shall be applied per Section 260553 – Electrical Identification.

1. Provide Equipment Identification Label
2. Provide identification for loads being served by overcurrent protective devices
3. Provide warning labels as required
4. Provide label indicating suitability for service entrance use
5. Provide identification for devices and instruments
6. Provide label for serviceable components concealed behind doors and removable panels
7. Indicate overcurrent protective device ratings or settings as applicable
8. Apply NRTL label as listed and approved

2.4 CIRCUIT BREAKERS

A. The circuit breakers shall be molded case, thermal magnetic and shall comply with Section 262800. The molded case circuit breakers as mounted in the switchboard, shall be UL listed as suitable for use as service equipment.

2.5 POWER QUALITY MONITOR (PQM)

A. Power monitor and display unit shall be provided and integrated into the overall switchboard assembly where indicated on the One-line Diagram, or as otherwise shown or specified.

B. Refer to Section 260913 – Electrical Power Monitoring and Control for equipment specifications.

2.6 BRANCH CIRCUIT ENERGY METER

A. Basis of Design: Square D; PowerLogic Enercept Meter or equal.

B. Energy meter to provide the following minimum requirements

1. Three CTs for all three phase circuits.
2. Frequency: 50/60 Hz
3. AIC rating: 100 kAIC
4. Case insulation: 600 VAC
5. Communication: RS-485, 2-wire plus shield, 9600 Baud, no parity or approved equal
6. Protocol: Modbus RTU
7. Outputs: kWH, Volts per phase, Amps per phase

C. Current transformers shall be closely matched for the load.

D. Communications shall be compatible with the communications of the SCADA system identified in Division 40. Provide interface device as necessary & coordinate with Systems Integrator.

2.7 SURGE ARRESTERS

A. Provide integral device as Specified in Section 264300 – Surge Protection for Low Voltage Electrical Distribution Systems.

2.8 NAMEPLATES

A. Nameplates shall be provided with black letters on white background for the normal power switchboard and red background for the stand-by power switchboard, in accordance with Section 260553 – Identification for Electrical Systems. Lettering shall be sized as follows:
   1. Main equipment nameplate - 1/2" letters
   2. Individual branch breakers - 3/8" letters

2.9 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have an ANSI 61 gray, baked enamel finish.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Prior to installation, coordinate rough-in requirements, conduit stub-ups, and anchoring provisions with the Manufacturer produced Shop Drawings.

B. Coordinate shipping splits and section dimensions as required to route equipment from the unloading area into the electrical space where it will be installed.

C. Equipment shall be placed on concrete housekeeping pads unless otherwise indicated.

D. The switchboard shall be installed with necessary floor sills and weld or provide anchor bolts and hardware required to properly level, align, and secure the switchgear as required by the manufacturer's instructions.
E. All electrical connections shall be made for supply and load circuits leaving all items in proper operating condition.

F. Switch board shall be secured so that installation is suitable for seismic conditions as defined in the International Building Code (IBC).

G. Field test bus, insulation systems and cabling for open and short-circuit conditions prior to energizing. Comply with additional NETA and NECA guidelines for electrical testing as applicable. Also, refer to Section 260800 – Commissioning of Electrical Systems.

3.2 GROUNDING

A. The switchboard shall be grounded as shown on equipment drawings with ground cable as sized on the drawings.

B. Where indicated on the One-line Diagrams, provide a neutral-to-ground bonding jumper per NEC requirements for service entrance equipment, and as required for equipment fed by separately-derived power sources.

3.3 METERING AND CONTROL

A. The interconnection and correction operation of all metering and control devices shall be checked for compliance with the shop drawings and installation instructions. The Contractor shall make any necessary corrections.

3.4 SHIPPING SECTION

A. The Contractor shall insure that all mechanical and electrical connections between shipping splits are complete and secure. The Contractor shall touch up all marred factory finishes with matching, factory-furnished paint.

END OF SECTION 262413
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies panelboards for lighting and power distribution.

B. Refer to Section 263213 – Engine Generators for mini power-zone style load center equipment integrated into the outdoor standby generator package.

1.2 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical Systems

B. Section 260548 – Seismic Control for Electrical Systems

C. Section 260553 – Identification for Electrical Systems

D. Section 262800 – Low-Voltage Circuit Protective Devices

E. Section 264300 – Surge Protection for Low-Voltage Electrical Distribution Systems

1.3 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.4 SUBMITTALS

A. General:

1. Submit materials in accordance with Section 260500.
B. Product Data:
   1. Technical data sheets for all components with the complete part number of the component clearly designated with all required options as specified in Part 2.

C. Shop Drawings: Shop Drawings shall be provided on 11” x 17” sheets (maximum) and shall be scaled using standard engineering or architectural scales. Submit the following:
   1. Bill of materials showing quantity, manufacturer, catalog number, and the supplier name and phone number for all components of the Panelboard.
   2. Image of proposed Panel Index for each Panelboard.
   3. Layout drawings showing dimensioned views of general panelboard arrangement, elevations, breaker and bus arrangement, connection lug locations, plan view layout, conduit and cable entry areas, and anchoring points.
   4. Information on ratings, type, sizes and protective curves of all equipment such as breakers, etc. Coordinate with Section 262800 Overcurrent Protective Devices Submittal requirements.

D. Operation and Maintenance Materials
   1. Operating and Maintenance Instruction materials
   2. Start-up and Inspection reports
   3. Spare Parts Receipt
   4. As-constructed panelboard indexes.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Panelboards shall be provided with a rating at the proper voltage and current for intended use with tin-plated copper bus bars.

B. Panels shall have 100 percent neutral, with equipment ground bar, unless noted otherwise.

C. Lugs:
   1. Temperature rated for a minimum of 60-degrees C for 100-amperes and below, and 75-degrees C for lug sizes greater than 100-amperes.
   2. Coordinate lugs with cable sizes indicated on the Conduit and Cable Schedules. Provide larger lugs where required to terminate fully-rated cables, such as for 600-kcmil.
   3. UL listed as being suitable for conductor material being terminated.
   4. Provide with feed-through or double-lug hardware as noted, or otherwise required, for intended configuration.

2.2 ACCEPTABLE MANUFACTURERS

A. Basis of Design: The size of the panelboards and arrangements shown on the drawings are based on panelboards manufactured by Eaton / Cutler-Hammer.
B. Approved Manufacturers:
   1. Eaton / Cutler Hammer.
   2. Square-D.
   4. Or Approved Equal.

C. The equipment of the proposed Manufacturer must fit within the space allocations shown on the Bid Document plans.

D. Use the same Manufacturer for production of Panelboards and Switchboards.

2.3 CIRCUIT BREAKERS

A. Refer to Overcurrent Protective Device requirements in Section 262800 for additional information.

B. The following interrupting capacity shall be considered minimum. Other ratings shall be as specified on the drawings.

   1. 240V and 208Y/120V Panelboards  10,000 AIC symmetrical
   2. 480V and 480Y/277V Panelboards  14,000 AIC symmetrical

C. Branch and feeder breakers shall be mounted in panelboards so that breaker handles operate in a horizontal plane. Common trip shall be provided on all multiple-pole breakers. Circuit breakers shall be bolt-on type. Main breaker and sub-feed breakers in the top and bottom sections of the panel may be mounted vertically.

D. Spare breakers shall be provided where indicated, complete for future connection of wiring circuits. Where "Space" is indicated for breakers, bussing and breaker mounting hardware shall be provided in the panelboards; with steel knockouts in dead front metal closure of unused part of panel. If any steel knockouts are removed, breakers shall be provided in such spaces, or opening may be covered by approved cover plates. Unprotected openings within the dead-front are not permitted.

2.4 CABINET

A. Panelboard cabinets and associated cover panels shall be flush or surface style as indicated with tight closing doors without play when latched. Where two cabinets are located adjacent to each other in finished areas, matching trim shall be provided of the same height.

B. Refer to Section 260500, Part 1.8 “Area Classification” for minimum NEMA environmental ratings.

C. Cabinets shall be sized with sufficient dimensions to allow for future expansion and addition of circuit breakers within the panelboards as indicated on drawings.

D. Doors shall be door-within-door style, with a locking hasp(s) for each cabinet door. The outer door shall provide access to the overcurrent protective devices, the inner door shall provide
access to wiring area within the panelboard. All electrical distribution equipment locks shall be keyed identically.

2.5 FINISH

A. Panelboard cabinet shall be fabricated from hot-dip galvanized steel in accordance with UL 50. Panelboard fronts shall have an ANSI 61 gray, baked enamel finish.

2.6 SURGE ARRESTERS

A. Refer to Section 264300 for detailed specifications.

B. Provide integrated Surge Protective Device for each panelboard.

2.7 SYSTEM OF NUMBERING AND BUS ARRANGEMENT

A. Bus arrangement shall be as shown on the Panel Schedules on the Drawings.

PART 3 - EXECUTION

3.1 MOUNTING

A. Secure in place with top of cabinet at 6' – 6”, unless otherwise noted. Top of cabinet and trim shall be level.

B. Fasten panelboard with machine screws with oval countersunk heads, finish hardware quality, with escutcheons or approved trim clamps. Clamps accessible only when dead front door is open are acceptable. Surface mounted panelboards with fronts greater than 48 inches vertical dimension shall have trim hinged at right side in addition to hinged door over dead front.

3.2 CIRCUIT INDEX

A. Each branch circuit panelboard shall be provided with as built information for each panelboard by circuit with its proper load designation. Panelboard index card shall be mounted inside the door of each panelboard in a clear plastic sleeve. One spare blank card shall be provided for each card used.

3.3 DEAD FRONT CLOSURES

A. All openings in dead front shall be closed with closures manufactured for the purpose or install spare breakers.

END OF SECTION 262416
SECTION 262419 – MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies a fully-integrated free standing, factory assembled 600 volt Motor Control Centers (MCC.)

B. The Contractor shall be responsible for ensuring that a complete and fully-functional Motor Control Center is provided, which is ready for its intended use. Portions of this work may be provided by the Manufacturer, and remaining portions by the System Integrator as defined in Division 40. The Contractor is fully responsible for establishing all division of responsibility between qualifying Trades and Suppliers.

1.2 RELATED SECTIONS

A. Section 260500 – Common Work Results for Electrical

B. Section 260519 – Low-voltage Electrical Power Conductors and Cables

C. Section 260548 – Seismic Controls for Electrical Systems

D. Section 260553 – Identification for Electrical Systems

E. Section 260913 – Electrical Power Monitoring and Control

F. Section 262800 – Low-voltage Circuit Protective Devices

G. Section 262923 – Variable Frequency Drives

H. Section 264300 – Surge Protection for Low-Voltage Electrical Distribution Systems

I. Section 409000 – Instrumentation and Control Systems

1.3 COORDINATION

A. The Control System Integrator, as defined in Division 40, shall be responsible for coordinating the required wiring and hardware elements necessary to implement all of the integrated control features within the motor control center. This coordination effort shall take place prior to the Manufacturer’s Shop Drawing preparation. Shop Drawings submitted for review shall be comprehensive and illustrate all integrated elements and wiring, regardless of whether they are provided by the Manufacturer or the System Integrator.

B. Coordinate field wiring, equipment placement and anchoring with the Manufacturer’s product data and Shop Drawings.
C. Coordinate equipment information with the MCC manufacturer and other trades furnishing equipment so that the correct types of motor starters and protection devices are provided and sized properly for the items being served, and to supply such equipment with the proper protection.

D. Verify that all MCC equipment will fit physically within the space allotted per the contract drawings.

E. Equip the assembly with all appurtenances and accessories (including but not limited to power supplies, transformers, control relays, control contacts, switches, instruments, devices, control wiring, and terminal strips) as required by the Control System Integrator and Manufacturer for interface with the Instrumentation and Control Systems to provide a totally integrated and operable system.

F. Direct the MCC Manufacturer to provide all intended elements and features of the equipment that may influence or affect the control system as determined by the System Integrator. The System Integrator shall determine all requirements for and shall cause integration of the control system and the MCC into a unified operating system. The System Integrator shall define all requirements for all interfacing equipment, appurtenances and accessories.

1.4 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.5 SUBMITTALS

A. General:

1. Submit materials in accordance with Section 260500.

B. Product Data:

1. Technical data sheets for all components with the complete part number of the component clearly designated with all required options as specified in Part 2. Provide at a minimum one tab section for each product listed in Part 2 of this section.
C. Shop Drawings: Shop Drawings shall be provided on 11” x 17” sheets (maximum) and shall be scaled using standard engineering or architectural scales. Submit the following:

1. Bill of materials showing quantity, manufacturer, catalog number, and the supplier name and phone number for all components of the MCC.
2. Descriptive text schema for wire markers.
3. Layout drawings showing dimensioned views of general line-up arrangement, equipment elevations, plan view layout, conduit and cable entry areas, and anchoring points.
4. Scaled arrangement drawings of all panel-front and internal-mounted instruments, switches, devices, and equipment indicated. Show all mounting details required. Deviations from approved arrangements require resubmittal and approval prior to installation.
5. System wiring diagrams for each unit in the entire motor control center including but not limited to: instruments, relays, starters, switches, lights, breakers terminals, and similar items. Diagrams shall indicate the terminals for remote devices as shown on the wiring diagrams in the contract drawings. Wire and terminal numbers shall be included on the schematic diagrams. Relay contacts shall be indicated for type and number available for each relay used.
6. Information on ratings and sizes of all equipment such as control transformers, fuses, breakers, etc. on the wiring diagrams for each bucket including time current curves.
7. Connection diagrams showing physical wiring layout within each unit.
8. Power flow diagrams showing bus arrangement and ratings.

D. Operation and Maintenance Materials

1. Operating and Maintenance Instruction materials
2. Start-up and Inspection reports
3. Spare Parts Receipt

E. Draft copy of intended Test Forms and written test procedures. Requirement applies to factory and field testing activities, segregating activities for each.

F. Demonstration Materials:

1. Outline of field demonstration Agenda.
2. Copy of written materials proposed for use in conjunction with field demonstrations.
3. Completed minutes of demonstration activities including sign-in sheet of attendees

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: The size of the MCC and arrangements shown on the drawings are based on MCCs manufactured by Allen-Bradley.

B. Approved Manufacturers:

1. Allen-Bradley.
2. Square-D.
3. EATON: Cuttler-Hammer
4. Or Approved Equal.

C. The equipment of the proposed Manufacturer must fit within the space allocations shown on the Bid Document plans.

2.2 CONSTRUCTION

A. General

1. Motor control centers shall be designed, assembled, tested and placed into operation by the MCC supplier. The motor control center shall fit into the space requirements as shown on the drawings. The contract drawings show general MCC layout and space requirements and may be modified by the MCC manufacturer if first approved by the Engineer.

B. Structure

1. The MCC shall consist of vertical sections that can be joined together to form a rigid free-standing, completely enclosed assembly. Vertical sections shall be fabricated of bolted No. 14 gage steel minimum. Each section shall have flange formed doors and/or covers both front and rear. Doors shall include provisions for padlocking all breakers in the open position.
2. MCC construction shall be suitable for the environment installed.
   a. Refer to 260500 and Contract Drawings for defined Area Classifications
   b. Damp or dusty areas: MCCs shall be NEMA 12 construction.
   c. General purpose areas (all other areas not described above): MCC construction shall be NEMA 1 gasketed, unless specified otherwise on the plans.

C. Arrangement

1. Motor control center sections shall have a minimum 72-inch working height to accommodate a minimum of six 12-inch high compartments. Sections shall be 20 inches deep with a 90-inch height, and minimum width shall be 20 inches.
2. Compartments shall have pan-type doors with quarter turn hold-down latches and neoprene gaskets. Doors for compartments with starter and feeder tap units shall be mechanically interlocked with the unit's disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while the door is open.
3. Starters and feeder tap units shall be draw-out plug-in construction with hardened, plated copper free-floating stabs, steel spring backups, and interference tabs which prevent door closure if unit is improperly installed. Units shall be latched to assure proper bus contact.

D. Finish

1. All steel parts shall be provided with an acrylic baked enamel paint finish, except plated parts used for ground connections. Painted parts shall be primed with a zinc-phosphate primer or undergo a phosphatizing pre-paint treatment for rust resistance and paint bond. Paint shall be applied by electrostatic process and baked to a durable hard finish.
Exterior and structure color shall be ANSI #61 gray. Starter bucket interiors shall be white.

E. Wiring / Terminals

1. The motor control center shall be suitable for operation on 480Y/277 volts, three-phase, four-wire, 60 hertz.
2. Wiring shall be NEMA Class II, Type B. Each unit shall be completely prewired with all control wiring numbered and terminated on terminal strips. Terminal's numbering shall be coordinated between units such that like devices have the same terminal numbers. Wiring within one bucket shall be labeled with a basic wire numbering scheme.
3. A minimum of 5 spare terminals shall be provided in each unit. Terminal strips are not required for the load wiring.
4. Auxiliary components, such as HOA selector switches, indicating lights and other indicating and/or recording devices, shall be mounted on the compartment door or cover.
5. All control power leads into and out of each unit shall pass through auxiliary contacts of the circuit breaker or be equipped with their own disconnecting device or disconnecting terminal strips, appropriately labeled.

F. Internal Communications Network

1. Ethernet/IP Devices
   a. Motor Control Center assemblies shall be provided with a factory assembled EtherNet/IP communications network providing direct connectivity between all MCC devices, system controller and/or HMI.
   b. Motor control centers shall provide required Ethernet 10/100 auto negotiate industrial switch per lineup. The Ethernet switch shall have sufficient ports available to connect to each EtherNet/IP device and have at least 2 open ports plus a customer connection and a PC connection for maintenance. Additional ports shall be provided for future loads and for spaces.
   c. The EtherNet/IP system installed in the MCC shall include a complete and tested cabling system. The cabling system shall be 600V Cat 6 and consist of home run connections from the device to a switch located in the MCC and in accordance with the ODVA specification. Non-standard, non-shielded cable will not be accepted.
   d. All cabling shall be securely supported and attached to the MCC structure in accordance with the contract drawings and the manufacturer’s recommendations.
   e. EtherNet/IP communications modules shall be provided at each device interfacing to the EtherNet/IP communications network. The communications modules shall be installed in the unit device compartment or bucket, and shall be direct-connected to the EtherNet/IP Ethernet cable. Each device shall be provided with the appropriate factory fabricated cable for interfacing the communications module with the associated EtherNet/IP device.
   f. Operator interface units shall be able to display the following: starter status, three-phase current, control voltage, overload condition (alarm), cause of device trip, operations count, run time, set points, starter description and identification, and system process graphics screens. Operator interface shall have the capability of communicating on the EtherNet/IP network.
G. Wireways

1. Full height vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4" for a 20" wide (9" for a 25") wide section with a separately hinged door. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the motor control center horizontal wireways.

H. Bus

1. The motor control center bus shall be tin-plated copper with connections between vertical and horizontal power bus bars made with 3/8-inch bolts and conical Belleville steel washers. Access for tightening connections shall be from the front, without the need for tools on the rear of the connection.

2. Unless otherwise specified all sections shall contain horizontal and vertical busses. Each end of the line up shall be provided for connection of future sections.

3. Unless otherwise specified or required by the components installed, main horizontal bus shall be rated a minimum 600 amperes continuous, vertical bus shall be rated a minimum of 300 amperes continuous. Bus elements shall maintain their full rating for the entire length and shall not be tapered.

4. A 1/4” X 2” minimum un-plated copper ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center and shall contain lugs to terminate, as a minimum, two (one at each end of ground bus) 4/0 AWG bare copper ground conductors.

2.3 MOTOR STARTER UNITS / CONTACTORS

A. Motor starter units shall be of the combination type with components as indicated on the drawings and as otherwise specified herein and under Division 40. Motor starters and associated equipment shall be provided to match the load being served.

B. Magnetic Contactors

1. Heavy duty NEMA-rated, size 1 minimum. Provided with two spare field convertible auxiliary contacts. An auxiliary switch shall be tied to the contactor mechanism and shall be provided to indicate the circuit breaker is in the "ON" position. Auxiliary switch shall be open when the circuit breaker is open.

C. Overload Relays

1. Solid-State Overload Relays:
   a. Switch or dial selectable for motor running overload protection.
   b. Sensors in each phase.
   c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
   d. Load protection for undercurrent.
   e. Line protection for under and over voltage.
   f. Line protection for voltage imbalance and phase loss.
Monitoring capability for:
1) Current – average and phase RMS
2) Voltage – average and phase RMS
3) Power – motor kW
4) Power factor
5) Frequency
6) Motor starts
7) Motor run hours

h. Communication module to interface with PLCs specified in Section 409443.

2. NO isolated overload alarm contact.
3. Circuit test button which shall simulate an overload trip.
4. External overload reset push button.

D. Control Transformers

1. Each Control Power Transformer (CPT) shall be rated 480/240-120 volt, single phase, 2 wire, 60 hertz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

<table>
<thead>
<tr>
<th>NEMA starter size</th>
<th>Minimum transformer volt-ampere rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
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<tr>
<td>3</td>
<td>200</td>
</tr>
<tr>
<td>4</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>500</td>
</tr>
</tbody>
</table>

2. Provided with time-delay, slow blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters.
3. Fuse holder for secondary fuse shall be drawout indicating type and mounted on the door of the compartment. Fuse holders for primary fuses shall be fuse clips with full barriers between fuses.

E. Contactor Coil Suppressors

1. All contactor coils shall be provided with diode surge arrestors to limit the high voltage transients, kick-back voltage, produced when power is removed from the coil.

2.4 CIRCUIT BREAKERS

A. General

1. Circuit breakers shall be molded-case design capable of being padlocked in the open position.

B. Motor Circuit Protectors

1. Provide motor circuit protectors for all full voltage starters.
2. The motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker.

3. The motor circuit protector shall be set at its lowest position at the factory.

4. All breakers for motor starters shall include auxiliary contacts which open when the breaker in the OFF or Tripped position.

C. Thermal Magnetic

1. Provide thermal magnetic circuit breakers for variable frequency drives, for feeders to packaged motor controllers and other loads indicated on the one-line diagram.

2. Circuit breakers shall be thermal-magnetic type with quick-make and quick-break operation. They shall have wiping type contacts. Each shall be provided with arc chutes, individual trip mechanisms on each pole. Two and three pole breakers shall be common trip.

3. All breakers shall be calibrated for operation in an ambient temperature of 40°C. Molded case circuit breakers shall be trip-free. Each breaker shall have separate trip indication independent of the ON or OFF positions.

4. Breakers shall meet the requirements of Section 262800 – Low-voltage Circuit Protective Devices.

2.5 OPERATING AND INDICATING DEVICES

A. Operating and indicating devices minimum rating shall be NEMA 13. Operator devices mounted in outdoor panels, corrosive areas or where exposed to moisture shall be NEMA 4X.

B. Selector Switches

1. Selector switches shall be for use on 120 volt control circuits. Contacts shall have a continuous current rating of 10 amperes both inductive and resistive. Selector switches shall be of the heavy duty oil tight type. Allen Bradley, Bulletin 800T, 800H, GE CR104P, Square D, Type K, or equal.

C. Push buttons

1. Push buttons and illuminated push buttons shall be for use on 120 volt control circuits. and shall have continuous current rating of 10 amperes both inductive and resistive. Pushbuttons for "standby" "help" applications shall have maintained contacts and red mushroom head operators. Allen Bradley, Bulletin 800T, 800H, or equal.

D. Indicating Lights

1. Indicating lights shall be push-to-test oil tight type. Units shall have LED lamps and shall be of the illuminated pushbutton type with the pushbutton wired for the push-to-test function required. Appropriate LED and lens color shall be provided as shown. Allen Bradley, Bulletin 800T, 800H, or approved equal.
E. FV Start Enable / Disable Control Switch
1. Selector switch with 1 N.O. and 1 N.C. contact with screw driver operated control knob and spring loaded pad lockable plastic cover. Switch shall be oil tight control switch, NEMA 12. Switch shall be Square D type SK Class 9001 or equal. Operator shall be Square D B18 with cover type K107 or equal.

F. Alarm Horn
1. The alarm horn shall be an electronic type 120 volt AC powered, 2900 hertz, continuous operation rated by Sonalert.

G. Control Relays
1. Relays for general purpose use shall be DPDT or 3PDT, 10 ampere contacts with the appropriate coil voltage for the application. They shall have an 8-pin or 11-pin base, matching socket, and contact status indicator. Units shall be Allen-Bradley, Bulletin 700 type HA, HB, or equal.

H. Time Delay Relays
1. Time delay relays shall be multi-function, multi-range with plug-in base, pin style terminations timing and timed out LED indicators, and calibrated scales. Relays shall have minimum .5 seconds to 60 minutes, 8 selectable timing ranges, 5 ampere contacts. Select coil voltage for the application. Minimum accuracy requirements (plus or minus) shall be as follows: 1) Repeat accuracy 1/2% 2) Timing change over full voltage range 1/2% change over full temperature range 2% 3) Scale tolerance 5%. Allen-Bradley, Bulletin 700 type HR series, or equal. Appropriate relay shall be selected based on application from the control wiring diagrams.

I. Terminal Blocks
1. Terminal blocks shall be 300 or 600 volt modular terminal blocks with tubular screw and pressure plate. Terminal shall be sized to accept No. 2 to No. 14 wire minimum. Provide a minimum of 20% or four whichever is greater, spare terminals in each bucket. Allen-Bradley, Bulletin 1492-CA1, or equal.

2.6 VARIABLE FREQUENCY DRIVES
A. Provide variable frequency drives (VFDs) per Section 262923 – Variable Frequency Drives.

2.7 PHASE FAILURE RELAY (PFR)
A. The motor control center shall be provided with phase failure relays wired for shutdown of 3-phase motors. It shall monitor phase loss, unbalance, low voltage and reverse phasing, with automatic reset. Each phase fail relay shall have 2 Form C contacts (DPDT).

B. PFR shall have under-voltage adjustment from 75-100%, response time delay set or adjustable between 3 and 5 seconds, phase unbalance set or adjustable between 5% and 19% and an LED indication for relay energized.
C. Sufficient control relays and wiring shall be supplied to provide one shutdown contact for each motor control circuit and 2 additional spare contacts. Blown fuse indicators shall be provided on all PFR, CPT, and control relay fuses and protection fuses. Blown fuse indicators associated with the phase fail system, shall be visible without opening the enclosure door. Relays for use with phase fail relays shall be heavy duty, industrial type with field convertible contacts.

D. Manufacture: Allen-Bradley 813S Series, or equal.

2.8 NAMEPLATES

A. Each motor control center compartment shall have a nameplate designating the equipment and its identifying number and size or rating in accordance with Section 260553. Data on the nameplate shall be as shown on One-Line Diagrams. Nameplates shall have name, number and/or function as is applicable for clear identification. ANSI designated devices shall include common-name descriptions in addition to the ANSI device number within parentheses.

B. Include Nameplates for the following:

1. MCC Equipment ID Nameplate: One large nameplate for each motor control center shall be provided identifying the motor control center name and number with 1” lettering.
2. Load ID Nameplates: Provide one nameplate on the door-front for each designated load using assigned Equipment Tag numbers, which are supplied/controlled by each MCC bucket.
3. Device Nameplates shall be provided for identifying all operator interface (lights, switches, push-buttons, etc.) and other devices that are located outside or inside the panels. Nameplates shall be provided for identifying all relays and devices that are located inside the panels.
4. Terminal Blocks

C. Type: Engraved phenolic laminated plastic with stainless steel fasteners or applied with epoxy adhesive as applicable to maintain equipment NEMA rating. Color shall be black with white engraved letters.

2.9 POWER QUALITY MONITOR AND DISPLAY (PQM)

A. Power quality monitor and display unit shall be provided. The unit shall monitor all three phases and shall display volts (phase to phase and phase to neutral), amperes, power factor, harmonic content, and hertz. The PQM shall be supplied with an Ethernet communication link to the PLC. Refer to Section 260913 – Electrical Power Monitoring and Control for additional specification requirements.

2.10 FUSES

A. Provide fuses, spares, fuse pullers, and etc. in accordance to Section 262800

B. Provide blown fuse indicators on all fuses.
2.11 CAPACITORS
A. Capacitors shall be provided where shown on the one-line diagrams for power factor correction. Capacitors shall be "self healing" to restore the dielectric should a breakdown occur, cell rupture protection, gasketed covers and discharge resistors. Fused capacitors shall include current limiting fuses and blown fuse indicators for each phase. Blown fuse indication shall be visible from the outside of the enclosure without opening the enclosure door. Capacitors for individual motors shall be sized to correct motor power factor to approximately 95%. Capacitors shall be Square D, Class 5840 or equal.

2.12 SURGE ARRESTERS
A. Surge arrestors with indicators shall be provided and integrated into the MCC assembly to protect against overvoltage transients. Refer to Section 264300 – Surge Protection for Low Voltage Electrical Distribution Systems.

2.13 OPERATING MECHANISMS
A. All circuit breakers in motor control centers shall be provided with external "thru-the-door" operating handles.

2.14 SPARE PARTS
A. In addition to spare parts mentioned elsewhere in this section, the Contractor shall supply the following spare parts:
   1. 100% spare lamp of each type used for indicating lights.
   2. One spare control, time delay, phase fail, etc. relay of each type used. or 20% whichever is the greater number.
   3. One spare lens of each color used for indicating lights.
   4. Two spare fuses for each fuse provided under 10 amperes and one spare fuse for each fuse provided over 10 amperes.
   5. One spare overload relay for each type and size provided.

PART 3 - EXECUTION

3.1 GENERAL
A. The Contractors shall verify that the motor starters, protection equipment, and other components, etc. provided are suitable (correct phase, voltage, starter type, correct breakers, and overload relays) for the motors and equipment loads being served.

B. The motor control center shall be assembled per the System Integrator’s requirements, and shipped to the Integrator’s Shop. The System Integrator shall complete the construction of the motor control center wiring and components per the contract documents. The motor control center shall be completely inspected by the Engineer and tested in the System Integrator’s shop.
and delivered to the site ready for external connections to field equipment. The motor control center shall be leveled and securely anchored to the floor.

C. All assembly and wiring not completed by the manufacturer or Integrator, due to shipping sections, multiple suppliers, etc. shall be the responsibility of the Contractor.

D. Nameplates shall be mounted in a manner or location such that other equipment or devices do not block them so they are easily viewed.

3.2 TESTING

A. Factory Testing

1. Manufacturer’s Factory Testing shall consist of Manufacturer’s established quality control protocol for component-level and assembly-level testing and verification.

2. System Integration Testing

   a. The motor control center shall be tested in the System Integrator’s shop along with the control system per the requirements in this Division 40. The testing shall include, but not be limited to, operation of all input and output (I/O) points, control devices and motor controllers 24 hours per day for a continuous period of at least one (1) week.

   b. Testing and inspection of the motor control center shall include all components. All motor controllers shall be interconnected with the control system and powered with rated incoming voltage.

   c. Demonstration Testing:

      1) After completion of initial testing, the Control System Integrator shall conduct subsequent demonstration testing in their shop facilities for observation by the Engineer.

      2) The Control System Integrator shall provide for time, equipment and support in their shop for the Engineer to test the motor control center for a period of up to 3 days.

      3) All control functions and all status and alarm monitoring and indication shall be demonstrated under simulated operating conditions. Simulating equipment shall be provided and wired into the motor control center system for this testing.

      4) The Control System Integrator shall revise, modify, adjust the system as required by the Engineer during the testing period.

B. Field Testing

1. Follow all Manufacturer’s recommended start-up checklists and procedures prior to energizing equipment.

2. Refer to Section 260800 – Commissioning for Electrical Systems for additional field testing requirements, standards and documentation forms.
3.3 INSTALLATION

A. The motor control system shall be installed in accordance with the installation drawings and manufacturer’s instructions. Installation shall be performed by workers who are skilled and experienced in the installation of motor control equipment.

B. The motor control center shall be installed to meet the Manufacturer’s requirement for Seismic Qualification as specified and represented in the Shop Drawings. Refer to Section 260548 – Vibration and Seismic Controls for Electrical Systems for performance criteria.

C. Coordinate and adjust applicable devices and components within the motor control center for proper operation. Parameters not specifically specified, shall be determined by the Contractor based on associated equipment nameplate data and other field conditions. Adjustable components include, but are not limited to:

   1. Phase Fail Relay
   2. Overload Relays
   3. Over-current Protective Devices
   4. Power Quality Monitor
   5. Variable Frequency Drives

3.4 WIRING

A. Refer to Section 260519- Low-voltage Electrical Power Conductors and Cables.

B. All signal and low voltage wiring shall be separated from 120 volt and 480 volt wiring and shall maintain a minimum of 1 inch separation of conductors.

END OF SECTION 262419
SECTION 262713 – SERVICE AND METERING

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies the new electrical services, pad-mounted transformer and service entrance equipment.

1.2 RELATED SECTIONS
A. Section 260500 – Common Work Results for Electrical
B. Section 260519 – Low-voltage Electrical Power Conductors and Cables
C. Section 260526 – Grounding and Bonding for Electrical Systems
D. Section 260533 – Raceways and Boxes for Electrical Systems
E. Section 260553 – Identification for Electrical Systems
F. Section 262413 - Switchboards

1.3 SCHEDULING WORK WITH THE UTILITY COMPANY
A. The Contractor shall be fully and completely responsible for all scheduling and coordination with the utility company. The Contractor shall coordinate and schedule power outages, power service for operation and construction, and power service as required by the facility prior to Certificate of Occupancy.

1.4 CONTRACTOR/UTILITY INTERFACE RESPONSIBILITIES
A. The electrical utility providing service to these facilities is Jefferson County PUD. During design, contact was made with Kevin Streett, 800-700-7152, at the serving Utility. The Contractor shall clarify all questions regarding utility installation prior to bid. The Contractor shall comply with all Utility Company standards and requirements.
B. The Contractor shall pay all expenses associated with the installation or upgrade of electrical service on this project, including all charges by the serving utility for fees, services, materials, or tasks executed by utility company crews associated with this project. The specific electrical service installation task assignments indicated in these specifications are preliminary and in no way shall limit the Contractor’s responsibility for all costs associated with electrical service installation or modification.
C. The division of responsibilities stated below has been determined by coordination with the Utility, and shall be confirmed by the Contractor prior to bid. The division of responsibility for installation tasks shall be coordinated with the Utility at the time of construction.

D. Contractor: For Bidding purposes, the Contractor shall assume to provide the following labor and materials in support of the electrical service:

1. Metering and other materials associated with temporary construction power per Section 260500, Part 1.4.
2. Excavation, bedding and backfill for raceways, vaults, pads and equipment. Primary raceways to be 42” below grade, secondary raceways to be 36” below grade.
3. Provide primary service raceways with riser elbows at utility pole. Provide 30’ of Schedule 40 raceway near pole for riser, which will be installed by the Utility. Primary raceway to be 4” trade size minimum. Maintain 12” minimum separation between raceways and other utilities.
4. Install utility-furnished Manholes / vaults needed for primary and secondary raceway systems.
5. Install utility-furnished vault and equipment pad for Utility Transformer
6. Provide CT switchboard enclosure, EUSERC-compliant, with provisions for bus bar CT’s and testing points.
7. Provide Type 9F, 13-jaw, remote meter base
8. 1-1/4” raceway between service entrance CT enclosure and remote meter base.
9. Provide a dedicated 2” raceway for utility SCADA use between the CT enclosure and the primary utility pole.
10. Provide secondary service raceways and conductors
11. Provide secondary terminations at the service entrance switchboard / breaker CT assembly

E. Utility: For Bidding purposes, the Contractor shall assume the Utility will provide the following labor and materials in support of the electrical service:

1. Overhead primary power line extension along with associated utility pole, conductors, guys, cross-arms, insulators and hardware necessary for crossing public roadway.
2. Coordinating and obtaining necessary Power Company Easements with affected property Owners
3. Install Contractor-furnished primary risers at utility pole to 30’ above grade.
4. Furnish manholes, vaults, and equipment pads for Contractor installation.
5. Provide and set in-place utility transformers.
6. Provide all grounding provisions at manholes, vaults and transformer.
7. Provide primary conductors and associated terminations
8. Provide any required equipment for primary system overcurrent protection and disconnecting means.
9. Terminate Contractor-furnished secondary conductors at the Utility transformer
10. Terminate grounding systems to the utility transformer
11. Provide utility revenue meter.
12. Provide conductors and terminations between CT enclosure and remote meter base
13. Provide utility metering CT’s for installation within Contractor-provided equipment
1.5 QUALITY ASSURANCE
   A. The Contractor shall comply with all serving Utility company standards and requirements.

1.6 STANDARDS AND CODES
   A. All work involving service installation shall be done in accordance with Utility standards and the National Electrical Code (NEC).
   B. Service equipment shall be listed and labeled by UL as "Suitable for Use as Service Equipment".

1.7 SUBMITTALS
   A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.
   B. Prior to submittal to the Engineer, the Contractor shall submit all equipment and construction details (such as size, mounting height, location of equipment, etc.) to the serving Utility for verification of compliance to the Utility’s requirements.
   C. Submit the following information:
      1. Product Data and shop drawings for remote meter base
      2. Product Data and shop drawings for service entrance switchboard with CT compartment. Refer to Section 262413 – Switchboards, for specifications and additional requirements.
      3. Letter of acceptance of material from Utility

PART 2 - PRODUCTS

2.1 METER ENCLOSURE
   A. Meter enclosure shall meet the requirements of the serving Utility. Installation shall be in vandal proof NEMA 3R enclosure with a lockable hinged door.
   B. The Contractor shall coordinate with the serving Utility on type of metering required and shall provide all labor and material necessary to meet the Utility requirements.

2.2 C.T. ENCLOSURE
   A. The CT enclosure shall be integrated into a separate compartment of the incoming Service Entrance Switchboard / Breaker.
2.3 SURGE ARRESTERS

A. Refer to requirements within Section 262413 – Switchboards, and Section 264300 – Transient Voltage Suppression.

PART 3 - EXECUTION

3.1 INSTALLATION – GENERAL

A. For service entrance switchboard / breaker, refer to Section 262413 – Switchboards

B. Secure meter base to mounting surface as recommended by the Manufacturer’s installation instructions.

C. Coordinate and provide labor and materials as necessary for utility primary and secondary service. Requirements shown or specified within the Contract Documents, which are deferred to the Utility after the Bid Date and not subsequently performed by the Contractor, shall be considered a basis for equitable adjustment to the Contract Price.

3.2 GROUND ELECTRODE SYSTEM

A. The grounded conductor and ground bus shall be connected to the grounding electrode system, via the grounding electrode conductor as indicated on system One-Line Diagram.

B. The grounding electrical system shall be bonded as indicated in Article 250 of the National Electrical Code.

END OF SECTION 262713
SECTION 262726 – WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY
A. This section covers furnishing and installing all receptacles, switches and other wiring devices indicated on the drawings.

1.2 STANDARDS AND CODES
A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS
A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.

B. Product Data shall be submitted for the following items
   1. Receptacles
   2. Plugs
   3. Switches
   4. Plug Strips
   5. Device plates

PART 2 - PRODUCTS

2.1 GENERAL
A. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with
captively held binding screws. Devices shall be brown except those located in finished areas, which shall be ivory.

2.2 **RECEPTACLES AND PLUGS**

A. **General:**

1. Receptacles shall be grounding type.

B. **120 Volt Receptacles:**

1. Indoor Clean Areas: Receptacles shall be duplex 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacles shall be Hubbell 5362, General Electric 4108-2, or equal. Where the manufacturer of cord connected equipment requires an isolated ground, a receptacle with isolated ground shall be provided. Isolated ground receptacles shall be Hubbell IG-5362, Arrow-hart 6766, or equal.

2. Outdoor, Process or Corrosive Areas: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacle and plug caps shall be corrosion resistant, marine duty. Covers shall be rated for “while-in-use” and installed per manufacturer’s directions. Manufacturer shall be Hubbell Series WP, or approved equal.

C. **Special NEMA Receptacles:**

1. Equipment-specific receptacles indicated by NEMA designator on the Contract Drawings by note or symbol use NEMA device numbers based on the best available information coordinated with the Design Team prior to Bid. The Contractor shall coordinate final device configurations required by individual equipment items prior to rough-in. Coordinate outlet devices for both Contractor-furnished and Owner-furnished equipment items.

D. **Plug Caps**

1. Male plug caps for 120 volt and 250 volt receptacles shall be of the cord grip armored type with heavy phenolic housing, of the same manufacture as the receptacle. Plug caps shall be rated 15 amperes. One plug cap shall be provided for every four receptacles furnished, with a minimum of two plug caps being provided. Plug caps shall be delivered to the Construction Manager.

E. **Three Phase Receptacles and Plugs:**

1. Receptacles shall be suitable for 480 volt, 3-phase, 4-wire service, with ampere ratings as specified. Receptacles and plugs shall be designed so that the grounding pole is permanently connected to the housing. The grounding pole shall make contact before the line poles are engaged when the plug is connected to the receptacle housing. The plug sleeve shall also make contact with the receptacle housing before the line and load poles make contact. Receptacles shall be provided complete with cast back box, angle adapter, gaskets, and a gasketed screw-type, weather tight cap with chain fastener. Each receptacle shall be provided with one plug. Receptacles shall be Crouse-Hinds “Arktite,” Appleton “Powertite,” or equal.
F. Receptacles for Hazardous Areas:

1. Receptacles for use in hazardous areas shall be rated in accordance with NEC for the area in which they are to be located and shall be factory sealed. Receptacles shall be designed so the plug must be inserted and turned before load is energized. Receptacles shall be provided with mounting box, sealing chamber, and compatible plug. Voltage and current ratings shall be as specified. Unless otherwise specified voltage and current ratings shall be 120 volts AC, 20 ampere. Receptacles shall be Appleton U-Line, Crouse-Hinds Ark-Gard 2, or equal.

2.3 SWITCHES

A. General Purpose (Indoor, Clean Areas):

1. General purpose switches shall be quiet AC type, specification grade, and shall be provided in accordance with rated capacities as required. Switches shall match receptacles in color. Switches shall be manufactured by General Electric, Hubbell, or equal, as follows:

<table>
<thead>
<tr>
<th>15A, 120-277V</th>
<th>20A, 120-277V</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.E. Co.</td>
<td>Hubbell</td>
</tr>
<tr>
<td>Single:</td>
<td></td>
</tr>
<tr>
<td>GE5931</td>
<td>1201</td>
</tr>
<tr>
<td>GE5933</td>
<td>1203</td>
</tr>
<tr>
<td>GE5934</td>
<td>1204</td>
</tr>
<tr>
<td>SPST momentary:</td>
<td></td>
</tr>
<tr>
<td>GE5953</td>
<td>1206</td>
</tr>
<tr>
<td>Three position center off momentary:</td>
<td></td>
</tr>
<tr>
<td>GE5935</td>
<td>1556</td>
</tr>
<tr>
<td>GE5951</td>
<td>1221</td>
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<td>GE5953</td>
<td>1223</td>
</tr>
<tr>
<td>GE5954</td>
<td>1224</td>
</tr>
<tr>
<td>--</td>
<td>1557</td>
</tr>
</tbody>
</table>

B. Switches for Outdoor and Corrosive Areas

1. Switches shall be 20 amp pressswitch type with weatherproof/corrosion resistant neoprene plate as manufactured by Hubbell or Arrow-Hart as follows:

<table>
<thead>
<tr>
<th>Hubbell with 17CM50 plate</th>
<th>Arrow-Hart with 2881 plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single pole:</td>
<td></td>
</tr>
<tr>
<td>1281</td>
<td>2991</td>
</tr>
<tr>
<td>Double pole:</td>
<td></td>
</tr>
<tr>
<td>1282</td>
<td>2992</td>
</tr>
<tr>
<td>3-way:</td>
<td></td>
</tr>
<tr>
<td>1283</td>
<td>2993</td>
</tr>
<tr>
<td>4-way:</td>
<td></td>
</tr>
<tr>
<td>1284</td>
<td>2994</td>
</tr>
</tbody>
</table>

2. Switches shall be mounted in “FS” type copper-free aluminum or PVC mounting boxes.

2.4 DEVICE PLATES

A. Indoor dry locations

1. Architecturally finished areas – Brushed 304 stainless steel faceplates with natural finish.
2. Unfinished indoor locations – Pressed galvanized steel plates with device knock-outs and natural finish.
B. Device plates in corrosive or outdoor areas shall be cast metal corrosion-resistant/marine-duty type of the same material as the device box.

C. Device plates for explosion-proof equipment shall be factory provided with the equipment.

D. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8 inch white characters on black background. Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

2.5 CAST IN PLACE FLOOR BOXES

A. Floor boxes shall be cast iron with non-metallic riser for cast in place construction. Shall accept conduits for both power and data.

B. System shall have a sub-plate system that will accommodate one duplex 20 ampere, NEMA 5-20R, and shall accept not less than two RJ-45 data jacks.

C. Cover plates shall be brass, flush mounted with hinged access covers.

D. Provide completes system as Hubbell series “SystemOne” or equal.

2.6 PLUG STRIPS

A. Plug strips shall be manufactured of sheet steel with the receptacles mounted on the front cover. The front cover shall be removable. Plug strips shall be Plugmold, or equal.

B. Plug strips for office areas shall have single 3 wire, 20 ampere grounding type receptacles mounted along the strip on a single circuit.

C. Plug strips for work benches in shop and in laboratory areas shall have 3 wire, 20 ampere grounding type duplex receptacles mounted along the strip on the circuits specified. Sufficient space shall be provided behind the receptacles for ten 12 AWG conductors in accordance with the NEC space rules.

PART 3 - EXECUTION

3.1 GENERAL

A. Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used to attachment.

B. Wiring devices shall be tested for correct connections.
3.2 POSITION OF OUTLETS

A. All outlets shall be centered with regard to building lines, furring and trim, symmetrically arranged in the room. Set outlets shall be set plumb and extend flush outlets to the finished surface of the wall, ceiling or floor without projecting beyond same. All receptacles, switches and outlets shown on the drawings shall be installed symmetrically along trim and where necessary, set the long dimension of the plate horizontal or gang in tandem.

3.3 MOUNTING HEIGHTS

A. Unless otherwise noted, wall mounted outlet devices shall generally be 24 inches above the floor, 18 inches in architecturally treated areas. Switches shall be 48 inches above the floor. All measurements are to centerline of device.

END OF SECTION 262726
SECTION 262800 – LOW VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies the requirements of all fuses and circuit breakers used in this project.

1.2 STANDARDS AND CODES
A. All materials and equipment specified herein shall within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label. All materials and equipment specified herein shall conform with all applicable NEMA, ANSI and IEEE standards.

1.3 SUBMITTALS
A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.

B. Submit product data for the following items
   1. Fuses
   2. Circuit Breakers
   3. Motor Circuit Protectors

PART 2 - PRODUCTS

2.1 FUSES
A. Fuses shall be of the type and amperage indicated on the drawings. The voltage rating shall be appropriate for the application indicated. The fuse types indicated on the drawings imply a certain set of fuse characteristics. No substitutions of fuse types will be allowed without written approval from the Engineer. Fuses in motor circuits which are indicated but not sized, shall be provided with manufacturer's recommended fuse size based on the actual motor installed. In-line or integrally-mounted fuse clips shall be provided on all control power or low-voltage transformers.

B. Fuses shall be Bussman, Gould Shawmut, Littlefuse, or Reliance.

2.2 MOLDED CASE CIRCUIT BREAKERS
A. Molded case circuit breakers shall be quick-make and quick-break type with wiping type contacts. Each breaker shall be provided with arc chutes and individual trip mechanisms on
each pole consisting of both thermal and magnetic trip elements. Two and three pole breakers shall be common trip. All breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Molded case circuit breakers shall be trip-free. Each breaker shall have trip indication independent of the ON or OFF positions.

B. Breakers shall be UL listed for accepting both copper and aluminum conductors. Circuit breakers lugs shall be capable of accepting the cable size indicated on the Drawings and in the Cable Schedule. Circuit breakers not capable of receiving the cable size shown without the use of cable terminators shall not be acceptable.

C. Breakers shall have the interrupting rating and trip rating indicated on the drawings.

2.3 MOTOR CIRCUIT PROTECTORS (MCP)

A. Application: for use in combination motor starter equipment where motor-protective thermal-overload elements are provided a separate component.

B. Shall be molded case design with quick-make and quick-break wiping type contacts. Each breaker shall be provided with arc chutes and individual trip mechanisms on each pole consisting of magnetic only instantaneous trip elements. Two and three pole breakers shall be common trip. Each MCP shall have trip indication independent of the ON or OFF positions.

C. Breakers shall be UL listed for accepting both copper and aluminum conductors. Circuit breakers lugs shall be capable of accepting the cable size indicated on the Drawings and in the Cable Schedule. Motor circuit protectors not capable of receiving the cable size shown without the use of cable terminators shall not be acceptable.

D. Breakers shall have the interrupting rating and trip rating indicated on the drawings.

2.4 USES

A. Breakers covered under this Specification may be installed in switchboards, panelboards, motor control centers, combination motor starters and individual enclosures.

2.5 ENCLOSURES

A. Unless otherwise shown on the drawings, enclosures for protective devices shall be NEMA rated for the environment in which they are installed as specified in Section 260500.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fuses and circuit breakers shall be installed in their respective enclosures and locations in such a manner as to insure tight connections so as to preclude arcing and overheating.
3.2 SPARES

A. A fuse puller or pullers shall be provided for all fuse sizes used.

B. A minimum of two spare fuses shall be provided for each fuse used.

END OF SECTION 262800
SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
7. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.
1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: one for each size and type.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NFPA 70.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Area Classification: As stated in Section 260500, Part 1.8.

1.9 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton / Cutler-Hammer or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
5. Or Substitution: Permitted.

B. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate required fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Basic Accessories: Provide the following accessory features.

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Lugs: Mechanical type, suitable for number, size, and conductor material.

D. Other Accessories: Where indicated or otherwise implied by the Contract Documents, provide the following accessory features.

1. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
2. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton / Cutler-Hammer or comparable product by one of the following:
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
5. Or Substitution: Permitted.

B. Type HD, Heavy Duty, Single Throw, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Basic Accessories: Provide the following accessory features.
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Lugs: Mechanical type, suitable for number, size, and conductor material.

D. Other Accessories: Where indicated or otherwise implied by the Contract Documents, provide the following accessory features.
   1. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   2. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

2.3 RECEPTACLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, Eaton / Cutler-Hammer or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.
   5. Or Substitution: Permitted.

B. Type HD, Heavy-Duty, Single-Throw Nonfusible Switch: UL 98 and NEMA KS 1; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

C. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.

D. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).
2.4 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton / Cutler-Hammer or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
5. Or Substitution: Permitted.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with one or more of the following field-adjustable settings as applicable:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I²t response.

F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

H. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.5 MOLDED-CASE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton / Cutler-Hammer or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
4. Square D; a brand of Schneider Electric.
5. Or Substitution: Permitted.

B. General Requirements: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Features and Accessories:

1. Standard frame sizes and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location. Refer to Section 260500, Part 1.8 – Area Classifications and Drawings for environments applicable to enclosure types.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.
3.3 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   3. Perform the following infrared scan tests and inspections and prepare reports:
      a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

END OF SECTION 262816
SECTION 262923 – VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies pulse width modulated (PWM) variable frequency drive (VFD) units, hereafter referred to as VFD’s, for operation on 460 volt, three phase, 60 cycle power systems. This section also specifies requirements for the provision of harmonic mitigation equipment required to address the current and voltage distortion effects caused by the application of VFD’s. See also section 263526.

1.2 RELATED SECTIONS

A. Section 263526: Active Harmonic Filters

1.3 ACCEPTABLE VFD CONFIGURATIONS

A. Power system compliance with all components of the most current version of IEEE 519 is mandatory when operating from the utility power source and shall be predicted by analysis and demonstrated by field testing. See section 263526.

1.  Basis of Design: 6 pulse VFD’s with line reactors and Active Harmonic Filters sized per Contractor-performed system analysis.

2.  12 pulse VFD’s with line reactors and with or without Active Harmonic Filters depending on system harmonics.

3.  18 pulse VFD’s with line reactors and with or without Active Harmonic Filters depending on system harmonics.

1.4 PROVIDER OF VARIABLE FREQUENCY DRIVES

A. VFD’s shall be provided by the Control System Integrator as specified in Division 40.

1.5 HARMONIC FILTERING EQUIPMENT

A. All projects that provide VFD’s shall provide harmonic filtering equipment per section 263526 unless system harmonics can be demonstrated by harmonic analysis and measurement to remain within the limits specified in the most current version of IEEE 519. The only acceptable harmonic filtering equipment shall be line reactors and Active Harmonic Filters as specified in Section 263526. Passive harmonic filters are not allowed.

B. A system harmonic analysis shall be performed and submitted to the Engineer. The harmonic analysis shall be performed by an analysis engineer routinely engaged in this type of analysis. The analysis and report shall bear the stamp of a professional engineer registered in the state of
Washington. The report shall indicate expected worst case system harmonics without mitigation, recommended harmonic mitigation equipment configuration, and expected system harmonics with mitigation equipment installed. The selected Harmonic filter equipment supplier shall provide the harmonic analysis per section 263526.

C. System harmonics shall be measured and analyzed at the time of system startup per the requirements of section 263526. The system harmonics measurements shall be conducted under the supervision of a professional engineer routinely engaged in this type of measurement and analysis. The system harmonic analysis and report shall be prepared by and shall bear the stamp of a professional engineer registered in the state of Washington. Findings shall be documented in a report and provided to the Engineer. In the event of non compliance with any provision of the most current version of IEEE 519 the contractor shall provide any and all additional harmonic filtering equipment required to comply with all components of IEEE 519 at no additional expense to the owner. No additional charges or additional time for the execution and completion of the project shall be granted and no penalties or liquidated damages, or other such fees shall be waived or relaxed in the event that the contractor must install harmonic mitigation equipment at the end of the project.

D. Provide 3% minimum line reactors for all VFD’s supplied unless specifically instructed to do otherwise by the Active Harmonic Filter supplier.

1.6 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.7 SUBMITTALS

A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.

B. In addition to the requirements of Section 260500, submittals shall include the following information:

1. Outline Dimensions with exterior and interior equipment elevation drawings.
2. Wiring diagrams with all interface points and terminal numbers clearly identified.
3. Specific information on the VFD’s components provided for this project and all optional equipment provided.
5. Maximum watts dissipated at nominal current.
6. Calculations specific to this installation predicting harmonic voltage distortion to be less than the values given in IEEE 519 for each odd harmonic (3rd, 5th, etc.), THD(V) less than 5%, and compliance with all other components of the most current version of IEEE 519 utilizing utility source. THD(V) requirement may be relaxed to 10% when utilizing stand-by power source.
7. Test plan and blank start-up form per Part 3.

1.8 COORDINATION

A. Coordinate all inputs and outputs with Control System Integrator per Division 40.
B. Coordinate all aspects of the VFD’s with Active Harmonic Filtering equipment per Section 263526.
C. The Contractor shall coordinate the installation of the VFD’s into the space provided and shown for them in the plans. The Contractor shall provide all additional equipment necessary for mounting and connection of all features and coordinate for the necessary space. If additional equipment is necessary for the proper operation of the VFD’s, including equipment for reducing harmonic distortion, it is the Contractor and Manufacturers responsibility to coordinate space and installation requirements for this equipment.

1.9 WARRANTY

A. The Contractor shall guarantee the VFD’s to be free of defects in design, materials and workmanship for a period of two (2) years following the date of acceptance, by formal action of the Owner, of all work under the contract. The guarantee shall include all parts and labor and shall be secured by a written guarantee from the Manufacturer to the Owner. The written guarantee shall be delivered to the Owner prior to date of acceptance of all work under the Contract.

PART 2 - PRODUCTS

2.1 GENERAL

A. The variable frequency drive (VFD) motor controller shall convert 460 volt, three-phase, 60 Hertz utility power to adjustable voltage (0 – 460 volt) and frequency (0 - 60 hertz) three-phase, AC power for stepless motor speed control with a capability of 10:1 speed range. All general options and modifications shall mount within the standard adjustable frequency controller enclosure.

B. The controller(s) shall be suitable for use with any standard configuration squirrel-cage induction motor(s) having a 1.15 Service Factor, or with existing standard squirrel-cage induction motor(s) with nameplate data as shown on the plans. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage, and RPM) in the field.
C. The variable frequency control shall operate satisfactorily when connected to a bus supplying other solid state power conversion equipment which may be causing up to 10% total harmonic voltage distortion and commutation notches up to 36,500 volt microseconds, or when all other VFD's and other harmonics producing equipment are operated simultaneously from the same bus.

2.2 HARMONICS

A. Power system harmonics shall comply with all components of the most current version of IEEE-519 for total and individual harmonic voltage and current distortion. Compliance shall be maintained during operation of any and all specified equipment configurations from the utility power source. THD(V) limits shall be relaxed to 10% when the facility is operated from the standby generator. The MCC Bus shall be the point of common coupling.

2.3 SERVICE CONDITIONS

A. The VFD shall be designed and constructed to operate within the following service conditions:

1. Elevation: To 3300 Feet
2. Ambient Temperature Range: 0°C to 40°C
3. Atmosphere: Non-Condensing relative humidity to 95%
4. AC Line Voltage Variation: -5% to +10%
5. AC Line Frequency Variation: ±3 Hertz

2.4 BASIC DRIVE

A. Description

1. The VFD shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.
2. The VFD shall have a continuous output current rating of 100% of motor nameplate current.
3. The VFD shall be a Pulse Width Modulated type with diode bridge rectifier front end to convert incoming fixed voltage/frequency to a fixed DC voltage. The front end rectifier assembly shall comply with section 1.03. All components for front end rectifier assembly including phase shifting transformers must be integral to VFD enclosure and require no additional installation costs. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage.
4. The inverter output shall be generated by Darlington power transistors or Insulated Gate Bipolar Transistors (IGBT) which shall be controlled by identical base driver circuits. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.
B. Selectable Drive Software

1. The VFD shall be software programmable to provide automatic restart after any individual trip condition resulting from either overcurrent, overvoltage, undervoltage, or overtemperature. The drive shall shut down and require manual reset and restart if the automatic reset/restart function is not successful within a maximum of three attempts within a short time period.

2. The VFD shall include a speed droop feature which shall reduce the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

3. The drive shall include a speed profile. Individual adjustable settings for start, stop, entry, slope, and minimum and maximum speed points. The drive shall include a process signal inverter, software selectable to allow speed of drive to vary inversely with input signal.

4. The drive shall be capable of picking up a spinning load. The VFD shall be able to determine the motor speed and resume control of a motor which is spinning in either direction without tripping.

C. External Communications Network

1. Provided with a factory assembled EtherNet/IP communications module(s) capable of providing direct connectivity the MCC or other Ethernet switches. Provide power monitoring as specified in Section 409011.

D. Keypad Operator Interface (Human Machine Interface – HMI)

1. The VFD shall be provided with a door mounted keypad which shall include the following:

   a. "POWER ON" light
   b. VFD "FAULT" light
   c. VFD "RUN" light
   d. Manual stop pushbutton
   e. Manual start pushbutton
   f. Fault reset pushbutton
   g. "AUTOMATIC" pushbutton
   h. Increase/decrease speed pushbuttons.

2. The door-mounted membrane keypad shall be provided with an integral 2-line minimum, 24-character minimum LCD display, which shall be capable of controlling the VFD and setting drive parameters, and shall include the following features:

   a. All diagnostic message and parameter values in English engineering units when accessed, without the use of codes.
   b. A "self-test" software program which can be activated to verify proper keypad operations.
   c. Allow the operator to enter exact numerical settings in English engineering units. A plain English user menu shall be provided in software as a guide to parameter setting (rather than codes). Drive parameters shall be factory set in EEPROM and
resettable in the field through the keypad. The EEPROM stored drive variables must be able to be transferred to new boards to reprogram spare boards.

d. Six (6) levels of password minimum.
e. Normally the digital display shall simultaneously display a minimum of the following parameters:

1) Speed demand in percent
2) Output current in amperes
3) Output frequency in hertz
4) Control Mode: Manual/Automatic
5) Output total three-phase KW
6) Output volts

2.5 ENCLOSURE

A. All VFD components shall be factory mounted and wired on a dead front, grounded, NEMA-1 enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad.

2.6 DRIVE PROTECTION

A. Faults / Short Circuits

1. The VFD shall be protected from single-phase fault or 3-phase short circuits on VFD output terminals without damage to any power component. Input power short circuit protection shall be a thermal magnetic circuit breaker mounted internal to the drive.

B. Overcurrent / Overvoltage

1. The VFD shall be protected from static instantaneous overcurrent and overvoltage trip with inverse overcurrent protection. The drive shall be provided with the following:

a. Static overspeed (overfrequency) protection.
b. Line or fuse loss and undervoltage protection.
c. Power unit overtemperature protection.
d. Electronic motor overload protection.
e. Responsive action to motor winding thermostatic switches.
f. LED monitor lamps for each inverter stage.
g. LED status indicators on regulator, printed circuit board face plates.
h. Isolated operator controls.
i. Input line fuses.
j. Be insensitive to incoming power phase sequence.
k. Have desaturation circuit to drive inverter section transistor base current to zero in event of controller fault.
l. Have DC bus discharge circuit for protection of operator and service personnel with an indicator lamp.
m. Input line noise suppression with line reactor (as required).
n. Individual transistor overcurrent protection.
2.7 PARAMETER SETTINGS

A. The VFD shall be provided with the following system configuring settings which shall be field adjustable through the keypad/display unit or via the serial communication port:

1. Motor Nameplate Data
   a. Motor frequency
   b. Number of poles
   c. Full load speed
   d. Motor volts
   e. Motor full load amps
   f. Motor kilowatts
   g. Current minimum
   h. Current maximum

2. VFD Operation Limits
   a. Independent acceleration/deceleration rates
   b. No load boost
   c. Output voltage minimum, output voltage maximum, output Volts/Hertz ratio.
   d. Full load boost
   e. Overload trip curve select (Inverse or Constant)
   f. Minimum/Maximum speed (frequency)
   g. Auto reset for load or voltage trip select
   h. Slip compensation
   i. Catch a spinning load select
   j. Overload trip time set

3. VFD Operation Parameters
   a. Voltage loop gain
   b. Voltage loop stability
   c. Current loop stability

4. Controller Adjustments
   a. Input signal scaling
   b. Input signal select (4-20mA/0-5 Volts)
   c. Auto start functions: On/Off, Delay On/Off,
   d. Level Select On/Off
   e. Speed Profile: Entry, Exit, Point Select
   f. Minimum, Maximum Speed Select
   g. Inverse profile select (allows VFD speed to vary directly or inversely with input signal.)

2.8 DIAGNOSTIC FEATURES AND FAULT HANDLING

A. The VFD shall include a microprocessor based digital diagnostic system that shall monitor its own control functions and displays faults and operating conditions.
B. A “FAULT LOG” shall record, store, display and print upon demand, the following data for the fifty (50) most recent events:

1. VFD mode (Auto/Manual)
2. Elapsed time (since previous fault)
3. Type of fault
4. Reset mode (Auto/Manual)

C. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2.7 millisecond intervals for the fifty (50) intervals immediately preceding a fault trip:

1. VFD mode (manual/auto/inhibited/tripped/etc.)
2. Speed demand
3. VFD output frequency
4. Drive inhibit (On/Off)
5. Motor amps
6. VFD output volts
7. Type of fault:
   a. Inverter Over/Temp.
   b. Over Voltage
   c. Detection Error
   d. Earth Leakage
   e. Watchdog
   f. PSU Power Fail
   g. Manual Test
   h. Out of Sat 1-6
   i. Software Fault
   j. Waveform Gen.
   k. Remote Watchdog
   l. Thermistor
   m. Sustained Overload
   n. Bypass SCR Trip
8. Drive inhibit (On/Off)

D. The fault log record shall be accessible via an RS232 serial link, per Standard TIA-232-F, as well as line by line on the keypad display.

2.9 DRIVE OPTIONS

A. The VFD shall be provided with the following options/modifications to the basic VFD unit. All special features shall be factory mounted and wired within the VFD enclosure unless otherwise specified.

1. Internally mounted input circuit breaker interlocked with the enclosure door, with through-the-door handle to provide positive disconnect of incoming AC power. The circuit breaker shall be rated for 25,000 AIC.
2. Door-mounted meters shall be provided on all units as listed below:
a. Analog ammeter (0% - 110%) with phase selector switch to measure source current.
b. Analog speed/frequency meter (0 - 110% speed as well as Hertz).
c. Analog voltmeter (0 - 600 volt AC) with phase selector switch to measure source voltage.
d. 5-digit elapsed time meter.

3. Isolated 4-20mA DC output signals proportional to speed and current for remote monitoring of the VFD.

2.10 SPARE PARTS

A. The drives shall be supplied with one set of 100% spare parts of each type of replaceable power part and logic cards (except main circuit breaker).

2.11 ACCEPTABLE MANUFACTURERS

A. VFD’s shall be Allen Bradley, Square D, Cutler-Hammer, or equal. Acceptable alternate Manufacturers must have a minimum of three (3) installations of VFD’s in Western Washington.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be the responsibility of the Contractor. The Contractor shall install the drive in accordance with the contract drawings and as recommended by the System Integrator, the VFD manufacturer, the harmonic filter equipment manufacturer, and as outlined in the installation manual.

B. Power and control wiring shall be completed by the Electrical Contractor. The Contractor shall complete all wiring in accordance with the recommendations of the System Integrator, the VFD manufacturer, the harmonic filter equipment manufacturer, and as outlined in the installation manual.

3.2 QUALITY ASSURANCE AND FACTORY TESTS

A. The controller shall be subject to tests including but not limited to the following quality assurance controls, procedures and tests:

1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
2. All printed circuit boards shall be tested at 50°C for fifty (50) hours. The VFD Manufacturer shall provide certification that the tests have been completed.
3. Every controller will be functionally tested with a motor to ensure that the unit will run properly when the drive is started up according to the instruction manual provided.
3.3 START-UP

A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A start-up test plan shall be submitted per Part 1. A certified start-up form shall be filled out for each drive with a copy provided to the Engineer, to the Owner, and a copy kept on file at the Manufacturer. A blank copy of the certified start-up test form shall be included with the test plan submittal per Part 1. Cost for this startup support shall be included in the VFD bid price. The Engineer shall be notified a minimum one (1) week in advance of the scheduled start-up.

B. The VFD’s shall be tested utilizing both utility and standby power sources. The VFD Representative shall make any and all adjustments and modifications to the VFD’s to operate within specified limits, without additional cost to the owner. The Manufacturer’s representative will be present during these tests.

C. VFD start-up shall be coordinated with and run coincidentally with the start-up and commissioning of harmonic filtering equipment per 263526. All adjustments and corrections needed to achieve satisfactory performance of the entire integrated system shall be complete for the VFD start-up to be considered complete. All harmonic distortion measurements and subsequently required system modifications shall be completed and the system tested and retested until the integrated system performs as required.

D. No additional payments or time for completion of the project shall be allowed and no waivers of any penalties, liquidated damages, or other fees shall be provided as a result of system modifications or adjustments necessary to comply with harmonic distortion requirements as specified in 263526.

3.4 OPERATION AND MAINTENANCE TRAINING

A. The Supplier shall conduct specifically organized training sessions in operation and maintenance of the VFD equipment for personnel employed by the Owner. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the system. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Setup and Calibration
4. Testing
5. Replacement of components.

B. At least two (2) training sessions, of at least four (4) hours in duration, shall be conducted after start-up of the system. The Supplier shall provide specific instruction materials for each training session and shall supply such materials to the Owner at least two (2) weeks prior to the time of the training.

END OF SECTION 262923
SECTION 263213 – ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies a packaged standby-power engine-generator set including diesel engine-driven generator with controls, output circuit breaker, weatherproof sound-attenuated enclosure, and all required auxiliary systems.

1.2 GENERAL

A. The generator set shall be a complete, factory-assembled power generating system including a diesel engine, radiator-type engine cooling system, engine exhaust system, engine fuel system, engine speed control system, engine starting system, generator, generator regulator system, control panel, main circuit breaker, structural steel support frame assembly, and all other components and ancillary devices required for a complete, operable system.

B. The generator set shall be designed by the Manufacturer and all components of the generator set shall be selected by the Manufacturer to:

   1. Be designed, equipped, installed, and selected for Optional Standby service as defined by the International Building Code (IBC)
   2. Be an integrated electrical generating system with compatible components and all required controls and appurtenances.
   3. Continuously produce the kVA demanded by the load described in 1.4 for any duration of interruption of the normal utility source.

C. The Generator shall be housed in a custom bidder-design skin-tight sound attenuated enclosure to meet performance criteria stated herein.

1.3 REGULATORY REQUIREMENTS

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.
1.4 REQUIRED PERFORMANCE

A. The output performance of the generator set shall be based on operation of the assembly with fan, battery charging alternator and all specified and required appurtenances.

B. The generator set shall be rated for continuous standby service, however the temperature rise of the generator shall not exceed 105 degrees C above a 40 degree C ambient, when producing full rated load for a continuous period of time.

C. The engine generator unit supplied must start a base load of 300kVA with additional step loading as defined in Section 409011 with a sustained RMS voltage drop no greater than 25% of rated phase to phase voltage during the starting period, but shall in no case be smaller than ratings indicated on the drawings. The starting period shall be from zero through the completion of the step loading as defined in Section 409011. The instantaneous voltage dip may be greater than 25% but shall not cause motor starter chatter or relay drop out or exceed a level which causes undesirable motor starting. If motor starting problems are encountered the size of the generator set shall be increased as required to reduce voltage dip until the motors can be started without problems. No additional cost shall be incurred by the Owner for the increased size of the generator set. The method of measurement shall be by light beam oscilloscope.

D. Frequency regulation shall be plus or minus 3 hertz maximum, no load to rated load. Voltage regulation shall be plus or minus 2% maximum.

E. The generator set shall be sized by the manufacturer to start and operate the load indicated herein while meeting the performance requirements set forth herein. The minimum acceptable engine generator set shall be capable of producing power for the loads and ratings indicated on the drawing at 0.8 power factor, continuously.

F. The generator set output voltage shall be 480Y/277 volts, 3 phase, 4 wire, 60 hertz.

1.5 SUBMITTALS

A. General:

1. Submit materials in accordance with Section 260500.

B. Product Data:

1. Technical data sheets for all components with the complete part number of the component clearly designated with all required options as specified in Part 2. Provide at a minimum one tab section for each product listed in Part 2 of this section.

2. Detailed specifications and standard operating characteristics of the engine, the generator and all components.

3. Weather-proof enclosure acoustical performance data based on proposed packaged unit for this project.

4. Certification by the manufacturer and documentation that appropriate linear and torsional vibration analyses have been performed and that engine and generator are compatible units.
5. Certification by the manufacturer and documentation that the generator set will meet or exceed the general requirements as specified in Part 1.2 of this Section and the required performance as specified in Part 1.4 of this Section.
6. Certification by the engine manufacturer of review and approval of the proposed engine application.
7. Seismic Qualification certificate and description of method used for compliance.
8. Warranty Certificate.

C. Shop Drawings: Shop Drawings shall be provided on 11” x 17” sheets (maximum) and shall be scaled using standard engineering or architectural scales. Submit the following:

1. Bill of materials showing quantity, manufacturer, catalog number, and the supplier name and phone number for all components.
2. Descriptive text schema for wire markers.
3. Detailed plan and elevation drawings of the generator set indicating overall dimensions and the specific location of all components, including the engine exhaust system, fuel tank, and enclosure.
4. Detailed drawings indicating installation requirements and the specific location of vibration isolators and seismic snubbers.
5. Detailed plan of the face of the control panel indicating overall dimensions and the specific location of all components.
6. Layout drawings showing conduit and cable entry areas, and anchoring points.
7. Detailed drawing showing generator plan and elevation views including all required Code clearances, ventilation clearances, as well as working clearances required for service and maintenance.
8. Scaled arrangement drawings of all panel-front and internal-mounted instruments, switches, devices, and equipment indicated. Show all mounting details required. Deviations from approved arrangements require resubmittal and approval prior to installation.
9. Wiring diagrams with details specific to this project showing all interface points and terminal numbers clearly identified.
10. Generator control schematic.
11. Engine control schematic.
12. Information on ratings and sizes of all equipment such as control transformers, fuses, breakers, heaters, etc. on the wiring diagrams.
13. Specific detailed information on the control features, their ranges, recommended set points etc.
14. Detailed specifications and drawings of the installation of the engine exhaust system.
15. Louver control schematic.
16. Installation details shall include the size, number, type and location of vibration isolators, seismic snubbers and anchor bolts; the size, number, type and location of interconnecting wiring and conduit; installation of the generator set and all appurtenances (including exhaust system), and other installation requirements. Shop drawings shall be submitted to the Contractor for review and approval.

D. Operation and Maintenance Materials

1. Operating and Maintenance Instruction materials
2. Start-up and Inspection reports
3. Spare Parts Receipt
E. Testing Materials:
   1. Draft copy of intended Test Forms and written test procedures. Requirement applies to factory and field testing activities, segregating activities for each.
   2. After break-in and testing of the generator set, the following project data shall be submitted by the Contractor:
      a. Certified results of testing of the engine by the engine manufacturer.
      b. Certified results of testing of the generator by the generator manufacturer.
      c. Certified results of break-in and testing of the generator set by the manufacturer of the assembly.

F. Demonstration Materials:
   1. Outline of field demonstration Agenda.
   2. Copy of written materials proposed for use in conjunction with field demonstrations.
   3. Completed minutes of demonstration activities including sign-in sheet of attendees

1.6 WARRANTY

A. The Contractor shall guarantee the generator set to be free of defects in design, materials and workmanship for a period of two (2) years following the date of acceptance, by formal action of the Owner, of all work under the contract. The guarantee shall include all parts and labor and shall be secured by a written guarantee from the manufacturer to the Owner. The final written guarantee shall be delivered to the Owner prior to date of acceptance of all work under the Contract.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The generator set shall be manufactured by one of the following acceptable manufacturers:
   1. Caterpillar
   2. Cummins Power Generation
   3. MTU/Detroit
   4. Kohler

B. The equipment of the manufacturer selected must fit within the space restrictions as shown on the plans and operate the equipment specified.

C. Other alternate equipment manufacturers not listed shall be considered by the Contractor only when specifically identified by Addenda issued prior to Bid. Acceptability of the manufacturers will be determined by the Owner. Other manufacturers which desire to be designated as acceptable shall deliver a detailed statement of qualifications to the Engineer at least twenty-one (21) calendar days prior to the scheduled bid opening. The statement of qualifications shall be in accordance with Division 1 and also include pertinent items listed in Paragraph G, Submittals, above and the following:
1. Description of company.
2. Resumes of principals and/or key employees.
3. Description of expertise in design, assembly, and installation of diesel engine-driven generator sets.
4. Description of generator sets designed, assembled and installed in the last ten (10) years. Description shall include:
   a. Names of employees involved in each system.
   b. Detailed description and drawings of each system.
   c. Cost of each system.
   d. Names and telephone numbers of persons involved in operation and maintenance of each system.
5. Description of the service capabilities normally provided by the company including resumes of employees assigned to field service and listing of service equipment.
6. Detailed plan and elevation drawings of the proposed generator set indicating overall dimensions and the specific location of all components, including the engine exhaust system.
7. Detailed specifications and standard operating characteristics of the engine, the generator and all components.
8. Additional information that may assist the Engineer in evaluation of the manufacturer and/or proposed generator set.

2.2 ENGINE

A. The engine shall be a liquid radiator-cooled, in-line or V-type, four-stroke cycle, compression ignition, diesel-fueled unit. The engine shall be fully and completely capable of and equipped for driving electrical generators. The specific model of engine selected by the manufacturer of the generator set shall have an acceptable history of successful similar applications.

B. The engine shall be equipped with an electronic governor which shall control the speed of the engine and generator. The speed shall be controlled to maintain the generator output frequency within 0.25 percent of rated frequency from no load to full load.

C. The engine shall be equipped for operation with ASTM D975, No. 2-D diesel fuel. The fuel system shall include a fuel pump and replaceable element fuel filter.

D. The engine shall be equipped with a pressurized oil lubricating system which shall include threaded, spin-on type, full flow lubricating oil filters which are located for easy removal. The lubricating system shall be equipped with spring-loaded bypass valves which will allow oil circulation if the filters are plugged.

E. The engine shall be equipped with a unit-mounted, radiator type cooling system which shall maintain the jacket water temperature at the level required for proper operation of the engine from no load to full load.

F. The engine shall be equipped with a block heater and water jacket heater(s) which shall be thermostatically controlled to maintain the coolant temperature at 120 degrees F and maintain block temperature for proper ignition.
2.3 GENERATOR

A. The generator shall be a brushless, revolving field type and shall be fully and complete capable of, and equipped to be driven by, a diesel engine and to produce the starting and running kVA demanded by the connected load. The generator subtransient reactance shall be less than 0.15 per unit. The specific model of generator, selected by the manufacturer of the generator set, shall have an acceptable history of successful similar applications.

B. The generator shall comply with NEMA MG 1-1998 Part 32. The generator shall be insulated to Class H requirements; however, the unit shall be designed so that the temperature rise of the unit will not exceed 105 degrees C over ambient temperature of 40 degrees C under continuous, full load conditions in accordance with NEMA MG1-1998-32.6. The generator shall be fully guarded in accordance with NEMA MG1-1998-1.25.

C. The generator shall be coupled directly to the engine flywheel through a flexible driving disc for positive alignment. The generator housing shall bolt directly to the engine flywheel housing and shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25 percent overspeed. The rotor shaft bearing shall be shielded type with provisions for easy servicing through grease pipes which extend to the exterior of the generator frame. The bearing shall be designed for a minimum B-10 bearing life of 40,000 hours.

D. A permanent magnet generator (PMG) shall provide excitation power to the automatic voltage regulator for immunity from voltage distortion caused by non-linear SCR controlled loads on the generator. The PMG shall sustain main field excitation power for optimum motor starting and to sustain short circuit current for selective operation and coordination of system overcurrent devices.

E. The automatic voltage regulator shall be temperature compensated, solid-state design. The voltage regulator shall be equipped with three-phase RMS sensing. The regulator shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The regulator shall include an under frequency roll off torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 Hz. The torque-matching characteristic shall include differential rate of frequency change compensation to use maximum available engine torque and provide optimal transient load response. Regulators that use a fixed volts-per-hertz characteristic are not acceptable.

2.4 CONTROL PANEL

A. The generator set shall meet or exceed NFPA 110 minimum requirements and be equipped with a control panel which includes the following minimum features:

1. Engine coolant temperature gauge
2. Engine lubricating oil temperature gauge
3. Engine lubricating oil pressure gauge
4. Engine running time meter
5. Battery charge ammeter
6. Engine/generator tachometer
7. Voltmeter
8. Ammeter
9. Ammeter-voltmeter phase selector switch
10. Frequency meter (45 to 65 hertz)
11. Voltage adjustment rheostat (minimum plus/minus 5%)
12. Individual indicating lights and dry contacts for:
   a. Generator running
   b. Selector switch in OFF position
   c. Selector switch in AUTOMATIC position
   d. High water temperature
   e. Low water temperature
   f. Low water level
   g. Low lubricating oil pressure
   h. Engine starting prohibited after three (3) cranking cycles
   i. Overspeed
   j. Generator run failure
   k. High battery voltage may be mounted on the battery charger
   l. Low battery voltage may be mounted on the battery charger
   m. Battery charger failure may be mounted on the battery charger
   n. Low fuel alarm
   o. Low fuel shutdown
   p. Common trouble alarm for all warning conditions above (dry contacts only)
   q. Common fail alarm for all conditions that cause the generator to shut down (dry contacts only)

13. Lamp test push-button for all indication lights listed above.

14. Three position (automatic/off/test) selector switch which shall:
   a. In the automatic position - allow the engine to automatically start when contacts in the transfer switch control circuit close and stop after the control circuit contacts open.
   b. In the off position - prohibit starting of the engine
   c. In the test position - cause the engine to start and remain in operation until the selector switch is moved to either of the other positions.
   d. Have a separate dry contact for each switch position.

15. An automatic starting system that shall cause and control operation of the engine starter motor until the engine has started. The starting system shall include manually adjustable timing circuits for control of the time of operation of the engine starter motor and the time from stopping of operation of the starter motor (after the engine has failed to start) to re-initiation of operation of the starter motor. The starting system shall enable the number of starting cycles to be manually selected and shall prohibit operation of the starter motor if the engine fails to start after three (3) starting cycles. The starting system circuitry shall include dry contacts for remote indication of generator set running and not running conditions.

16. Engine standby shutdown controls that shall include sensors and control circuits which shall stop operation of the engine when the engine coolant temperature rises to a preselected value, when the engine coolant drops below a preselected level, the engine lubricating oil pressure drops to a preselected value, when the fuel level reaches the critical low level, and the engine speed rises to a preselected value. The controls shall prohibit subsequent restarting of the engine until a reset switch is manually engaged.
17. The louver controls shall include control circuits which shall cause the intake and exhaust
louvers to open prior to starting of the engine and to close after the engine has stopped.

a. The louver shall spring open upon loss of power and motor closed. Louver
operators shall be chosen that will open the louvers within 15 seconds.
b. Engine starting shall be delayed for a field adjustable period of up to 15 seconds to
allow louvers to fully open. Time of closing shall be adjustable up to 5 minutes
after the engine has stopped. Louver controls shall operate by this procedure with
the selector switch in either the automatic or test position and in the exercise mode.

2.5 MAIN CIRCUIT BREAKER

A. A main line molded case 3-pole circuit breaker shall be installed in a NEMA-1 enclosure
adjacent to the generator control panel as a load circuit interrupting and protection device. It
shall operate both manually as an isolation switch and automatically during overload and short
circuit conditions. Include ground-fault protection as required by code for site-specific
application.

B. The trip unit for each pole shall have elements providing inverse time delay during overload and
instantaneous magnetic tripping for short circuit protection.

2.6 SUPPORT FRAME

A. The engine and generator shall be mounted on and supported by a welded support frame
fabricated of structural steel members. The support frame shall specifically be designed by
manufacturer to:

1. Resist bending forces and loads imposed by the engine and generator during
   transportation and during operation.
2. Limit torsional and bending movement caused by torque reactions
3. Prevent resonant vibration
4. Resist the bending and seismic loads per the IBC.

B. The support frame shall be mounted on and supported by spring-type vibration isolators and
shall be restrained by all-directional seismic snubbers as required by seismic conditions. The
isolators and snubbers shall be selected by the manufacturer. The manufacturer shall design the
support frame for incorporation of and attachment to the isolators and snubbers and shall define
all requirements for mounting of the isolators and snubbers on to the supporting surface.
Vibration isolation hardware placement and unit movement shall be coordinated with the
custom fabricated sound attenuated enclosure.

2.7 BATTERIES AND CHARGING SYSTEM

A. The engine shall be equipped with an electric starting system which includes a lead acid battery
set, an engine-driven battery charging alternator and appropriate electrical controls. The system
shall be minimum 12 volt. The batteries shall be mounted adjacent to the generator set on a
fabricated steel housing. Batteries shall be rated minimum 225 ampere-hours.
B. The battery charger shall be located on the generator frame or within the enclosure unless otherwise indicated on the plans. The battery charger shall include high and low voltage and failure status indication.

2.8 FUEL STORAGE TANK SYSTEM

A. The fuel storage tank system shall be a separately-mounted above-grade type and shall have fuel storage capacity to operate the generator at full capacity for 72 hour run-time at full load.

B. Refer to Section 231323 “Fuel Oil Distribution System” for additional fuel tank specifications.

C. The following fuel tank features and accessories shall be integrated with the generator set package:
   1. Low level fuel alarm
   2. Critical low fuel alarm, which shall also cause the generator engine to shutdown

D. The low level fuel alarm shall be set to trip when the fuel tank quantity reaches 33% of capacity.

2.9 EXHAUST SYSTEM

A. The exhaust system shall include a flexible stainless steel bellows exhaust pipe connection to the engine exhaust manifold, exhaust piping, silencer, exhaust pipe flashing, collar and rain cap and support system. Exhaust system components shall be of size(s) as recommended by the generator manufacturer. Specific requirements are as follows:
   1. Silencer shall be critical-rated unit in accordance with engine manufacturer’s recommendations.
   2. Flexible bellows exhaust pipe shall be seamless stainless steel exhaust pipe with a minimum length of 12 inches of bellows piping.
   3. Exhaust pipe shall be Schedule 40 steel and shall have welded or flanged end connections except connections at engine exhaust manifold and silencer shall be flanged or NPT. All elbows shall be long radius. Size shall be same as silencer end connections.
   4. Exhaust outlet shall include an operable rain-cap which excludes moisture when the unit is not in operation.

2.10 SOUND ATTENUATED ENCLOSURE

A. Generator set shall be completely enclosed in a high-performance sound attenuated enclosure. The enclosure shall be weatherproof and shall have a critical-grade muffler installed within the enclosure. The enclosure shall be rated minimum NEMA 3R.

B. Performance Criteria: The generator enclosure shall be designed to operate the generator set at 100% full load continuously up to an ambient temperature of 104 deg F without overheating or shutdown while maintaining a maximum 0.5 inch of water column of static pressure within the enclosure. Openings shall be screened to limit access of rodents into the enclosure. The enclosure shall include provisions to allow for lifting with spreader bars. Enclosure that will
comply with wind and snow loads demanded by local building codes. The enclosure shall be
designed to reduce the overall noise level at full load operation to a maximum of 70 dBA at any
location, 23ft from the generator set, in a free field environment.

C. Provide custom fabricated skin-tight drop-over enclosure with the following features:

1. Minimum 12-gauge galvanized sheet steel or aluminum construction.
2. Electrostatically applied paint, with baked enamel finish.
3. Stainless steel hardware.
4. Hinged doors and flush-mounted handles with stainless steel padlock eyes.
5. Roof overhangs to direct rain runoff.
6. Sealed collars surrounding the roof exhaust opening.
7. Baffles as required for sound attenuation as determined by analysis of published engine
data. The air intake shall be designed and constructed to minimize water penetration;
airflow velocity shall not exceed 1250 FPM.
8. Designed to withstand wind, snow and seismic loads as per IBC code.
9. Sufficient insulation to ensure acoustic performance is met and to be covered with a
galvanized steel perforated liner.
10. Fluorescent lights inside enclosure with switch mounted to the inside face of the
enclosure and near the strike-side of the control panel area access door. Provide four
single-lamp fixtures, each with one F32T8 lamps, full gasket, clear protective lens and
cold-weather ballast. Basis of design is Paramount Craft-Lite C0 Series.
11. Provide an integrated electrical AC branch-circuit panel to feed the generator set and
enclosure accessories.
   a. All electrical is mounted & wired to the distribution panel with surface mounted
      EMT galvanized conduit with EMT compression connections. Provide seal-tite
      flex raceway for vibration isolation where spanning components with differential
      movement.
   b. Panelboard shall be similar to Square-D Model QO Series. Provide integral SPD
      per Section 262400.
   c. Refer to one-line diagrams and Panel Schedules for voltage and ratings.
   d. Provide four 20 amp GFCI duplex receptacles inside the enclosure, and one WP
      GFCI convenience receptacle on the outside of the enclosure.
   e. All installed AC powered generator features shall be pre-wired into load center and
      control panel.

D. Large full swing opening doors to provide access to the engine, alternator, circuit breaker and
control panel.

1. Doors and hardware shall be provided furnished as follows:
   a. Door locks shall be provided
   b. Neoprene gasket single sealed around door perimeters
   c. Rain drip lips over all doors
   d. Bolting and mounting hardware will be stainless steel
   e. Include hold open latches and door strike panel or bumper
   f. Door thickness to maintain R values and acoustical noise levels

2. Paint requirements, All exterior galvanized surfaces will be: Custom color as determined
   by Architect.
a. Solvent cleaned per SSPC-SP1 and painted  
b. Primer - Epoxy (3 mils DFT)  
c. Finish - Polysiloxane or Acrolon Acrylic Polyurethane (2 mil DFT)  
d. Paint requirements, All carbon steel surfaces will be: Color to be determined  
e. Power tool cleansed per SSPC-SP1 and SSPC-SP3 and painted:  
f. Primer – Epoxy (3 mils DFT)  
g. Finish - Polysiloxane or KEM 400 Enamel CC-B26 (2 mil DFT)

3. Mechanical  
a. Oil and coolant lines piped to exterior of enclosure with ball valves  
b. Crankcase vent piped to exterior of enclosure.  
c. Fuel ‘fill and return’ lines piped to exterior of enclosure for remote or bulk fuel tank.

PART 3 - EXECUTION

3.1 INSTALLATION  
A. The generator set shall be installed by the Contractor, in accordance with the installation drawings and instructions prepared by the manufacturer. Installation shall be performed by workers who are skilled and experienced in the installation of generator sets and electrical systems.

B. It is the Contractors responsibility to ensure equipment assembly and installation provides necessary access and clearance requirements for the entire genset installation. Verify all mechanical and electrical clearance requirements are met.

3.2 INSPECTION AND VERIFICATION OF INSTALLATION  
A. After completion of the installation of generator set, the manufacturer shall inspect the installation and verify that all components and wiring are correctly installed. The manufacturer shall determine the exact scope and nature of work required to correct deficiencies and errors in the work and shall supervise the performance of such work.

1. Calibration: All components of the generator set shall be calibrated by the manufacturer after completion of installation. Each component shall be adjusted to be within the manufacturer's required range and for the specific application. Components that cannot be properly calibrated or that are found to exceed the manufacturer's specified range or accuracy shall be removed and replaced.

2. Start-Up: After installation of the generator set is completed, the generator set shall be placed into operation by the manufacturer. The manufacturer shall revise, modify, adjust and reprogram the various components as required during and following start-up to provide proper operation.
3.3 TESTING

A. Factory Testing

1. The actual engine and generator to be incorporated in the generator set shall be fully and completely tested by the manufacturer of each unit after manufacturing to determine specific operating characteristics. Testing of the engine shall be performed in accordance with procedures certified by an independent test laboratory. Testing of the generator shall be performed in accordance with IEEE Standard 115 and NFPA 110.

2. The assembled generator set shall be operated by the generator set manufacturer in the manufacturer's plant, to break in and test the unit. The sequence and each load level shall be as required by the engine manufacturer to properly break in and test the engine. The generator set shall be operated as required to verify and adjust the functioning of all other components.

B. On-Site Operation and Load Test

1. After the manufacturer has inspected and verified the generator installation, the generator set shall be tested by the manufacturer. All components of the generator set shall be fully and completely operated and tested under simulated power failure conditions and under a full load for a period of at least two continuous hours. Load banks shall be provided by the manufacturer of the generator set as required to simulate the connected facility load and to provide full load conditions. Operating temperature, load amperes and voltage shall be recorded every 30 minutes.

2. The on-site operation testing shall take place in the presence of the Engineer. The Contractor shall inform the Engineer a minimum of (5) days prior to the testing taking place. All controls and functions of the generator shall be operable and all auxiliary equipment shall be connected and all field wiring complete before the testing is to take place.

3. The generator set shall also be tested under full VFD operating conditions. The VFD representative will also be present at this test. The manufacturer shall be present during the VFD testing utilizing the generator as the power source. The manufacturer shall make any and all adjustments and modifications to the generator set to operate within specified limits with the VFDs, without additional cost to the owner.

3.4 OPERATION AND MAINTENANCE TRAINING

A. The generator set manufacturer shall conduct specifically organized training sessions covering operation and maintenance of the unit for the Owner’s personnel. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the unit. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components
6. Automatic mode operation
7. Manual mode operation
B. At least one two (2) training sessions, at least four (4) hours in duration, shall be conducted at the site after start-up of the system. The manufacturer shall prepare and assemble specific instruction materials for each training session and shall supply such materials to the Owner at least two (2) weeks prior to the time of the training.

3.5 OPERATION AND MAINTENANCE DATA

A. The manufacturer of the generator set shall prepare and assemble detailed Operation and Maintenance Manuals in accordance with the requirements of Section 260500. The manuals shall include, but not be limited to, the following:

1. Preventive maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components
6. Automatic mode operation
7. Programming
8. Manual mode operation
9. System schematics
10. As-built wiring diagrams of overall system
11. Catalog data and complete parts list for all equipment and control devices
12. Listing of recommended spare parts
13. Listing of recommended maintenance tools and equipment

3.6 MAINTENANCE SUPPORT PROGRAM

A. The manufacturer or local representative the generator set shall provide a maintenance support program covering all routine service maintenance and repair of the engine generator set for a period of one year from the date of acceptance. The cost of the maintenance support program shall be shown individually, but must be included in the engine generator total bid price.

B. Under the maintenance support program contract, the generator set manufacturer shall be solely and completely responsible for correction of all deficiencies and defects and shall make any and all repairs, replacements, modifications and adjustments as malfunctions or failure occur. The maintenance contract will cover the furnishing of all material, labor, testing equipment, load banks, tools, and transportation necessary to perform the preventative maintenance work herein described. The manufacturer or local representative shall stock common replacement parts (i.e. filter, etc.) for service or repair work for engines, generators, control panels, switchgear, and automatic transfer switches. The manufacturer or local representative shall be equipped with service technicians, tools, and transportation "on-call"; 24 hours a day, 365 days a year, to provide standby service.

C. It is the responsibility of the manufacturer or local representative to notify the Owner of the scheduled maintenance interval at least two (2) weeks prior to the actual performance of their contractual obligations. The Owner reserves the right to witness the evaluation, testing, and maintenance of the equipment at its discretion. It is the responsibility of the manufacturer or local representative to coordinate testing and preventative maintenance on the existing operational system.
D. Three (3) copies of the evaluation, testing, and preventative maintenance work shall be submitted no later than (14) days following the completion of the service interval. All site documentation shall be typed.

E. The reports shall contain but shall not be limited to:

1. Summary of findings and corrective work.
2. Recommendations of repairs, overhauls, and other maintenance work that should be scheduled prior to the next scheduled service interval.
3. Complete documentation of all test and inspection results on each significant item (i.e. engine, generator, transfer switch, and alarm functions).

F. As a minimum, the maintenance program shall include work as shown on the attached maintenance schedule. Any deletions from the schedule must be noted in writing as a part of the bid package.

3.7 MANUFACTURER FIELD SERVICE PERSONNEL SUPPORT CERTIFICATION

A. The engine-generator manufacturer shall have factory authorized distributorships nationwide with field service departments staffed by factory-trained field service technicians dedicated to startup, maintenance, and repair of engine-generator sets. The distributor shall be the authorized distributor of the represented engine-generator set package for the geographic area in which it is installed. The authorized distributor shall consist of local and regional offices with a local office located no more than 150 miles from the installation. The authorized distributor shall employ a minimum of 8 field service technicians with an assigned maintenance / repair vehicle located in the local office to handle multiple emergencies. Additional field service technicians shall be available from other local or regional offices located within 250 miles of the installation. If emergency service is required, response time shall be 4 hours or less, 365 days a year.

3.8 REPLACEMENT PARTS STOCKING CERTIFICATION

A. Replacement parts shall be available through a nationwide parts center network to ensure around-the-clock parts availability throughout the country. Recommended spare parts shall be stocked by the local field office with back-up available from national parts centers and manufacturing locations. Parts from a national parts center shall be shipped on the next available flight out and delivered to the customer’s site within 24 hours of placing the parts order.

END OF SECTION 263213

ATTACHMENT: ENGINE-GENERATOR SET MAINTENANCE SCHEDULE.
## ENGINE-GENERATOR SET MAINTENANCE SCHEDULE

### Air Intake

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<tr>
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<th>1 yr.</th>
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<tbody>
<tr>
<td>- for leaks</td>
<td>x</td>
<td>x</td>
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<tr>
<td>- air cleaner restriction</td>
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<td>x</td>
</tr>
<tr>
<td>- piping and connections</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>- crankcase breather</td>
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<td>x</td>
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<tr>
<td>- or change air cleaner element</td>
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<td>- fuel level/take sample</td>
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<td>- sediment from tanks &amp; filter</td>
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<td>- float tank breather</td>
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### Clean

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<td>x</td>
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<tr>
<td>- for exhaust restriction</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>- turbocharger bearing clearances</td>
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### Torque

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### Clean

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<td>- turbocharger comp. wheel and diffuser</td>
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### Electrical

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<td>- battery charging system</td>
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<td>- battery electrolyte level and specific gravity/check battery voltage</td>
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</tr>
<tr>
<td>- safety controls and alarms</td>
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### Engine Related

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<td>- for unusual vibration</td>
<td>x</td>
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<tr>
<td>- tighten mounting hardware</td>
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## ENGINE-GENERATOR SET MAINTENANCE SCHEDULE

### Page 2

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SECTION 263526 – ACTIVE HARMONIC FILTERS (AHF)

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies requirements for the analysis of power system harmonic distortion and the application of Active Harmonic Filters, subsequently referred to as AHF’s, to reduce power system harmonic distortion to acceptable levels.

1.2 ESTABLISHMENT AND VERIFICATION OF NEED FOR AHF EQUIPMENT

A. All projects which include VFD’s or other harmonics producing power equipment shall assume the requirement for an Active Harmonic Filter system to mitigate the harmonics created by the equipment. The contractor shall undertake to provide a system harmonic analysis to establish the level of harmonic mitigation required. The analysis shall be submitted to the engineer for review. The acceptability of the analyst and the analysis shall be at the discretion of the engineer. Upon verification of the need for harmonic mitigation and selection of an AHF equipment vendor, the chosen vendor shall provide a harmonic analysis of the system and recommendations for AHF equipment and configuration. The analysis shall predict power system harmonics without mitigation equipment installed as well as system harmonics with the recommended equipment installed. It is recommended that the preferred AHF equipment vendor also provide the initial power system harmonic analysis stated above.

B. Acceptance of the harmonic analysis by the Owner and Engineer shall not imply or be construed to constitute approval of the contractor’s harmonic mitigation approach. Acceptability of the Contractor’s installation and harmonic performance shall depend entirely on the actual start-up measurements and analysis performed prior to system commissioning.

C. The Contractor shall be responsible for all required coordination between the subcontractors, the VFD supplier and manufacturer, the harmonic filtering equipment supplier and manufacturer, the serving electric utility company, the standby generator manufacturer, and the harmonic measurement and analysis consultants.

D. Harmonic testing and analysis of the facility at startup shall be required per section 3.03-D for installations which include and which do not include AHF equipment. Additional equipment required to achieve IEEE 519 compliance shall be provided at no additional cost to the owner in the event that system harmonic testing reveals noncompliance with any aspect of IEEE 519.

E. System harmonics measurements shall be conducted under the supervision of a professional engineer routinely engaged in this type of measurement and analysis. The system harmonic analysis and report shall be prepared by and shall bear the stamp of a professional engineer registered in the State of Washington.

F. No additional charges or additional time for the execution and completion of the project shall be granted and no penalties, liquidated damages, or other such fees or costs shall be waived or relaxed in the event that the contractor must install harmonic mitigation equipment at the end of
the project. The Contractor shall bear the full burden of all costs associated with shutdowns, utility charges or refusal to serve the facility, delays and any associated impacts, additional permits and inspections, additional testing and analysis, etc. which result from the need to install additional equipment due to failure to comply with harmonic distortion limits as specified herein.

G. VFD start-up shall be coordinated with and run coincidentally with the start-up and commissioning of harmonic filtering equipment. All adjustments and corrections needed to achieve satisfactory performance of the entire integrated system shall be complete for the VFD and system start-up to be considered complete. All harmonic distortion measurements and subsequently required system modifications shall be completed and the system tested and retested until the integrated system performs as required.

H. The cost of all harmonic analysis and testing shall be included in the Contractors bid

1.3 PROVIDER OF THE AHF’s, HARMONIC ANALYSIS, AND HARMONIC MEASUREMENTS

A. Active Harmonic Filtering equipment characteristic shall be coordinated with VFD (or other rectifier front end) equipment. It is recommended that the provider of the VFD’s (or other rectifier front end equipment) also provide the AHF’s. It is required that the supplier of the AHF’s provide the required power system harmonic analysis submittals and the required power system harmonic measurements at the time of system startup.

1.4 STANDARDS

A. The power correction systems shall be designed in accordance with the applicable sections of the following documents. Where a conflict arises between these documents and statements made herein, the statements made in this specification shall govern.

2. CSA 22.2, No. 14 & 66, CSA requirements for power electronics
3. ANSI IEEE std 519-1992, Harmonic limits
4. UL 508C, UL requirements for power conversion equipment
5. IEC 529, IP20 (NEMA 1), type of enclosure
6. ICBO Building Code, Section 16, Seismic Zone 4 Vibration Standard

B. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

C. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

D. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at
the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price

1.5 SUBMITTALS

A. Submit all catalog data in accordance with the Submittals requirements in Section 260500. Show material information and confirm compliance with these specifications.

1. In addition to the requirements of Section 260500, submittals shall include the following information:

   a. Calculations specific to this installation showing compliance with all components of the most current revision of IEEE 519. Calculations shall predict with a high level of confidence and accuracy that harmonic voltage distortion will be less than the values given in IEEE 519 for each odd harmonic (3rd, 5th, etc.), total harmonic voltage distortion THD(V) will be less than 5%, and total current demand distortion TDD will be less than 5% when operating from the utility power source. THD(V) limits may be relaxed to 10% for operation from the standby generator.

   b. Submit AHF manufacturer and product line even if initial harmonic analysis indicates harmonic mitigation is not needed for pre approval purposes.

   c. Outline Dimensions with exterior and interior equipment elevation drawings, installed weight, and heat dissipation for each size unit provided.

   d. Wiring diagrams with all interface points and terminal numbers clearly identified.

   e. Specific information on all optional equipment provided.


   g. Maximum watts dissipated at nominal current.

   h. System configuration in a single line diagram.

   i. Detailed layouts of customer power and control connections.

   j. Detailed installation drawings including all terminal locations.

   k. Technical brochure detailing the standard features of the AHF.

   l. Start-up test procedure including blank start-up certification form per Part 3

2. Submittals upon delivery of power correction system shall include:

   a. Complete set of corrected proposal submittal drawings.

   b. Two (2) sets of Installation and Operation Manuals. Manuals shall include a functional description of equipment with block diagrams, safety precautions, installation instructions, start-up instructions, and troubleshooting guide.

   c. Factory test report

3. Submittals at startup completion


1.6 COORDINATION

A. The contractor shall be responsible for all required coordination between the subcontractors, the VFD supplier and manufacturer, the harmonic filtering equipment supplier and manufacturer,
the serving electric utility company, the standby generator manufacturer, and the harmonic measurement and analysis consultants.

B. In the event that the VFD’s (or other rectifier front end power equipment) and AHF’s are provided by different parties it shall be the responsibility of each party jointly and separately to coordinate requirements, characteristics, and interconnections of the AHF’s as it relates to the VFD’s (or other rectifier front end power equipment), the electrical system, and the control system.

C. Coordinate all signal inputs and outputs with Control System Integrator in Division 25.

D. Coordinate AHF equipment connection and sensing with Electrical Contractor in Division 26.

E. Coordinate AHF equipment characteristics with rectifier front end power equipment, service characteristics and the serving utility, and the standby generator per Division 26.

F. Coordinate AHF system start-up and commissioning, system harmonic measurement and analysis, and VFD startup and commissioning.

G. The Contractor shall coordinate the installation of the AHF’s into the space provided and shown for them in the plans. The Contractor shall provide all additional equipment necessary for mounting and connection of all features and coordinate for the necessary space. If additional equipment such as line reactors etc. are necessary for the proper operation of the AHF’s and the system, it is the Contractors and Manufacturers responsibility jointly and separately to coordinate the provision, space, and mounting requirements for this equipment.

1.7 QUALITY ASSURANCE

A. Prior to shipment, the manufacturer shall fully test the performance at full current and voltage while functioning as a harmonic correction device to assure compliance with equipment specifications defined herein. A certified report shall be provided to the owner of successful completion of performance tests.

1.8 WARRANTY

A. The AHF system manufacturer shall warrant products against defects in material and workmanship for a period of two (2) years from date of shipment.

B. The Contractor shall guarantee the AHF’s to be free of defects in design, materials and workmanship for a period of two (2) years following the date of acceptance, by formal action of the Owner, of all work under the contract. The guarantee shall include all parts and labor and shall be secured by a written guarantee from the Manufacturer to the Owner. The written guarantee shall be delivered to the Owner prior to date of acceptance of all work under the Contract.
PART 2 - PRODUCTS

2.1 GENERAL

A. The purpose of Active Harmonic Filters is to reduce current harmonics and correct power factor on low voltage electrical systems. This specification defines the electrical and mechanical characteristics for AHF systems required to comply with all components of the most current revision of IEEE 519.

2.2 SYSTEM DESCRIPTION

A. Voltage: 480 volts, 3 phase, 3 wire plus ground.

B. Output Load Capacity: Rated capacity shall be the specified current capacity at the voltage required as indicated on the electrical drawings.

C. Field Installable Capacity Upgrade: Additional power correction capacity shall be added by installing additional units in parallel to previously installed power correction units or systems. A maximum of 10 units shall be installed in parallel per set of current transducers. Any and all units shall be installed in parallel as a standard function of the power correction system design.

D. Current Transducers:
   1. Split core type current transducers shall be installed per manufacturers instructions and recommendations.
   2. Two current transducers per power correction system location are required and mounted on phases A & B.
   3. Current ratings of the current transducers shall be according to full load current of the circuit on which installed.
   4. Current transducers rated for 400 hertz shall be used.

2.3 MODES OF OPERATION

A. The AHF system shall have operation modes as follows.

   1. The power correction system shall be designed to electronically inject harmonic current to cancel load produced harmonic current such that the upstream power harmonic current and voltage are reduced to below 5% TDD and 5% THD(V), respectfully. TDD as used herein refers to the total load demand of the applied circuit. The applied circuit may be a single nonlinear load, a distribution-bus with multiple loads, or the facility load at the point-of-common coupling (PCC) with the power source. The power correction system shall be capable of correcting for all types of nonlinear loads. Refer to electrical one-line drawings for specific locations.
   2. Reactive current compensation (aka displacement power factor correction) shall be activated or deactivated via a digital keypad/display mounted on the door of the enclosure.
   3. Both A. and B. above: When both harmonic and reactive current compensation is activated, the power correction system shall first perform harmonic current correction and
then use the remaining capacity to inject reactive current compensation to attain the specified level herein defined.

2.4 PERFORMANCE REQUIREMENTS

A. Input Power:
   1. Voltage: automatically adapted to 208 - 480V, 3 phase plus ground
   2. Voltage Tolerance: +/- 10% of nominal
   3. Frequency: automatically adapted to 50 or 60 Hz, +/- 3 Hz
   5. Input Fuses: Rated at 200,000 AIC (amperes interrupting capacity), Class T
   6. The system shall meet the requirements of the most current version of IEEE-519 for total and individual harmonic current and voltage distortion under conditions of individual or simultaneous operation of the VFD's (or other rectifier front end power equipment)

B. Output Performance
   1. Performance of the power correction system shall be independent of the impedance of the power source. All performance levels shall be attained whether on the AC lines, backup generator, or output of UPS.
   2. Harmonic Correction:
      a. Limit the 2nd through 50th order harmonic current to <5% TDD at each installed location indicated herein. Harmonic levels for individual harmonic orders shall comply with respective levels established in ANSI/IEEE std 519-1992, Table 10.3.
      b. Limit the THD(V) added to the electrical system immediately upstream of the power correction system location(s) to less than or equal to 5%. The power correction system shall not correct for utility supplied voltage distortion levels.
      c. Reactive Current Compensation: reactive current correction is required to maintain a set point of .95 lagging displacement power factor or better under all load conditions. Reactive current compensation shall be dynamic and shall never cause leading displacement power factor to occur.

C. Current Transducers
   1. Current transducers shall be rated for the total rated rms current of the total load at each installed location or higher.
   2. Two current transducers, mounted on phases A and B, are to be installed per location.
   3. Each current transducer shall have a current output of 5 amperes. Current capacity of each current transducer shall be 5000, 3000, 1000 or 500, as required for the electrical system where installed. No other ratings are acceptable.
   4. Each current transducer shall be rated for 400 hertz.

2.5 ENVIRONMENTAL CONDITIONS

A. The power correction system shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics or life.
1. Operating Ambient Temperature: 0 degrees C to 40 degrees C (32 degrees F to 104 degrees F).
2. Storage Temperature: -40 degrees C (-40 degrees F) to 65 degrees C (149 degrees F).
3. Relative Humidity: 0 to 95%, non-condensing.
4. Altitude: Operating to 1000 meters (3300 ft). Derated for higher elevations.
5. Audible Noise: Generated by power correction system not to exceed 65 dbA measured 1 meter from surface of unit.

2.6 ENCLOSURE

A. Each power correction unit shall be provided in an IP-20 (aka NEMA 1) rated enclosure. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad.

B. All units shall meet IBC Seismic vibration requirements when installed according to installation requirements defined by the vendor.

C. Units rated 100 amperes and under for total output current shall be designed for wall mounting with cable entry through the bottom. Units rated greater than 100 amperes for total output current shall be freestanding for mounting to the floor with cable entry though the top.

D. When indicated in the electrical-mechanical drawings, the power correction system shall be mounted in the motor control centers or power distribution panels.

E. Freestanding units shall include a door-interlocked disconnect that provides power interruption when the door is opened. Disconnect shall be lockable in the power-off position. Wall mount units shall be disconnected from the power source by a disconnect device or circuit breaker contained in the power distribution center as defined by local and national codes for branch circuit protection.

F. Freestanding units shall include lifting provisions by forklift truck and lifting lugs. Wall mount units weighing more than 80 pounds shall have lifting lugs.

G. All units shall include 200,000 AIC rated fuses with Class T actuation.

H. All units shall be provided with a grounding lug. Grounding by the contractor is to be performed according to local and national standards.

I. The paint shall be the manufacturer’s standard type and color.

2.7 OPERATOR CONTROLS AND INTERFACE

A. All units shall include a digital interface model (DIM) that includes an alphanumeric display consisting of 2-lines minimum with 20 characters minimum per line. All information shall be in English. Display shall be easily viewed under all lighting conditions, including sunlight, as found inside buildings.

B. Operators include run, stop, setup, enter, and up/down scroll.
C. The display shall provide operating data while functioning. Standard operating parameters available for display are AC line voltage, total rms load current, harmonic current of load, reactive current of load, output harmonic and reactive current of AHF system.

D. When the output of the AHF unit is at full rated capacity, the display shall indicate at-maximum capacity and actuate an at-maximum capacity relay.

E. All fault conditions shall be displayed as they occur. Diagnostic information shall be provided in English and clearly indicate the nature of the fault.

F. The run pushbutton shall include a green LED. LED shall be lighted when unit is operating.

G. Contacts shall be provided for operator information for power-on, run, fault and at-maximum capacity. Each contact shall be rated for 10 amperes at 120/240 volts. One form C contact shall be provided for each relay.

H. An RS485 serial data link, per Standard TIA/EIA 485, shall be provided for ModBus TCP/IP communications. A separate RJ45 jack, per Standard ANSI / TIA 1096-A, shall be provided for Ethernet connectivity to access the imbedded web server via standard PC browser software.

2.8 DESIGN

A. All AHF units shall be defined as a power electronic device consisting of power semiconductors that switch into the AC lines to modulate its output to cancel detrimental harmonic and/or adjust reactive currents. A DC bus shall store power for power semiconductor switching. A microprocessor shall control the operation of the power converter.

B. Each unit shall be designed with a current limiting function to protect the semiconductors. When this level is attained, a message shall be displayed indicating the output capacity is at-maximum capacity and actuate the at-maximum capacity relay. Operation shall continue indefinitely at this level without trip off or destruction of the power correction unit.

C. Each unit shall incorporate an over-temperature output roll back that reduces the total output current in order to maintain maximum current correction within the electrical system.

D. Two distinct levels of faults shall be employed. Non-critical level faults will provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action.

E. Faults such as AC line over voltage, AC line under-voltage, AC line power loss, and AC line phase imbalance shall be automatically restarted. Upon removal of these fault conditions, the power correction system shall restart without user action. Automatic restart will not occur if 5 faults have occurred in less than 5 minutes. During the fault condition, except line loss, the display shall state the type of fault and indicate that automatic restart will occur. The run relay and run LED shall be disabled. The fault relay shall not be enabled unless time out occurs. Upon AC line loss, the power-on relay shall be disabled and no display shall be provided.

F. All other types of faults shall be considered critical and stop the power correction system. The display shall indicate the fault condition and “stop.” The run LED and relay shall be disabled
and the fault relay enabled. User shall be required to initiate a power reset (turn power off and on) to restart the power correction system.

G. The logic of the power correction system shall monitor the load current by utilizing two (2) current transducers (CTs) mounted on phases A and B (3 CTs for 4 wire systems) to direct the function of the power electronic converter. The ratio of the CTs must be entered into the logic via the digital keypad/display to calibrate the operation of the power correction system. The output of the current transducers shall be 5 amperes.

H. Up to 10 power correction units may be installed in parallel to inject current according to the information received from one set of CTs. The units will function independently. If one unit is stopped or faulted, the remaining units will continue to maintain harmonic cancellation levels up to the capacity of the remaining units.

2.9 LINE REACTORS

A. Provide 3% minimum line reactors for each rectifier front end power device unless specifically directed otherwise by the supplier of the AHF system.

2.10 ACCEPTABLE MANUFACTURERS

A. The Active Harmonic Filter System shall be Schneider Electric Accusine Power Correction System, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be the responsibility of the Contractor. The Contractor shall install the drive in accordance with the contract drawings and as recommended by the Manufacturer.

B. Power and control wiring shall be completed by the Electrical Contractor. The Contractor shall complete all wiring in accordance with the recommendations of the Manufacturer.

3.2 QUALITY ASSURANCE AND FACTORY TESTS

A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:

1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
2. All printed circuit boards shall be tested at 50°C for fifty (50) hours. The Manufacturer shall provide certification that the tests have been completed.
3. Every unit shall be functionally tested to ensure proper operation.
3.3 START-UP

A. Certified factory start-up shall be provided for each AHF by a factory authorized service center. A certified start-up form shall be filled out for each AHF with a copy provided to the Engineer, Owner, and a copy kept on file at the Manufacturer. Cost for this startup support shall be included in the AHF system bid price. The Engineer shall be notified a minimum one (1) week in advance of the scheduled start-up.

B. The AHF’s shall be tested utilizing both Utility and standby power sources. The AHF Representative shall make any and all adjustments and modifications to the AHF’s to operate within specified limits, without additional cost to the owner. The Manufacturer’s representative will be present during these tests.

C. The following inspections, measurements, analysis, and test procedures shall be performed by factory trained field service personnel and qualified consultants during startup.

1. Visual Inspection
   a. Inspect equipment for signs of damage.
   b. Verify installation per drawings.
   c. Verify ground conductors are properly sized and configured.
   d. Verify current transducer orientation and wiring to power correction system.
   e. Verify logic setup corresponds to performance specifications defined herein.

2. Mechanical Inspection
   a. Check all control wiring connections for tightness.
   b. Check all power wiring connections for tightness.
   c. Check all terminal screws, nuts, and/or spade lugs for tightness.

3. Electrical Inspection
   a. Check all fuses for continuity.
   b. Confirm input voltage and verify unit match.
   c. Check current transducers for proper phase location and orientation.

4. Site Harmonic Measurement, Analysis, and Corrective Action (if required)
   a. The manufacturer shall provide field test personnel to initialize all equipment. A 3 phase harmonic analyzer shall be used to measure TDD and THD(V) levels to verify performance to the specifications defined herein. Test reports shall be prepared for each point of test. Test reports shall be documented, signed, and dated. All tests shall be submitted to the Engineer.
   b. System harmonics measurements shall be conducted under the supervision of a professional engineer routinely engaged in this type of measurement and analysis. The system harmonic analysis and report shall be prepared by and shall bear the stamp of a professional engineer registered in the state of Washington.
   c. No additional charges or additional time for the execution and completion of the project shall be granted and no penalties, liquidated damages, or other such fees or costs shall be waived or relaxed in the event that the contractor must install harmonic mitigation equipment at the end of the project.
d. The contractor shall bear the full burden of all costs related to shutdowns, utility charges or utility refusal to serve the facility, delays of any kind, additional permits and inspections, additional testing and analysis, complaints from the community, etc. which result from failure to comply with harmonic distortion requirements as specified herein and the subsequent need to install additional equipment.

e. VFD start-up shall be coordinated with and run coincidentally with the start-up and commissioning of harmonic filtering equipment. All adjustments and corrections needed to achieve satisfactory performance of the entire integrated system shall be complete for the VFD and system start-up to be considered complete. All harmonic distortion measurements and subsequently required system modifications shall be completed and the system tested and retested until the integrated system performs as required.

3.4 OPERATION AND MAINTENANCE TRAINING

A. The Supplier shall conduct specifically organized training sessions in operation and maintenance of the AHF equipment for personnel employed by the Owner. The training sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the system. Training shall include, but not be limited to, the following:

1. Preventive maintenance procedures
2. Trouble-shooting
3. Setup and Calibration
4. Testing
5. Replacement of components.

B. At least two (2) training sessions, of at least four (2) hours in duration, shall be conducted after start-up of the system. The Supplier shall provide specific instruction materials for each training session and shall supply such materials to the Owner at least two (2) weeks prior to the time of the training.

END OF SECTION 263526
SECTION 264300 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL DISTRIBUTION SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Surge Protective Device (SPD) equipment having the electrical characteristics, ratings, and modifications as specified herein. To maximize performance and reliability and to obtain the lowest possible let-through voltages, the ac surge protection shall be integrated into electrical distribution equipment such as switchboards, panelboards, and motor control centers.

1.2 RELATED SECTIONS

A. Section 262413 – Switchboards
B. Section 262416 – Panelboards
C. Section 262419 – Motor Control Centers

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL). Compliance may be in the form of a file number that can be verified on UL’s website or on any other NRTL’s website, as long as the website contains the following information at a minimum: model number, SPD Type, system voltage, phases, modes of protection, Voltage Protection Rating (VPR), and Nominal Discharge Current (Iₘₙ).
   3. Descriptive bulletins
   4. Product sheets

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

E. Manufacturers:

1. Eaton / Cutler-Hammer
2. Square-D
3. GE

2.2 VOLTAGE SURGE SUPPRESSION - GENERAL

A. Electrical Requirements

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall not be less than 115% of the nominal system operating voltage.
3. The suppression system shall incorporate thermally protected metal-oxide varistors (MOV s) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
4. Protection Modes – The SPD must protect all modes of the electrical system being utilized. The required protection modes are indicated by bullets in the following table:

<table>
<thead>
<tr>
<th>Protection Modes</th>
<th>L-N</th>
<th>L-G</th>
<th>L-L</th>
<th>N-G</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wye</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Delta</td>
<td>N/A</td>
<td>●</td>
<td>●</td>
<td>N/A</td>
</tr>
<tr>
<td>Single Split Phase</td>
<td>●</td>
<td>●</td>
<td>●</td>
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</tr>
</tbody>
</table>

5. Nominal Discharge Current ($I_n$) – All SPDs applied to the distribution system shall have a 20kA $I_n$ rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage. SPDs having an $I_n$ less than 20kA shall be rejected.
6. **ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR)** – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

<table>
<thead>
<tr>
<th>Modes</th>
<th>208Y/120</th>
<th>480Y/277</th>
<th>600Y/347</th>
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<td>1500</td>
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<tr>
<td>L-L</td>
<td>1200</td>
<td>2000</td>
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</table>

B. **SPD Design**

1. **Maintenance Free Design** – The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

2. **Balanced Suppression Platform** – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules shall not be accepted.

3. **Electrical Noise Filter** – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.

4. **Internal Connections** – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

5. **Monitoring Diagnostics** – Each SPD shall provide the following integral monitoring options:

   a. **Protection Status Indicators** - Each unit shall have a green / red solid-state indicator light that reports the status of the protection on each phase.

      1) For wye configured units, the indicator lights must report the status of all protection elements and circuitry in the L-N and L-G modes. Wye configured units shall also contain an additional green / red solid-state indicator light that reports the status of the protection elements and circuitry in the N-G mode. SPDs that indicate only the status of the L-N and L-G modes shall not be accepted.

      2) For delta configured units, the indicator lights must report the status of all protection elements and circuitry in the L-G and L-L modes.

      3) The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
b. Remote Status Monitor – The SPD must include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition.

c. Audible Alarm and Silence Button – The SPD shall contain an audible alarm that will be activated under any fault condition. There shall also be an audible alarm silence button used to silence the audible alarm after it has been activated.

d. Surge Counter – The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.

1) The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter’s display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter’s memory shall not require a backup battery in order to achieve this functionality.

6. Overcurrent Protection

a. The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

7. Fully Integrated Component Design – All of the SPD’s components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality shall not be accepted.

8. Safety Requirements

a. The SPD shall minimize potential arc flash hazards by containing no user serviceable / replaceable parts and shall be maintenance free. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. SPDs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. SPDs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.

b. SPDs designed to interface with the electrical assembly via conductors shall require no user contact with the inside of the unit. Such units shall have any required conductors be factory installed.
2.3 SYSTEM APPLICATION

A. The SPD applications covered under this section include distribution and branch panel locations, motor control centers (MCC), and switchboard assemblies. All SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C, B, and A environments.

B. Surge Current Capacity – The minimum surge current capacity the device is capable of withstanding shall be as shown in the following table:

<table>
<thead>
<tr>
<th>Category</th>
<th>Application</th>
<th>Per Phase</th>
<th>Per Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Service Entrance Locations (Switchboards, Switchgear, MCC, Main Entrance)</td>
<td>250 kA</td>
<td>125 kA</td>
</tr>
<tr>
<td>B</td>
<td>High Exposure Roof Top Locations (Distribution Panelboards)</td>
<td>160 kA</td>
<td>80 kA</td>
</tr>
<tr>
<td>A</td>
<td>Branch Locations (Panelboards, MCCs, Busway)</td>
<td>120 kA</td>
<td>60 kA</td>
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</table>

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

2.4 LIGHTING AND DISTRIBUTION PANELBOARD REQUIREMENTS

A. The SPD application covered under this section includes lighting and distribution panelboards. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.

1. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
2. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
3. The panelboard shall be capable of re-energizing upon removal of the SPD.
4. The SPD shall be interfaced to the panelboard via a direct bus bar connection. Alternately, an SPD connected to a 30A circuit breaker for disconnecting purposes may be installed using short lengths of conductors as long as the conductors originate integrally to the SPD. The SPD shall be located directly adjacent to the 30A circuit breaker.
5. The SPD shall be included and mounted within the panelboard by the manufacturer of the panelboard.
6. The SPD shall be of the same manufacturer as the panelboard.
7. The complete panelboard including the SPD shall be UL67 listed.
B. Switchboard and MCC

1. The SPD application covered under this section is for switchboard and MCC. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.

2. The SPD shall be of the same manufacturer as the switchboard and MCC.

3. The SPD shall be factory installed inside the switchboard and/or MCC at the assembly point by the original equipment manufacturer.

4. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bar.

5. The SPD shall be connected through a disconnect (30A circuit breaker). The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.

6. The SPD shall be integral switchboard and/or MCC as a factory standardized design.

7. All monitoring and diagnostic features shall be visible from the front of the equipment.

2.5 ENCLOSURES

A. All enclosed equipment shall have NEMA 1 general purpose enclosures, unless otherwise noted. Provide enclosures suitable for locations as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads.

D. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.

2. Inspect anchorage, alignment, grounding, and clearances.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.
3.3 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313
SECTION 265000 - LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies all light fixtures and lamps indicated on the Drawings or specified herein.

1.2 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS

A. Submit catalog data showing material information and conformance with specifications. The intended use of each item shall be indicated.

B. Submit product data for the following items

1. Lighting fixtures, unit battery lights and exit signs
2. Lamps
3. Ballasts

PART 2 - PRODUCTS

2.1 LIGHT FIXTURES

A. Lighting fixtures shall be provided in accordance with Lighting Fixture Schedule as shown on the drawings.

B. The fixture catalog numbers listed in the fixture schedule indicate manufacturer, fixture design, quality of design and manufacture, appearance, features and options required. Lighting fixtures
specified shall be the basis for comparison in the consideration of fixtures of other manufacturers.

C. All fixture component parts shall be manufactured and/or assembled at the manufacturing plant prior to shipment. The shipment from the fixture manufacturer shall include integrally mounted and/or remote mounted ballasts where ballasts are required for the proper operation of the fixture lamps.

2.2 BALLASTS

A. Fluorescent ballasts shall be high-frequency (25kHz or better), integrated circuit electronic type with programmed-start configuration.

B. Ballasts shall be of the high power-factor type.

C. Ballast Factor for completed systems shall not be less than 0.87.

D. Current-crest factor shall be less than 1.7

E. Ballasts shall be suitable for prevailing operating temperature ranges.

F. Class-P with automatic resetting protective devices in accordance with UL requirements.

G. Fluorescent Ballasts shall have a Class A sound rating, HID Ballasts may have Class A or Class B sound rating.

2.3 LAMPS

A. Refer to the Lighting Fixture Schedule on the drawings for the ordering information of lamps. Fluorescent lamps shall be energy efficient T8, or equal unless otherwise specified on the fixture schedule. Approved manufacturers are: WESTINGHOUSE, SYLVANIA and GE. Lamps shall be provided for all lighting fixtures.

2.4 EMERGENCY LIGHTING UNIT

A. Provide UL 924 battery backup, self-contained emergency lighting unit, with the following features:

1. Housing to be NEMA 4X, stainless steel or impact resistant, fiberglass reinforced polyester, fully gasketed.
2. Lamps: Two 12-volt industrial grade lamps
3. Voltage: 120/277V
4. Battery Charger
5. Batteries: 12-year, maintenance free, sealed nickel cadmium batteries. Batteries to operate fixture for four hours at 85% of rated voltage.
6. Manufacturer: Light Guard Luminator Series.
2.5 EXIT SIGN
   A. Provide UL 924, battery back-up, self-contained exit sign, with the following features:
      1. Housing to be NEMA 4X, stainless steel or fiberglass reinforced polyester, fully gasketed.
      2. Lamps Green LED
      3. Voltage: 120/277V
      4. Battery Charger
      5. Batteries: 12-year, maintenance free, sealed nickel cadmium batteries
      6. Manufacturer: Light Guard NX Series.

2.6 SPECIAL ACCESSORIES
   A. Accessories such as junction boxes, plastic frames, stem, hangers, canopies, couplings, cords, toggle bolts, etc. shall be provided as necessary to mount fixture in a proper and approved method.

2.7 CONTROLS
   A. Refer to Section 260923 for lighting controls

PART 3 - EXECUTION

3.1 FIXTURE MOUNTING
   A. General
      1. The Contractor shall investigate ceiling construction and supply fixtures designed for the application.
   B. Support
      1. Pendant mounted lighting fixtures shall be supported by a flexible fixture hanger CROUSE-HINDS Type "Al" and shall have locking couplings, CROUSE-HINDS Type "COUP". Where fixtures are indicated for installation on low-density ceiling material, fixture shall be mounted on 1 1/2" ceiling spacers unless UL approved for mounting directly to ceiling material.
      2. Fixtures shall be properly supported and aligned provided with all necessary steel shapes for support of the fixtures. Complete fixture installation shall be coordinated with the facility construction. All lighting fixtures shall be cleaned and provided with new lamps immediately prior to final inspection.
   C. Arrangement
      1. Square and rectangular fixtures shall be mounted with sides parallel to building lines and parallel with ceiling lines. Fluorescent fixtures shall be installed per the manufacturer’s
requirements as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection or angular jointing of fixtures installed in continuous rows.

END OF SECTION 265000
SECTION 266013 – MOTORS

PART 1 - GENERAL

1.1 SUMMARY

A. This section specifies alternating current induction motors, 500 horsepower or less, to be provided with the driven equipment. This section does not specify medium voltage (2300 volts and greater) motors or specialty motors such as submersible motors, hoist motors, valve operator motors or torque rated motors. Unless specified otherwise, electric motors shall be provided by the manufacturer of the driven equipment. This section refers to motors by enclosure type as defined in NEMA MG 1-1998, except as noted.

1.2 STANDARDS AND CODES

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS

A. In accordance with the Submittals requirements in Section 260500, submittal data on all motors for equipment shall include the following for the equipment:

1. Drawings and Data: Catalog information and complete name-plate and efficiency information.
2. Motor wiring and connection diagrams for all provided external connections including power, overtemp contacts, space heaters, moisture sensors, etc.
3. Drawing showing physical location of electrical connection.
4. Motor terminal connection box size
5. Individual equipment specification requirements
6. Motor manufacturer's certification of conformance to the specified bearing life on all motors 20 horsepower and larger. Also submit, upon the Engineer's request, certification of bearing life on smaller motors.
PART 2 - PRODUCTS

2.1 GENERAL

A. Ratings

1. All motors shall be suitable both electrically and mechanically to drive the connected equipment under any and all modes of operation. The speed, horsepower, torque, base, bearing, shaft, insulation, and enclosure shall be closely coordinated with equipment requirements specified herein and in other portions of this Specification so as to provide a satisfactory, efficient drive without overloading, overheating, abnormal noise or vibration.

2. All motors shall be designed and built for long, trouble-free life in industrial service and shall be capable of operating successfully under the following application conditions:

   a. 40 degrees centigrade maximum ambient temperature to -20 degrees centigrade minimum ambient temperature.
   b. 3,000 ft. maximum altitude
   c. Voltage variations to plus or minus 10% of nameplate rating.
   d. Frequency variations to plus or minus 5% of nameplate rating.
   e. Variable speed motor suitable for use with variable speed controller.

3. All motors shall be rated for full voltage starting, NEMA Design B, normal torque, normal starting current, unless otherwise required by the driven equipment or specified.

4. All motors shall be suitable for the environment in which they are to be installed. Regardless of environment involved, all motors shall, at minimum, be suitable for exposure to 100% humidity continuously. Motors for use with variable frequency drives shall be labeled by the manufacturer for inverter use.

B. Energy-Efficient Motors

1. Where specified as energy efficient, motors shall be designed to comply with the minimum nameplate efficiency in Schedule A. Motor nameplate efficiency shall conform with the nominal values shown in NEMA MG 1-1998, Table 12-10, and with the minimum acceptable efficiencies listed in Schedule A. Energy efficient motors shall be Reliance Electric Duty Master XE, Baldor Super-E, US Motors Premium Efficiency motors, or equal.
## Schedule A
Nominal Efficiencies for “NEMA Premium™” Induction Motors
Rated 600 Volts or Less (Random Wound)

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<th>1800 RPM</th>
<th>3600 RPM</th>
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</table>
C. Vertical Motors
   1. Unless otherwise specified, vertical motors shall be full voltage with a Type P base specifically designed for vertical installation. Universal position motors are not acceptable. Vertical motors shall have solid shafts unless specified otherwise. Thrust bearing rating shall be compatible with the loads imposed by the driven equipment.

D. Efficiency
   1. Efficiency shall be determined by testing production motors with a dynamometer at rated output, voltage and frequency in accordance with IEEE Specification 112-1996, Method A.

2.2 ENCLOSURES
   A. Three phase motor enclosures shall be totally enclosed fan cooled (TEFC) with cast iron stator frames, fans, and end shields, and rigid construction, unless otherwise specified. Motors with a frame size of 184, or smaller, may be steel frame.
   B. Single phase motors shall be heavy fabricated steel or cast iron.

2.3 MOTOR ACCESSORIES
   A. Motors shall be provided with the following features and accessories:
      1. Conduit Entrance
         a. Conduit entrance box size and drilling shall conform to the conduit or wiring requirements indicated on the electrical drawings. Motor leads and all accessory leads shall terminate in a common conduit entrance box.
      2. Motor Leads
         a. Motor leads shall be compatible with motor insulation system and be permanently identified.
      3. Eyebolts
         a. Drilling and tapping for eyebolts shall be provided on all motors weighing more than 83 pounds.
      4. Nameplates
         a. Engraved stainless steel stamped metal nameplate shall be provided with the information required by NEMA-MG1-1998; 10.39-10.40 and the following additional information:
            1) Bearing number
            2) Motor connection diagram if more than three motor leads enter the motor terminal box
5. Single-Phase Motors
   a. Single phase motors shall be self-protected unless specified "for separate protection," and the self-protection characteristic shall be indicated on the motor nameplate. Protection shall be manual or automatic-reset type as specified or required by safety considerations of the equipment served.

6. Enclosed Motors
   a. Drain plugs shall be provided for all non-explosion proof motors. Drain and breather plugs shall be provided for all explosion proof motors.

7. Winding Over Temperature Protection
   a. Embedded thermostats, one (1) per winding, (normally closed contact) shall be provided for an external thermal alarm or motor cut out for all motors 40 Hp and above, unless otherwise shown. Thermal cutout leads shall be brought out to the motor terminal convection box.

2.4 MOTOR TERMINAL CONNECTION BOX
   A. Conduit boxes shall be cast iron, split construction, with threaded hubs. Conduit boxes shall be designed for rotation to permit installation in four positions at least 90 degrees apart. Motors shall be furnished with petroleum-resistant gaskets at the base of the conduit box and between the halves of the conduit box. Motors shall have a grounding lug located within the box for the ground connection.
   B. Motor terminal connection box shall be two connection box sizes larger than the manufacturer's standard size for the frame motor provided to accommodate motor feeder splices.

2.5 INSULATION CLASS
   A. Motors shall be provided with NEMA Class F insulation with Class B temperature rise with additional nonhygroscopic moisture protection that will maintain a minimum resistance of 1.0 megohms after 168 hours of exposure at 100% humidity. The temperature rise as measured by resistance when operating at rated service factor and load shall conform to the limiting observable temperatures in NEMA-MGI, for class B insulation.

2.6 MOTORS ON VARIABLE FREQUENCY DRIVES (VFDS)
   A. Motors powered by VFDs shall be inverter duty and rated for use with VFDs. Motors on VFDs shall comply with the requirements of NEMA MG1 Part 31. The Contractor shall coordinate between the VFD and motor manufacturers to provide a motor/VFD combination suitable for the application. For motors on VFDs:
      1. Provide data on expected speed range of load being served.
      2. Provide proof of inverter duty rating and insulation rating as specified.
   B. Provide motors with adequate cooling for the lowest expected speed for load served.
C. Any line terminators, filtering devices, harmonic filters, line reactors, or other devices required for proper operation of the motor/VFD combination shall be provided and installed by the Contractor at no extra cost to the Owner.

2.7 SERVICE FACTOR

A. Three phase motors shall be provided with a 1.15 service factor for all process (pumping) equipment. The rated nameplate horsepower of ancillary (HVAC, fan, etc.) motors, when operating at a service factor of 1.0, shall be equal to or greater than the horsepower required to drive the connected equipment under any and all modes of operation.

2.8 POWER RATINGS

A. Motor horsepower, if indicated in the detailed equipment specifications, are minimum size acceptable. Ratings indicated on the electrical drawings are for guidance only and do not limit the equipment size.

2.9 SYNCHRONOUS SPEED

A. The motor speeds indicated in the drawings and specifications are the rated synchronous speed. Provide motor rated full-load speeds which are compatible with the specified performance of the driven equipment.

2.10 STANDARD RATED VOLTAGE PHASE AND FREQUENCY

A. Motors shall be nameplate-rated for 60 hertz power supply as follows unless otherwise specified or shown on the drawings:

1. Motors less than 1/6 hp, single-phase, 115 volt
2. Motors 1/6 hp to 1/2 hp, single-phase, 115/208-230 volts
3. Motors 3/4 hp through 250 hp, three-phase 230/460 volts

2.11 BEARINGS AND SHAFTS

A. All bearings shall be anti-friction-type AFBMA standard sizes. All motors shall provide a minimum bearing life of one year (approximately 8,700) hours. All motors shall have thrust ratings not less than the combined static and dynamic loads to be imposed.

B. Shafts shall be in accordance with NEMA "T" or "TS" dimensions. Long shafts shall be suitable for belt, chain or gear drive within limits established by good industrial practice and documented by NEMA. Short shafts shall be used for direct connection.

C. Motor balance and vibrations shall conform to the latest revision of NEMA Standard MG1.
2.12 DUTY CYCLE

A. Motors shall be rated for continuous duty in accordance with NEMA Standard MG1, Paragraph 10.35, and NEMA standard MG10 for motors utilized in pumping operation, unless otherwise specified.

2.13 LUBRICATION

A. Horizontal polyphase motors shall be grease lubricated. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent re-lubrication, but facilities shall be provided for adding new grease and draining out old grease without major motor disassembly. Motors 180T frame and smaller may utilize grease release fitting in lieu of grease drain plug. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings or leakage of grease out of the bearing cavity.

B. Vertical polyphase motor lubrication shall conform to the motor manufacturer's recommendations. Except as otherwise recommended, guide bearings shall be ball bearings, grease lubricated; thrust bearings shall be grease lubricated through frame 280T, oil lubricated in larger frame sizes.

2.14 CURRENT IMBALANCE

A. Current imbalance shall not exceed the values tabulated below when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system:

1. Under 5 horsepower: 25 percent
2. 5 horsepower and above: 10 percent

B. Imbalance criteria shall be based upon the lowest value measured.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Motors shall be factory installed on, aligned and connected to driven equipment, common bases, stands, etc., with the driven equipment. Suitable couplings and guards shall be provided between motor and driven equipment. Personnel guards shall be provided over all shafts, couplings, or others exposed moving parts.

B. Motor leads shall be connected utilizing a splice kit specifically designed for motor lead connection as described in Section 260519.

3.2 INSTALLATION CHECK

A. The Contractor shall provide services of an experienced, competent, and authorized representative of manufacturer to visit site of work and inspect, check, adjust if necessary, and
approve equipment installation for motors. The equipment manufacturer's representative shall be present when equipment is placed in operation.

B. The equipment representative shall revisit the job site, to correct any equipment installation and operation problems. The representative shall provide service until all conditions are, in the opinion of the Engineer, satisfactory.

C. The Contractor shall verify that all motor overcurrent protection is in accordance with the NEC.

3.3 TESTS

A. Shop Tests

1. Each polyphase motor shall be given a routine test to determine that it is free from electrical or mechanical defects and to prove that it meets the Specifications. The routine test shall conform to applicable NEMA and IEEE standards latest revision and shall be as generally defined as "Standard Commercial Test."

2. Copies of the test report will not be required unless actual operation and installation suggest the motors' performance should be verified, in which case certified copies of the test report shall be submitted upon the Engineer's request.

B. Field Test

1. The Contractor shall perform voltage, current and resistance tests as required to complete the Motor Test Report form included at the end of this section. The Contractor shall inform the Engineer a minimum of 5 days in advance of testing and shall only perform tests with the Engineer or Owner’s representative present.

   a. Voltage, current and circuit and winding resistance readings shall be taken with a volt ohmmeter, clamp-on ammeter, and a Kelvin-type milli- or microohmmeter.

   b. Insulation resistance readings shall be taken with a 500 volt megger for 30 seconds with the circuit conductors connected to the motor.

2. Test reports shall be submitted to the Engineer prior to final acceptance.

3. If the test results indicate corrective measures are required, the Contractor shall undertake all such corrective measures until the electrical system is accepted by the Engineer. No additional compensation will be paid for corrective measures.

END OF SECTION 266013

ATTACHMENT MOTOR TEST REPORT
### 266013 - MOTOR DATA AND TEST REPORT

**EQUIPMENT NAME AND NUMBER:** ________________________________

**EQUIPMENT SPECIFICATION SECTION:** ________________________________

**MOTOR STARTER LOCATION** ________________________________

**CONTRACTORS REPRESENTATIVE** ___________________ **DATE** __________

**MOTOR NAMEPLATE DATA**

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**MOTOR STARTER INFORMATION**

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* **RECORDED FULL LOAD DATA**

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**INSULATION RESISTANCE**

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**MOTOR CIRCUIT RESISTANCE**

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* **VOLTAGE & CURRENT READINGS SHALL BE TAKEN AT THE CLOSEST ACCESSIBLE POINT TO THE LOAD**

**CERTIFIED** ________________________________ **Date** __________________

Contractor’s Representative

**WITNESSED** ________________________________ **Date** __________________

Engineer
SECTION 270513 – TELEPHONE SERVICES

PART 1 - GENERAL

1.1 SUMMARY
A. This section specifies the installation hardware for a leased line communication system; and dial-up telephone service.

1.2 SCHEDULING WORK WITH THE TELEPHONE COMPANY
A. The Contractor shall be fully and completely responsible for all scheduling and conduit installation coordination with the Telephone Company and Control System Integrator.

1.3 CONTRACTOR RESPONSIBILITIES
A. Contractor responsibilities are described herein and shown on the drawings. The Contractor shall provide the following service and material:

1. Install conduit and handholes and pull cords as shown on the drawings.
2. All trenching and backfill required for installation of the telephone conduit, and shall use common trench provided for other piping where possible and in accordance with utility easement detail on electrical drawings.

B. The Contractor shall coordinate telephone conduit installation with electrical service installation. Refer to Section 262713.

PART 2 - MATERIAL

2.1 CONDUIT SIZES
A. Conduit sizes shall be in accordance with 260533.

PART 3 - EXECUTION

3.1 COORDINATION
A. The Contractor shall coordinate the installation of telephone service with the Telephone Company and Control System Integrator shall cause the instigation and completion of such installation.
3.2 TRENCHING

A. Trenching and backfill for telephone conduits shall be in accordance with Section 260533 of these specifications.

B. Telephone conduits shall be installed at least 24 inches below the finish ground surface.

C. Telephone conduits may run in the same trench with power conduits as shown on drawings, or as permitted by the telephone company. Spacing from power cables shall be per Section 260533 or as required by the telephone company, whichever is greater.

3.3 INSTALLATION

A. Provide a raceway from each telephone/data outlet to an accessible ceiling space. Provide raceway sleeves through all fire area smoke separation walls. Provide raceways to outlets located in fixed casework.

END OF SECTION 270513
SECTION 272100 – TELECOMMUNICATIONS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: This section specifies requirements for data telecommunications components and systems.

B. Related Sections: The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work. It is the Contractor’s responsibility to perform all the work required by the Contract Documents.


C. Performance Benchmarks: Items listed by part number are intended to serve as performance benchmarks. Submit most current model meeting the benchmark performance requirements for items that have been superseded or are otherwise obsolete UNO.

D. Not all products listed are required for all applications. Submit only products required for the application.

1.2 QUALITY ASSURANCE

A. Listing:

1. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing/label.

2. Equipment listed/labeled by an NRTL acceptable to the local authority having jurisdiction.

3. When a product is not available with a listing/label for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly or as a completed assembly in the field. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS

A. Per Section 409000
1.4 SERVICE REQUIREMENTS

A. Environmental conditions of equipment operation are described in Section 409000 “Service Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Communications systems hardware shall be standard commercial off-the-shelf products that have not been customized in any way for the project to meet the specified requirements.

B. The specified component descriptions are to be considered as minimum required performance benchmarks for each component. Submit the most recent component from the listed manufacturers.

C. Contractor shall install, configure, test, commission, etc., all devices, cards, and accessories supplied.

D. Modems shall comply with part 15 of the FCC rules

2.2 VOICE TELEPHONY CARDS:

A. Voice telephony cards shall provide the following features and characteristics:

1. Voice telephony cards shall be provided with computers with remote alarm notification software installed. Cards shall be compatible with alarm software supplied.
2. Voice telephony cards shall be Dialogic D4PCI or approved equal, card slot type shall match supplied computers.
3. Card shall be universal PCI Bus Interface Computer Telephony Card.
4. Include Card and Dialogic Drivers with RJ-11 telephone connection.
5. Supports 1 dial-out line & 4 dial-in lines.
6. Contractor shall provide computers with sufficient number and type of PCI slots to accommodate all required PCI cards. Contractor shall supply PCI cards compatible with supplied computers.

2.3 DIAL UP MODEMS

A. Dial up modems shall be capable of full duplex communication in point-to-point operations and shall auto negotiate connection between DTE equipment. Voltage surge protection shall be provided with the unit. The Contractor shall provide all cables, accessories, programming and configuration, as well as any software necessary to program and maintain the equipment. Dial up modems shall be TAPI compliant. Dial up modems shall be MultiTech Multi Modem series or approved equal.
2.4 LINE MODEMS:
A. The modem shall allow full duplex asynchronous data transmission over AC, DC or dry power lines at data rates up to 9600 BPS. The unit shall utilize FSK modulation in the 100 KHz frequency range such that EMI and RFI sources will not impact reliable communication. The modem shall be capable of operation in point to point or multi-point configurations. Voltage surge protection shall be provided with the unit. The Contractor shall provide all cables, programming and communication, as well as any software necessary to program and maintain the equipment. Line modems shall be MDL 500 manufactured by Data-Linc Group or Engineer approved equal.

2.5 LEASED LINE MODEMS:
A. Leased line modems shall be capable of functioning on 2 wire or 4 wire leased or private lines in a point to point or multi-point arrangement. Modems shall be capable of full duplex communication in point to point operation and half duplex in point to multi-point arrangement. Voltage surge protection shall be provided with the unit. The Contractor shall provide all cables, programming and communication, as well as any software necessary to program and maintain the equipment.

B. Leased line modems shall be available in standalone and rack mount versions. Standalone modems shall be capable of operation on DC voltage. Modems shall be V.34/33.6K as manufactured by MultiTech or Engineer approved equal.

2.6 AUTOMATIC TELEPHONE DIALER
A. The Automatic Dialing Alarm Monitor shall monitor discrete and analog points and shall initiate a call-out sequence when any one of these inputs or a power failure is detected. If the first number does not acknowledge the alarm the next of four numbers shall be dialed until the alarm is acknowledged. The dialer shall utilize voice synthesis for fault reporting. The unit shall be mounted in a NEMA 1 enclosure, battery backup for 4 hours minimum. The Automatic Telephone Dialer shall be by Raco Model Verbatim VSS16C, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Equipment shall be mounted and connected in compliance with the manufacturer’s instructions and recommendations.

B. The Contractor shall configure all specified devices and equipment to function according to the Contract Documents unless specifically noted otherwise.

3.2 MODEM CONFIGURATION AND VERIFICATION:
A. The contractor shall configure devices for the type of communications medium and protocols required by the communicating equipment.
B. The contractor shall provide to the Engineer in writing all internal and external settings utilized to affect proper operation.

C. The Contractor shall verify proper communication across all installed communication medium by a reliable, convincing, and well documented method:

1. Computer file transfer or RTU data exchange: Utilize two computers with “terminal emulation” software. Connect a computer at each end of the communications channel. Transfer a text or graphic file from one computer to the other. Verify and document file integrity.

2. Use manufacturer provided PLC communications and programming software to verify connection of a computer to a PLC over the communications channel. Verify ability to go online with, download a program, and edit the running program.

3. The Contractor shall provide written verification to the Engineer indicating the verification method and successful data transfer rate prior to factory testing.

3.3 WARRANTY:

A. Warranty shall be per Section 409000. All warranties shall be registered to the Owner.

3.4 TESTING:

A. Testing shall be per Section 409000 and 409002

3.5 OPERATION AND MAINTENANCE DATA:

A. O&M data shall be per Section 409000.

END OF SECTION 272100
SECTION 272200 – COMPUTER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. SCOPE: This section specifies requirements for computer components and systems.

B. Related Sections: The work of the following Sections is related to the work of this Section. Other Sections, not referenced below, may also be related to the proper performance of this work. It is the Contractor’s responsibility to perform all the work required by the Contract Documents.

2. Section 409600: SCADA Software

C. Performance Benchmarks: Items listed by part number are intended to serve as performance benchmarks. Submit most current model meeting the benchmark performance requirements for items that have been superseded or are otherwise obsolete UNO.

D. Not all products listed are required for all applications. Submit only products required for the application.

1.2 QUALITY ASSURANCE

A. Listing:

1. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing/label.
2. Equipment listed/labeled by an NRTL acceptable to the local authority having jurisdiction.
3. When a product is not available with a listing/label for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly or as a completed assembly in the field. All costs and expenses incurred for such inspections shall be included in the original contract price.

1.3 SUBMITTALS

A. Per Section 409000.
1.4 SERVICE REQUIREMENTS

A. Environmental conditions of equipment operation are described in Section 409000 “Service Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL

A. Computer system hardware shall be standard commercial off-the-shelf products that meet the specified requirements.

B. The specified component descriptions are to be considered as minimum required performance benchmarks for each component. Submit the most recent component from the listed manufacturers.

C. Contractor shall supply computers with pre installed software installed. Contractor shall provide separate installation media for all software components. OEM media is not acceptable.

D. Contractor shall install and configure all devices, cards, and accessories supplied.

E. Contractor shall provide computers with sufficient number and type of PCI slots to accommodate all required PCI cards. Contractor shall supply PCI cards compatible with supplied computers.

2.2 EQUIPMENT RACK:

A. Electronic equipment racks shall be as specified in Section 409543. Provide a sufficient number of racks to accommodate all networking, communications, and computer equipment needed.

2.3 RACK MOUNT COMPUTERS

A. Machines shall be of the following configuration and provide the listed features and characteristics:

1. Manufacturer: Dell R5500 workstation or approved equal. Model TBD, bidder shall budget $4000 pre tax retail cost for hardware and pre installed software only for each machine.
2. Enclosure: Rack mount or desktop configuration on shelf
3. Processors: Intel, 3.0 ghz Dual or 2.0 ghz quad core
4. RAM: 4 Gigabyte
5. Drives:
   a. Minimum 2 each 300 GB, RAID 1 OS hot swap mirror SCSI ~15000 RPM and 320K data speed.
   b. 300 GB external USB backup HDD, provide automatic backup software utilities.
6. Power Supply: Dual hot swappable
7. Floppy: 1-3.5 in drive
8. Disc: CD/DVD burner
9. NIC: Cat 5
10. Interfaces: Minimum 4 each USB 2.0, serial RS232
11. Spare slots for all required cards, including sound and telephony card. Contractor shall verify appropriate card slots and cards are provided.
12. Monitor: One monitor on KVM for all rack mounted computers.
13. Provide one USB optical mouse and one USB keyboard for rack computers. Connect to KVM console ports.
14. Provide 1 pair of speakers for remote alarm notification installations. Connect to audio capable KVM.
15. Warranty: 3 year hardware warranty, Dell Pro support or equal for workstations.
16. UPS: Rack mounted with battery module as specified below.

B. Generic Preinstalled Software Requirements:

1. Microsoft Windows Server 2010 R2 or later. Most current version compatible with SCADA and special application software shall be supplied. Contractor shall coordinate. Provide separate retail Microsoft media. Format drive and reinstall OS at Contractors facility.
2. Microsoft SQL Server as required by SCADA and data historian software. Contractor shall coordinate correct release with software manufacturers.
3. Firewall Software: TBD owner preference. Contractor shall coordinate with the Owner.
5. Contractor shall supply computers with pre installed software installed. Contractor shall provide separate installation media for all software components. OEM media is not acceptable.

C. Installation: Computers shall be provided and installed complete by the Contractor unless specifically noted otherwise.

2.4 VOICE TELEPHONY CARDS:

A. Per Section 272100.

2.5 SOUND CARDS

A. Good quality commercial/retail sound cards shall be supplied for computes with remote alarm notification software installed. Sound card shall be Sound Blaster or equal. Equivalent motherboard audio is only acceptable if quality and features are comparable.

B. Contractor shall provide computers with sufficient number and type of PCI slots to accommodate all required PCI cards. Contractor shall supply PCI cards compatible with supplied computers.
2.6 RACK MOUNTED UPS SYSTEMS

A. Per Section 409543.

2.7 RACK MOUNTED KVM SWITCH

A. KVM switches shall be provided as indicated on the Drawings. Rack mount KVM switch shall be Belkin, IO Gear, D-Link, or approved equal and shall provide the following features and characteristics:

1. Number of channels required for all rack mounted computers plus 2 spare.
2. All cabling required to connect the rack computers and the shared mouse, monitor, and keyboard
3. Supports 2048 x 1536 at 65 Hz video resolution
4. Switches computers with device mounted buttons or with software and on screen icon
5. LED status monitor/port indicators
6. Operating system: Windows Server 2010 R2 or later
7. Monitor support: VGA, SVGA, Multisynch
8. VGA port: 15 pin HDDB type
9. Keyboard support: USB
10. Mouse support: USB
11. Operating temperature: 0 to 40 degrees C
12. Storage temperature: -20 to 60 degrees C
13. Humidity: 0-80% RH, non-condensing
14. Waranty: 3 years
15. Audio support
16. Keyboard, monitor, and mouse shall be located on a minimum 2’x3’ table located near the rack. Contractor shall provide the table and coordinate the installation and location of the table and the installation of the monitor, keyboard, and mouse on site.

2.8 WORKSTATION COMPUTERS

A. Machines shall be of the following configuration and provide the listed features and characteristics:

1. Manufacturer: Dell T5400 workstation tower or approved equal, Model TBD. Bidder shall budget $4000 pre tax retail cost for hardware and pre installed software only for each machine.
2. Processors: Intel, dual core 3GHz
3. RAM: 2 Gigabyte
4. Drives: SATA 10K rpm, 200 Gigabyte minimum
5. Floppy: 1-3.5 in drive
6. Disc: CD/ DVD burner
7. NIC: Cat 5
8. Interfaces: Minimum 4 each USB 2.0, serial RS232
9. Monitor: Provide one monitor for each machine as specified below.
10. Provide USB optical mouse and keyboard for each machine.
11. Warranty: Extended 3 year hardware warranty, Dell Pro support for workstations.
12. UPS: Smart, APC or approved equal for desk top computing, services computer and monitor, 30 minute hold up at full load, submit hold up time calculations.

B. Generic Preinstalled Software Requirements:

1. Microsoft Windows 7 or later. Most current version compatible with SCADA and special application software shall be supplied. Contractor shall coordinate. Provide separate retail Microsoft media. Format drive and reinstall OS at contractors facility
3. Firewall Software: TBD owner preference. Contractor shall coordinate with the Owner.
4. Anti-Virus: TBD owner preference. Contractor shall coordinate with the Owner.
5. Contractor shall supply computers with pre installed software installed. Contractor shall provide separate installation media for all software components. OEM media is not acceptable.

C. Installation: Computers shall be provided and installed complete by the Contractor as specified unless specifically noted otherwise.

2.9 MONITORS

A. 20 in. LCD, 1280 minimum x 1024 minimum resolution.

B. Dell E207FP widescreen or approved equal.

C. Provide one total monitor for the electronic equipment rack and one each for each workstation PC.

2.10 LAPTOP COMPUTERS

A. General: Computers shall be provided complete as specified and shall provide the following features and characteristics:

1. Manufacturer: Dell M6700 mobile workstation. Model TBD. Bidder shall budget $4000 pre tax retail cost for hardware and pre installed software only for each machine.
2. Processor: Intel 2.4GHz dual core
3. RAM: 4 Gigabyte
4. 200 GB minimum HDD, 7200 RPM
5. Floppy: 1-3.5 in drive, fixed
6. Disc: CD/DVD burner, fixed
7. Monitor: 17 in. 1900 x 1200 resolution
8. NIC: Cat 5
9. Serial Port: 1
10. USB serial Port: Minimum 4
12. Communication: Cellular modem or compatible Cell/Modem phone.
13. Port replicator.
15. Extended 3 year hardware warranty, Dell Pro support for mobile workstations.
B. GENERIC PREINSTALLED SOFTWARE REQUIREMENTS:

1. Microsoft Windows 7 or later. Most current version compatible with SCADA and special application software shall be supplied. Contractor shall coordinate. Provide separate retail Microsoft media. Format drive and reinstall OS at contractor's facility.
3. Firewall Software: TBD owner preference. Contractor shall coordinate with the Owner.
4. Anti-Virus: TBD owner preference. Contractor shall coordinate with the Owner.
5. Contractor shall supply computers with pre installed software installed. Contractor shall provide separate installation media for all software components. OEM media is not acceptable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment shall be mounted and connected in compliance with the manufacturer’s instructions and recommendations unless specifically noted otherwise.

B. The Contractor shall configure all specified devices and equipment to function according to the Contract Documents unless specifically noted otherwise.

C. Generic commercial software specified in this section shall be preinstalled on all supplied computers by the Contractor UNO.

D. All operating systems shall be clean install from original retail Microsoft media. This install shall be performed by the contractor at the contractor’s facility. OEM operating system installations are expressly forbidden.

E. Computers listed in Part 2 shall be supplied and installed complete as specified. Special application software shall be provided, installed, programmed, configured, tested, and commissioned by the Contractor unless specifically noted otherwise. Special application software shall include the following:

1. SCADA HMI application software.
2. Data acquisition software.
3. Remote SCADA access software.
4. SQL Server DBMS software.
5. Historical data logger software and reporting tools.
6. Remote alarm notification software.

3.2 THIRD PARTY PROGRAMMER:

A. Third party programmers will install special application software they program as specifically defined. Contractor shall install all other software on the computers.
3.3 WARRANTY:
   A. Warranty shall be per Section 409000. All warranties shall be registered to the Owner.

3.4 TESTING:
   A. Testing shall be per Section 409000 and 409002

3.5 OPERATION AND MAINTENANCE DATA:
   A. O&M data shall be per Section 409000.

END OF SECTION 272200
SECTION 283100 – FIRE ALARM SYSTEM (ADDRESSABLE)

PART 1 - GENERAL

1.1 SUMMARY

A. Scope:

1. This design performance criteria Section is intended for the Contractor to include the requirements for designing, furnishing, installation, commissioning and connection of the analog addressable, intelligent reporting fire alarm equipment required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein. Drawings indicate a minimum system layout and do not show complete details.

2. Contractor designated designer shall be FPE, who shall affix their stamp and signature to submittals and drawings submitted to the AHJ for their review.

3. The fire alarm system shall comply with the requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

4. The fire alarm manufacturer shall be of the highest caliber and quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of EN29001, BS5750: Part 1: ANSI/ASQC Q91-1987.

5. Maintenance Agreement: A proposed maintenance agreement for this project shall be included with submittals indicating:

   a. The installation is covered by a maintenance agreement between the property owner and a UL listed fire alarm company whereby the service company issuing the certificate bears responsibility for inspecting, testing, maintaining, and providing any necessary repairs.

   b. Documentation is maintained on the alarm system including description of system operation, location of alarm equipment throughout the area protected, initial acceptance tests and the performance of periodic testing and maintenance.

   c. An executed maintenance agreement for the system shall also be forwarded to the Owner, upon certification of this fire alarm system, for the Owner's consideration in selecting a system maintenance and confidence testing Fire Alarm Company.

1.2 QUALITY ASSURANCE

A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

B. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department
of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.

C. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer’s place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.

D. The equipment and the installation shall comply with the current provisions of the following standards:

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<td>National Fire Alarm Code</td>
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<tr>
<td>NFPA 70 (NEC)</td>
<td>National Electrical Code, Article 760</td>
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<tr>
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<tr>
<td>WAC</td>
<td>Washington Administrative Code 296</td>
</tr>
</tbody>
</table>

E. All requirements of the Authority Having Jurisdiction (AHJ).

1.3 SUBMITTALS

A. PROCEDURES: Sections 013300, and 260500.

B. A construction schedule for this work shall be developed in coordination with the overall master construction schedule. Design drawings and information along with the construction schedule shall be submitted at the same time.

C. Contractor shall prepare design drawings, in conjunction with applicable HVAC and Fire Protection Piping Shop Drawings, which are suitable for submission to the AHJ. Upon review by the AHJ, any additions required by the AHJ shall be added to the drawings and provided as part of the fire alarm system. Include in the base bid the following items, and the associated labor to install these items, over and above those items indicated on the bid documents:

<table>
<thead>
<tr>
<th>Item</th>
<th>Additional Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection Loop in Panel</td>
<td>2 circuits</td>
</tr>
<tr>
<td>Output Control Loop in Panel</td>
<td>2 circuits</td>
</tr>
<tr>
<td>Spare Points in Each Loop</td>
<td>25%</td>
</tr>
<tr>
<td>Conduit and Wire</td>
<td>15% of total length</td>
</tr>
<tr>
<td>Fire Detection Devices (each type)</td>
<td>15% (round up)</td>
</tr>
<tr>
<td>Evacuation Alarm Devices (each type)</td>
<td>15% (round up)</td>
</tr>
</tbody>
</table>
Smoke Detectors for Attic/or above ceiling space | As required for complete coverage per NFPA

1. Items not used shall be delivered to the Owner.
2. Additional devices required by the AHJ beyond those shown on the plans and included above shall be provided as a change order to the contract.

D. Submittal Data: Prepare shop drawings with drafters under the supervision of a licensed FPE. Drawings shall be drawn on 24" X 36" standard size sheets. Submitted drawings shall have AHJ approval marked thereon. Layout Plan Drawings, Interconnect Drawings, and Wiring Diagrams submitted without AHJ approval will not be reviewed during the submittal review process. The following documents shall be submitted for review:

1. Catalog Sheets: Show the color, configuration and dimensions of the equipment or device described. Provide technical specifications, such as operating voltage, operating temperature and humidity limitations, mounting and wiring information and a description of the function and operation of the device.
2. Layout Plan Drawings: Floor plans drawn with AutoCAD to same scale as architectural drawings showing only the fire alarm system device layout, raceway routing, riser diagrams, conduit and wire size/type, wire identification numbers and room/floor identification numbers. Drawings shall be produced from electronic background data obtained from the Engineer.
3. Interconnect Drawings: Show only external connections between equipment and devices. All wires shall be identified with alphanumeric designators and all termination points shall show the correct terminal identification.
4. Equipment Mounting Details: Show the mounting location for all floor and wall mounted equipment including distance from floor and column lines, and fabrication details for all special mounting brackets. Details shall also provide any special installation instructions. These details may be included on the plan drawings if space allows.
5. Battery Calculations: Calculations shall document the basis for selecting battery size. The calculations shall include an itemization of all battery loads under standby and alarm conditions.
6. Acceptance Test Procedure: Submit a written Acceptance Test Procedure (ATP) to Engineer for approval at least two (2) weeks prior to scheduled testing. The ATP shall include step-by-step procedures for performance testing every fire alarm device and system output to demonstrate functionality in accordance with specification requirements. Coordinate with all other specifications sections (i.e. leak detection and inventory control panel) to verify all items have been incorporated within the design.
7. Operation and Maintenance Manuals: Reference Division 0 specification for complete O&M manual requirements. In addition, provide the following; if there is a conflict in requirements, the more stringent will be provided; nominal 8-1/2 X 11 inch size, three-hole loose leaf with good quality covers; properly identified on the exterior of the cover and the contents indexed and tabbed. Provide three copies of the Operation and Maintenance Manuals to the Engineer within thirty (30) days after acceptance tests are satisfactorily completed. The manuals shall be typewritten or printed instructions which contain the following minimum information:
   a. Complete operating instructions
   b. Preventative maintenance instructions

FIRE ALARM SYSTEM (ADDRESSABLE)
c. Catalog sheets on all devices and equipment
d. Manufacturer's operation and maintenance instructions
e. 11" X 17" copies of all system drawings

8. Record Drawings: All review drawings shall be revised to reflect the accurate as-built condition. Working Plans shall show actual, accurate locations of devices, and actual routing of conduit and location of end of line devices. The Contractor shall provide three sets of electronic CAD and pdf files in a CD-ROM, and three sets of current hard copies of the record drawings.

9. Acceptance Test Procedures: Shall be submitted for review and accepted by the Engineer.

E. Software Modifications:

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 24 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

1.4 AUTHORITY HAVING JURISDICTION

A. The Authority Having Jurisdiction ("AHJ") for this project is the Jefferson County Fire Marshall.

1.5 SYSTEM:

A. A new intelligent reporting, analog addressable fire detection system shall be installed in accordance with the specifications and drawings.

B. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto an NFPA Class B (Style 4) Signaling Line Circuit (SLC).
2. Initiation device circuits shall be wired Class B (NFPA Style B).
3. Notification appliance circuits shall be wired Class B (NFPA Style Y).
4. Digitized electronic signals shall employ check digits or multiple polling.
5. A single ground [or open] on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
6. Alarm signals arriving at the main fire alarm panel shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.
C. Basic System Functional Operation: When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

1. The system alarm LED shall flash.
2. A local piezo-electric signal in the control panel shall sound.
3. The 80-character 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.
4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
5. 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.

D. Basic System Functional Interface with SCADA System: When a fire alarm or supervisory condition is detected the following functions shall immediately occur:

1. An alarm output contact shall change state from closed to open for SCADA monitoring.
2. A supervisory output contact shall change state from closed to open for SCADA monitoring.

E. Basic System Functional Interface With Security System: When a fire alarm condition is detected the following functions shall immediately occur:

1. An alarm output contact shall change state from closed to open for security system monitoring to allow all secured doors with electric strikes to be de-energized.

1.6 GUARRANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least two (2) year from the date of acceptance. 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.

1.7 REQUIREMENTS

A. Component Listing: All fire detection and alarm components furnished under this section shall be Underwriters Laboratories, (UL), listed in the Fire Equipment List or Factory Mutual, (FM), approved for fire signaling or fire suppression use. All accessory equipment shall be manufactured with UL listed components.

B. Reference Standards (Edition Currently Adopted By AHJ)

1.8 DESIGN REQUIREMENTS

A. The system shall provide for the areas indicated on the riser diagram and on the plans.
B. Thermal Detectors:

1. Shall be provided to detect a high temperature condition in the indicated areas.
2. Thermal detectors shall be located in accordance with guidelines in NFPA 72 or manufactures UL listed spacing on a spacing not to exceed 550 square feet per detector.
3. Thermal detectors shall not be installed immediately above heating appliances.
4. Thermal detectors, rated as required, shall be provided to detect a high temperature condition in ceiling and roof structure cavities only as required by code authority.

C. A combination of ionization and photoelectric detectors shall be provided to detect fire conditions in the required areas. Detectors shall be installed where shown on drawings and as required by AHJ. Detectors shall be located in accordance with the guidelines of IFC Standards.

D. A rechargeable battery supply shall be provided to automatically operate the entire fire detection and alarm system, including detectors, control panel, remote fire annunciator, alarm sounding devices and auxiliary control equipment (unless otherwise specified herein) in the event of a loss of primary power.

1. The batteries shall be sized at 150% of size prescribed by code. Where not so prescribed, the batteries shall be sized to operate the system for a time period prescribed by Code.

E. Manual fire alarm stations, connected to alarm points, shall be provided where shown and as required by AHJ.

F. Evacuation Alarm Requirements:

1. Evacuation alarm device locations shown on the drawings are intended to show approximate locations where the devices may be installed. It shall be the responsibility of the vendor to properly design the system showing the appropriate number of devices and locations to meet the dBA requirements. These locations shall be shown on the submittal drawings and the locations shall be approved by the Owner and the project engineer for architectural and maintenance acceptability. In order to meet the requirements, the dBA rating in the most remote area from the speakers shall not be less than 55 dBA or 10 dBA above the ambient, whichever is greater. Should a deficiency be found during testing of the system, it is the vendor’s responsibility to provide and install additional devices and re-test the system at no additional cost to the Owner.
2. Compliance with ADA required.

G. A remote fire annunciator shall be provided and installed where shown on drawings. The annunciator shall contain LED's to individually annunciate alarms for each of the fire points, and a fire alarm control panel (FCP) trouble condition.

H. Provide auxiliary controls and switches including interposing relays as required for the interface with fan and smoke control, elevators, fire door release, fire dampers and sprinkler system alarms.

I. Exterior Alarm: Provide a weatherproof audible alarm (95 dB at 10 feet minimum) on building exterior at side of building directed by the (AHJ).
J. Automatically Released Doors: Connection to door hardware shall be made as directed by door manufacturer. Coordinate device requirements with doors, hardware, and adjacent mounting surfaces to assure that doors are held in a position acceptable to the Engineer.

K. Provide an auto dialer alarm transmitter to communicate alarm, supervisory and trouble conditions to an approved central monitoring agency.

L. Combustible Gas Detection:

1. Combustible gas detectors are used for compliance with NFPA 820 “Standard for Fire Protection in Wastewater Treatment and Collection Facilities”. Refer to Section 409113 – Analytical Instruments for specification of devices to be interfaced.

2. Minimum air-flow volumes are being used to reduce area hazard classifications in selected areas. The fire alarm system shall monitor the integrity of this air-flow system and report a supervisory condition upon loss of air flow.

3. Gas detection and air-flow monitoring devices may require use of monitor modules which are UL Listed for use with the fire alarm system. Provide as required.

4. Notification: Provide Go / No-Go green and red beacons for warning personnel that combustible gas has been detected, or if the air flow is below that required to provide the desired reduction in hazard classification. Place beacons at entry to spaces and at other locations per NFPA 820, Table 7.5.3.

5. The supervisory alarms for gas detection and air flow shall transmit via the Fire Alarm Control Panel, to the SCADA system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. The following manufacturers are acceptable provided that the fire alarm system is furnished by a UL (UUJS) listed signal subcontractor.

1. Notifier
2. Simplex
3. Thorn
4. Edwards
5. Pyrotronics

2.2 MATERIALS

A. Conduit and Wire:

1. Conduit:
   a. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
   b. All wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
c. Cable 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.

d. 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. 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.

e. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the fire alarm panel manufacturer.

f. Conduit shall be 3/4 inch minimum, and follow the requirements as specified in Section 260533 – “Raceway and Boxes for Electrical Systems.”

2. Wire:

a. All fire alarm system wiring shall be new.

b. 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. 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.

c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

d. 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).

e. 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 and the engineer. The system should permit use of Initiating Device Circuit and Notification Appliance Circuit wiring in the same conduit with the communication loop.

f. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

g. The fire alarm control panel shall be capable of T-Tapping Class B (NFPA Style 4) Signaling Line Circuits. Systems which do not allow, have restrictions to, for example, the amount of T-Taps, length of T-Taps etc., are not acceptable.

3. Terminal Boxes, Junction Boxes and Cabinets:

a. All boxes and cabinets shall be UL listed for their use and purpose.

b. Size per NEC requirements.

4. Initiating circuits shall be arranged to serve like categories (manual, smoke, water flow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

5. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the branch circuit panel as FIRE
ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded.

B. MAIN FIRE ALARM CONTROL PANEL:

1. One enclosure shall house the main fire alarm panel. The main fire alarm panel shall be listed for Class B operation with appropriate supervisory zones and include all control modules, power supplies, supplemental pilot relays and auxiliary hardware required to perform the functions specified.

   a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
   b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.
   c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.
   d. Visually and audibly annunciate any trouble, supervisory or alarm condition on operator's terminals, panel display, and annunciators.

2. System Capacity and General Operation

   a. The control panel shall provide, or be capable of expansion to 198 intelligent/addressable devices per loop and 2048 annunciation points per system.
   b. The FACP shall include a full featured operator interface control and annunciation panel that shall include a backlit, 80 character liquid crystal display, individual, color coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
   c. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
   d. The FACP shall be able to provide the following features:

   1) Block acknowledge
   2) Charger rate control
   3) Control-by-time
   4) Automatic day/night sensitivity adjust
   5) Device blink control
   6) Drift compensation
   7) NFPA 72 smoke detector sensitivity test
   8) System status reports
   9) Alarm verification, by device, with tally
   10) Multiple printer interface
   11) Multiple CRT display interface
   12) Non-alarm module reporting
   13) Periodic detector test
   14) Trouble reminder
   15) Upload/download to PC
   16) Alarm verification with tally
   17) Walk test
   18) Smoke detector maintenance alert
19) Security monitor points

e. The fire alarm control panel shall include a full featured auto dialer.

3. Power Supply:

a. The main power supply shall operate on 120 volts AC, 60 Hz, and shall provide all necessary power for the FACP.

b. It shall provide a minimum of 3.0 amperes of usable notification appliance power, using a switching 24 volt DC regulator.

c. It shall be expandable for additional notification appliance power in 3.0 ampere increments.

d. It shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge.

e. It shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.

f. It shall be power-limited using Positive Temperature Coefficient (PTC) resistors.

g. It shall provide meters to indicate battery voltage and charging current.

h. The power supply shall be capable of charging NICAD batteries up to 55 ampere-hours.

4. System Circuit Supervision:

a. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding.

b. Sprinkler system valves, standpipe control valves, PIV and main gate valves shall be supervised for off-normal position.

5. Field Wiring Terminal Blocks: For ease of service, all wiring terminal blocks shall be the plug-in type, and have sufficient capacity for 18 AWG to 12 AWG wire. Terminal blocks permanently fixed are not acceptable.

6. Operators Terminal: Provide the following functions in addition to any other functions required for the system.

a. Acknowledge (ACK/STEP) Switch:

1) Activation of the control panel acknowledge switch in response to a single new alarm and/or trouble condition shall silence the local panel piezo electric signal and change the system alarm or trouble LED from flashing mode to steady-ON mode. If additional new alarm or trouble conditions exist or are detected and reported in the system, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.

2) Depression of the acknowledge switch shall silence all remote annunciator piezo sounders.
b. Signal Silence Switch: Activation of the signal silence switch shall cause all programmed notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards.

c. System Reset Switch.

1) Activation of the system reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.

2) If the alarm condition(s) still exist, or if they reoccur in the system after system reset switch activation, the system shall then resound the alarm conditions.

d. System Test Switch. Activation of the system test switch shall initiate an automatic test of all intelligent/addressable detectors in the system. The system test shall activate the electronics in each intelligent sensor, simulating an alarm condition and causing the transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the liquid crystal display and on any CRT or printer in the System.

e. Lamp Test Switch. Activation of the lamp test switch shall sequentially turn on all LED indicators, liquid crystal display and local piezo-electric signal, and then automatically return the fire alarm control panel to the previous condition.

7. Addressable Devices - General

a. Addressable devices shall provide an address-setting means using rotary decimal switches.

b. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches. Devices which use a binary address setting method, such as a dip switch, which are difficult to install and subject to installation error. This type of device is not an allowable substitute.

c. Detectors shall be intelligent and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits.

d. Addressable smoke and thermal detectors shall provide dual (2) alarm and power LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs shall be optional through the system field program. An output connection shall also be provided in the base to connect an external remote alarm LED.

e. Smoke detector sensitivity shall be set through the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.

f. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their
performance. The detectors shall be listed by UL as meeting the calibrated
sensitivity test requirements of NFPA Standard 72, Chapter 7.
g. The detectors shall be ceiling-mount and shall include a separate twist-lock base
which includes a tamper proof feature. An optional base shall be available with a
built-in (local) sounder rated at 85 dBA minimum.
h. The detectors shall provide a test means whereby they will simulate an alarm
condition and report that condition to the control panel. Such a test may be
initiated at the detector itself (by activating a magnetic switch) or initiated
remotely on command from the control panel.
i. Detectors shall also store an internal identifying type code that the control panel
shall use to identify the type of device (ION, PHOTO, THERMAL).

8. Addressable Pull Box (manual station): Addressable pull boxes shall, on command from
the control panel, send data to the panel representing the state of the manual switch.
They shall use a double action requiring two separate actions for operation.

9. System Expansion: Design the main FACP and transponders so that the system can be
expanded in the future (to include the addition of twenty percent more circuits or loops)
without disruption or replacement of the existing control panel. This shall include
hardware capacity, software capacity and cabinet space.

10. Field Programming
   a. The system 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 keyboard or
      through the video terminal.
   c. All field defined programs shall be stored in non-volatile memory.
   d. The programming function shall be enabled with a password that may be defined
      specifically for the system when it is installed. Two levels of password protection
      shall be provided in addition to a key-lock cabinet. One level shall be used for
      status level changes such as zone disable or manual on/off commands. A second
      (higher-level) password shall be used for actual change of program information.
   e. System programming shall be backed up on electronic media format (i.e. CD).
      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.

11. It shall be the responsibility of the equipment supplier/installer to ensure that all
equipment supplied will fit in locations designated on plans and in the specifications.

12. Specific System Operations
   a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the
      sensitivity of any or all analog intelligent smoke detectors in the system from the
      system keypad or from the keyboard of the video terminal. Sensitivity range shall
      be within the allowed UL window.
   b. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the
      system may be independently selected and enabled to be an alarm verified
      detector. The alarm verification function shall be programmable from 5 to 50
      seconds and each detector shall be able to be selected for verification during the
      field programming of the system or anytime after system turn-on. Alarm
      verification shall not require any additional hardware to be added to the control
      panel. The FACP shall keep a count of the number of times that each detector has
entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

c. System Point Operations

1) Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
2) System output points shall be capable of being turned on or off from the system keypad or the video terminal.

d. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:

1) Device status
2) Device type
3) Custom device label
4) Software zone label
5) Device zone assignments
6) Analog detector sensitivity
7) All program parameters

e. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status:

f. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 400 system output/input/control activations. Each of these activations will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.

g. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.

h. Automatic Detector Maintenance Alert:

1) The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
2) If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

C. System Components

1. Programmable Electronic Sounders:

a. Electronic sounders shall operate on 24 volt DC nominal.
b. Electronic sounders shall be field programmable without the use of special tools, to provide continuous tones with an output sound level of at least 90 dBA measured at 10 feet from the device.

c. Shall be flush or surface mounted as shown on plans.

2. Audible/Visual Combination Devices:

a. Shall operate on 24 volt DC nominal.

b. Shall meet the requirements of the ADA as defined in UL standard 1971 and shall meet the following criteria:

1) The maximum pulse per UL 1971.

2) Candela intensity shall meet the requirements of UL 1971.

3) The flash rate shall meet the requirements of UL 1971.

4) The appliance shall be placed 80 in (2,030 mm) above the highest floor level within the space, or 6 in (152 mm) below the ceiling, whichever is lower.

3. Addressable Devices - General: Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed at heights per ADA requirements.

4. Intelligent Photoelectric Smoke Detector: The detectors shall use the photoelectric (light-scattering) principle to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

5. Intelligent Thermal Detectors

a. Thermal Detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 Celsius) and have a rate-of-rise element rated at 15 degrees F. (9.4 C.) per minute. It shall connect via two wires to the Fire Alarm Control Panel Signaling Line Circuit.

b. An optional intelligent heat detector shall be available for applications which do not require a rate-of-rise element.

6. Intelligent Duct Smoke Detector: In-duct smoke detector housing shall accommodate an intelligent photoelectric sensor, that provides continuous analog monitoring and alarm verification from the panel.

7. Addressable Dry Contact Monitor Module: Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel Signaling Line Circuit (SLC) Loops.

8. Addressable Control Module: Addressable control modules shall be provided to supervise and control the operation of one conventional Notification Appliance Circuit (NAC) of compatible, 24 volt DC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay.

9. Sprinkler System Alarm and Supervisory Switches: Shall be provided and installed by the contractor. Wiring, raceway and final connection to the devices and the fire alarm system provided under this section.
10. **LCD Alphanumeric Display Annunciator:**
   
a. The alphanumeric display annunciator shall be a supervised, locally or remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
b. The LCD annunciator shall display all alarm and trouble conditions in the system.
c. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system-wide functions such as system acknowledge, silence and reset.
d. LCD display annunciators shall mimic the main control panel 80 character display and shall not require special programming.

11. **Autodialer:** Autodialer capable of sending signals over telephone lines and communicating with authorized supervising station.

12. **Components:** All components shall be listed for the environment in which they are installed. Reference the drawings and Section 260500 for area classification.

### 2.3 SPARE PARTS

A. In addition to the additional quantity noted on 1.3 C, include in the base bid the following spare parts items, and the associated labor to install these items, over and above those items indicated on the bid documents.

1. Addressable smoke detectors, three (3)
2. Addressable heat detectors, two (2)
3. Addressable pull box, two (2)
4. Addressable dry contact monitor module, two (2)
5. Audible/visual combination devices, five (5)
6. Wire for initiation devices 1000 feet
7. Wire for notification devices 1000 feet
8. Conduit 500 feet

B. Items not used above shall be delivered to the Owner at the completion of the project. All items shall be in their original packaging.

### PART 3 - EXECUTION

3.1 **INSTALLATION**

A. No equipment shall be provided at the job site until shop drawings have been reviewed and approved by the Engineer, and AHJ. An approved shop drawing set shall be continuously available at the job site during construction.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
C. Breakers in the panels feeding the control panel shall be fitted with suitable guard, such that the breaker cannot be turned off, but fixed so the breaker can trip and requiring the removal of a screw to remove the guard. Separate breakers shall be provided for each control panel main power and trouble circuits.

D. Conductors shall be copper and shall be of the type and AWG size specified herein or as shown on the Drawings.

E. Provide adequate alarm horns for appropriate signal level throughout building.

F. Remote Indicators: Provide in an adjacent area where readily visible for all concealed detectors.

G. Auxiliary Controls: Conductors and power supplies of sufficient size shall be installed to minimize voltage drop consistent with the proper operation of all devices. Destructible link smoke dampers shall not be connected to the fire alarm system. Fan shutdown control circuits, smoke removal control circuits supervised (subject to NFPA 72) and may be incorporated into the fire alarm raceway system, except that limited energy circuits shall be routed separately from line voltage circuits as required by NEC Article 760.

H. Air Duct Smoke Detectors: Coordinate installation of detectors with sheet metal installer for mounting; electrically connect and provide remote indicator lights (for duct smoke detectors) where the detector is located above a suspended ceiling or in an area which is not readily accessible. Connect auxiliary contact to shutdown fan system.

I. Transmitter: Coordinate with fire department for setup and testing of alarm transmitter.

J. Certification: Manufacturer's representative shall submit a letter stating he has tested system and found it acceptable in all respects.

3.2 TESTING

A. The complete system shall be tested by the Contractor’s factory trained technicians, in compliance with NFPA 72.

B. All wiring shall be tested for proper connections, continuity and resistance to ground.

C. The entire system shall be tested in accordance with a written Acceptance Test Procedure (ATP) to demonstrate and certify proper system operation. As a minimum, the ATP shall provide a detailed method of testing the following to demonstrate to the Owner that the system functions as intended by the design. The ATP shall be written by supplier of this section.

1. All alarm and control functions.
2. All trouble and supervisory functions.

3.3 TRAINING

A. Provide a minimum of two training sessions, each lasting 4 hours. Provide a complete set of printed information no less than two week in advance of scheduled training session. Information shall include as minimum general product information on Fire Alarm Control
panel(s), initiation devices, notification devices and 11”x17” drawings of the different structures showing location of the different devices. Provide no less than 8 sets of training information.

END OF SECTION 283100
SECTION 311000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above and below grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

C. Do not commence site clearing operations until temporary erosion and sedimentation control, and tree protection measures are in place.

D. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain Engineer approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.

C. Survey and flag clearing and grading limits shown on Drawings before any construction disturbance activities.

D. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion and sedimentation control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Engineer.

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
   1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary utility services according to requirements indicated:
   1. Notify the Engineer not less than two days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without the Engineer's written permission.

C. Removal of underground utilities including decommissioning of existing monitoring well are included in Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
   1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
   2. Use only hand methods for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory fill material unless further excavation or earthwork is indicated.
   1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
3.7 SITE IMPROVEMENTS
   A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS
   A. Remove surplus soil material, soil materials not meeting satisfactory soil material requirements, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
   
   B. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. All municipal solid waste and construction debris shall be disposed of at the Jefferson County Landfill. All hazardous waste shall be disposed of at the Jefferson County Household Hazardous Waste Facility.
   
   C. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000
SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies earthwork which consist of material, excavating, backfilling, compacting, grading and testing.

1.2 DEFINITIONS

A. Compaction: the degree of compaction is specified as percent compaction. Maximum or relative densities refer to dry soil densities obtainable at optimum moisture content.

B. Excavation slope: an inclined surface formed by removing material from below existing grade.

C. Imported backfill: select material which meets the Fill Class specified and is obtained from a supplier regularly engaged in the business of supplying soil/fill material. It is not material which is obtained from excavation.

D. Native material or Selected Native Material: materials excavated from within the Project limits.

E. Suitable Native Material: native material which meets the Fill Class specified.

1.2 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.

B. Submittals:

   1. Procedures per Section 013300.
   2. Samples of all fill materials to be used 30 days in advance of use. Samples shall consist of 0.5 cubic feet of each type of material.
   3. Laboratory test reports and samples of fill materials to be used, certifying:

      a. Moisture density relationships and gradation test reports and curves.
      b. Gradation tests for non-cohesive materials.

1.3 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Do not commence earth moving operations until tree-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. Native materials

1. May be reused on the project, except where noted as import, provided they meet the requirements of the fill classification including gradation, moisture content and can achieve required in-place density.
2. Prior to reusing native materials Contractor shall submit samples to a laboratory for testing and documentation that they meet the fill specifications. Submit test results to the Engineer before reusing the material. The County does not warrant that the contract geotechnical information is adequate to determine if native soils can meet the requirements for project fill.
3. Native material not meeting the specifications cannot be used in the project and imported material must be used at no additional cost.

B. Type A1, A2 (Pit Run) See Table A:

1. Select granular material free from organic matter.
2. Sand equivalent value of not less than 20.
3. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-80</td>
</tr>
<tr>
<td>No. 10</td>
<td>10-70</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-50</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-30</td>
</tr>
</tbody>
</table>

4. The coefficient of uniformity shall be three or greater.
5. The material may be an imported quarry waste, clean natural sand or gravel, select trench excavation, or a mixture thereof.

C. Type B (Clean Gravel-Sand):

1. Clean gravel-sand mixture free from organic matter.
2. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch</td>
<td>100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>35-100</td>
</tr>
<tr>
<td>No. 10</td>
<td>10-100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0-60</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>
D. Type C1, C2 (Unclassified) see Table A:

1. Free from peat, wood, roots, bark, debris, garbage, rubbish or other extraneous material.
3. Obtained from on-site excavations and from spoils piles.
4. Moisture content: less than optimum to allow compaction.
5. Percent passing No. 200 sieve: 5% maximum.

E. Type E (Drain Rock):

1. Clean, washed, and well graded.
2. Composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.
3. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>0-2</td>
</tr>
</tbody>
</table>

F. Type F (Crushed Rock):

1. Composed of hard, durable, sound pieces having a specific gravity of not less than 2.65.
2. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2 inch</td>
<td>87-100</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>45-90</td>
</tr>
<tr>
<td>No. 4</td>
<td>20-50</td>
</tr>
<tr>
<td>No. 30</td>
<td>6-29</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-12</td>
</tr>
</tbody>
</table>

G. Type G (Ballast):

1. Crushed, partially crushed, or naturally occurring granular material.
2. The portion of the ballast retained on sieve shall not contain more than 0.2 percent wood waste.
3. The material from which the ballast is to be manufactured shall meet the following test requirements:
   - Los Angeles Wear, 500 Rev: 40% max
   - Degradation Factor: 15 min
4. Meet the following requirements for grading and quality:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>2-inch</td>
<td>65-100</td>
</tr>
<tr>
<td>1-inch</td>
<td>50-85</td>
</tr>
<tr>
<td>1/4-inch</td>
<td>30-50</td>
</tr>
<tr>
<td>No. 40</td>
<td>16 max</td>
</tr>
<tr>
<td>No. 200</td>
<td>9 max</td>
</tr>
</tbody>
</table>
H. Type L (Structural Fill):

1. Well-graded sand and gravel, free of organic debris and other deleterious material.
2. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>60-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-80</td>
</tr>
<tr>
<td>No. 10</td>
<td>0-35</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5 (wet sieving)</td>
</tr>
</tbody>
</table>

I. Type M (Foundation Drain Filter):

1. Well-rounded rock.
2. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 inch</td>
<td>100</td>
</tr>
<tr>
<td>3 inch</td>
<td>80-100</td>
</tr>
<tr>
<td>1-1/2 inch</td>
<td>40-90</td>
</tr>
<tr>
<td>1-inch</td>
<td>20-65</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>5-50</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>0-15</td>
</tr>
</tbody>
</table>

J. Type N (Trench Backfill):

1. Free of stones greater than 2-1/2 inches in the greatest dimension, free from clay and organic matter, moisture content that is less than the material’s optimum value, and compacts readily.
2. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/4-inch</td>
<td>25 min</td>
</tr>
<tr>
<td>No. 200</td>
<td>10 max</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dust ratio</th>
<th>% Passing No. 200</th>
<th>2/3 max</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Passing No. 40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

K. Type P (Crushed Surfacing Base Course):

1. The fracture requirement shall be at least one fractured face and will apply to material retained on each specification sieve size U.S. No. 10 and above if that sieve retains more than 5 percent of total sample.
2. The portion retained on a 1/4-inch sieve shall not contain more than 0.15 percent wood waste.

3. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>5/8-inch</td>
<td>50-80</td>
</tr>
<tr>
<td>1/4-inch</td>
<td>30-50</td>
</tr>
<tr>
<td>No. 40</td>
<td>3-18</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>

L. Type Q (Quarry Spalls):

1. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 inch</td>
<td>100</td>
</tr>
<tr>
<td>3 inch</td>
<td>40 max</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>10 max</td>
</tr>
</tbody>
</table>

2. For construction entrances, meet the above requirements with the exception that the percent passing the 3/4-inch screen shall be limited to 5 percent maximum.

M. Type R (Crushed Surfacing Top Course):

1. Conform to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/4 inch</td>
<td>55-75</td>
</tr>
<tr>
<td>No. 40</td>
<td>8-24</td>
</tr>
<tr>
<td>No. 200</td>
<td>5% max</td>
</tr>
</tbody>
</table>

| % Fracture | 75 min |
| % Sand Equivalent | 35 min |

2. The fracture requirement shall be at least one fractured face and applies to material retained on each specified sieve size No. 10 and above if that sieve retains more than five percent of the total sample.

3. The portion retained on a 1/4-inch sieve shall not contain more than 0.15 percent wood waste.

N. Type S (Bedding Material for Rigid Pipe):

1. Crushed, processed, or naturally occurring granular material. It shall be essentially free from various types of wood waste or other extraneous or objectionable materials.

2. Characteristics of size and shape that compacts readily.

3. A maximum of five percent shall pass the No. 200 sieve for sanitary sewer installations.

4. Conform to the following for grading and quality:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 inch</td>
<td>100</td>
</tr>
<tr>
<td>1/4-inch</td>
<td>25-80</td>
</tr>
</tbody>
</table>
O. Type U (Bedding Material for Flexible Pipe): Clean sand/crushed gravel mixture free from organic matter and conforming to the following gradation:

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent by Weight Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4-inch</td>
<td>100</td>
</tr>
<tr>
<td>3/8-inch</td>
<td>70-100</td>
</tr>
<tr>
<td>No. 4</td>
<td>55-100</td>
</tr>
<tr>
<td>No. 10</td>
<td>35-95</td>
</tr>
<tr>
<td>No. 20</td>
<td>20-80</td>
</tr>
<tr>
<td>No. 40</td>
<td>10-55</td>
</tr>
<tr>
<td>No. 100</td>
<td>0-10</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-3</td>
</tr>
</tbody>
</table>

P. Type V (Clay/Glacial Till Core): Glacial till or lacustrine clay/clayey silt or a manufactured soil containing at least 30% passing the No. 200 mesh sieve. Clay core shall be above its optimum moisture content per ASTM D-1557 when placed and compacted.

Q. Pea Gravel is not acceptable for backfill or bedding.

2.2 CLASSIFICATION OF FILL

A. Fill material shall be placed in horizontal layers and compacted with power operated tampers, rollers, idlers, vibratory equipment, or hand operated compactors.

B. Material type, maximum layer depth, relative compaction, and general application are specified in Table A below.

C. Unless otherwise specified, fill classes shall be used where specified in Table A under general application.

<table>
<thead>
<tr>
<th>TABLE A - FILL CLASSIFICATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill Class</td>
</tr>
<tr>
<td>A1</td>
</tr>
<tr>
<td>A2</td>
</tr>
<tr>
<td>A1 A2</td>
</tr>
<tr>
<td>B</td>
</tr>
</tbody>
</table>
### TABLE A - FILL CLASSIFICATIONS

<table>
<thead>
<tr>
<th>Fill Class</th>
<th>Material Type</th>
<th>Maximum Layer Depth inches</th>
<th>Minimum Uncompressed Compaction Percent</th>
<th>General Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>C</td>
<td>8</td>
<td>90</td>
<td>Subsequent pipeline back-fill in unimproved areas. Maybe used in improved areas as subsequent backfill a minimum of three feet below grade.</td>
</tr>
<tr>
<td>C2</td>
<td>C</td>
<td>8</td>
<td>95</td>
<td>Site fill and embankments.</td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>8</td>
<td>90</td>
<td>Bedding and backfill around foundation drain pipes and directly under slabs for structures and tanks.</td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>6</td>
<td>95</td>
<td>Substation yard surfacing, placed loose.</td>
</tr>
<tr>
<td>G</td>
<td>G</td>
<td>6</td>
<td>95</td>
<td>Railroad bedding.</td>
</tr>
<tr>
<td>L</td>
<td>L</td>
<td>8</td>
<td>95</td>
<td>Fill under slabs or structures.</td>
</tr>
<tr>
<td>M</td>
<td>M</td>
<td>8</td>
<td>95</td>
<td>Alternative foundation drain pipe bedding and backfill and for stone filter.</td>
</tr>
<tr>
<td>N</td>
<td>N</td>
<td>8</td>
<td>90</td>
<td>Trench backfill to replace unsuitable excavated materials.</td>
</tr>
<tr>
<td>O</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>P or C</td>
<td>8</td>
<td>90</td>
<td>Roadway base course.</td>
</tr>
<tr>
<td>Q</td>
<td>Q</td>
<td>12</td>
<td>95</td>
<td>Temporary road base.</td>
</tr>
<tr>
<td>R</td>
<td>R</td>
<td>6</td>
<td>95</td>
<td>Roadway top course.</td>
</tr>
<tr>
<td>S</td>
<td>S</td>
<td>6</td>
<td>95</td>
<td>Bedding for pipe.</td>
</tr>
<tr>
<td>U</td>
<td>U</td>
<td>6</td>
<td>95</td>
<td>Bedding for pipe.</td>
</tr>
<tr>
<td>V</td>
<td>V</td>
<td>a. 6</td>
<td>b. 92</td>
<td>Clay Core</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. 92</td>
<td>b. 92</td>
<td>a. heavy equipment compactor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>b. hand-operated compactor</td>
</tr>
</tbody>
</table>

### 2.3 ACCESSORIES

A. **Warning Tape:** Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. **Detectable Warning Tape:** Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.
PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsuitable soil materials and rock, replace with suitable soil materials.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Utility Structures, Slabs, Footings and Foundations: Excavate using a smooth face (toothless) bucket. Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Prepare fill under structures per the Geotechnical Report recommendations and as specified herein. Trim bottoms to required lines and grades to leave solid base to receive other work.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a loaded pneumatic-tired dump truck to identify soft pockets and areas of excess yielding.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.
3.8 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated suitable soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with suitably compacted soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033000 Cast-in-Place Concrete.

D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 033000 Cast-in-Place Concrete.

E. Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Place and compact final backfill of suitable soil to final subgrade elevation.

G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer to within 2 percent of optimum moisture content before compaction.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise suitable soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3. Where necessary, dry Portland cement may be mixed with wet soil to absorb excess moisture and improve compactability. Cement concentration may not exceed 2 percent (by dry weight).
3.11 COMPACTION OF PERCOLATION POND

A. Place backfill and fill soil materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 3 inches in loose depth for material compacted by hand-operated tampers.

B. Clay core shall be above its optimum moisture content per ASTM D-1557 when placed and compacted.

C. Fill embankment slopes shall be compacted with a Hoe-Pac or overbuilt and then cut back.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 6 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 6 inches of existing subgrade and each layer of backfill or fill soil material to 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material to 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material to 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material to 95 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.
3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place base course under pavements and walks as follows:
   1. Shape base course to required crown elevations and cross-slope grades.
   2. Place base course in layers of equal thickness, with no compacted layer more than 6 inches thick.
   3. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness, to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.15 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course in layers of equal thickness, with no compacted layer more than 6 inches thick.
   2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.16 FIELD QUALITY CONTROL

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

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

C. Clay Core: Probe clay core with a T-bar and test each layer with a nuclear densometer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
3.17 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.18 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus suitable soil and waste materials, including unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

B. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. All municipal solid waste and construction debris shall be disposed of at the Jefferson County Landfill. All hazardous waste shall be disposed of at the Jefferson County Household Hazardous Waste Facility.

END OF SECTION 312000
SECTION 312319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes construction dewatering.

1.2 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.3 FIELD CONDITIONS
   A. Survey Work: Engage a qualified licensed land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1.4 PERFORMANCE REQUIREMENTS
   A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
   B. Dewatering at Influent Pump Station:
      1. Provide three (3) dewatering wells with the following design performance:
         a. pumping capacity of at least 500 gpm each
         b. 30 feet deep
         c. 30 inches in diameter
         d. Gravel packed

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PREPARATION
   A. Provide temporary grading to facilitate dewatering and control of surface water.
B. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 312500 Erosion Control, during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-ump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.

C. Remove dewatering system from Project site on completion of dewatering. Decommission and abandon dewatering wells lawfully and in compliance with WAC 173-160-381 requirements.

3.4 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Engineer if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION 312319
SECTION 312500 – EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies constructing and maintaining the drainage and temporary erosion and sediment control system, (TESC). Work shall include providing required materials; installation and maintenance of temporary and permanent erosion and sedimentation control measures; preparing slopes; seeding; fertilizing; mulching; and temporary covering of graded slopes, disturbed areas, and stockpile areas in accordance with the permits, these Specifications and as shown on the Drawings.

1.2 QUALITY CONTROL

A. References: This section references the latest revisions of the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM A392</td>
<td>Specification for Zinc-Coated Steel Chain-Link Fence Fabric</td>
</tr>
<tr>
<td>ASTM D 882</td>
<td>Test Method for Tensile Properties of Thin Plastic Sheeting</td>
</tr>
<tr>
<td>ASTM D 1004</td>
<td>Test Method for initial Tear Resistance of Plastic Film and Sheeting</td>
</tr>
<tr>
<td>ASTM D1505</td>
<td>Test Method for Specific gravity of polymer</td>
</tr>
<tr>
<td>ASTM D 1777</td>
<td>Test Method for Thickness of Textile Materials</td>
</tr>
<tr>
<td>ASTM D 3776</td>
<td>Test Method of Mass per Unit Area (Weight) of Fabric</td>
</tr>
<tr>
<td>ASTM D3786</td>
<td>Test Method of Mullen Burst Strength</td>
</tr>
<tr>
<td>ASTM D 5034</td>
<td>Test Methods for Breaking Strength and Elongation for Textile Fabrics (Grab Test)</td>
</tr>
<tr>
<td>ASTM D4491</td>
<td>Test Method of Water Permittivity</td>
</tr>
<tr>
<td>ASTM D4632</td>
<td>Test Method of Grab Tensile Strength</td>
</tr>
</tbody>
</table>

B. Testing: Testing may be conducted by the Engineer to determine compliance with the specified materials, soil preparation, hydroseed mix, spreading and physical erosion protection barrier.

C. Comply with all applicable requirements of local, state, and federal agencies.

D. Conform to local and state Water Quality Standards for all discharge.

1.3 SUBMITTALS

A. Procedures: Section 013300.

B. Shop drawings and product data:
1. A Construction Stormwater Pollution Prevention Plan (SWPPP). The plan shall identify the Contractor’s designated Erosion and Sedimentation Control (ESC) lead by name and 24-hour telephone number, erosion control measures to be used by the Contractor, including those already shown and specified. The SWPPP shall employ best management practices.

2. Complete specification for catch basin filter fabric, filter fabric fence and all other geotextile fabrics used.

3. Manufacturer’s or supplier’s certificates of compliance with Specifications.

4. Haul routes ingress and egress.

5. Submittal of responses to the questions referencing this Section.

1.4 SEQUENCING AND SCHEDULING

A. No construction work permitted without a Contractor-provided, and Engineer-approved erosion control plan.

B. Construct erosion control system prior to clearing, grubbing or excavation activities.

1.5 CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

A. Consists of Best Management Practices (BMPs) that control erosion and sedimentation from the Contractor’s activities and treats stormwater to meet discharge requirements.

B. The SWPPP shall address all twelve plan elements as described in Volume I-Minimum Technical Requirements, Section 2.5.2 of the 2012 SMMWW.

C. Drawings:

1. Indicate the minimum requirements at the start of work.
2. During the construction period, the BMPs shall be upgraded and modified as needed to meet discharge requirements for changing construction activities, storm events, and changing site conditions.

D. Schedule BMP implementation correlated to Wet Season and Dry Season activities.

E. Provide at a minimum, the following information:

1. Requirements in the Drawings and Specifications.
2. Locations and construction details of proposed TESC BMPs including (at a minimum):
   a. Silt fences.
   b. Clearing limits fences.
   c. Stabilized construction entrance(s).
   d. Temporary diversion systems.
   e. Check dams.
   f. Inlet protection.
   g. Interception of inlet and catch basin drainage.
   h. Pipe slope drains.
   i. Sediment ponds.
j. Sediment traps.
k. Temporary stormwater application systems.
l. Ditches.
m. Berms.
n. Culvert Pipes.
o. Filter systems.
p. Outfalls.
q. Erosion control seeding.

3. Locations, types, and quantities of plantings, slope coverings, and ditch liners.
4. Show necessary rerouting of existing surface water and underground drainage within the Site to erosion control facilities prior to release to the offsite drainage systems.
5. Location of cut and fill slopes.
6. Approximate slopes, contours, and direction of stormwater flow before and after major grading activities.
7. Location of off-site material, stockpiles, waste storage, borrow areas, and vehicle/equipment storage areas.
8. Location of surface water bodies, including wetlands, ponds, lakes, streams, and drainage ditches.
9. Location of water quality sampling stations.
10. Maintenance schedule of TESC.
11. Measures to prevent the addition of Process Water or domestic wastewater into the stormwater.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Geotextile for silt fence, filter fabric filters, and gravel wire mesh filters. Geotextile shall be Mirafi 100X or approved equal, and shall have the following characteristics:

1. Puncture: 60 lbs
2. Grab Strength/Elongation: 120 lbs/15%
3. Mullen Burst Strength: 280 psi
4. EOS: 20
5. Ultraviolet light resistance: 70% (% Strength Retained)

B. Where seeding is required, the seed mixture and application rate shall be as follows:

<table>
<thead>
<tr>
<th>Kind of Seed in Mixture</th>
<th>Pounds/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creeping red fescue (Pennlawn)</td>
<td>48</td>
</tr>
<tr>
<td>Red Top (Agrostis Alba)</td>
<td>36</td>
</tr>
<tr>
<td>Birdsfoot trefoil (Lotus Corniculatus)</td>
<td>36</td>
</tr>
<tr>
<td>Total Pounds/Acre</td>
<td>120</td>
</tr>
</tbody>
</table>

C. Where fertilizer is required, it shall be a standard commercial grade of organic or inorganic fertilizer of a kind and quantity recommended by the supplier.
D. Where mulching is required, it shall be:
1. Straw mulch material shall be in an air-dried condition free of noxious weeds and other materials detrimental to plant life. Straw shall be seasoned before baling or loading. Straw mulch so provided shall be suitable for spreading with mulch blower equipment.
2. Wood cellulose fiber mulch shall be specially processed wood fiber containing no growth or germination inhibiting factors and shall be dyed a suitable color to facilitate inspection of the placement of the material. It shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form homogenous slurry. When hydraulically sprayed on the ground, the material shall allow the absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air dry weight content.

E. Straw bales shall be bales of straw tied with wire or plastic. The straw shall be free of noxious weeds and reed canary grass seed.

F. Quarry spalls for use in temporary and permanent erosion control applications shall consist of hard, sound, and durable stones with a percentage wear less than 35 percent when tested in conformance with ASTM C535. It shall be free from roots, organic material, segregation, seams, cracks, and other defects tending to destroy its resistance to weather. Quarry spalls shall meet the following requirements for grading, by weight:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-inch</td>
<td>100</td>
</tr>
<tr>
<td>4-inch</td>
<td>40-60</td>
</tr>
<tr>
<td>3/4-inch</td>
<td>0-10</td>
</tr>
</tbody>
</table>

G. Composite Drainage Net (CDN): CDN shall consist of geonet with nonwoven geotextile bonded at the factor to each side. The laminate bond strength between the geonet and geotextile shall be 1 pound per inch measured in accordance with ASTM D413. The bonding process shall not impair the transmissivity of the geonet or the permeability of the geotextile.

1. Geonet shall be domestic polyethylene resin extruded ribs made to form a rigid, porous net of uniform pattern with distinct measurable openings. Geonet shall be Tex-Net TN-3002, as manufactured by Fluid Systems, Inc., Cincinnati, OH; Tendrain 100-2, as manufactured by Tenax Corporation, Baltimore, MD; or DC 4205, as manufactured by Tensar Corp., Morrow, GA, or approved equal. Approximately 2 percent carbon black shall be added to the resin for ultraviolet light resistance.

<table>
<thead>
<tr>
<th>Thickness, in. (MinARV)</th>
<th>ASTM D1777</th>
<th>0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture Size center to center of ribs, in., max</td>
<td>Direct measure</td>
<td>0.39</td>
</tr>
<tr>
<td>Specific gravity of polymer</td>
<td>ASTM D1505</td>
<td>0.937</td>
</tr>
</tbody>
</table>

2. Geotextile shall be nonwoven bonded to each side of the geonet. The geotextile shall be a pervious sheet of polypropylene or polyester filaments oriented into a stable network so that the filaments retain their relative position with respect to each other. The geotextile shall be manufactured into a width 6 inches greater than the width of the geonet roll. The geotextile shall conform to the following maximum or minimum average roll (MaxARV or MinARV) physical property values:
Thickness, mil (MinARV) | ASTM D1777 | 80
Weight oz/sq yd (MinARV) | ASTM D3776 | 6.0
Water Permittivity, see-1 (MinARV) | ASTM D4491 | 1.8
Grab Tensile Strength, lb (MinARV) | ASTM D4632 | 145
Grab Elongation, % (MaxARV) | ASTM D4632 | 50-90
Mullen Burst Strength, psi (MinARV) | ASTM D3786 | 220

H. Reinforced Plastic Fabric:
1. Constricted, copolymer laminate.
2. Reinforcing: Non-woven grid of high strength nylon cord submerged in a permanently flexible adhesive medium.
3. Equal tear resistance in all directions.
5. Ultraviolet light stabilized.
6. Material to from a single manufacturer.
7. Physical strength requirements:
   a. Tear strength, lbs: 130 per ASTM D1004.
   b. Elongation percent; 620 per ASTM D882.
   c. Minimum life expectancy: 2 ½ years of normal outdoor exposure.

I. Fabrics/mats/blankets:
1. Jute mesh
2. Permanent revegetation mat:
   a. Highly flexible polymeric mat with a three dimensional web-like weave.
   b. Color: Green.
   c. Biologically inert.
   d. Acid and alkaline resistant.
   e. Ultraviolet degradation resistant.
   f. Physical properties:
      1) Porosity: 85-95%
      2) Flexibility: 2000 mg/cm
      3) Weight: 18 oz/sy ASTM D 3776
      4) Thickness: 0.12-inch ASTM D 1777.
      5) Tensile Strength: Length 15 Lbs, width 5 lbs ASTM D 5034.
3. Temporary erosion control blankets:
   a. Biodegradable wood materials.
   b. No chemical additives.
   c. Photodegradable extruded plastic netting top and bottom.
   d. Smolder resistant.
   e. Physical properties of blanket for slope protection:
      1) Weight: 0.98 lbs./sy.
      2) Netting: 1-inch by 2-inch.
f. Physical properties for blanket for channel protection:
   1) Weight: 1.0 lbs/sq.

J. Wire fabric for silt fence:
   1. 2-inch x 2-inch mesh, 14 gage or approved equal.
   3. Height: As shown on Drawings.

K. Posts: Nominal 2-inch by 4-inch wooden posts, No. 2 grade or better, pressure treated for exterior applications, Alternatively, Contractor may submit proposal to utilize aluminum-coated steel fence posts and aluminum alloy tie wire.

L. Hold Downs:
   1. Sand bags as approved by the Engineer.
   2. Secure with 1/4-inch polypropylene rope at 10 feet on center maximum each way.
   3. Anchor rope with 2-inch by 4-inch fir, standard or better.

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING
   A. Schedule or phase excavation to minimize impacts to critical habitat, mitigation areas, wetlands, streams and creeks.
   B. Install perimeter protection (silt fence) prior to clearing and grubbing.
   C. For work impacting the street right-of-way, in the area of the work, sequence the work to allow for collection and treatment of surface water runoff prior to its reaching the local drainage system.
   D. Complete SWPPP and construct TESC BMPs prior to commencing trenching, cut and fill, or other earthwork activity.

3.2 PREPARATION
   A. Prior to general stripping of topsoil and excavation, install all temporary erosion and sedimentation control as shown in the Drawings.
   B. Install catch basin protection at all catch basins within 100 feet of work area or at nearest downstream catch basin if none within 100 feet.
   C. Install silt fences at locations shown in the Drawings.
   D. Utilize Baker Tanks to meet detention requirements for sediment control.
E. Install stabilized construction entrances per Drawings.

F. Install straw bales as necessary and as required by permit or as directed by the Engineer.

G. Hydroseed and provide temporary control blankets and permanent revegetation mats for all erosion control ditches, drainage ditches, and sedimentation traps unless otherwise noted. Maintain, in accordance with the specifications.

H. Provide additional silt fence or construction fencing to protect areas of landscaping that will not be affected by construction.

3.3 SEEDING AND FERTILIZING

A. Preparation: Hydroseed all disturbed areas following completion of construction of the temporary sediment and erosion control system. Seed areas outside the protected areas that are damaged during excavation work. Areas to be seeded shall meet the specified finish grades and shall be free of undesirable weed or plant growth and all clods, rocks, and debris 3 inches or larger in any dimension.

B. Compaction: In addition to the compaction that may be required elsewhere in the Specifications, areas to be seeded, including excavation slopes, shall be compacted and prepared unless otherwise specified. A cleated roller, crawler tractor, or similar equipment that forms longitudinal depressions at least 2 inches deep shall be used for compaction and preparation of the surface to be seeded. The entire area shall be uniformly covered with longitudinal depressions formed perpendicular to the natural flow of water on the slope. The soil shall be conditioned with sufficient water so the longitudinal depressions will remain in the soil surface until completion of seeding. The area shall be compacted within three weeks of the time of seeding.

C. Seeding: Notify the Engineer not less than 24 hours in advance of seeding operations. Do not begin the work until areas prepared or designated for seeding have been approved by the Engineer. Begin immediately following the Engineer’s approval. Do not place seed during windy weather or when the ground is frozen, excessively wet, or otherwise untillable. Place seed at the rate and mix specified.

1. Seed shall be sown by one of the following methods:

   a. An approved hydroseeder which utilizes water as the carrying agent and maintains continuous agitation through paddle blades. It shall have an operating capacity sufficient to agitate, suspend, and mix into a homogeneous slurry the specified amount of seed, water, fertilizer, and mulch. Distribution and discharge lines shall be large enough to prevent stoppage and shall be equipped with a set of hydraulic discharge spray nozzles which will provide a uniform distribution of the slurry.

   b. Approved hand seeders.

2. Seed and fertilizer may be applied in one application provided that the fertilizer is placed in the hydroseeder tank no more than 30 minutes prior to application. The seed shall have a tracer added to visibly aid uniform application. This tracer shall not be harmful to plant and animal life. If wood cellulose fiber is used as a tracer, the application rate shall not exceed 250 pounds per acre.
D. Mulching:
   1. Wood cellulose fiber mulch shall be included in the hydroseeding process unless approved by the Engineer. The application of seed, fertilizer, and mulch shall be in a single operation for all seed applications.
   2. The application of straw mulch as a temporary stabilization method shall be in disturbed areas with slopes 4 (horiz):1 (vert) or steeper as directed by the Engineer. Straw mulch shall be applied by means of an approved-type mulch spreader that uses forced air to blow mulch material on seeded areas. In spreading straw mulch, the spreader shall not cut or break the straw into short stalks. The minimum depth of the straw mulch shall be 2 inches.
   3. Areas not accessible by mulching equipment shall be mulched by approved hand methods.

E. Dates for Application of Seed, Fertilizer, and Mulch:
   1. Unless otherwise approved by the Engineer, seeding, fertilizing, and mulching of all designated areas shall be performed during the period of March 1 to May 15 and August 15 to October 1. Written permission to seed after October 1 will only be given when completion of the project is imminent and the environmental conditions are conducive to satisfactory growth.
   2. Excavation and embankment slopes, including excavation and embankment of slopes that are partially completed to grade, must be prepared and seeded during the first available planting period and shall not be allowed to sit idle for long periods of time without receiving the erosion control specified in these specifications. When the environmental conditions are not conducive to satisfactory results from seeding operations, the Engineer may order the work suspended, and it shall be resumed only when the desired results are likely to be obtained.
   3. Restore eroded areas, clean up eroded materials, and reseed, fertilize, and mulch the areas failing to show a uniform stand of grass. Restoration and reseeding shall be at the Contractor’s sole expense.

3.4 INSTALLATION

A. Quarry Spalls:
   1. Construct stabilized construction entrances in accordance with the locations shown on the Drawings and as required by the Engineer.

B. Plastic sheeting:
   1. Install in accordance with the Drawings at all excavation faces and at stockpiles.
   2. Completely cover stockpiles including slope faces.
   3. Anchor plastic sheeting in 2-foot by 2-foot trench around the entire perimeter of plastic sheeting.
   4. Overlap joints with minimum 2-foot lap and tape seam.
   5. Install hold downs at all excavation faces and at stockpiles.
   6. Secure hold downs with polypropylene rope at 10-foot on center, maximum each way, across the entire surface of plastic sheeting.
7. Anchor the polypropylene rope by driving 2-inch by 4-inch stake at the top of excavations or bottom of stockpiles and tying rope to stake.

C. Filter Fabric Silt Fence:
1. Install filter fabric over wire fabric.
   a. Use aluminum alloy wire, minimum 10 gage.
   b. Spacing at top: maximum of 4-foot on center
3. Repairs: patch with filter fabric extending 6 inches beyond damaged area in all directions.

D. Wire Fabric:
2. Secure wire fabric to posts with heavy duty wire staples (at least 1-inch long), aluminum alloy tie wires (10 gage) or wire rings. Secure at top, middle, and bottom.
3. Backfill area immediately upslope and adjacent to the fences line with drain rock as shown on the Drawings.
4. Set posts at 6-foot maximum spacing.
5. Wire fabric to extend 24 inches above ground surface.

3.5 CLEARING AND GRADING
A. Comply with the requirements of all applicable permits.
B. Limit daily scope of clearing and grading operation to minimize the area of exposed soils open at one time. Submit daily clearing limit as part of Contractor’s erosion/sedimentation control plan.
C. Maintain intact all landscaping and planting to remain.
D. Cast and save topsoil for use as required by permits or these Contract Documents.

3.6 SOURCE SEDIMENT CONTROLS
A. Placement and use of temporary erosion controls shall be provided during construction using filter fences, straw bales, and sediment traps.
B. Gravel Filter Berms: Where required, construct gravel filter berms of 3/4- to 3-inch well graded gravel or crushed rock with less than 5 percent fines.
C. Temporary Cover: Complete temporary seeding, site seeding or utilize filter fabric, straw, or plastic sheeting to cover the bare earth surfaces.
3.7 MAINTENANCE

A. Maintain and modify the erosion control system and change the Plan throughout construction as required.

B. Implement structural Best Management Practices (BMPs) to divert flows from exposed soils. Store flows or otherwise limit runoff and the discharge of pollutants from exposed areas of the site. Such practices may include silt fences, earthen dikes, drainage swales, sediment traps, check dams, subsurface drains, pipe slope drains, level spreaders, storm drain inlet protection, rock outlet protection, reinforced soil retaining systems, gabions, and sediment basins:

1. Prior to leaving the site, pass all site runoff through a silt fence, catch basin filter, sediment pond, Baker Tank or other appropriate BMP.
2. Protect adjacent properties and surface waters from sediment deposition.
3. Protect properties and waterways downstream from the construction site from erosion due to increases in storm water runoff from the site.

C. Initiate stabilization measures as soon as practical in portions of the site where construction activities have temporarily or permanently ceased:

1. Stabilize all exposed and unworked soils by suitable and timely application of BMPs, which may include temporary seeding permanent seeding, mulching, geotextiles, sod stabilization, vegetative buffer strips, protection of trees, preservation of mature vegetation, and other appropriate measures.
2. Use wattles on exposed soil of borrow area as necessary to provide temporary erosion protection until permanent vegetation can be established.
3. All exposed and unworked soils shall be stabilized according to the following criteria:
   a. From October 1 to April 30, no exposed and unworked soils shall remain unstabilized (exposed) for more than two days. Non-erodible, clean, granular base materials shall be applied to stabilize all trafficked areas.
   b. From May 1 to September 30, no exposed and unworked soils on slopes shall remain unstabilized (exposed) for more than seven days.
4. Cover stockpiles when runoff from rain is or would likely cause turbid waters to enter local waterways. Suspend work in the rain if such work cannot be performed without causing turbid runoff.
5. Existing vegetation should be preserved where attainable. Clearly mark clearing limits. Mark and fence areas which are not to be disturbed, including setbacks, sensitive/critical areas and their buffers, trees, and drainage courses.
6. Construct cut and fill slopes in a manner that will minimize erosion.
7. Properly protect and maintain all storm drain inlets during construction.
8. Make provisions to minimize the transport of sediment onto paved roads as described in WSDOT-APWA Section 1-07.15 and 1-07.23.

D. General Maintenance Activities:

1. Inspect temporary erosion and sediment control (TESC) facilities on active sites daily and immediately after each rainfall.
2. Inspect TESC facilities on inactive sites a minimum of once a month, within 24 hours following any storm event and as the Engineer or permitting agency deems necessary.
3. Repair or replace damaged or missing items immediately.
4. Clean sediment accumulation from surface of catch basin to prevent blockage. Prevent sediments form being flushed to the downstream system during cleaning.
5. Remove sediment from behind sediment fence when deposit has reached a height of 6 inches above drain rock backfill.

E. If erosion or discharge of sediment-laden runoff is occurring, the Contractor shall make modification to the erosion control system and the Plan to mitigate the problem(s).

3.8 REMOVAL OF TESC FACILITIES

A. Remove temporary erosion/sedimentation control fencing following completion of work in specific areas. The fencing shall not be removed until the grass has established a minimum of 75% coverage, or as approved by the Engineer. Place additional temporary erosion/sedimentation control fencing if necessary for other areas still under construction. The Contractor shall take care when removing the fencing to ensure that trapped sediments are removed along the fence and are not released outside the project area.

B. Contractor shall remove catch basin protection after it has served its useful purpose but not before construction activities have advanced to a point 100 feet beyond the catch basin.

C. Contractor shall remove temporary erosion and sedimentation control (TESC) facilities not otherwise described for removal herein after they have served their useful purpose, or as requested by the Engineer.

3.9 MODIFICATIONS TO EROSION CONTROL SYSTEM

A. The Engineer and regulatory agencies will determine the effectiveness of the erosion control system.

B. If erosion control system designed by Contractor is determined to be ineffective by the Engineer or regulatory agencies, upgrade erosion control system to satisfaction of the Engineer and regulatory agencies.

C. Refusal to upgrade erosion control system may result in the Engineer having erosion control work completed and the cost of the work being withheld from Contractor’s payments.

D. Refusal to upgrade erosion control system may result in the requirement for suspension of construction activity until TESC measures are satisfactory to the Engineer and regulatory agencies.

END OF SECTION 312500
SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes temporary excavation support and protection systems.

1.2 QUALIFICATIONS

A. Designer: Professional Engineer registered in the state of Washington with a minimum of three years of experience in designing earth retaining structures for temporary construction similar to the type and depth proposed and in similar soil and groundwater conditions in this Contract.

B. Contractor: Minimum of three years’ experience with the installation of excavation support systems for temporary construction of similar type and depth proposed and in similar soil and groundwater conditions in this Contract.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Qualifications.

B. Excavation Support System Plans: provide for each location.

C. Designer Certifications of installed excavation support systems.

D. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.5 EXCAVATION SUPPORT SYSTEM PLAN

A. Provide separate Excavation Support System Plans for different trenching and open excavation conditions.

B. Detailed description of excavation support systems including materials, sizes and configuration, required equipment, work sequence, and work schedule.
C. Design calculations:
   1. Calculations, drawings, and installation and removal procedures.
   2. Demonstrating conformance to the Design Requirements and Excavation Support System Requirements listed in this Section.
   3. Prepared, stamped, dated, and signed by the Designer.

D. Drawings include dimensions, spacing, and layout of components of the excavation support systems and include plans, elevations, sections, details showing the arrangement and method of installation, and details of guides or templates to be used in construction.

E. Detailed shop drawings and manufacturer literature of equipment and installation systems.

F. Methods and procedures for installing and removing excavation support systems.

G. Descriptions for geotechnical instrumentation and monitoring as required by the Designer.

H. Integrate with the dewatering design in Section 312319.

I. Provide information required by Chapter 296-155 WAC, Part N.

J. Review by the County is to determine the Contractor's general compliance with the requirements and references and shall not be construed as a detailed analysis for adequacy of the excavation support systems, nor shall any provisions of the requirements be construed as relieving the Contractor of its overall responsibility and liability for the work.

1.6 FIELD CONDITIONS

A. Survey Work: Engage a qualified licensed land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1.7 DESIGN REQUIREMENTS

A. It is the responsibility of the Contractor to adequately size the excavation and to ensure that the excavation support system design is free of errors or omissions that may affect its safety, functionality, or performance. The Contractor accepts full responsibility for complying with relevant references, specifications, and standards that apply to the design including those that are not named in this Section.

B. The design, planning, installation, and removal of excavation support systems shall be accomplished in such a manner as to:
   1. Maintain the required excavation or trench section.
   2. Provide adequate and safe working space necessary to complete the task for which the excavation is to be performed.

C. Comply with dewatering requirements per Section 312319.
D. Utilization of materials in the excavation support systems shall be in compliance with manufacturer’s recommendations and requirements.

E. Design excavation support systems to withstand anticipated loads including earth pressure, hydrostatic pressure, surcharge loads from surface equipment and material storage, and construction loads.

F. Include sequence of excavation and placement of the lateral support elements in the excavation support system designs.

G. Design the excavation support system in accordance with Chapter 296-155 WAC, Part N.

H. Design excavation support systems to meet the criteria as developed in Washington State law and the requirements of the local authority having jurisdiction (LAHJ) in which the excavation support system is being used.

I. Comply with applicable requirements of the WISHA with respect to excavation and construction.

1.8 EXCAVATION SUPPORT SYSTEM REQUIREMENTS

A. Select and design support systems, methods, and details to assure safety to the public, adjacent property and the completed work.

B. Shall perform functions for which it is intended.

C. Dewatering inside the shored work area is allowed subject to the requirements of Section 312319.

D. Shall be of adequate strength to withstand ground and groundwater pressures as well as additional loads as a result of equipment movement or construction activities at the Site.

E. Shall use only undamaged, industry tested, and accepted materials in compliance with federal, state and other regulatory requirements. It is the responsibility of the Contractor to comply with standards, laws, regulations and requirements that may apply.

1.9 DESIGNER responsibilities

A. Excavation Support System Certification:

1. After review at the Site, the Designer shall certify in writing, at each level of bracing installed and prior to proceeding with the excavation, that each excavation support system is constructed in general compliance with the Designer’s stamped, dated, and signed excavation support system design.

2. Designer shall also review and certify in writing the acceptability of modifications made by the Contractor during construction and revise the applicable drawings and submit to the Engineer.
B. Review the Contractor daily reports and notify the Contractor of items that do not meet the requirements of the approved Excavation Support Plan. Contractor shall follow-up with the Designer to rectify and implement requirements of the Designer.

C. Meet, review, and confirm that applicable standard requirements of the LAHJ are included in the as-constructed excavation support system.

D. Visit the Site of the work no less than once per week to review and confirm compliance with the approved permitted design and that it meets the requirements of this Section.

E. Provide inspection report of the site visit to the Contractor no less than weekly.

F. Meet with the Contractor on an as-needed basis to review completed work and identify items for Contractor to modify for the constructed design to be accepted at the completion and prior to use of the excavation support system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Construction activities shall observe applicable federal, state, and local regulatory requirements as well as applicable good practice guidelines. It is the Contractor’s responsibility to ensure construction activities are in compliance with all pertinent existing laws and regulations.

B. Perform work of this Section in compliance with work plan, drawings, and submittals provided by the Contractor.

C. Excavation and backfill shall be in accordance with Section 312000.

D. Control water in accordance with Section 312319.

E. Designer shall inspect the constructed excavated support system and certify as indicated in this Section. Multiple certifications may be required.

F. Notify the Designer for situations where the excavation support system may be unsafe. Suspend work when the unsafe conditions are present. Do not resume work until issues have been rectified as evidence of written certification of the Designer.

G. Monitor per the Excavation Support System Plan.

3.2 REMOVAL

A. Unless otherwise indicated, excavation support systems shall be removed.

B. Abandoned elements of excavation support systems shall be removed to at least 4 feet below the ground surface and shall be indicated on the Record Drawings.
C. Removal shall be performed in such a manner that will not damage adjacent new or existing facilities. Fill all voids immediately with controlled density fill or other approved means.

D. All damage to property resulting from removal shall be promptly repaired.

END OF SECTION 315000
SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt patching.
   2. Hot-mix asphalt paving.

B. Related Requirements:
   1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

C. Qualification Data: For manufacturer.

D. Material Certificates: For each paving material, signed by manufacturers.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer.
   1. Manufacturer shall be a paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of the state in which Project is located.

B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated, as documented according to ASTM E 548.

D. Asphalt-Paving Publication: Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.

PART 2 - PRODUCTS

2.1 AGGREGATES
   A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
   B. Fine Aggregate: ASTM D 1073 sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
   C. Mineral Filler: ASTM D 242/D 242M rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS
   A. Asphalt Binder: AASHTO M 320, PG 64-22.
   B. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS
   A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
   B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
   C. Joint and Crack Sealant Materials
   D. Seal Coating Material
      1. Seal coating material shall be a mineral-reinforced, reactive polimerized, bituminous emulsion, such as Special Asphalt Products’ Resurfacer XLR8, or Project Representative-approved equivalent presenting characteristics equal or better than the following:
         a. General:
            1) Materials shall meet the requirements of ASMA specification section 1-3.02
2) Performance shall conform to the requirements of ISSA A105

b. Solids content (no fibers): 70% or higher.
c. Density: 11 lbs./gal. minimum.
d. Coverage rate: suitable for one-coat application with minimum coverage rates of 25 to 45 square feet per gallon of undiluted material.
f. Curing rate:

1) Ready for vehicle traffic within no more than 2-1/5 hrs. when applied at ambient conditions of 70% humidity and 55° to 60° F.
2) Ready for vehicle traffic within no more than 1 hr. when applied at ambient temperatures of 75° to 85° F.

g. Wet Track Abrasion: passing ISSA Test Method number T-100

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in A1 MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base and Crushed Surfacing Course: Per Specification Section 312000.

PART 3 - EXECUTION

3.1 PATCHING

A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

C. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Spread mix at a minimum temperature of 250 degree F.
   2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg. F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

H. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch, no minus.
B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 FIELD QUALITY CONTROL

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

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017300 "Execution"

END OF SECTION 321216
SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes chain-link fences and swing gates.

1.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet high, and post spacing not to exceed 10 feet for chain-link.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each zinc-coated product and for each color and texture specified, in 6-inch lengths for components and on full-sized units for accessories.

D. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of chain-link fence and gate, from manufacturer.

B. Product Test Reports: For framing strength according to ASTM F 1043.

C. Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.
1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, deterioration of metals, metal finishes, and other materials beyond normal weathering.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CHAIN-LINK FENCE FABRIC

A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:

1. Fabric Height: 6’ high or as indicated on Drawings.
2. Steel Wire Fabric: Wire with a diameter of 0.148 inch.
   a. Mesh Size: 2.0 inch
   b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.
3. Selvage: Twisted and Barbed at both selvages.

2.2 FENCE FRAMING

A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 based on the following:

1. Fence Height: As indicated on Drawings
   a. Line Post: 2.375 inches in diameter
   b. End, Corner and Pull Post: 2.875 inches in diameter.
5. Metallic Coating for Steel Framing:
   a. Type A zinc coating.
   b. Type B zinc with organic overcoat.
   c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
   d. Type C, Zn-5-Al-MM alloy coating.
2.3 TENSION WIRE

A. Galvanized Steel Wire: 3/8 to 1/2 inch- diameter.

2.4 SWING GATES

A. General: Comply with ASTM F 900 for gate posts and double swing gate types.
   1. Gate Leaf Width: As indicated on Drawings.
   2. Gate Fabric Height: As indicated on Drawings.

B. Pipe and Tubing:
   1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; manufacturer's standard protective coating and finish.
   4. Gate Frames and Bracing: Round tubular steel.

C. Frame Corner Construction: assembled with corner fittings.

D. Hardware:
   2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
   3. Lock: Manufacturer's standard

2.5 FITTINGS

A. General: Comply with ASTM F 626.

B. Finish:
   1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. zinc.

2.6 GROUT AND ANCHORING CEMENT

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create
pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.

1. Do not begin installation before final grading is completed unless otherwise permitted by the Engineer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

D. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.

E. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.

F. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.

2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

   a. Exposed Concrete: Extend 2 inches above grade; shape and smooth to shed water.

   b. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.

G. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment as indicated on Drawings.

H. Line Posts: Space line posts uniformly at 10 feet o.c.

I. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Provide horizontal tension wire at the following locations:

1. Extended along bottom of fence fabric.
J. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 4 inches between finish grade or surface and bottom selvage unless otherwise indicated.

K. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

L. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

END OF SECTION 323113
SECTION 328400 - PLANTING IRRIGATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Piping.
3. Automatic control valves.
4. Sprinklers.
5. Quick couplers.
6. Battery operated controllers.

B. Related Sections:

1. Section 329113 "Soil Preparation".
2. Section 329300 “Plants”
3. Section 329200 “Turf and Grasses”
4. Section 312000 “Earth Moving”

1.2 PERFORMANCE REQUIREMENTS

A. Irrigation zone control shall be automatic operation with battery operated controller attached to automatic control valves.

B. Location of Sprinklers and Specialties: Make minor adjustments necessary to avoid pavements and obstructions such as signs and light standards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Submit detail drawings for valves, sprinkler heads and battery operated controllers. Include on the drawings a complete list of equipment, materials, and manufacturer’s descriptive and technical literature and catalog cuts. Also show on the drawings any details required to demonstrate that the system has been coordinated and will function as a unit. Show on the drawings water source connections, proposed system layout, type and number of heads and zone valves.
2. Submit material cut sheets and product literature for valves, sprinkler heads and battery operated controllers. Include a complete list of equipment, materials, and manufacturer’s descriptive and technical literature catalog cuts.

1.4 INFORMATIONAL SUBMITTALS

A. Zoning Chart: Show each irrigation zone and its control valve.
B. Controller Timing Schedule: Indicate timing settings for each battery operated control zone.
C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
B. PE Pipe with Controlled ID: ASTM F 771, PE 3408 compound; SIDR 11.5 and SIDR 15.
   1. Insert Fittings for PE Pipe: ASTM D 2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.
C. PVC Pipe: ASTM D 1785, PVC 1120 compound, Schedule 40 and Schedule. Fittings in first subparagraph below are available in NPS 1/2 to NPS 12 (DN 15 to DN 300). Select last option if retaining both thicknesses in the piping schedule.
   1. PVC Socket Fittings: ASTM D 2466, Schedule 40 and Schedule 80.
   2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
   3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
   4. Pipe and fittings shall be R1 (purple pipe)
   1. PVC Socket Fittings: ASTM D 2467, Schedule 80.
2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.
3. Pipe and fittings shall be R1 (purple pipe)

2.2 PIPING JOINING MATERIALS

A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.3 MANUAL VALVES

A. Gate Valves: Iron body, brass trimmed, double disc wedge, and integral taper seats with non-rising stem square actuator. Minimum 150 psi - 300 WOG.
B. Stop and Waste Valves: Brass construction, 175 psi water working pressure. Mark II Oriseal, or as approved.

2.4 AUTOMATIC CONTROL VALVES

A. Control valves shall be solenoid actuated globe valves of 1 inch to 1-1/2 inch size, suitable for 24 volts, 60 cycle, and designed to provide for shut-off in event of power failure. Valve shall be cast bronze or brass or plastic housing suitable for service at 150 psi operating pressure with external flow control adjustment for shut-off capability, external plug at diaphragm chamber to enable manual operation, filter in control chamber to prevent valve body clogging with debris, durable diaphragm, and accessibility to internal parts without removing valve from system. Valves shall be capable of handling reclaimed water. Purple tags and handles should be added identifying the use of non-potable water.

2.5 SPRINKLERS

A. Pop-up Sprinkler heads to be of the same manufacturer and marked with the manufacturer’s name and identification, in such a position that they can be identified without being removed from the system. Sprinkler heads to include:
   1. Built-in pressure-regulating device to regulate nozzle pressure to the design pressure.
   2. Built-in check valve to prevent low head drainage and prevent back pressures equal to 14 feet of elevation change.
   3. 12” pop-up stem.
   4. Matched precipitation rate nozzles across arcs and radius settings.
   5. Screens under the nozzles.

B. Hunter PROS-12-PRS40-CV-R sprinkler model with Hunter MP Rotator series nozzles or approved equivalent.
C. Piping connections to sprinkler heads shall include prefabricated flex swing assemblies. Hunter SJ-512 or approved equivalent.

D. Shrub heads on risers with Hunter MP Rotator series nozzles and compatible shrub adapters or approved equivalent.

2.6 QUICK COUPLERS

A. Brass, two piece body, with locking rubber cover. Cover color: purple identifying use of reclaimed water

B. Provide three sets of corresponding valve keys, operating keys and hose swivels to the project engineer.

2.7 BATTERY OPERATED CONTROLLER

A. Battery operated single valve or multiple-valve controller operating DC latching solenoids. Unit to be waterproof and powered by one or two 9-volt batteries and shall provide power throughout the one-year plant establishment period. Features to include an easy-to-program LCD screen and uses standard controller programming.

2.8 VALVE BOXES

A. Control, pressure reducing and manual control valves: 12-inch-by-18-inch valve box of polyolefin and fibrous material (preferably recycled material) with a locking cover. The bottom section of valve box is to be slotted so as to extend below the pipe. One valve per valve box.

1. Carson 1419B with bolt down locking lid and extensions as required to meet finished grades, or approved equivalent. Color: purple identifying use of reclaimed water.

B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch minimum to 3 inches maximum.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

B. Provide minimum cover over top of underground piping according to the following:

1. Irrigation Main Piping: Minimum depth of 18 inches below finished grade.
2. Circuit Piping: 8 inches.
C. Trenches:

1. Excavation: Excavate minimum six inches wide with straight runs, bottoms smooth and free of stones over one-inch in diameter.

2. Backfill and compaction:
   a. Backfill: Main and lateral lines - Selected fill dirt or sand shall be used if soil conditions are rocky. In rocky areas the trenching depth shall be two inches below normal trench depth to allow for this bedding. The fill dirt or sand shall be used in filling four inches above the pipe. The remainder of the backfill shall contain no lumps or rocks larger than two inches. The top six inches of backfill shall be free of rocks over one-inch, subsoil or trash.
   b. Compaction: Landscape areas – 90-percent maximum density

3. Trenches for irrigation lines shall be excavated of sufficient depth and width to permit proper handling and installation of the pipe and fittings. No backfilling will be permitted other than at the centers of pipe lengths until pressure testing requirements are completed. Backfill shall be thoroughly compacted and evened off with the adjacent soil level.

4. The trench shall be kept free from water until pipe is laid and backfilled. All surface water is to be diverted so as not to enter the trench. Boulders, rocks, roots and other obstructions shall be entirely removed or cut out to the width of the trench and to a depth below the elevation of bottom of pipe. All loose and excess excavated materials are to be removed and disposed of offsite at Contractor's pre-arranged location.

3.2 PIPE INSTALLATION

1. Pipe shall lay side-by-side in trench and shall be separated by six horizontal inches of clean fill. No stacking of pipe in trench is allowed.

2. All plastic-to-plastic joints shall be solvent-weld joints. Only the solvent recommended by the pipe Manufacturer shall be used. All plastic pipe and fittings shall be installed as per Manufacturer's recommendations and field assistance. All solvent will be kept in original can with expiration date legible.

3. All plastic to metal joints to be made with plastic male adapters.

4. Follow Manufacturer’s instructions for gluing of joints. Allow PVC joints 24 hours to set up between gluing and application of water pressure.

5. Sleeves shall be placed under all pavement areas where pipe is crossing, and shall extend 12 inches beyond edge of pavements. Empty sleeves shall be capped.

3.3 JOINT CONSTRUCTION

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

B. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

C. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.

D. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

3. PVC Nonpressure Piping: Join according to ASTM D 2855.

3.4 VALVE INSTALLATION

A. Underground Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve box with top flush with grade.

B. Automatic Control Valves: Install per detail shown on drawing.

3.5 SPRINKLER INSTALLATION

A. All sprinklers heads along pavement edges and curbing shall be pop-ups. All other sprinkler heads shall be on schedule 80 risers. Contractor shall provide all required fittings and materials for complete pop-up and riser configuration per details.

B. Sprinkler heads shall be staggered in location whenever possible. Laterals shall be laid across prevailing slopes as nearly level as possible. Set heads perpendicular to finish grade unless noted otherwise. Provide four inches clearance from all walks, walls, curbs and other pavements.

C. Provide prefabricated flex swing assemblies per details.

3.6 BATTERY OPERATED CONTROLLER INSTALLATION

A. Mount battery operated controllers to valve or valve manifold. Install in accordance with manufacturer’s recommendations.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: Operate automatic control valves to confirm proper system operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Any irrigation product will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.9 ADJUSTING

A. Adjust settings of battery operated controllers.

B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.

C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch above, finish grade.

3.10 FLUSHING AND TESTING

A. Contractor is required to flush and test system, observed by the Engineer.

B. Flushing:
   1. Thoroughly flush main line prior to installing zone control valve(s).
   2. After all new irrigation piping and risers are in place and connected, all necessary division work has been completed and prior to installation of irrigation heads, all control valves shall be opened and a full head of water used to flush out the system completely.

C. Pressure Testing:
   1. Main lines: After flushing is complete and all joints exposed, pressure test main lines at 125-psi. The system will pass the test when it maintains no drop in pressure over a 15-minute test period.
   2. Lateral lines: After flushing is complete and all joints exposed, pressure test lateral circuit lines at 80-psi. The system will pass the test when it maintains less than a five-psi drop over a 15-minute test period.
   3. To be valid, all tests must be observed and approved by the Engineer. The Contractor shall give a minimum 48 hour notice prior to the anticipated date and time of pressure testing. All testing shall be approved prior to installation of valves or sprinkler heads.
D. Coverage Testing: After the new irrigation systems are 100-percent installed perform a water coverage test to determine whether water coverage and operation of the systems are adequate for planting, without areas of excessive flooding, dry spots areas of insufficient overlap, or overspray onto pavements. If any circuit and/or systems are determined by the project engineer to be inadequate due to incorrect installation procedures and/or Contractor’s poor workmanship or materials, it shall be replaced or repaired at Contractor’s expense, and both pressure and coverage tests repeated until accepted.

3.11 FINAL ACCEPTANCE

A. Notify the Engineer one week prior to the anticipated 100-percent completion of the irrigation installation, including programming of the battery-operated controllers. The Engineer and the Owner’s maintenance personnel will review the completed Work. Final acceptance of the irrigation work in this Section will be made by the Engineer after a subsequent review to determine 100-percent completion of the Contract Work, including punch list items, and issues requiring remedy as identified by the Owner’s maintenance personnel. Final acceptance will not be granted incrementally for partially-completed work unless authorized by the Engineer. The date of final acceptance constitutes the beginning of the one-year warranty period.

3.12 SYSTEM FAMILIARIZATION AND COMMISSIONING

A. Upon final acceptance of the system by the Engineer, provide the necessary keys and other tools necessary to operate, drain and activate the irrigation systems. Allow sufficient time with the Owner’s maintenance personnel to ensure familiarity with system operations, controls, maintenance, activation and winterizing procedures.

B. Provide one full winterization and draining of the irrigation system prior to the onset of freezing weather and one full activation of the irrigation system at the onset of the spring season as part of the warranty period under this Contract.

C. Include, as part of the winterization and activation procedures, a meeting with the Owner’s maintenance personnel to review system operations, adjustments to controls, and other maintenance concerns.

3.13 WARRANTY

A. It shall be the Contractor's responsibility to ensure and guarantee complete irrigation coverage of all new landscape areas shown on the Drawings. Contractor shall also guarantee the satisfactory operation of the irrigation system and the workmanship and restoration of the area. The irrigation system shall be guaranteed to be complete in every detail for a period of one year from the date of final acceptance of the Work. Contractor to repair or replace any such defects occurring within that year, free of expense to the owner.

END OF SECTION 328400
SECTION 329113 - SOIL PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes planting soils specified by composition of the mixes.

B. Related Sections:
   1. Section 329300 "Plants"
   2. Section 328400 “Planting Irrigation”
   3. Section 329200 “Turf and Grasses”

1.2 DEFINITIONS

A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

B. Imported Soil: Soil that is transported to Project site for use.

C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture to support optimum plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.


1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.
1.4 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

1.5 QUALITY ASSURANCE
   A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Regional Materials: Imported soil, manufactured planting soil and soil amendments shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2.2 TOPSOIL MATERIALS
   A. Type I Topsoil – Organic Material or Compost
      1. Organic material or “compost” shall conform to the following requirements:
         a. Shall consist of 100% organic material
         b. Shall consist of 100% recycled content
         c. Shall pass a standard cress test for seed germination (90% germination compared to standard)
         d. Shall have a pH from 5.5 to 7.5
         e. Shall have a maximum electrical conductivity of 3.0 ohms/cm.
         f. Shall have a maximum carbon to nitrogen ration of 40:1
         g. Shall be certified by the Process to Further Reduce Pathogens (PFRP) guideline for hot composting as established by the United States Environmental Protection Agency (US EPA)
         h. Shall be fully composted, mature and stable before being acceptable
         i. Conform to the following gradation:
            
            | U.S. Standard Sieve Size | Percent by Weight Passing |
            |--------------------------|---------------------------|
            | 5/16 inches to 7/16 inches | 100                      |

   B. Type II Topsoil – Planting Mix
      1. Type II Topsoil or Planting Mix shall consist of 2/3rd sandy loam and 1/3rd organic material and shall conform to the following requirements:
         a. Sandy loam or loamy sand shall consist largely of sand, but with enough silt and clay present to give it a small amount of stability. Individual sand grains can be seen and felt readily. On squeezing in the hand when dry, it shall form a cast that
will not only hold its shape when the pressure is released, but shall withstand careful handling without breaking.

<table>
<thead>
<tr>
<th>U.S. Standard Sieve Size</th>
<th>Percent Retained</th>
<th>Percent Passing</th>
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<td>30</td>
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<tr>
<td>#270</td>
<td>85</td>
<td>15</td>
</tr>
</tbody>
</table>

b. Shall have pH range of 5.0 - 6.5, with dolomite lime added as necessary to attain this range.
c. Organic amendments shall consist of composted organic material as described above.

PART 3 - EXECUTION

3.1 GENERAL

A. Control of Water

1. Keep all planting areas free from ponding water during construction.

B. Control of Erosion

1. Maintain earthwork surfaces true and smooth and protected from erosion.
2. Where erosion occurs, fill or excavate as necessary to return earthwork surfaces to the grade and finish specified.

C. Disposal Site

1. Provide a legal off-site location for disposal of other unsuitable excavated material.

3.2 EXCAVATION

A. Clear and grub site areas to receive planting or landscaping improvements in accordance to Section 311000 – Site Clearing.

B. Except as otherwise noted or specified, any method of excavation may be used which meets the intent of the Contract Documents, including the Geotechnical Report, and does not damage adjacent improvements. Material excavated may be placed adjacent to the excavation if space is available.

C. Existing utilities of record are shown on the Civil Drawings. These are shown for convenience only, and the Owner assumes no responsibility for improper locations or failure to show utility locations on the Drawings. Protect existing utilities and infrastructure, not scheduled for demolition, from damage at all times.
D. Perform all excavation of every description and of whatever materials encountered to the depth indicated on the Drawings or specified.

E. Exercise sound construction practices in excavating and maintain the excavation area so that no damage will occur to any foundation, structure, pole line, pipeline, or other adjacent facility because of slough or slopes, or from any other cause. If, as a result of the excavation, there is ground deformation which may endanger other property, immediately take remedial action to correct the problem. No act, representation, or instruction of the project engineer shall in any way relieve the Contractor from liability for damages or costs that result from excavation.

F. Take care not to excavate below the depth specified. If ground is excavated below the depth specified, backfill excavation below that depth with Select Backfill at no cost to the owner. See 312000 – Earthwork and Trenching for Select Backfill specification.

G. Stockpiling of topsoil, excess material and unsuitable material at the work site is allowed at the existing stockpile area; segregate materials by soil type.

3.3 PREPARATION OF SUBGRADE

A. Subgrade elevation shall be as follows for each topsoil type area as specified in the record drawings:

1. In Type I Topsoil areas, the subgrade shall be the same as the finish grade when lightly compacted.
2. In Type II Topsoil areas, the subgrade shall be 8 inches below finished grade.

B. Subgrade shall be prepared as follows:

1. In Type I Topsoil areas, the subgrade will be scarified by furrowing grooves perpendicular to the slope.
2. In Type II Topsoil areas, the subgrade shall be ripped, rototilled or scarified to a depth of 6 inches below subgrade in all areas designated as “Foundation Plantings” and 4” in all areas designated as “Native Plantings”.

3.4 BACKFILL

A. Backfill Type I Topsoil planting areas as follows:

1. Place 1/2-inch of Type I Topsoil over prepared subgrade in all open seeded areas as shown on the Landscape Plans.

B. Backfill Type II Topsoil planting areas as follows:

1. Place Type II Topsoil over prepared subgrade in all areas identified as “Foundation Plantings” to an 8-inch depth after compaction. Place Type II Topsoil over prepared subgrade in all areas identified as “Native Plantings” to a depth of 4 inches.
3.5 FINISH GRADE

A. Grade all areas covered by the work, including excavated and filled sections and transition areas, uniformly to the elevations shown.

B. Rake out all rocks, roots, sticks and other debris larger than 1-inch diameter. Leave surface even and readily able to accommodate hydroseeding or planting installations.

C. Compaction level shall be between 80 to 90 percent density.

D. Finish surface reasonably smooth, compacted, free from any irregular surface changes, and free draining. Correct grades as directed by the project engineer to provide free draining surfaces.

E. Degree of Finish

1. Native planting areas: That ordinarily obtainable from a blade-grader operation.

2. Foundation Planting areas: Not more than 1 inch below the adjacent permanent grade.

END OF SECTION 329113
SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.

B. Related Sections:

1. Section 329113 “Soil Preparation”
2. Section 328400 “Planting Irrigation”
3. Section 329300 “Plants”

1.2 DEFINITIONS

A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 “Soil Preparation and drawing designations for planting soils.

1.3 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.

1. Certification of each specified seed mixture.

B. Product certificates: For soil amendments and fertilizers, from manufacturer

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful application and establishment of native grass hydroseeding.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

PART 2 - PRODUCTS

2.1 SEED

A. Native grass seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed mix species as follows:

<table>
<thead>
<tr>
<th>Percent by weight</th>
<th>Plant / Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>35%</td>
<td>Perennial Rye</td>
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<tr>
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<td>Annual Rye</td>
</tr>
<tr>
<td>35%</td>
<td>Creeping Red Fescue</td>
</tr>
<tr>
<td>10%</td>
<td>Highland Bentgrass</td>
</tr>
<tr>
<td>10%</td>
<td>Red Clover</td>
</tr>
</tbody>
</table>

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2.3 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

C. Wood cellulose fiber mulch: Use recovered materials of either paper-based (100 percent) or wood-based (100 percent) hydraulic mulch. Processed to contain no growth or germination-inhibiting factors and dyed an appropriate color to facilitate visual metering of materials application. Composition on air-dry weight basis: 9 to 15 percent moisture, pH range from 5.5 to 8.2. Use with hydraulic application of grass seed and fertilizer. Hydrophilic colloid shall be
applied at the rate recommended by the manufacturer, using hydraulic equipment suitable for thoroughly mixing water. A uniform layer shall be applied over the area.

D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

PART 3 - EXECUTION

3.1 NATIVE GRASS AREA PREPARATION

A. General: Prepare areas for hydroseed placement according to Section 329113 "Soil Preparation."

B. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil or runoff.

C. Before seeding, obtain Engineer’s acceptance of finish grading; restore grades if eroded or otherwise disturbed after finish grading.

3.2 HYDROSEEDING

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackifier.

2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 3,000-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

3.3 NATIVE GRASS MAINTENANCE

A. General: Maintain and establish hydroseeded areas by watering, reseeding and performing other operations as required to establish healthy, stand of grasses. Reseed bare or eroded areas to produce a uniform stand of grass. Provide materials and installation the same as those used in the original installation.

3.4 SATISFACTORY NATIVE GRASS ESTABLISHMENT

A. Seeded installations shall meet the following criteria as determined by Engineer:

1. At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft.
B. Use specified materials to reestablish seeded areas that do not comply with requirements, and continue maintenance until seed is established.

END OF SECTION 329200
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plants.

B. Related Sections:
   1. Section 329113 "Soil Preparation"
   2. Section 328400 “Planting Irrigation”
   3. Section 329200 “Turf and Grasses”

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscidicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation” for drawing designations for planting soils.

D. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.3 INFORMATIONAL SUBMITTALS

A. Product Data: For each type of product.

B. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.
1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by owner for maintenance of plants during a calendar year.

1.6 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

B. Handle planting stock by root ball or container.

C. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by owner.
   b. Structural failures including plantings falling or blowing over.

2. Warranty Periods: From date of planting completion.

   a. Trees, Shrubs and Groundcovers: 12 months.
PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.2 FERTILIZERS

A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: 21-gram tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.3 MULCHES

A. Arborist wood chips with minimum 100% biomass content. Wood chips shall consist of fir, hemlock or hardwood species shipped to a size of four (4) inches or less. Fines shall not exceed 25% of mix.

B. Chipped material from on-site trees that have been removed is acceptable.

2.4 WEED-CONTROL BARRIERS

A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. This fabric shall only be installed below crushed rock surfacing as indicated on the landscape drawings.
PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."

B. Before planting, obtain Engineer’s acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.
   1. Excavate planting pits to width and depth as per details on drawing with sides sloping inward at an angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated. Native soil from excavated planting pits mixed with imported topsoil (50-50 mix) shall be used for tree planting backfill.

3.3 TREE AND SHRUB PLANTING

A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Roots: Remove stem girdling and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. If root ball has been formed with protective wire baskets, these shall be carefully removed prior to tree planting.

D. Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
   1. Backfill: Use half planting soil and half native soil. Mix thoroughly prior to backfill.
   2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap and twine from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.

5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets, in quantities recommended by manufacturer, beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.


E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4 TREE AND SHRUB PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune trees and shrubs as directed by project engineer and according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by project engineer, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

C. Do not apply pruning paint to wounds.

3.5 GROUND COVER PLANTING

A. Set out and space ground cover plants as indicated on Drawings.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated as per drawings.

3.7 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

D. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

3.8 MAINTENANCE SERVICE

A. Provide maintenance by skilled employees of landscape Installer. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than 12 months from date of substantial completion.

END OF SECTION 329300
SECTION 330513 – PRECAST CONCRETE MANHOLES

1.1 SUMMARY

A. Section Includes:

1. 48- and 54-inch diameter Gravity Sewage Manholes
2. 48-inch diameter Stand Pipe
3. 60-inch diameter Internal Drop Manhole
4. 144-inch diameter Influent Pump Station Wetwell

1.2 DESIGN REQUIREMENTS

A. HL-93 Design Truck (HS-20) Wheel Load with 30% impact per AASHTO.
B. Equivalent strength: Based on structural design of reinforced concrete as outlined in ACI 318.
C. Design of Lifting Devices for Precast Components: According to ASTM C913.
D. Design of Joints for Precast Components: According to ASTM C913; maximum leakage of 0.025 gal per hour per foot of joint at 3 feet of head.

1.3 SUBMITTALS

A. Shop Drawings: Indicate manhole locations, elevations, sizes and elevations of penetrations.
B. Product Data: Cover and frame construction, features, configuration and dimensions.
C. Calculation: Submit calculations, including buoyancy calculations, sealed by a Professional Engineer registered in the State of Washington.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing products specified in this Section with three years’ experience.

1.5 DESIGN REQUIREMENTS.

A. Loading: HL-93 Design Truck (HS-20) with 30% impact or as required per AASHTO.
B. Water Table Elevation: Maximum height estimated at ground surface. Assume empty manhole.
C. Factor of safety against flotation shall be 1.25
D. Soil at Rest Lateral Pressure: 90 PCF (equivalent fluid pressure)
E. Seismic Uniform Lateral Pressure on Below Grade Walls: $30 \ H^2$ Line Load applied at 0.6 H

1.6 DELIVERY, STORAGE AND HANDLING

A. Comply with precast concrete manufacturer’s instructions and ASTM C913 for unloading, storing and moving precast manholes and drainage structures.

B. Store precast concrete manholes and drainage structures to prevent damage to Owner’s property or other public or private property. Repair property damaged from materials storage.

C. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers as shown on Drawings to indicate its intended use.

PART 2 - PRODUCTS

2.1 MANHOLES

A. Manhole Sections: Reinforced precast concrete according to ASTM C478 with gaskets according to ASTM C923. ASTM C150, Type II Cement.

2.2 ACCESS

A. Frames and Cover for Gravity Sewage Manholes and Internal Drop Manhole

1. Lid: Cast or ductile iron with integrally cast non-skid pattern with the word “SEWER” cast in 3-inch raised letters.
3. Lift Hole: One 1-inch diameter lift hole approximately 3 inches from the outside edge of cover. Provide 5/8 x 2-1/2 inch stainless steel carriage bolt installed in manhole lift hole.
5. Clear Cover Opening: 26 inch diameter.
6. Manufacturer:
   a. Olympic Foundry Model No. MH30 ADT.
   b. Approved equal.

B. Access Hatch for Influent Pump Station Manhole and Stand Pipe:

1. Per Drawings. See Section 083100 “Access Hatches”

2.3 MANHOLE STEPS AND GRAB BARS

A. Manhole Steps

1. Acceptable Manufacturer:
b. Bowco Industries.
c. Approved Equal.

2. Construction:
   a. 1-inch finished diameter copolymer polypropylene plastic encapsulating rebar
   b. Grade 60 ASTM A615 deformed rebar
   c. Step shaped “U”

B. Grab Bars
   1. Acceptable Manufacturer:
      b. Bowco Industries.
      c. Approved Equal.

   2. Construction:
      a. 1-inch finished diameter copolymer polypropylene plastic encapsulating rebar
      b. Grade 60 ASTM A615 deformed rebar
      c. Straight grab rail, not step shape.

2.4 MANHOLE AND STRUCTURE PIPE GASKETS OR CONNECTIONS

A. Gravity Pipe:
   1. Approved Manufacturer:
      a. Kor-n-Seal.
      b. Sand Collar.
      c. Approved equal.

B. Pressure Pipe:
   1. Per Pipe Penetration Details on Drawings.

C. Pipe to manhole connection shall be watertight.

2.5 CONFIGURATION

A. Shaft Construction
   1. Gravity Sewer Manholes: Concentric with reduced cone top section.
   2. Stand Pipe: Concentric with flat top section.
   3. Influent Pump Station Manholes: Concentric with flat top section.

B. Design Depth: As indicated on the Drawings.
2.6 FINISHING - STEEL
A. Galvanizing: ASTM A123; hot dip galvanize after fabrication.

2.7 COATINGS
A. See Section 099601 “Coatings - Wetwell and Manholes” for the following structures:
   1. 48- and 54-inch diameter Gravity Sewage Manholes
   2. 144-inch diameter Influent Pump Station Wetwell

PART 3 - EXECUTION

3.1 PREPARATION
A. Do not install structures where Site conditions induce loads exceeding structural capacity of structures.
B. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.

3.2 INSTALLATION
A. Excavation and Backfill:
   1. Excavate for manholes according to Section 312000 “Earth Moving”, 312319 “Dewatering”, and 315000 “Excavation Support and Protection.”
   2. Place manholes in dry trench.
   3. Backfill excavations for manholes according to Section 315000 “Excavation Support and Protection.”
   4. Coordinate with other Sections of Work to provide correct size, shape, and location.
B. Precast Concrete Manhole:
   1. Set precast structures bearing firmly and fully on crushed stone bedding, compacted according to provisions of Section 312000 “Earth Moving” and Geotechnical Report recommendations.
   2. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.
   3. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
   4. Joint sealing materials may be installed on Site or at manufacturer’s plant.
   5. Verify manholes installed satisfy required alignment and grade.
   6. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.
   7. Cut pipe to finish flush with interior of structure.
8. Shape inverts through manhole as indicated.

C. Frame and Cover:

1. Set frames using mortar and masonry. Install radially laid concrete brick with 1/4 inch thick vertical joints at inside perimeter. Lay concrete brick in full bed of mortar and completely fill joints. Where more than one course of concrete brick is required, stagger vertical joints.

2. Set frame and cover 2 inches above finished grade for manholes with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.3 WATERTIGHTNESS

A. Manholes shall be watertight. No visible leaks shall be present after backfilling and shutdown of dewater system. Watertightness means freedom from leaks. Leakage which cannot be attributed to absorption into concrete or evaporation reflects lack of watertightness.

B. Precast manholes shall be infiltration leak tested for at least three hours after backfilled to subgrade. No visible leakage shall be permitted. If water leakage occurs, determine cause and take action to repair such leakage as recommended by the manufacturer.

END OF SECTION 330513
SECTION 330517 – PRECAST CONCRETE VAULTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stormwater Catch Basins
   2. Valve Vaults
   3. Meter Vaults
   4. Backwater Valve Vault
   5. Electrical Handholes

1.2 SUBMITTALS

A. Shop Drawing: Indicate plan, location and inverts of connecting piping.
B. Product Data: Precast concrete vaults
C. Manufacturer’s Certificates: Statement of Compliance, supporting data, from materials suppliers attesting that precast concrete valve vaults and meter boxes provided meet or exceed ASTM Standards and specification requirements.
D. Manufacturer’s Installation Instructions: Special procedures for precast concrete valve vaults and meter boxes installation.
E. Calculation: Submit calculations sealed by a Professional Engineer registered in the State of Washington.

1.3 QUALITY ASSURANCE

A. Perform Work according to ACI 318, ASTM A 615 and ASTM C890.

1.4 DESIGN REQUIREMENTS.

A. Loading: HL-93 Design Truck (HS-20) with 30% impact or as required per AASHTO.
B. Water Table Elevation: Maximum height estimated at ground surface.
C. Soil at Rest Lateral Pressure: 90 PCF (equivalent fluid pressure)
D. Seismic Uniform Lateral Pressure on Below Grade Walls: 30 H² Line Load applied at 0.6 H
1.5 COORDINATION

A. Coordinate Work with utilities within construction area.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE VAULTS

A. Acceptable Manufacturer:
   1. Oldecastle Precast, Inc.
   2. Pacific International Pipe and Engineering, Inc.
   3. Approved equal.

B. Materials:
   1. Portland Cement: ASTM C150, Type II.
   2. Coarse Aggregates: ASTM C33; Graded 1 inch to No. 4 Sieve.
   4. Water: Potable; clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.
   6. Reinforcing Steel:
      a. Deformed Bars: ASTM A615, Grade 60.
   7. Joint Sealant:
      a. ASTM C990.
   8. Riser Sections: As required.

C. Mixes:
   1. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.

D. FABRICATION AND MANUFACTURE
   1. Fabricate precast reinforced concrete structures according to ASTM C913, to dimensions indicated, and to specified design criteria.

2.2 ACCESS:

A. Access hatches for all vaults and electrical handholes:
   1. See Section 083100 “Access Hatches.”
B. Frames and covers for stormwater catch basins:

1. Cast Iron Castings: ASTM A48, Class 30 or better; free of bubbles, sand and air holes, and other imperfections.
3. Contact surfaces machined and matched.
4. Cast cover inscription with pipeline service.

2.3 ACCESS STEPS:

A. Provide for all vaults.
B. Steel-reinforced copolymer polypropylene meeting following specifications:

1. ASTM C478.
2. ASTM C497, Method of test.
3. ASTM D4104, PP0344B33534Z02 copolymer polypropylene.
4. ASTM A615, Grade 60, 1/2 inch reinforced rod.
C. Aluminum: ASTM B221, Alloy 6061-T6.

2.4 DAMPROOFING

A. Acceptable Manufacturer:
1. Sonneborn Hydrocide 700
2. Approved equal.
B. Two or more coats at manufacturer’s recommended dry film thickness. Drying time between coats per manufacturer’s recommendation.
C. Field-apply after grouting of seams, pickholes, and pipe penetrations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify piping connection, size, location, and invert is as indicated.

3.2 PREPARATION

A. Establish invert elevations for each component in system.
3.3 INSTALLATION

A. Set precast structures bearing firmly and fully on crushed stone bedding, compacted according to provisions of Section 312000 “Earth Moving” and Geotechnical Report recommendations.

B. Backfill around sides of vaults and meter boxes, tamped in place and compacted to 95 percent.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

D. Install vaults and meter boxes and related components on bedding.

E. Place level and plumb, without damage to structural capacity, shape or finish. Repair or replace damaged structures.

F. Vault Joints: Install gasket. After coating concrete at vault joint with a suitable bonding agent, grout interior and exterior joint with nonshrink grout. Provide bituminous coating on the exterior of the vault prior to backfilling.

G. Site Tolerances: Maximum variation from level of plumb: 1/4 inch per 10 feet.

H. Protect from damage caused by backfilling operations.

I. Pipe penetrations shall be as shown on Drawings.

J. Field-coat all joints, pickholes, and penetrations per Section 033000 “Cast-in-Place Concrete.”

3.4 WATERTIGHTNESS

A. Vaults shall be watertight. No visible leaks shall be present after backfilling and shutdown of dewater system. Watertightness means freedom from leaks. Leakage which cannot be attributed to absorption into concrete or evaporation reflects lack of watertightness.

B. The vaults shall be tested after piping and vault penetrations have been completed and the vault backfilled to subgrade.

C. If water leakage occurs, determine cause and take action to repair such leakage, including the use of chemical grout, or replace as required.

END OF SECTION 330517
SECTION 331213 - WATER SERVICE CONNECTIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe and fittings for domestic water service connections.
   2. Meter setting equipment.
   3. Water meters.
   4. Meter box.
   5. Bedding and cover materials.

1.2 REFERENCE STANDARDS

A. AWWA - American Water Works Association

1.3 SUBMITTALS

A. Section 013300 “Submittal Procedures” Requirements for submittals.
B. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventer, and accessories.
C. Water System Work Plan.

1.4 CLOSEOUT SUBMITTALS

A. Section 017300 “Execution” and Section 017700 “Closeout Procedures”: Requirements for submittals.
B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, and invert elevations.
C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 WORK PLAN

A. Work plan outlining the following:
1. Work activities necessary to perform the work per this Section and as indicated on the Drawings.
2. Work delineation between Jefferson County PUD (PUD) and Contractor. Include the schedule and sequencing of these activities.
3. Identify activities that require advance scheduling and coordination with PUD, including:
   a. Request for water meter installation by PUD.
   b. Inspection by PUD of water service connection

1.6 PUD/CONTRACTOR RESPONSIBILITIES

A. Contractor Responsibilities:
   1. System development charge for connection.
   2. Cost of water meter.
   3. Schedule PUD meter installation work and inspection by PUD.
   4. Expose existing 6” water main.
   5. Provide and install tapping sleeve and tapping valve.
   6. Install water piping from tapping valve to water meter valve.
   7. Provide and install all required fittings and appurtenances for water service connection (with the exception of the water meter and meter transmitter).
   8. Provide and install meter box and lid.
   9. Excavation and trenching for new water service piping.
  10. Backfill after installation of water service connection

B. PUD Responsibilities:
   1. Provide and Install water meter and meter transmitter.
   2. Operate existing valves to accomplish shutdowns as required.
   3. Inspection during water service connection and prior to backfilling and final restoration.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Section 016000 “Product Requirements”: Requirements for transporting, handling, storing, and protecting products.

B. During loading, transporting, and unloading of materials and products, exercise care to prevent any damage.

C. Store products and materials off ground and under protective coverings and custody, away from walls and in manner to keep these clean and in good condition until used.

D. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.
PART 2 - PRODUCTS

2.1 POTABLE WATER PIPING AND FITTINGS
   A. Refer to Drawings.

2.2 WATER METERS
   A. Furnished by PUD.

2.3 UNDERGROUND PIPE MARKERS
   A. Refer to Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Section 017300 “Execution” and Section 017700 “Closeout Procedures”: Requirements for installation examination.
   B. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION
   A. Section 017300 “Execution” and Section 017700 “Closeout Procedures”: Requirements for installation preparation.
   B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
   C. Remove scale and dirt on inside and outside before assembly.
   D. Prepare pipe connections to equipment with flanges or unions.

3.3 PIPE INSTALLATION
   A. Trenching, Backfilling and Compacting: Provide trenching, backfilling and compacting of trench as described in Section 312000 “Earth Moving.”
   B. Bedding: Per Drawings.
C. Locating Wire: Side services installed shall have 14 gauge solid insulated copper wire placed over the water service line and brought up into the meter box. All connections or splicing shall be made with Split Bolt Wire Connectors.

D. Depth of Cover: Provide minimum cover over piping of 36 inches below finished grade.

E. Connection to Existing Water System:

1. Provide new water services between existing main and proposed meter as shown on the Contract Drawings.
2. Connect to water main as shown on the Drawings and in accordance with requirements of PUD.
3. Service line must be pressure tested before placing in service.
4. New piping shall be flushed, disinfected, and tested. Temporary plugs and blocking shall be installed at the points of connection to the existing system. PUD shall be notified 2 days prior to any water main shut downs.
5. After the new piping has been flushed, pressure tested, and disinfected, the remaining connections to the existing main can be made. All closure pieces and fittings shall be swabbed with an appropriate chloride solution (5-6% CL), in accordance with AWWA Standard C601.

3.4 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Flush and disinfect system in accordance with Section 331300 “Disinfecting of Water Utility Distribution.”

3.5 FIELD QUALITY CONTROL

A. Pressure test system in accordance with AWWA C600 and the following:

1. Test Pressure: Not less than 200 psi, or 50 psi in excess of maximum static pressure, whichever is greater.
2. Conduct hydrostatic test for at least two-hour duration.
3. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
4. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
5. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
6. Compute maximum allowable leakage by the following formula:

<table>
<thead>
<tr>
<th>L = (SD \sqrt{P})/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>L = testing allowance, in gallons per hour</td>
</tr>
<tr>
<td>S = length of pipe tested, in feet</td>
</tr>
<tr>
<td>D = nominal diameter of pipe, in inches</td>
</tr>
<tr>
<td>P = average test pressure during hydrostatic test, in psig</td>
</tr>
<tr>
<td>C = 133,200</td>
</tr>
</tbody>
</table>

When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

7. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

END OF SECTION 331213
SECTION 331219 - FIRE HYDRANTS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Fire hydrant assemblies.

1.2 SUBMITTALS
   A. Product Data: Manufacturer's latest published literature includes illustrations, installation instructions, maintenance instructions, and parts lists.
   B. Manufacturer’s Certificates: Statement of Compliance, supporting data, from material suppliers attesting that hydrants and accessories provided meet or exceed AWWA Standards and specification requirements.

1.3 QUALITY ASSURANCE
   A. Provide uniform color scheme for fire hydrants according to NFPA 281.
   B. Perform Work according to Jefferson County PUD standards.

1.4 DELIVERY, STORAGE AND HANDLING
   A. Prepare hydrants and accessories for shipment according to AWWA Standards.

PART 2 - PRODUCTS

2.1 FIRE HYDRANTS
   A. Per Jefferson County PUD standard details as shown on Drawings.

2.2 ACCESSORIES
   A. Concrete for Thrust Restraints: Per Drawings. Concrete type as specified in Section 033000 “Cast-in-Place Concrete.”
   B. Aggregate: Aggregate for hydrant drainage as per Drawings.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify invert elevations of existing work prior to excavation and installation of fire hydrants.

3.2 PREPARATION
   A. Locate, identify, and protect utilities to remain from damage.
   B. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.
      1. Notify Jefferson County PUD not less than 2 days in advance of proposed utility interruption.
      2. Do not proceed without written permission from Jefferson County PUD.
   C. Perform trench excavation, backfilling, and compaction according to Section 312317.

3.3 INSTALLATION
   A. Install Work according to Jefferson County standard details.

3.4 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
   A. Flush and disinfect system according to Section 331300 “Disinfecting of Water Utility Distribution.”

3.5 FIELD QUALITY CONTROL
   A. Perform pressure test on water distribution system according to AWWA C600.

END OF SECTION 331219
SECTION 331300 - DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes disinfection of potable water distribution system; and testing and reporting results.

1.2 REFERENCES

A. American Water Works Association:

   1. AWWA B300 - Hypochlorites.
   2. AWWA B301 - Liquid Chlorine.
   3. AWWA B302 - Ammonium Sulfate.
   4. AWWA B303 - Sodium Chlorite.
   5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   6. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

A. Section 013300 “Submittal Procedures”: Requirements for submittals.

B. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.

C. Test Reports: Indicate results comparative to specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. Section 017300 “Execution” and 017700 “Closeout Procedures”: Requirements for submittals.

B. Disinfection Report:

   1. Type and form of disinfectant used.
   2. Date and time of disinfectant injection start and time of completion.
   3. Test locations.
   4. Name of person collecting samples.
   5. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
   6. Date and time of flushing start and completion.
   7. Disinfectant residual after flushing in ppm for each outlet tested.

C. Bacteriological Report:

   1. Date issued, project name, and testing laboratory name, address, and telephone number.
   2. Time and date of water sample collection.
   3. Name of person collecting samples.
   4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certify water conforms, or fails to conform, to bacterial standards of Jefferson County PUD.

D. Water Quality Certificate: Certify water conforms to quality standards of Jefferson County PUD suitable for human consumption.

1.5 QUALITY ASSURANCE
A. Perform Work in accordance with AWWA C651.

1.6 QUALIFICATIONS
A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.
B. Testing Firm: Company specializing in testing potable water systems, certified approved by State of Washington
C. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS
2.1 DISINFECTION CHEMICALS
A. Chemicals: AWWA B300, Hypochlorite, AWWA B301, Liquid Chlorine, AWWA B302, Ammonium Sulfate, and AWWA B303, Sodium Chlorite.

PART 3 EXECUTION
3.1 EXAMINATION
A. Verify piping system has been cleaned, inspected, and pressure tested.
B. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 INSTALLATION
A. Provide and attach required equipment to perform the Work of this section.
B. Perform disinfection of water distribution system and installation of system and pressure testing.
C. Inject treatment disinfectant into piping system.
D. Maintain disinfectant in system for 24 hours.
E. Flush, circulate, and clean until required cleanliness is achieved; use domestic water.
F. Replace permanent system devices removed for disinfection.

3.3 FIELD QUALITY CONTROL

A. Section 014000 “Quality Requirements”; 017300 “Execution”: Field inspecting, testing, adjusting, and balancing.

B. Disinfection, Flushing, and Sampling:

1. Disinfect pipeline installation in accordance with AWWA C651. Use of liquid chlorine is not permitted.
2. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
3. Legally dispose of chlorinated water. When chlorinated discharge may cause damage to environment, apply neutralizing chemical to chlorinated water to neutralize chlorine residual remaining in water.
4. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test and certify water quality suitable for human consumption.

END OF SECTION 331300
SECTION 333100 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. This section includes sanitary utility sewerage piping outside the buildings for:
      1. Sanitary sewage pipe.
      2. Clean outs
      3. Bedding and cover materials.

1.2 SUBMITTALS
   A. Product Data: Pipe material used, pipe accessories.

1.3 CLOSEOUT SUBMITTALS
   A. Project Record Documents: Record location of pipe runs, connections, cleanouts, and invert elevations.

PART 2 - PRODUCTS

2.1 PIPING MATERIAL
   A. See Specification Section 422700 “Process Piping General”.

2.2 CLEAN OUTS
   A. Clean-outs shall be installed at locations shown on the Drawings.

2.3 BEDDING AND COVER MATERIALS
   A. Bedding, cover, and backfill per Drawings.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Verify excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION
   A. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING
   A. Excavate pipe trench according to Section 312000.
   B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 6 inches.
   C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE
   A. Pipe is to be installed in accordance with the Section 7-08 of WSDOT Standard Specifications. Install pipe outside the building foundation, including raised planter beds.
   B. Pipe and fittings shall be joined by flexible compression rings conforming to ASTM C443. All connections are to be made with approved fittings as recommended and furnished by the manufacturer. Connections to existing sewer lines to be made at locations shown on the drawings.
   C. Connections to building plumbing shall include necessary fittings to make vertical and horizontal transition.

3.5 FIELD QUALITY CONTROL
   A. Cleaning and testing shall be in conformance with Section 7-17.3(2) of the WSDOT Standard Specifications. All new lines shall be subjected to testing after installation. Tests shall be exfiltration test or air pressure test.
   B. Clean all structures prior to final acceptance.

END OF SECTION 333100