3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

J. Electrical Supply: Two (2) **25hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 200A rated with a 125A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.

2. Inside the container, provide 125A Square D NF, MLO, 480Y/277V panelboard with 30 spaces, with separate circuit breakers for each air compressor (80A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).

3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

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K. Electrical Supply: Two (2) **30hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 400A rated with a 250A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.

2. Inside the container, provide 250A Square D NF, MLO, 480Y/277V panelboard with 30 spaces, with separate circuit breakers for each air compressor (100A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).

3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

L. Electrical Supply: Two (2) **40hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 400A rated with a 400A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.

2. Inside the container, provide 400A Square D NF, MLO, 480Y/277V panelboard with 30 spaces, with separate circuit breakers for each air compressor (125A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).

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3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

M. Electrical Supply: Two (2) **50hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 400A rated with a 400A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.
2. Inside the container, provide 400A Square D I-Line HCM, MLO, 480Y/277V panelboard with 27 spaces, with separate circuit breakers for each air compressor (150A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).
3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

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N. Electrical Supply: Two (2) **60hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 400A rated with a 400A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.
2. Inside the container, provide 400A Square D I-Line HCM, MLO, 480Y/277V panelboard with 27 spaces, with separate circuit breakers for each air compressor (175A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).
3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

O. Electrical Supply: Two (2) **75hp** Air Compressors (**277/480V**, 3 Phase, 4 Wire).

1. Compressed air station shall have a Square D, heavy duty, fusible, pad-lockable, NEMA 3R, 600V switch, for a 4-wire system. This disconnect shall be 400A rated with a 400A Class R fuse for single point electrical connection located outside the container, approved and labeled for service entry to feed all equipment and lighting. All fuses shall be Class "R" Bussman Fusetrons, unless otherwise noted. Provide three spare fuses for each size used. All necessary accessories to make a complete electrical system are required. This includes equipment grounding kit, rainproof bolt-on hub, neutral assembly kit, and the lock off guard kit.

2. Inside the container, provide 400A Square D I-Line HCM, MLO, 480Y/277V panelboard with 27 spaces, with separate circuit breakers for each air compressor (225A, 480V, 3 pole) and Mini-Power Zone (25A, 480V, 2 pole). Provide appropriately sized breakers per the National Electrical Code (NEC) for any other loads (ie. heater, air conditioner, etc.). Balance load across phases. Also provide a 5kVA Square D Mini-Power Zone, 480V input to 120/240 volt, with separate breakers to service lighting (20A, 120V, 1 pole) and receptacles (20A, 120V, 1 pole).

3. All conductors for interior wiring shall be 98 percent conductivity copper. Insulation shall be 600V THW or THWN thermoplastic, unless otherwise specified. No wire shall be smaller than #10 unless otherwise noted. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet or junction boxes. All exposed interior raceways shall be galvanized rigid steel (RGS). Minimum size conduit shall be 3/4 IN nominal trade size. All panels, wire and conduit shall comply with NEC. All panels shall provide at least 25 percent spare breaker capacity. Panelboards and disconnects shall be marked with permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8 IN in height. Indicate panel name, or designation and voltage, phase, and wire characteristics (ie, 120/208V, 3P, 4W).

P. Station shall have a 2 IN flanged compressed air outlet pipe located outside the container and clearly labeled.

2.02 COMPRESSOR BUILDING

A. The standard container sizes are listed on the project drawings and shall meet ICC specifications or UPRR approval for a container of similar dimensions. It is to be free of dents, punctures, bulges, and any damage which detracts from its general function and appearance.

B. The compressor building shall be provided with thermostat controlled electric heaters and ventilation system to protect from freezing, overheating, or premature shutdown under all ambient conditions. The internal temperature is to be maintained to ensure maximum compressor efficiency.

C. Flooring shall be appropriate for ease of cleaning and resistance to contaminants and/or oils.

D. Lighting inside container shall be comprised of Lithonia Lighting Model MSL LED style fixtures, providing a minimum of twenty (20) foot-candles.

E. Install equipment to maximize service clearance around compressors and dryer for ease of maintenance.

F. All clearances required by the latest published edition of the NEC shall be observed.

G. A minimum of two (2) 120-volt duplex outlets shall be provided. One (1) is to be located by the Control Panel and one (1) by the Compressor. If the control panel and compressor are next to each other, place the outlets opposite each other at either end of the container. If heat tracing is required, a third outlet is to be furnished in proximity to the condensate lines or equipment to be traced.

H. A lockable, wall mounted metal cabinet shall be provided for all lists of daily, weekly, and monthly maintenance procedures, as well as manuals and keys.

I. An adequate drain system for all condensates shall be installed and directed to an Oil / Water Separator. All condensate lines shall be heat traced when regional temperatures dictate such precautions, or as required on the design drawings (refer to outlet requirements – previous).

J. Weather-tight metal double doors shall be provided to provide ease of installation and removal of the compressor(s). Dual compressors require double doors for each compressor.

K. All doors shall be fitted with industrial grade locking devices to prohibit unauthorized access.

L. Appropriate duct work for demand air and heated exhaust air shall be provided. Compressor exhaust air shall not be vented directly into the container.

M. Appropriate duct work for demand air and heated exhaust air shall be provided. Compressor exhaust air may be vented directly into the container provided the ventilation system is sized adequately to handle additional air flow.

N. Compressor building penetrations (piping, vents, etc.) shall be made water-tight by installing flashing, sealed, and caulked.

O. Air intake openings are to have filters installed.

P. Completed package shall be transported to installation sites via truck without special handling, disassembly, etc. (e.g. 13 FT-6 IN transport height).

2.03 COMPRESSOR

A. The compressor(s) shall be single stage, air cooled, oil flooded rotary screw type. The compressor is to meet stated cfm requirements and the manufacturer is to submit the CAGI performance sheet. The Compressor package is to take into account compressor performance results.

B. Compressor shall include, but not limited by, the following:

1. Multi-stage, 3-micron dust inlet filter and differential pressure indicator (dirty filter).
2. Air inlet / unload valve assembly.
3. Integral gear drive – Belt drive systems shall not be used (except for small horsepower compressors at the discretion of the engineer).
4. High efficiency, ODP motor (voltage, phase, and hp as required per application; performance specifications to be provided to UPRR).
5. TEFC cooling fan motor (for oil cooler and after-cooler).
6. Wye/Delta starter or other “soft start” on main motor.
7. NEMA 12 enclosure.
8. ASME coded air/oil separator tank.
9. High efficiency air/oil separator element.
10. Differential pressure oil circulation system.

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11. Integrated after-cooler and high efficiency moisture separator with manual and No-Loss demand drain valve.
12. Oil stop valve and thermostatic oil cooler by-pass valve.
13. Spin-on type oil filter and oil level indicator.
14. Minimum pressure check valve.
15. Air check valve.
16. Factory fill of 8000 HR synthetic lubricant.
17. Full six (6) sided enclosure (85 max. dB, per CAGI standards).
18. Start-Stop controls, without modulation.

2.04 COMPRESSOR CONTROL SYSTEM

A. Microprocessor control system (120-volt) which utilizes an energy efficient "load/no-load" control. During periods of prolonged operation in the unload mode, the unit will automatically shut off stay in an auto restart mode which will automatically start the unit when demand increases.

B. Controller program and operating parameters shall not be lost by power failure. Air compressor shall restart automatically with restoration of power.

C. In the case of dual compressors, logic is to be configured to allow for alternate start/stop operation. Controller Logic shall allow one (1) compressor to be taken off line while the other compressor continues to run.

D. System will include a minimum of the following:

1. LED Indicators:
    a. Automatic Operation.
    b. Voltage On.
    c. General Alarm.
2. Push Buttons:
    a. Start/Stop and Emergency Stop.
    b. Function Keys.
    c. Scroll Keys.
    d. Tabulator Keys.
3. Data Display:
    a. Discharge Outlet Temperature.
    b. Delivery Air Pressure.
    c. Motor Overload Status.
    d. Running Hours and Loaded Hours.
4. Service Indicators:
    a. Air and Oil Filter.

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b. Oil Separator and Oil Level.

5. Remote Exterior LED Indicator Lights:

a. Green = Ready/Operating.

b. Red = General Alarm.

2.05 AIR DRYER

A. The air dryer shall be designed as a refrigerated cycling type (or desiccant type when specified by UPRR) and built to ASME code standards. Design Dew point shall be 35-39 pdp.

B. Air dryer may be incorporated within the compressor system.

C. Dryer system shall be approximately sized for the combined air flow of all compressors.

2.06 INLINE FILTER

A. The filter shall remove any remaining water, mist, oil, particulates, etc. up to one (1.0) micron from the air entering the air receiver.

B. The filter shall be deep bed media design, with a maximum range of 2 psid indicating when the element is due to be changed.

C. The filter vessel shall be ASME coded.

D. A three (3) valve filter bypass system shall be installed.

2.07 AFTER FILTER

A. The filter shall remove any remaining water, mist, oil, particulates, etc. up to one-tenth (0.01) micron from the air entering the air receiver.

2.08 OIL/WATER SEPARATOR

A. The oil/water separator is to collect drainage from the air receiver, inline filter and air dryer.

B. The separated water is to be piped to the outside of the building for drainage.

C. The oil collection system shall be designed for removal of the oil on an annual basis concurring with the compressor oil change.

2.09 DEMAND CONTROLLER

A. Sized for maximum flow of compressed air system.

B. Field adjustable range from 60 - 120 psig. Initially set at 90 psig discharge pressure. Include 0 - 200 psig pressure gauges to read inlet & discharge pressures.

C. Maximum allowable pressure drop through the demand controller shall not exceed 3 psid at maximum flow of compressed air system.

D. The demand controller shall keep the system pressure ±1.5 psig at all flow conditions within the turndown range of the valve.

E. The demand controller shall have a turn down of 30 percent minimum.

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F. Demand controller to be located on wall near air outlet pipe. Demand controller shall remain inside container and piping from the external air receiver tank will be piped back into container, through demand controller and back out. Compressor provider will provide all internal piping to and from demand controller. The connections from the demand controller to the outside of the container will be 2 IN.

2.10 AIR RECEIVER

A. An internal air receiver may be installed if compressor stations do not have air tanks.

B. Internal air receivers to have automatic no loss air drains tied to Oil/Water separator.

C. Receivers to be of steel construction, ASME National Board coded for 150 psi minimum working pressure.

2.11 PIPING

A. Air line piping shall be ASTM A53 Grade B or API-5L Grade, schedule 40, seamless or ERW. Condensate lines shall be type M copper.

B. Fittings:

1. Threaded pipe fittings shall be 3000 #, forged steel conforming to ANSI B16.11.

2. Piping is not to present a tripping hazard, a maintenance obstacle, or violate NEC required clearances.

C. Pipe dope to be used on all threaded connections, no Teflon tape shall be used.

2.12 VALVES

A. Valves shall be ANSI Class 600 ball valve with lever handle, carbon steel body, Teflon seats, stainless steel trim and NPS ends.

B. Drain valves shall be low loss type air drains, tied to Oil/Water separator.

2.13 HEATER/ VENTILATION

A. Heater shall be electric type.

B. More than one heating element may be installed to allow for appropriate heating of container.

C. Ventilation to be sized to allow for required compressor air demand.

D. Ventilation Inlet to have air filters installed to minimize dust build-up.

PART 3 - EXECUTION

3.01 PAINTING

A. All pipe, couplings, equipment and pipe fittings shall be prepared and painted per Specification Section 09 90 00.

B. Container exterior shall be painted light gray with a minimum 3 mils DFT alkyd enamel with appropriate primer pre-applied to bare metal or modification areas.

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3.02 START-UP SERVICES

A. Services of a factory trained start-up engineer for the Owner's on-site installation shall be included in total cost of the equipment.

B. The Start-up Engineer shall certify that all assembled equipment and components in this specification have been pre-tested, installed, and in good working order prior to any acceptance for shipment by the Railroad. Upon receipt of the system to the installation site, the Start-up Engineer shall ensure that the owner's representatives responsible for future system operation have been fully instructed as to proper maintenance and operation parameters as required or specified by the vendor.

C. The Start-up Engineer shall examine field installation and make any recommendation he deems fit to ensure proper operation under all conditions.

3.03 GUARANTEE

A. The vendor shall guarantee all materials and workmanship furnished will replace or make any satisfactory adjustments for any part shown to be defective within twelve (12) months after the acceptance by the Railroad.

3.04 MAINTENANCE

A. To prevent nullification Original Equipment Manufacturer's warranties container manufacturer shall provide maintenance for the period of one (1) year.

1. Quarterly operational checks shall be performed which will include a complete system analysis.

END OF SECTION

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SECTION 22 15 11 - HUMP COMPRESSED AIR SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Compressed air systems including:
    a. Rotary screw air compressors and controls.
    b. Air filters.
    c. Air dryer.
    d. Air receivers.
    e. Flow controller
    f. Flow meter.
    g. Pressure transmitter.

B. Section does not include:

1. Compressed Air Stations to supply yard air systems. See Section 22 15 10.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Division 1 - General Requirements.

1.03 REFERENCED STANDARDS

A. American Society of Mechanical Engineers (ASME):

1. Section VIII, Construction of Pressure Vessels Division 1.

B. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

C. Underwriters Laboratories, Inc. (UL).

D. Compressed Air and Gas Industries (CAGI) ADF-100.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Sections 01 61 02 and 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Detailed literature describing the equipment. This information includes dimensional information concerning the overall dimensions, power / control requirements, operating characteristics, options included, etc.
3. Fabrication Drawings:
    a. Air receiver fabrication Drawing showing all tap locations and ASME data plate information.

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b. Show location of all control equipment.

c. Show location and dimension of air compressors top and end exhaust duct connections.

4. Controller and related equipment system description and diagrams.

5. A complete I/O points list for control system that describes all analog and discrete I/O points and their description.

6. A detailed control panel layout drawing with a complete Bill of Material (BOM) that lists each panel mounted component including part numbers, description and quantity.

7. Manufacturer's installation instruction.

8. Manufacturer's statement of proper installation and start-up.

B. Operation and Maintenance Manuals:

1. See Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. Electronic copies of the manuals are sufficient for initial submittal to Railroad. One hard copy print should be provided to Railroad at completion of the project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Air compressor:

a. Ingersoll-Rand.

b. Atlas-Copco.

c. Kaeser.

d. Or approved equal.

2. Air Compressor Controller:

a. Ingersoll-Rand.

b. Or approved equal.

3. Air Filtration:

a. Ingersoll-Rand.

b. Zeks.

c. Atlas-Copco.

d. Kaeser.

e. Or approved equal.

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4. Air dryer:
    a. Ingersoll-Rand.
    b. Zeks.
    c. Or approved equal.
5. Automatic pneumatic no-loss drain valves:
    a. Ingersoll-Rand.
    b. Zeks.
    c. Or approved equal.
6. Flow Controller:
    a. Ingersoll-Rand.
    b. Or approved equal.
7. Flow Meter:
    a. Rosemount.
    b. Or approved equal.
8. Pressure Transmitter:
    a. Rosemount.
    b. Or approved equal.

2.02 COMPRESSED AIR SYSTEM

A. General:

1. Provide an air compressor system with the following components:
    a. Rotary screw air compressors: Four (4) each.
    b. Wet air receiver: Two (2) each.
    c. Dry air receiver: Two (2) each.
    d. Supplemental dry air receivers: Six (6) each.
    e. Controls: As specified.
        1) Pressure transducer: Two (2) each.
        2) Pressure dew point instrument: One (1) each.
    f. Desiccant Air Dryer: Two (2) each.
    g. Air dryer pre-filter and after filter package: Two (2) each.
    h. No loss drains: As needed.
    i. Flow controller: One (1) each.
    j. Flow meter: One (1) each.
    k. Pressure transmitter: Two (2) each.
2. Equipment shall be factory assembled piped and wired requiring only field

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connection of air piping, and electrical power, and condensate piping.

2.03 ROTARY SCREW AIR COMPRESSOR

A. Each compressor shall have the following performance and configuration:

1. Capacity: 1,440 scfm at 135 psig.
2. Maximum pressure: 145 psig.
3. Horsepower: 300 (Main Motor).
4. Air Cooled.
5. Two stage.
6. Oil Flooded.
7. Variable Speed Drive (VSD).
8. Power outage restart.
9. Each compressor shall be configured to include the standard top (of unit) exhaust, and will be modified to include an end mounted exhaust. See Drawings for configuration.

B. Compressor features:

1. Multiple unit control system with display.
2. Coolant filter with replaceable element.
3. 1- micron dust inlet filter and differential pressure indicator.
4. ODP 460 V, 3 PH, 60 Cycle, high efficiency motors.
5. TEFC cooling fan motor (for oil cooler & after cooler)
6. Inerter controlled cooling fan motor.
7. ASME coded air/oil separator tank.
8. Two stage air/oil separator element, oil carry over shall be less than 3 ppm.
9. Aftercooler and high efficiency moisture separator with manual and automatic electric demand drain.
10. Air Check valve.
11. Oil stop valve and thermostatic oil cooler by-pass valve.
12. Spin-on type oil filter and oil level indicator.
13. Differential pressure oil circulation system.
14. Minimum pressure valve.
15. Control system with display.
16. Integrated VFD.
17. Factory fill of 8000 HR synthetic lubricant.
18. Full (6) sided acoustical sound attenuating enclosure (79 Max DB per CAGI).

C. Controls:

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1. Microprocessor control system (120-volt control voltage).
2. Variable frequency drive.
3. Controller program and operating parameters shall not be lost by power failure. System shall restart automatically with restoration of power.
    a. Provide Power Outage Restart Option (PORO) module.
4. Modbus communication.
5. Provide events log capability.
    a. Provide continuous monitoring with logging of abnormal conditions and display of relevant messages.
6. Built in sequence compressor control.
7. System will include a minimum of the following:
    a. LED Indicators:
        1) Automatic Operation.
        2) Power On.
        3) General Alarm.
    b. Push Buttons:
        1) Start/Stop and Emergency Stop.
        2) Function Keys.
        3) Scroll Keys.
        4) Tabulator Keys.
    c. Data display:
        1) Compressed air discharge temperature.
        2) Delivery air pressure.
        3) Motor overload fault alarm.
        4) Running hours and loaded hours.
        5) Performance analysis.
    d. Service Indicators:
        1) Air & oil filter.
        2) Oil Separator & oil level.

2.04 COMPRESSOR MASTER CONTROL PANEL

A. Furnish an Allen Bradley CompactLogix PLC compressor controller / sequencer suitable for minimum of five (5) units and flow controller.
    1. Controls shall be housed in a NEMA 4X stainless steel enclosure.

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2. Provide a managed Ethernet switch with 8 copper ports and 2 fiber ports. Managed Ethernet switch shall be Allen Bradley Stratix 5700 switch or approved equal.
3. PLC shall be supplied with sufficient digital and analog I/O points to enable the compressor sequencing, monitoring and control as called out in this specification. Provide at least 20 percent spare I/O points of each type. Provide at least 30 percent spare terminal blocks. All PLC I/O points, including spares, shall be wired to terminal blocks. Terminal blocks shall be Phoenix Contact UT4 or UT5 feed through type.
4. Provide a mushroom type (red colored) padlockable E-Stop pushbutton for emergency stop of all compressors. E-Stop pushbutton shall be hardwired to each compressor motor starter. Sufficient contact blocks shall be provided for this purpose.
5. All pushbuttons, selector switches and pilot lights shall be Allen Bradley Bulletin 800T/H 30.5mm devices. All pushbuttons shall be black colored with 1 NO and 1NC contact. Pilot lights shall be LED push-to-test (PTT) type. Selector switches shall be black colored.
6. Compressor vendor shall provide the PLC code in both native and pdf format to the Owner, Contractor and Union Pacific PLC Contractor for coordination. Each step of the PLC code shall be explained in simple English language on the side for easy understanding by others.
7. Provide an Allen Bradley PanelView Plus 6 1000 10.4 IN touchscreen OIT on the Compressor Master Control Panel. OIT shall have a main screen that displays status and alarms for the five compressors and two dryers and associated instruments/components. There shall be a separate alarms screen that shall display all active alarms in red background. A graphic pushbutton shall be available on each screen to enable the operator to go to the alarms screen. A separate graphics screen shall be provided for each compressor and dryer.
8. Coordinate with the Owner and Contractor prior to commencement of development of OIT graphics to obtain the Owner HMI graphics standards (colors and symbols). Vendor shall try to mimic the Owners HMI graphics as closely as possible. Submit a set of OIT graphics in color to the Owner and Engineer for approval prior to finalizing the graphics. Vendor shall address any comments arising out of this submittal prior to factory testing and final shipment.
9. Provide a redundant 24VDC power supply in the Master Control Panel to provide 24VDC power to the Ethernet switch and OIT and any other components that require 24VDC power. Power supply shall be manufactured by SolaHD or approved equal. Power supply shall be provided with a redundancy module that shall monitor the active 24VDC power supply and upon failure of the active module it shall automatically switch over to the standby module without loss of 24VDC power to the associated components.
10. Submit a complete I/O points list that describes all analog and discrete I/O points and their description.
11. Submit a detailed control panel layout drawing with a complete Bill of Material (BOM) that lists each panel mounted component including part numbers, description and quantity.

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B. The Automation system should monitor and trend supply pressure, each compressor amperage, system pressure, system flow, pressure dew point, as well as, valve position the flow controller. The flow controller should be controlled by the compressor master control PLC.

C. The following will be required from the PLC as a minimum:

1. Utilize different pressure setpoints and permissive times during trim mode and active mode.
2. Utilize different PID loops for flow controller during active and trim modes.
3. Rotate compressors based on running hours or programmed sequence.
4. Start, load, unload, and stop compressors as required.
5. Delay starting and loading of a compressor when the rate of pressure change is positive or zero.

D. Provide package to allow monitoring of compressed air system through Modbus TCP or Ethernet/IP.

1. PLC in Compressor Master Control Panel will communicate with UP provided Hump Air Supervisory Control Panel via Modbus TCP or Ethernet/IP. Compressor vendor shall coordinate with UP's Hump Air Supervisory Control Panel supplier to establish communication with the Supervisory PLC. Compressor vendor shall provide PLC I/O Register Map to UP PLC Contractor. UP PLC Contractor, CSE Services, Tony Schmitz (Phone: 402-733-2100 x2102) shall provide the Supervisory Control Panel.
2. Package to provide user with the following items (not limited to):
   a. System status & control.
   b. System performance monitoring.
   c. Equipment status monitoring.
   d. Equipment maintenance scheduler.
   e. Graphing and trending tools for flow (from flow meter), pressure, pressure dew point, compressor amperage, flow controller valve position.
   f. Reporting tools.
   g. Warning and alarm monitoring.

E. Low pressure alarm: 110 psi.

F. Pressure Transducer

1. Provide two (2) total, one (1) on each air receiver as located on Drawings, 0 – 150 PSIG pressure transducers. One (1) active and one (1) back-up.
2. Pressure transducers shall provide 4-20 mA output to Compressor Master Control Panel.
3. See plans for location and schedule.
4. Manufacturer:
   a. Dwyer, Model 628.

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b. Or approved equal.

5. Pressure range (gage):
   a. 0 – 150 PSIG.
6. Pressure transducer shall include:
   a. Conduit housing.
      1) 1/2 IN FNPT conduit connection.
   b. 1/4 IN MNPT process connection.
   c. Include isolation valve.
   d. NEMA 4X enclosure.
   e. Stainless steel wetted parts.

G. Pressure Dew Point Instrument:
1. Provide pressure dew point instrument.
2. Pressure dew point instrument shall provide 4-20 mA output to Compressor Master Control Panel.
3. Instrument sensor shall be compatible with dry compressed air from desiccant air dryer (Vaisala DRYCAP 180M or equal).
4. See plans for location and schedule.
5. Manufacturer:
   a. Vaisala, DMT242.
   b. Or approved equal.
6. Pressure range (gage):
   a. 0 – 150 PSIG.
7. Dew point range:
   a. -100 DegF to +80 DegF
8. Pressure dew point instrument shall include:
   a. 1/2 IN MNPT connection.
   b. Include isolation valve.
   c. NEMA 4 enclosure.
   d. Stainless steel probe.

H. New compressors shall be equipped with Variable Frequency Drives (VFD).

I. Provide control scheme to respond to air consumption demands.
1. Air flow shall be monitored downstream of the flow controller (by flow meter) as located on plans.
2. Air pressure shall be monitored downstream of the dryer near the main air receivers as located on plans.

3. The master compressor controller will use the (4) 300 HP compressors to maintain a target pressure. The controller shall utilize flow rate of change and pressure drop to determine compressor operations.

    a. Normal Compressor Master Control system operation:

        1) Maintain a target pressure of 130 psig (adjustable) at the main air receiver tanks.

        2) Compressors shall be cycled on/off as necessary to maintain the target pressure. Controller shall utilize flow rate of change and pressure drop to determine/predict compressor operations.

    b. Back-up control system operation (local controls):

        1) In the event of a Compressor Master Control Panel failure, system shall default into local control operation. Operation sequence shall default to the following:

            a) The first compressor that is brought on will be a "trim" compressor. This compressor will throttle between 30 percent - 100 percent of capacity to try to maintain 135 psig. If the pressure drops to the "Add" pressure (132 psig), the controller will begin the process of turning on another compressor. The next compressor brought on-line would be a "base" compressor. This compressor will be able to throttle between 70 percent - 100 percent. Both the trim and base compressors will be able to throttle together to prevent rapid cycling of the system. If the pressure drops to the next "Add" pressure setting (129 psig), the controller will begin the process of turning on the third compressor. It would only be able to run at 100 percent capacity. If the pressure drops to the next "Add" pressure setting (126 psig), the controller will begin the process of turning on the last compressor. It would only be able to run at 100 percent capacity. As the pressure rises to the "Remove" pressure, compressors would then be taken off-line.

            b) System will be set up to rotate operation of compressors from "trim", "base", "third" or "last" compressor.

2.05 AIR RECEIVERS

A. See Section 23 05 99 for inspection and testing requirements.

B. Provide wet air receivers at locations as shown on plans.

1. Size:

    a. Provide two (2) vertical wet air receivers with capacity as scheduled on Drawings. Condensate from wet receiver shall be routed to condensate management system installed within compressor building. Condensate piping shall be insulated.

2. Receivers to be of steel construction, ASME National Board coded for 165 psi minimum working pressure.

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C. Provide dry air receivers at locations as shown on plans.

1. Size:

a. Provide two (2) horizontal dry receiver tanks with capacity as scheduled on Drawings, dry air for primary air storage.

2. Receivers to be of steel construction, ASME National Board coded for 150 psi minimum working pressure.

D. Provide supplemental air receivers at locations as shown on plans.

1. Size:

a. Provide four (4) horizontal dry receiver tanks with capacity as scheduled on Drawings, dry air for supplemental air storage.

b. Provide two (2) vertical dry receiver tanks with capacity as scheduled on Drawings, dry air for supplemental air storage.

2. Receivers to be of steel construction, ASME National Board coded for 150 psi minimum working pressure.

E. Receiver shall have following accessories:

1. Pressure gage, 4-1/2 IN, 0-300 psi.

2. Vent valve.

3. Safety relief valve.

a. Manufactuer:

1) Kunkle Series 6000.

2) Or equal.

b. Safety relief valves shall be set to pressure rating of tank.

c. Wet air receivers and primary dry air receiver tank safety relief valves shall be capable of exhausting combined flow capacity of compressors.

d. Safety valve quantity and sizing shall meet state and/or local requirements.

F. Horizontal air receivers are to be provided with saddles.

G. Air receivers shall be mounted on concrete slabs.

2.06 COMPRESSOR INLET AIR FILTER

A. Compressor Inlet Particulate Filters:

1. Provide inlet particle filter.

2. Filter shall remove 99.9 percent of particles down to 3.0 micron rating.

3. Provide with replaceable filter element.

2.07 IN LINE OIL / PARTICULATE FILTERS

A. In Line Filters:

1. Ingersoll Rand – NL Module.

2. Or approved equal.

B. Filters shall remove oil and water liquid/mists, and solid particulates from compressed air. Filter must be capable of removing oil and water liquid/mist down to 0.5 ppm by weight.

C. Filters shall use both mechanical and centrifugal action to remove up to 99 percent of all solid particles and droplets of water or oil before it reaches the filter element.

D. Filter elements to provide 99.98 percent efficiency at 0.1 micron retention.

E. The filters shall have the following features:

1. Replaceable cartridge type filter elements.

2. Differential pressure gauges.

3. Housing to be cast aluminum, 250 LB working pressure.

2.08 AIR DRYERS

A. Desiccant Air Dryer:

1. Provide heated desiccant type air dryer size for compressor flow and corrected for operational temperature and pressure factors.

a. Flow Rating (not corrected): 6000 SCFM (minimum).

2. Dried air shall have a pressure dewpoint of -40 DegF.

3. Dryer capacity shall be based upon inlet air at 145 psig, 100 percent relative humidity, 100 DegF ambient temperature with a maximum of 5 psi maximum pressure loss across the unit.

4. Automatic cycling shall be controlled by included PLC controller.

5. Twin drying towers comprised of pressure vessels that are UL approved or ASME coded for 200 psi operating pressure.

a. Provide safety relief valve on each tower.

6. Construct with corrosion resistant materials with heat exchanger being aluminum, stainless steel or epoxy coated copper.

7. All copper components exposed to ambient air to be epoxy coated.

8. Provide following unit mounted indicators:

a. Temperature indicators:

1) Inlet air.

2) Outlet air.

3) Purge heater outlet.

4) Purge exhaust.

b. Pressure indication:

1) Air outlet.

2) Each tower.

3) Purge pressure.

c. Indicator lights:

1) Power on.

2) Compressor on.

3) High temperature.

4) Dryer cycle status.

9. Provide digital controls to automatically start, stop, and control compressor with safety shut down interlocks for thermal overloads.
10. Unit enclosure to be NEMA 4.
11. Power supply to be 460 V, 3 PH, 60 HZ.
12. Provide filter package with 3-way valved bypass including:
    a. Pre-filter.
        1) Filter to remove oil and liquid water to 0.01 PPM (by weight) and capable to remove solid particles as small as 0.01 micron.
        2) Employ a replaceable element for coalescing oil mists.
        3) Provide no-loss drains.
        4) Provide differential pressure gauge.
    b. After-filter.
        1) Filter to remove particulate matter with minimum efficiency of 99.95 percent of particles larger than 1 micron.
        2) Provide differential pressure gauge.
13. Provide a purge adjustment valve.
14. Provide noise reducing mufflers of depressurization exhaust.
15. Provide purge exhaust discharge sensor. Sensor shall shut down purge air heater when purge exhaust has reached regeneration temperature.
16. Dryer to be equipped with an Energy Management System / Dewpoint Control (EMS).
    a. Include;
        1) Digital dew point display.
        2) Dew point control of the dryer cycle.
17. Purge exhaust to be piped outside of building.
    a. Provide two (2) each 4 IN MNPT purge mufflers.
18. Desiccant type: Activated alumina.

2.09 FLOW CONTROLLER

A. Provide automatic rotary control valves.

1. Flow controller with PID (Proportional – Integral – Derivative) controller for the hump air supply shall be provided.
    a. The PID controller shall maintain a setpoint by adjusting the control output to meet changing air demand.
    b. Controller to have two-line display that displays both target and actual pressures.
2. Control valve to default to open on loss of control signal.
3. Demand controller shall be controlled through Master Control Panel. Provide pressure transducers located as shown on plans, pressure transducers shall be integrated into control system.
4. Valve body type:
    a. Butterfly or Ball flanged.
5. Characteristic:
    a. Modified equal percentage.
6. Actuator type:
    a. Spring and diaphragm.
7. Positioner type:
    a. I/P.
    b. 4 – 20 mA dc input signal.
    c. Enclosure: NEAM 4.
8. Modbus communication port.

B. Manufacturer:

1. Ingersoll-Rand, Intelliflow.
2. Or approved equal.

C. Flow requirements:

1. 200 scfm to 7,200 scfm.

D. Pressure requirements:

1. Inlet: 135 psig.
2. Outlet: 130 psig.
3. Provide controller to +/- 0.75 psi throughout rated flow range.
4. Provide ability to control downstream pressure for full range of compressor flow rate.

E. Electrical:

1. 110 VAC, 1 PH

F. Accessories

1. Mounted pressure transducer and 3-valve bypass.
2. NEMA 4 enclosure.
3. Drain port
4. Filter / regulator on pneumatic control line.

2.10 PRESSURE GAGES.FLOW METER

A. Provide flow meter for hump air supply.

B. Manufacturer:

1. Rosemount, 3051SFA Annubar.
2. Or approved equal.

C. Flow requirements:

1. 7,200 SCFM (maximum).

D. Pressure requirements:

1. 125 PSIG.

2.11 PRESSURE TRANSMITTER

A. Provide two (2) pressure transmitters as located on plans to provide system pressure.

B. Pressure transmitters shall provide 4-20 mA HART output to Hump Air Supervisory Control Panel.

C. Manufacturer:

1. Rosemount, 2088.
2. Or approved equal.

D. Pressure range (gage):

1. 0 – 150 PSIG.

E. Pressure transmitter shall include:

1. Pipe mounting bracket.
2. LCD display configured for engineering units.
3. Integral manifold, block and bleed 2 valve configuration.
    a. Rosemount, 306 Manifold or similar.

2.12 ACCESSORIES

A. Automatic pneumatic no-loss drain valves:

1. Provide automatic drain valve for condensate.
2. Provide No Loss Drains on compressors, package filters, oil / particulate filter, and wet air receivers.

2.13 FABRICATION

A. Complete all brackets or connections and openings for air receiver and vessels prior to testing in manufacturer's plant.

1. No field welding or drilling permitted.

2.14 SOURCE QUALITY CONTROL

A. Dryers:

1. Performance test in accordance with ISO Guidelines CAGI ADF-100.

2.15 MAINTENANCE MATERIALS

A. Filter Element:

1. Provide a minimum of three (3) filter replacement elements for each filter.

B. Coolant: Provide 1 GAL container.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Air receivers shall be painted in accordance with Section 09 90 00.

3.02 FIELD QUALITY CONTROL

A. Employ and pay for services of compressor, dryer, and control system manufacturer's representatives to:

1. Supervise shop installation and shop startup.
2. Inspect final installation.
3. Supervise field startup and perform final adjustments.
4. Provide final programming and adjustments for control system.
5. Coordinate controls system tie-in with UP Controls Contractor (Hump Air Supervisory Control Panel).
6. Initial testing to verify equipment and controls (as a whole) operate as specified prior to railroad operations. Correct / adjust system as necessary to meet operational requirements.
7. Operational testing shall be conducted during actual hump operations. System shall be monitored during actual hump operations for a minimum of 16 HRS and as necessary for a fully functioning system as specified.

a. Include follow-up operational monitoring/testing for six (6) months and twelve (12) months after initial operational testing for a minimum of 8 HRS on-site each visit. Follow-up operational monitoring/testing to verify operational performance, compliance with this specification, instrumentation calibration, equipment condition/servicing & maintenance recommendations, and overall condition and operation of the system.

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8. Provide training for a minimum of 12 HRS on operation and maintenance procedures.
9. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

END OF SECTION

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SECTION 22 20 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Plumbing fixtures and trim.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 01 61 02 - Basic Mechanical Requirements.
4. Section 01 61 03 - Equipment: Basic Requirements.
5. Section 22 10 00 - Plumbing.
6. Section 40 05 07 - Hangers and Support.
7. Section 40 50 02 - Basic Mechanical Material and Methods.

1.02 REFERENCED STANDARDS

A. Americans with Disabilities Act (ADA):

1. Accessibility Guidelines for Buildings and Facilities (ADAAG).

B. American National Standards Institute (ANSI):

1. Z358.1, Emergency Eyewash and Shower Equipment.

C. American Society of Mechanical Engineers (ASME):

1. A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).

D. American Society of Sanitation Engineers (ASSE):

1. 1011, Performance Requirements for Hose Connection Vacuum Breaker.

E. Canadian Standards Association (CSA).

F. NSF International (NSF).

G. Underwriters Laboratories, Inc. (UL).

H. Building Code:

1. International Code Council (ICC):

a. International Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.03 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. See Specification Section 01 61 03
3. Color selection charts for Owner color selection.
4. Fabrication and/or layout Drawings:
    a. Layout plan(s) showing dimensions, elevations, etc.
    b. Details showing connections, installation, rough-in locations, etc.
5. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Chemical-resistance data.

B. Operation and Maintenance Manuals:
1. See Division 1 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

B. Catalog numbers shall not be considered complete. These are given as an aid to the contractor and to indicate the quality required. The contractor is responsible for the complete description of material before ordering. The material description takes precedence over the catalog number.
1. Plumbing Fixtures (Vitreous China):
    a. American Standard.
    b. Crane.
    c. Kohler.
    d. Eljer.
2. Water Closet and Urinal Trim:
    a. Zurn.
    b. Sloan.
    c. American Standard.
    d. Kohler.
3. Water Closet Seats:
    a. Same as water closet manufacturer.
    b. Church.

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c. Beneke

4. Lavatory Trim:
   a. American Standard.
   b. Chicago Faucets.
   c. Kohler.
   d. Sloan.
5. Stainless Steel Sinks:
   a. Just Manufacturing.
   b. Elkay.
6. Sink Trim:
   a. American Standard.
   b. Chicago Faucets.
   c. Kohler.
   d. Just.
   e. Zurn.
7. Wash Fountains:
   a. Best Sheet Metal, Inc.
   b. Engineer/Owner approved equal.
8. Mop Sinks:
   a. Fiat.
   b. Standard - Elsmer Granite Co.
   c. Williams.
   d. Florestone.
9. Mop Sink Trim:
   a. American Standard.
   b. Chicago Faucets.
   c. Kohler.
10. Shower Trim:
    a. Symmons.
    b. Leonard.
    c. American Standard.
11. Electric Water Coolers:
    a. Halsey-Taylor.
    b. Elkay.

c. Haws.

d. Oasis.

e. Sunroc.

12. Floor Drains and Floor Sinks:

a. Wade.

b. Josam.

c. Zurn.

d. Smith.

13. Trap Primers:

a. Mifab.

b. PPP.

14. Cleanouts:

a. Wade.

b. Josam.

c. Zurn.

d. Smith.

15. Wall Hydrants and Hose Bibbs:

a. Nibco.

b. Wade.

c. Woodford.

d. Smith.

16. Domestic Electric/Gas Water Heaters:

a. A.O. Smith.

b. Rudd.

c. Rheem.

d. State.

17. Electric Instantaneous Water Heaters:

a. Eemax.

b. Engineer/Owner approved equal.

18. Reduced Pressure Backflow Preventers:

a. Watts.

b. Febco.

c. Clayton.

19. Double Check Backflow Preventers:
    a. Watts.
    b. Febco.
    c. Clayton.
20. Expansion Tanks:
    a. Amtrol.
    b. Taco.
    c. Wessels.
    d. Elbi.
21. Remote Mixing Valves:
    a. Watts.
    b. Apollo.
    c. Powers.
    d. Leonard.
22. Emergency Mixing Valves:
    a. Leonard.
    b. Bradley.
    c. Lawler.
    d. Powers.
23. Emergency Eye/Face Washes:
    a. Bradley.
    b. Acorn Safety.
    c. Encon.
    d. Guardian.
    e. Haws.
24. Ice Machine Valve Boxes:
    a. Guy Gray.
    b. Water-Tite.
    c. Oatey.
25. Yard Office Drug Testing Valve Cabinet:
    a. Acorn.
    b. Engineer/Owner approved equal.
26. Water Hammer Arrestors:
    a. Zurn.

b. Smith.

c. Wade.

d. Josam.

e. Watts.

f. Mifab.

27. Water Pressure Reducing Valves:

a. Fisher.

b. Masoneilan.

c. Trerice.

d. Watts.

28. Water Filters:

a. Aqua-Pure.

b. Campbell.

C. Submit request for substitution in accordance with Division 1.

2.02 MANUFACTURED UNITS

A. Plumbing Fixtures (Vitreous China):

1. Water closet (WC-1, WC-2, and WC-3):

a. White.

b. 1.28 gallons per flush

c. Siphon jet.

d. Elongated bowl.

e. 1-1/2 IN top spud.

f. Bolt caps.

g. Mount water clo

h. Type:

1) WC-1 (wall hung) American Standard Model 3351.101.

2) WC-2 and WC-3 (handicapped wall hung) American Standard Model 3351.101.

2. Sensor Operated Flushometer Type (For WC-1 and WC-2):

a. Diaphragm type.

b. Plug-in AC powered with universal input voltage of 100-240 Vac, 60Hz. Provide with transformer.

c. Chrome plated.

d. Permex synthetic rubber diaphragm.

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e. Self-adaptive infrared sensor with indicator light.

f. Courtesy flush override button.

g. Non-hold open integral solenoid operator.

h. Two (2) chrome plated wall covers.

i. Screw driver Bak-Chek angle stop.

j. Wall and spud flanges.

k. Spud size as required.

l. Type:

1) American Standard Selectronic, Model 6067.121.002 (top spud).

3. Sensor Operated Flushometer Type (For WC-3):

a. Diaphragm type.

b. Plug-in AC powered with universal input voltage of 100-240 Vac, 60Hz. Provide with transformer.

c. Chrome plated.

d. Permex synthetic rubber diaphragm.

e. Screw driver Bak-Chek angle stop.

f. Wall and spud flanges.

g. Spud size as required.

h. Remote electric push button.

1) ADA compliant non-hold-open feature type actuator, large diameter, spring loaded, operates on 120 VAC or 24 VAC, mounted on a standard 4"x4" 2-ganag electrical box, includes wall plate with four vandal resistant screws. Provide with transformer.

i. Type:

1) Sloan, Model 111-ES-S (top spud) with remote electric push button Sloan Model EL-172-A.

4. Water closet seat:

1) Molded plastic, anti-microbial, open front, no cover, self-sustaining, stainless steel hinge with check, and designed for an elongated bowl.

5. Urinal (UR-1 and UR-2):

a. White.

b. Top spud.

c. 0.125 gallons per flush.

d. Type:

1) UR-1 (wall hung) American Standard "Washbrook FlowWise", Model 6590.530.

2) UR-2 (handicapped wall hung) American Standard "Washbrook FlowWise", Model 65590.530.

6. Sensor Operated Flushometer Type (For UR-1 and UR-2):
   a. Diaphragm type.
   b. Plug-in AC powered with universal input voltage of 100-240 Vac, 60Hz. Provide with transformer.
   c. Chrome plated.
   d. Permex synthetic rubber diaphragm.
   e. Self-adaptive infrared sensor with indicator light.
   f. Courtesy flush override button.
   g. Non-hold open integral solenoid operator.
   h. Two (2) chrome plated wall covers.
   i. Screw driver Bak-Chek angle stop.
   j. Wall and spud flanges.
   k. Spud size as required.
   l. 0.125 gallons per flush.
   m. Type:
      1) American Standard Selectronic, Model 6062.301.007 (back spud).
7. Lavatory (LAV-1 and LAV-2):
   a. White.
   b. Front overflow.
   c. Wall mounted with single center faucet hole.
   d. Drilled for concealed arm carriers.
   e. Provide quarter turn 3/8" chrome plated heavy brass angle supply loose key stops, chrome plated soft copper supply lines, offset drain and tailpiece, 1-1/4" 20 gauge cast brass p-trap, and support carrier.
   f. LAV-1: Overall size: 20 IN x 18 IN
   g. LAV-2: Overall size: 27 IN x 20 IN
   h. Type:
      1) LAV-1 American Standard "Lucerne" Model 0356.421.
      2) LAV-2 American Standard Model 9140.047
8. Lavatory Electronic Hand Washing Faucet (For LAV-1 and LAV-2):
   a. ADA compliant.
   b. 0.5 gpm.
   c. Sensor range adjustment screw.

d. LED indicator lights.

e. Filtered solenoid valve with serviceable "Y" strainer filter.

f. Bak-chek tee.

g. Trim plate (4 IN center) with anti-rotation pin.

h. Plug-in AC powered with universal input voltage of 100-240 Vac, 60Hz. Provide with transformer.

i. Vandal resistant spray head.

j. Below deck mixing valve.

k. Type:

1) Sloan Optima Model ETF-80.

9. Sink (S-1):

a. White.

b. Front overflow.

c. Overall size: Oval 20 IN x17 IN.

d. Countertop mounted with holes on 8 IN centers.

e. Self-rimming.

f. Provide quarter turn 3/8" chrome plated heavy brass angle supply loose key stops, chrome plated soft copper supply lines, offset drain and tailpiece, and 1-1/4" 20 gauge cast brass p-trap.

g. Type:

1) American Standard Model 0475.020.

10. Sink Faucet (For S-1):

a. Polished chrome-plated 11" tall rigid gooseneck faucet with 2.5 IN lever handles.

b. 8 IN centers.

c. Quarter turn ceramic disc cartridges.

d. Vandal resistant 1.5 GPM aerator.

e. Install MV-1 in accessible location below S-1.

f. Type:

1) Zurn, Model Z831B1-XL

B. Wash Fountain (WF-1 and WF-2):

1. Wall mounted, type 304, 14 gage stainless steel.

2. WF-1 Overall size: 72IN side to side and 20 IN front to back with 10 IN high backsplash.

3. WF-1Bowl Size: 69 IN side to side, 16 IN front to back, and 16 IN deep.

4. WF-2 Overall size: 72IN side to side and 20 IN front to back with 6 IN high backsplash.
5. WF-2 Bowl Size: 69 IN side to side, 16 IN front to back, and 6 IN deep.
6. Three separate faucets. Each faucet provided with a thermostatic mixing valve
7. Two liquid soap dispensers located on either side of center faucet.
8. Single drain centered in bowl with strainer.
9. Stainless steel 14 gauge brackets for wall hanging.
10. Hard-wired 115V electronic infrared sensor, single hole faucets, gooseneck, backsplash-mounted, aerator with maximum of 2.2 gpm @ 60 psi, and integral thermostat mixing valve. Provide with transformer.
11. Provide quarter turn 3/8" chrome plated heavy brass angle supply loose key stops, chrome plated soft copper supply lines, offset drain and tailpiece, 1-1/4" 20 gauge cast brass p-trap, and support carrier.
12. Mixing valve shall be accessible from faucet.
13. Type:
    a. WF-1 (Non-ADA): Best Sheet Metal Model 084WS72208BS.
    b. WF-2 (ADA): Best Sheet Metal Model ADA-032E722066B
    c. WF-1 and WF-2 Trim: Best Sheet Metal Model BSM045.

C. Sink (S-2):
1. Self-rimming, double compartment with faucet deck, type 304, 18 gauge stainless steel, completely undercoated.
2. Overall size: 33IN side to side and 21 IN front to back.
3. Each bowl: 13 IN side to side, 16 IN front to back, and 6.5 IN deep.
4. Removable stainless steel basket strainer with neoprene stoppers.
5. Provide quarter turn 3/8" chrome plated heavy brass angle supply loose key stops, chrome plated soft copper supply lines, offset drain and tailpiece, and 1-1/4" 20 gauge cast brass p-trap.
    a. Type:
        1) Just Model DL.

D. Sink Faucet (For S-2):
1. Polished chrome-plated 9" tall swing gooseneck faucet with 4 IN wrist blade handles.
2. Quarter turn ceramic disc cartridges.
3. Vandal resistant 1.5 GPM aerator.
4. 8 IN centers.
5. Spray hose with lever control.
6. Install MV-1 in accessible location below S-2.

7. Type:
    a. Zurn, Model Z871J4-XL

E. Insulation kit for all lavatories, sinks, and wash fountains:
    1. Provide for all lavatory, sink, or wash fountain ADA applications where the p-trap, stop valves, and supply lines are visible without opening up a cabinet to the rest of the room.
    2. Pre-manufactured insulation kit for p-trap, stop valves, and supply lines.
    3. Provide an insulation kits for each p-trap, stop valve, and supply line per lavatory, sink, and wash fountain. Contractor shall determine the exact quantity required.
    4. Type:
        a. Truebro Model Lav-Guard

F. Mop Sink (MS-1):
    a. Precast terrazzo, one piece.
    b. Overall size: 24 IN x 24 IN x 12 IN
    c. Stainless steel integral drain with removable strainer.
    d. 3" outlet.
    e. Continuous stainless steel cap on all edges.
    f. Lowered front wall for access.
    g. Type:
        1) Fiat Model SB-2424.

G. Mop Sink Fittings (For MS-1):
    1. Exposed, two handle mixing faucet, brass construction, chrome plated finish, single wing handles, wall mounted, 3/4 IN hose thread spout with integral vacuum breaker, wall brace, pail hook, and check stops.
    2. Mop hanger, hose, and hose bracket.
    3. Caulk between mop sink and wall with silicone based caulk.
    4. Type:
        a. Chicago Model 897-CP.

H. Showers (SH-1):
    1. SH-1 enclosure by others. Refer to Architectural plans for shower enclosure requirements.
    2. Shower Fittings (For SH-1):
        a. Single handle pressure balanced mixing faucet, brass or bronze construction, washerless design, off-cold-hot temperature range indicator dial, polished chrome cast metal lever handle, integral check stops, adjustable temperature limit stop.

b. Adjustable spray hand held shower, chrome plated 24" mounting rail, chrome plated brass swivel connector, 60" chrome plated metal hose and quick disconnect.

c. Chrome plated brass supply elbow with flange, chrome plated elevated vacuum breaker with chrome plated piping and flanges.

d. ADA compliant.

e. 2.5 gpm.

f. ASSE 1016 listed.

g. Type:

1) Symmons 1-117-FS

I. Electric Water Cooler (EWC-1):

1. Wall hung, bi-level, high-efficiency electric refrigerated water cooler and bottle filling station.
2. ADA compliant.
3. Exact finish to be determined by Architect/Owner.
4. Shall deliver a minimum 8 gph of 50°F drinking water at 90°F ambient and 80°F inlet water temperature.
5. Front and side electronic pushbars for activation for the bubbler.
6. Electronic sensor for touchless activation with auto 20 second shutoff timer for the bottle filling unit.
7. Bottle filler shall provide 1.1 gpm flow rate with laminar flow to minimize splashing.
8. Provide 3,000 gallon capacity filter, certified to NSF/ANSI 42 and 53 with visual monitor to indicate replacement is necessary.
9. Stainless steel fountain top.
10. Hermetically sealed, air-cooled condensing unit.
11. Bubbler to be shielded for protection with an anti-squirt, anti-sweat and abrasion resistant design.
12. 115V-1P
13. Type:

a. Elkay Model LZSTLG8WS

J. Carriers:

1. All carriers shall be compatible with the specified fixtures.
2. Closets (wall hung):

a. Wade W-330 or 340 for vertical stacks.

b. Wade W-310, 4 IN for horizontal lines.

3. Urinals: Wade W-400 series.

4. Lavatories: Wade W-520 series.
5. Drinking fountains (electric water coolers): Wade W-400 series.

K. Drains:
1. Floor drain (FD-1):
   a. Cast iron body, nickel bronze adjustable top.
   b. 6" round with bottom outlet. Refer to plans for exact outlet size.
   c. Flashing collar, deep seal trap.
   d. Provide trap primer connection for all floor drains not serving ice machines.
   e. Type:
      1) Wade 1100
2. Floor Sink (FS-1):
   a. Bottom outlet.
   b. Clamping seepage flange.
   c. Seepage openings.
   d. 8 IN x 8 IN with 6 IN sump.
   e. Refer to plans for outlet size.
   f. Cast iron body.
   g. White porcelain coated interior.
   h. 1/2 IN nickel bronze top.
   i. Plastic dome bottom strainer.
   j. Provide trap primer connection for all floor sinks not serving ice machines.
   k. Type:
      1) Wade Model 9110.

L. Traps:
1. Floor and equipment drains:
   a. Same material and coating as the piping system.
   b. 3 IN minimum seal.
2. Fixture drains:
   a. 2 IN minimum seal.
   b. Cast brass.
   c. Chrome plated.
   d. Size as required.

M. Trap Primers (TP-1):
1. Pressure drop activated, 1/2" male NPT inlet and 1/2" female NPT outlet, built-in air gap, and removable filter screen.
2. No adjustments or pre-charge requirements.
3. ASSE 1018 listed.

4. Distribution system
    a. Provide trap primer distribution unit when two or more traps are served by a single trap primer. Refer to plans for locations.
5. Provide for all floor drains/sinks not serving ice machines.

N. Cleanouts:
1. Floor Cleanouts (FCO)
    a. Adjustable, cast iron housing, anchor flange, tapered thread plug, round secured stainless steel top.
    b. Top style shall match floor finish as follows:
        1) Unfinished floor – Round solid scoriated top.
        2) Tile or terrazzo – Round recessed top.
        3) Carpet – Round top with carpet flange.
    c. Type:
        1) Zurn Model Z1400
2. Yard Cleanout (YCO)
    a. 2-way round, dura-coated cast iron, size as listed on plans.
    b. Double flanged heavy duty secured scoriated dura-coated cast iron cover.
    c. Lifting device.
    d. Bronze cleanout plug with gas/water tight seal.
    e. Type:
        1) Zurn
3. Wall Cleanout (WCO)
    a. End cap, cast iron access body, gas and water tight bronze or brass threaded plug, round stainless steel access cover, extended machine screw.
    b. Type
        1) Zurn Model Z-1441
4. Additional cleanout requirements:
    a. Provide cleanouts of same size as pipe up to 4 IN and not less than 4 IN for larger pipes.
    b. Close access openings for concealed cleanouts with flush floor plates.
    c. Provide screws which match cover plate material.
    d. Cleanouts turning out through walls and up through floor shall be made by long sweep ells or "y" and 1/8 bends with plugs and face or deck plates to conform to architectural finish in room.
    e. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast-brass or bronze cleanout plug installed in a T-pattern, 90 degree drainage fitting.

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f. Close access openings for concealed cleanouts with flush floor or flush wall cover plates or flush ceiling access panels.

g. Provide screws which match cover plate material.

h. Cleanouts installed in completely accessible pipe chases or where piping is exposed do not require special covers.

O. Wall Hydrant (WH-1):

1. Freezeless, brass valve body and seat, standard finish.
2. Non-ferrous metal stem, automatic draining, vacuum breaker, ¾"male hose thread.
3. Wall clamp, concealed in flush wall mounted lockable wall box, key operated.
4. ASSE 1019 approved and listed.
5. Verify number of key operators to be provided with Owner. Box cover and hydrant shall use a common key.
6. Length as recommended by manufacturer for wall thickness.
7. Type:
   a. Woodford Model B67.

P. Hose Bibb (HB-1):

1. Brass construction, standard finish, vacuum breaker, 3/4 IN hose thread, metal wheel handle, loose tee key.
2. Type:
   a. Woodford Model 24.

Q. Domestic Water Heater (EWH):

1. Electric tank type:
   a. Size and capacity as scheduled.
   b. UL listed and compliant to NAECA, ASHRAE 90.1 and ASHRAE 90A.
   c. Vertical, metal cabinet, baked enamel finish, glass-lined welded steel tank, 150 PSI working pressure, fiberglass or foam insulation.
   d. Brass water connections and drain valve.
   e. ASME approved T&P relief valve, anode rod.

R. Instantaneous Water heater (IWH)

1. Size and capacity as scheduled.
2. High strength reinforced plastic body, thermostatically controlled, enclosed controls, fully adjustable thermostat (100-140°F), high temperature limit swtich, 150 psi working pressure, replaceable element, and capable of operating down to 0.3 gpm.

S. Domestic Water Heater (GWH):

1. Gas-fired tank type:

a. Size and capacity as scheduled.

b. Certified by CSA and bear NSF approval.

c. Internal surfaces:

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

2) Provide magnesium rods rigidly supported for cathodic protection.

d. Equip heaters with safety shutoff in case of pilot failure, gas pressure regulator, certified draft diverter and pressure and temperature relief valve.

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

f. Heavy gage steel jacket with baked enamel finish over bonderized undercoating.

g. Warranty against corrosion for three (3) year period.

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

i. Sealed combustion. Exact size, termination, and routing of flue/combustion air shall be per manufacturer requirements.

T. Reduced Pressure Backflow Preventer (BFP-1):

1. Bronze or FDA approved epoxy coated cast iron construction, size shall be same as pipe, non-corrosive internal parts, stainless steel springs, differential pressure relief valve between spring-loaded check valves, shutoff valves on inlet and outlet of unit, and air gap drain fitting.

2. Test ports with shutoff valves, factory tested.

3. Rated for 175 PSI at 33°F to 140°F, 13 PSI maximum pressure drop at 10 FPS.

4. All parts to be serviceable without removing unit from line.

5. Approved by USC FCCC and HR, AWWA C511-92, ASSE 1013, and IAPMO listed.

6. Mount a maximum of 60" above finished floor.

7. Provide and install bronze or epoxy coated strainer upstream of each unit. Install additional valve upstream from each strainer for servicing strainer.

8. Flow pressure drop curves shall be submitted.

9. Type:

a. Watts Series 909

U. Double Check Backflow Preventer (BFP-2):

1. Bronze or FDA approved epoxy coated cast iron construction, size shall be same as pipe, non-corrosive internal parts, stainless steel springs, spring-loaded check valves, shutoff valves on inlet and outlet of unit, and air gap drain fitting.

2. Test ports with shutoff valves, factory tested.

3. Rated for 175 PSI at 33°F to 140°F, 13 PSI maximum pressure drop at 10 FPS.

4. All parts to be serviceable without removing unit from line.

5. Approved by USC FCCC and HR, AWWA C511-92, ASSE 1013, and IAPMO listed.
6. Mount a maximum of 60" above finished floor.
7. Provide and install bronze or epoxy coated strainer upstream of each unit. Install additional valve upstream from each strainer for servicing strainer.
8. Flow pressure drop curves shall be submitted.
9. Type:
    a. Watts Series 007/709

V. Water Meter:

1. As indicated of a type approved by Water Department.
    a. Coordinate meters furnished by Water Department as to type and size.
    b. Obtain and pay necessary permits and approvals required to complete installation of water service.
    c. Provide valve on each side of meter and 3/4 IN drain valve spilling over floor drain.
2. Install full sized bypass line around meter with a sealed valve approved by Water Department.
    a. Meters 2 IN and less: Threaded fittings.
    b. Meters 2-1/2 IN and larger: Flanged connections.

W. Expansion Tank (ET)

1. Size and capacity as scheduled on plans.
2. Welded black steel construction.
3. ASME stamped.
4. Guaranteed airtight and leakproof.
5. Stainless steel system connection.
6. Heavy butyl diaphragm and rigid polypropylene liner mechanically bonded to tank to provide a 100% non-corrosive water reservoir.
7. Diaphragm and liner shall be spproved for use in potable water systems.
8. All wetted components shall be made of FDA approved materials.
9. Provide standard Schrader air valve for field charging.

X. Remote Mixing Valve (MV-1)

1. Remote anti Remote anti-scald thermostatic mixing valve for tempered water control.
2. All bronze/brass construction with rough finish, threaded inlets and tamper resistant setpoint.
3. ASSE 1070 approved.
4. Install below SK-1 and SK-2 in accessible location.

5. Type:
    a. Watts USG-B

Y. Emergency Mixing Valve (MV-2)

1. Thermostatic mixing valve for emergency eyewash or combination eyewash/facewash fixture, bronze body construction, cold water bypass, inlet and outlet thermometers, integral checkstops, outlet and inlet isolation valves, and mounting bracket.
2. Provide with recessed mounted cabinet 18 gauge stainless steel with 16 gauge locking door to enclose mixing valve, inlet stops, outlet thermometer, and inlet/outlet isolation valves.
3. Thermostatic mixing and pressure regulating valves to deliver 3 gpm of tempered water (65-90°F0 with 10 psi pressure differential.
4. Shall meet ANSI Standard Z358.1.
5. Type:
    a. Bradley Model S19.

Z. Emergency Eye/Face Wash (EEW-1)

1. Accessible, wall mounted, stainless steel bowl, twin chrome plated spray heads with caps and retaining chains/straps, brass supply arms, integral flow control fitting, brass piping and fittings with brass/bronze stay open ball valve, and 1-1/4 IN drain outlet with chrome plated brass tailpiece and trap.
2. Universal identification sign, ANSI Z358.1 compliant.
3. Minimum flow rate of 3.0 gpm at 30 psi. Activation time shall be 1 second or less. Brass/bronze piping, fittings, and valves shall be chrome plated or chemical resistant powder coated.
4. Install MV-2 in recessed cabinet beside EEW. Coordinate exact location of cabinet with Architect/Owner.
5. ADA Compliant.
6. Install flow switch on cold water branch line serving EEW. Flow switch shall send an alarm to the DDC system when flow is detected. The exact location of the EEW where flow is detected shall be shown on the DDC system.
    a. Flow Switch shall be rated for 125/250 V, 5 A.
    b. Single pole, double throw.
    c. UL listed.
7. Type:
    a. Bradley Model S19-220.

AA. Emergency Eye/Face Wash (EEW-2)

1. Accessible, wall mounted, stainless steel bowl, twin chrome plated spray heads with caps and retaining chains/straps, brass supply arms, integral flow control fitting, brass piping and fittings with brass/bronze stay open ball valve, and 1-1/4 IN drain outlet with chrome plated brass tailpiece and trap.

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2. Universal identification sign, ANSI Z358.1 compliant.
3. Minimum flow rate of 3.0 gpm at 30 psi. Activation time shall be 1 second or less. Brass/bronze piping, fittings, and valves shall be chrome plated or chemical resistant powder coated.
4. Install MV-2 in surface mounted cabinet beside EEW. Coordinate exact location of cabinet with Architect/Owner.
5. ADA Compliant.
6. Provide heat trace for all piping located outside.
7. Hinged stainless steel dust cover.
8. Anti-freeze valve.
9. Install flow switch on cold water branch line serving EEW. Flow switch shall send an alarm to the DDC system when flow is detected. The exact location of the EEW where flow is detected shall be shown on the DDC system.
    a. Flow Switch shall be rated for 125/250 V, 5 A.
    b. Single pole, double throw.
    c. UL listed.
10. Type:
    a. Bradley Model S19224.

BB. Ice Machine Valve Box (VB-1)

1. Galvanized steel enclosure, angle valve with 1/4 IN compression outlet.
2. Type:
    a. Guy Gray Model BIM675.

CC. Yard Office Drug Testing Valve Cabinet (VC-1)

1. One piece, 18 gauge, stainless steel recessed box with all seams continuously welded with door and wall flange. Contractor shall ensure valve cabinet is large enough to enclose 1" pipe and associated shutoff valve serving the Yard Office Drug Testing Restroom water closet.
2. Door shall include cam and cylinder lock with two keys. Concealed hinges shall be mounted in heavy reinforcing channels and allow door to fully open 150 degrees. Door shall be easily removable if needed.
3. Provide with adjustable, wide beveled flange to cover irregularities in the wall opening.
4. Type:
    a. Acorn.

DD. Water Hammer Arrestor (WHA-1, WHA-2, and WHA-3)

1. Bellows type.
2. Pre-charged.
3. All stainless steel construction.

4. ASSE 1010 approved.
5. PDI Certified.
6. WHA-1: Rated for 1-11 fixture units.
7. WHA-2: Rated for 12-32 fixture units.
8. WHA-3: Rated for 33-60 fixture units.
9. Type:
    a. Zurn Model Z1700

EE. Water Pressure Reducing Valves:

1. Up to 2-1/2 IN line size.
    a. Self-contained type, diaphragm actuated, with cast iron body, stainless steel springs, diaphragm, trim and seats for maximum operating pressure of 150 psig gauge and maximum pressure drop of 100 psi.
2. 2-1/2 IN through 6 IN line size,
    a. Single seated plug valve, with cast iron body, stainless steel seat, maximum 125 psig gauge inlet, 20 - 100 psi differential.

FF. Water Filter (F-1)

1. Cast brass or stainless steel head, stainless steel sump, 5 micron filter cartridge, FDA approved.
2. Install in accessible location on cold water lines serving ice machines.

GG. Vent flashings: Plumbing vent flashings shall be furnished and installed as indicated on the plans.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Fixtures:

1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
2. Connect plumbing supply, drain and vent line sizes as shown on Drawings.
3. Set proper grounds to form secure base for each fixture and rigid setting.
4. Install fixtures except water closets with water supply above rim and with Code approved backflow preventers.
5. Seal fixture joints abutting walls and floors with silicone sealant.
6. Connect exposed traps and supply pipes for fixtures and equipment to rough piping systems at wall, unless otherwise specified.
7. Install emergency fixtures in accordance with ANSI Z358.1.

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C. Drains:

1. Install drains at locations indicated on Drawings and in compliance with local Codes.
2. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.
3. In uncovered concrete slabs:
    a. Install at the low points of surface areas to be drained or as indicated.
    b. Set tops of drains flush with the finished floor.
    c. Install drain flashing collar or a flange so that no leakage occurs between the drain and the adjoining surfaces.
    d. Maintain the integrity of waterproof membranes, where penetrated.

D. Wall Hydrants:

1. Refer to plans for mounting height requirements.
2. Support units from the structure and mount flush with structure face.
3. Prior to final setting, fill the back of the face with a non-hardening silicone calk and press firmly in place to stop infiltration and water leakage.
4. Install isolation valves in line to each wall hydrant.

E. Hose Bibbs:

1. Refer to plans for mounting height requirements.

F. Water Hammer Arrestors:

1. Install on hot and cold water lines adjacent to each battery of fixtures or other equipment where indicated on Drawings.

G. Cleanouts:

1. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.
2. Install cleanouts:
    a. Above floor in each vertical riser that connects to horizontal branch below floor.
    b. At test tee to receive proper test plugs in each vertical riser at least every other floor.
    c. As required by local Code.

H. Trap primers: Provide shutoff valve in cold water line to each trap primer. Install per manufacturer's requirements.

I. Wall Plates and Escutcheons: Install as specified in Specification Section 22 10 00 or this Specification Section.

J. Water Heater:

1. Install all water heaters in accordance with details, manufacturer's recommendations, and applicable Codes.

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2. For units located on concrete pads, plumb level and orient to allow access to the controls, elements and other items requiring service.
3. Connect hot and cold water piping to the unit with line-size, isolation valves and dielectric unions.
4. Connect recirculating hot water to cold inlet piping with unions and valves at check valves as detailed.
5. When required, connect gas piping as detailed in accordance with Specification Section 23 11 23 and located so as not to interfere with the unit service where applicable.
6. Start up the unit and adjust all controls for proper temperature control and maximum efficiency.

K. Reduce Pressure Backflow Preventer: Install on water lines as required by Code.

3.02 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 40 05 03.

END OF SECTION

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SECTION 22 42 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Showers.
6. Electric water coolers.
7. Wash fountains.
8. Mop sinks.

1.02 REFERENCED STANDARDS

A. ANSI/ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

B. ANSI/ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. IAPMO/ANSI Z124.1 - Plastic Bathtub Units.

G. IAPMO/ANSI Z124.2 - Plastic Shower Receptors and Shower Stalls.

H. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

I. ANSI/ARI 1010 - Drinking-Fountains and Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers.

1.03 SUBMITTALS

A. Submit under provisions of Division 01, for all Products specified in this Section.

B. Product Data: Provide catalog illustrations of fixtures and trim, indicating manufacturer, sizes, rough-in dimensions, utility sizes, and finishes.

C. Submit Manufacturer's installation instructions under provisions of Division 1.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01, for all Products specified in this Section.

B. Maintenance Data: Include fixture trim exploded view and replacement parts lists.

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1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.06 FIELD MEASUREMENTS

A. Verify that field installation measurements are as indicated on shop drawings.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.07 EXTRA MATERIALS

A. Furnish under provisions of Division 01.

B. Provide two sets of faucet, valve, and flush valve service kits.

PART 2 - PRODUCTS

2.01 WATER CLOSET

A. WC-1 (1.6 GAL Flush):

1. Bowl: ANSI/ASME A112.19.2; wall mounted, siphon jet, white vitreous china, elongated bowl, 1-1/2 IN (38 mm) top spud, bolt caps, designed to flush efficiently on 1.6 gallons of water. Model Kingston manufactured by Kohler, or approved equal.

2. Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type, escutcheon, integral screwdriver stop, vacuum breaker, electric solenoid operated actuated by infra-red sensor, chrome plated wall cover plate with tamper proof screws, control circuit transformer, maximum 1.5 GAL flush volume. Model Royal 111ES-S manufactured by Sloan, or approved equal.

3. Seat: Solid white plastic, open front, external check and self-sustaining hinge, stainless steel posts, brass bolts, without cover. Model 255 manufactured by Church, or approved equal.

B. HWC-1 (1.6 GAL Flush):

1. Bowl: ANSI/ASME A112.19.2; wall mounted, siphon jet, white vitreous china, elongated bowl, 1-1/2 IN (38 mm) top spud, bolt caps, designed to flush efficiently on 1.6 GAL of water, top of seat 18 IN (450 mm) above finish floor. Model Kingston manufactured by Kohler.

2. Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type, escutcheon, integral screwdriver stop, vacuum breaker, electric solenoid operated actuated by infra-red sensor, chrome plated wall cover plate with tamper proof screws, control circuit transformer, maximum 1.5 GAL flush volume. Model Royal 111ES-S manufactured by Sloan, or approved equal.

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3. Seat: Solid white plastic, open front, external check and self-sustaining hinge, stainless steel posts, brass bolts, without cover. Model 255 manufactured by Church, or approved equal.

C. HWC-2 (1.6 GAL Flush):

1. Bowl: ANSI/ASME A112.19.2; wall mounted, siphon jet, white vitreous china, elongated bowl, 1-1/2 IN (38 mm) top spud, bolt caps, designed to flush efficiently on 1.6 GAL of water, top of seat 18 IN (450 mm) above finish floor. Model Kingston manufactured by Kohler.

2. Flush Valve: ASME A112.18.1; exposed chrome plated, diaphragm type, escutcheon, integral screwdriver stop, vacuum breaker, electric solenoid operated actuated by infra-red sensor, chrome plated wall cover plate with tamper proof screws, control circuit transformer, maximum 1.5 GAL flush volume. Model Royal 111-1.6 manufactured by Sloan, or approved equal.

3. Seat: Solid white plastic, open front, external check and self-sustaining hinge, stainless steel posts, brass bolts, without cover. Model 255 manufactured by Church, or approved equal.

2.02 URINAL

A. UR-1/HUR-1:

1. ANSI/ASME A112.19.2; white vitreous china, no water wall hung urinal with integral housing and drain insert. For handicap installation, mount rim 17 IN (425 mm) above finished floor. Model FloWise Flush-Free Waterless Urinal model number 6150 or 6154 manufactured by American Standard, or approved equal.

2. Wall Mounted Carrier: ANSI/ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.03 LAVATORY

A. LAV-1 Basin: Integral in the countertop.

B. Trim: Sloan Optma ESP-20 infra-red sensor operated electrical solenoid, off-set drain, strainer/tailpiece, P-trap and waste to wall. Wheel handle supply pipes. All trim below the sink to be insulated.

2.04 SINK

A. SK-1:

1. Bowl: ANSI/ASME A112.19.3; Type 304 stainless steel, double compartment 33 x 22 x 7.5 IN (8.4 x 5.6 x 1.9 cm), 18 gauge (1.37 mm) thick, self-rimming with heavy duty undercoating, 3-1/2 IN (90mm) diameter stainless steel sink drain with crumb cup, ledge back drilled for trim, 4 hole. Model LRAD3319 manufactured by Elkay, or approved equal.

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2. Trim: ASME A112.18.1; chrome plated brass supply with gooseneck swing spout, water economy aerator, spray fitting, 2.2 GPM maximum flow, lever handles and retractable spray; chrome plated 17 gauge (1.3mm) brass P-trap with clean-out plug and arm with escutcheon. Supply pipes with wheel handles. Model LKD2443 faucet as manufactured by Elkay, or approved equal.

2.05 SHOWER

A. SH-1:

1. Shower: IAMPO/ANSI Z124.2: Heavy duty, reinforce glass fiber shower, gel-coated, 45-5/8 x 51-3/8 x 78-1/4 IN (11.6 x 13.1 x 20.0 cm) high one piece, soap dish, shower curtain, chrome plated brass drain with perforated strainer, fold-up seat, beige color. Model 1423-BFS, base unit, horizontal L-shape grab bar as manufactured by LASCO or approved equal.

2. Trim: ANSI/ASME A112.18.1: Concealed cast brass shower supply, non-scald, lever handle, wall-hand shower with 5 FT metal flexible hose, wall connection and flange, in-line vacuum breaker and 30 IN slide bar. Model S-96-300X-B30-6-V as manufactured by Simmons or approved equal.

2.06 ELECTRIC WATER COOLER

A. EWC-1 (Wall Mounted):

1. Fountain: ANSI/ARI 1010; wall mounted two level electric water cooler with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, mounting bracket, refrigerated with integral air cooled condenser, UL listed and labeled. Model EBFATL-8 manufactured by Elkay or approved equal.

2. Capacity: 8 GPH (30.3 L/h) of 50 DegF (10 DegC) water with inlet at 80 DegF (27 DegC) and room temperature of 90 DegF (32 DegC).

3. Electrical: Hardwired for connection to 120 volt 60 Hz electric wiring system including grounding connector.

2.07 WASH FOUNTAINS

A. WF-1:

1. Bowl: Semi-circular, 80 IN (203 cm) diameter, precast stone, 16 gauge stainless steel bowl and base, 3 stations, vandal resistant spray nozzles, 0.4 GPM flow restrictor, soap tray, cast brass P-trap. Model SS-3N manufactured by Bradley, or approved equal.

2. Accessories: Automatic solenoid valve operated by infra-red sensor, control transformer, automatic shut-off delay, thermostatic mixing valve, combination stop, strainer, and check valves, liquid soap dispenser.

2.08 MOP SINKS

A. MS-1 (Floor Mounted):

1. ASME A112.61M mopsink: Florestone MSR-2424, one piece molded mop receptor, integral drain, strainer, 2 IN IPS.

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2. Trim: MR-371 faucet, MR-370 hose, MR-372 mop hanger, MR-373 rim guards and two 24 IN x 24 IN stainless steel wall plates.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.02 PREPARATION

A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with trap, easily removable for servicing and cleaning.

C. Provide chrome plated supplies and [lock-shield, loose key] stops, reducers, and escutcheons for each fixture. Provide all necessary mounting hardware for complete installation.

D. Install components level and plumb.

E. Install and secure fixtures in place with [wall supports] [wall carriers] and bolts.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 92 00, color to match fixture.

G. Solidly attach water closet flanges to floor with lag screws.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

A. At completion, clean plumbing fixtures and equipment.

3.07 PROTECTION OF FINISHED WORK

A. Protect finished Work and fixtures with adequate covers.

B. Use of fixtures during construction is not permitted.

END OF SECTION

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SECTION 22 48 00 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Hose bibs.
3. Hydrants.
4. Back water valves.
5. Backflow preventers.
6. Water hammer arrestors.
7. Water Pressure Reducing Valves.
8. Relief Valves.
9. Trap seal primer valve.
10. Floor drains and Area Drains.
11. Floor sinks.
12. Trench Drains.
13. Garbage Disposal.

1.02 SUBMITTALS

A. Submit under provisions of Division 01.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

C. Product Data: Provide component sizes, rough-in requirements, service sizes, materials of construction, and finishes.

D. Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.03 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 01.

B. Record actual locations of equipment, cleanouts, backflow preventers

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Division 01.

B. Operation Data: Indicate frequency of treatment required for interceptors and testing procedures for backflow preventers.

C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

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1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products under provisions of Division 01.

B. Accept specialties on site in original factory packaging. Inspect for damage.

1.06 EXTRA MATERIALS

A. Furnish under provisions of Division 01.

B. Provide two loose keys, one hose end vacuum breaker, and service kits for hose bibs.

PART 2 - PRODUCTS

2.01 FLOOR DRAINS AND AREA DRAINS

A. FD-1: ANSI A112.21.1; painted cast iron two piece body with flange, weep holes, reversible clamping collar, and round vandal proof, adjustable nickel-bronze strainer. Provide 1/2 IN IPS trap primer.

1. Model: W-1100 series manufactured by Wade; Z-415 manufactured by Zurn; or approved equal.

a. FD-2: ANSI A112.21.1; painted cast iron two piece body with flange, weep holes, reversible clamping collar, and square vandal proof, adjustable bronze strainer. 1/2 IN IPS trap primer.

2. Model: W-1100 series manufactured by Wade; Z-415 manufactured by Zurn; or approved equal.

a. AD-1: ANSI a112.21.1; ANSI Load Class – Special Duty, Cast iron 16 IN square drain with sediment bucket and ductile iron tractor grate. Grate free area = 76.4 SQ IN Wade 2360 series.

2.02 FLOOR SINKS

A. FS-1, square: 8 IN deep acid resisting enameled cast iron body, aluminum dome strainer 8 x 8 IN top with cast iron 3/4 grate, 1/2 IN IPS trap primer.

1. Model: W-9100 series manufactured by Wade; Z-1900 Series manufactured by Zurn; or approved equal.

2.03 CLEANOUTS

A. Exterior Surfaced Areas (GCO): Round cast iron access frame and heavy duty non-skid cover, cast iron ferrule with brass plug.

1. Model: W-7000 Series manufactured by Wade; Z-1402 manufactured by Zurn; or approved equal.

B. Interior Finished Floor Areas (FCO): Painted cast iron, two piece adjustable body, PVC plug, round top with scoriated nickel-bronze cover in service areas and square with depressed cover to accept floor finish in finished floor areas.

1. Model: W-6000 Series manufactured by Wade; Z-1400 manufactured by Zurn; or approved equal.

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C. Interior Finished Wall Areas (WCO): Line type with cast iron body and PVC countersunk plug, and round stainless steel access cover secured with machine screw.

1. Model: W-8460 manufactured by Wade; Z-1446 manufactured by Zurn; or approved equal.

D. Interior Unfinished Accessible Areas (UCO): Line type with cast iron body and PVC raised head plug.

1. Model: Z-1445 manufactured by Zurn; W-8560 manufactured by Wade; or approved equal.

2.04 HOSE BIBBS

A. Interior: 125 psi WOG, bronze or brass with integral mounting flange, replaceable seal disc, 3/4 IN hose thread spout, with handwheel, vacuum breaker in conformance with ANSI/ASSE 1011.

1. Model: 102-304 VB manufactured by B & K Industries; or approved equal.

2.05 HYDRANTS

A. Wall Hydrant: ANSI/ASSE 1019; non-freeze, self-draining type with polished bronze wall plate, 3/4 IN hose thread spout, 3/4 IN inlet, handwheel, and vacuum breaker.

1. Model: W-8620 manufactured by Wade; Z-1310 manufactured by Zurn; or approved equal.

B. Post Hydrant: ANSI/ASSE 1019; Non-freeze, self-draining type, cast aluminum housing, bronze casing, 3/4 IN hose thread vacuum breaker outlet, 3/4 IN inlet, 4 FT minimum depth of bury, lever handle.

1. Model: W-8610 manufactured by Wade; Z-1385/Z-1390 manufactured by Zurn; or approved equal.

2.06 BACKFLOW PREVENTERS

A. Reduced Pressure Principle Backflow Preventers 2 IN and smaller: ANSI/ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; non-threaded vent outlet, air gap drain fitting; assembled with two ball valves, bronze strainer, and four test cocks; Suitable for water temperature range of 33 - 180 DegF (1 - 82 DegC) at a working pressure of 150 psi (1034 kPa).

1. Model: 990 or 909 manufactured by Watts Regulator; Model 825Y manufactured by Febco; Series 40-200 manufactured by Conbraco; or approved equal.

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B. Reduced Pressure Principle Backflow Preventers, Larger than 2 IN: ANSI/ASSE 1013; Epoxy coated ductile iron body; two independently operating check valves with replaceable bronze seats, elastomeric disks, and stainless steel springs; Removable bronze or epoxy coated cast iron body differential pressure relief valve; air gap drain fitting; assembled with two non-rising stem gate valves, epoxy coated cast iron strainer, and four test cocks; Suitable for water temperature range of 33 - 180 DegF (1 - 82 DegC) at a working pressure of 150 psi (1034 kPa).

1. Model: 990 or 909 manufactured by Watts Regulator; Model 825YD manufactured by Febco; Series 40-200 manufactured by Conbraco; or approved equal.

C. Backflow Preventer Test Kit: Provide complete test kit including pressure gauge, test valves, high pressure hoses, adaptor fittings, mounting strap, and instructions; All test equipment shall be contained in a corrosion resistant carrying case.

1. Provide one test kit for each type of backflow preventer specified.

2.07 WATER HAMMER ARRESTORS

A. ANSI A112.26.1M; stainless steel construction, sized in accordance with PDI WH-201, precharged suitable for operation in temperature range -100 to 300 DegF (-73 to 149 DegC) and maximum 125 psig (860 kPa) working pressure.

1. Model: Shokstop manufactured by Wade; Z-1700 manufactured by Zurn; or approved equal.

2.08 WATER PRESSURE REDUCING VALVES

A. Up to and including 3 IN: Bronze body, rated for maximum inlet pressure of 300 psig (2064 kPa), stainless steel seat, integral stainless steel strainer, sealed spring cage, outlet pressure adjustment, built-in thermal expansion by-pass, gage tapping.

1. Model: U5B manufactured by Watts Regulator; or approved equal.

2.09 RELIEF VALVES

A. Bronze body, Teflon seat, steel stem and springs, testing lever, automatic, direct pressure actuated, capacities ASME certified and labeled, rated for working pressure suitable for system installation.

2.10 TRAP SEAL PRIMER VALVES

A. Trap Seal Primer Valves: ASSE 1018. water-supply-fed type, with the following characteristics:

1. 125 psig (860 kPa) minimum working pressure.
2. Bronze body with atmospheric – vented drain chamber.
3. Inlet and Outlet connections: 1/2 IN NPS (DN15) threaded, union or solder joint.
4. Gravity Drain Outlet Connection: 1/2 IN NPS (DN15) threaded or solder joint.
5. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

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B. Trap Seal Primer System: Factory-fabricate, automatic-operation assembly for wall mounting with the following:

1. Piping: 1/2 IN NPS, ASTM B88, Type K; copper, water tubing inlet and manifold with number of 1/2 IN NPS (DN15) outlets as required.
2. Cabinet: Steel box and stainless-steel cover.
3. Electric Controls: 24 HR timer, solenoid valve and manual switch for 120 V ac power.
4. Vacuum Breaker: ASSE 1001.

2.11 TRENCH DRAINS

A. Polydrain trench drains, Type Series 021 through 191, as manufactured by ABT, Inc. Components:

1. Drain trench: Fabricated of polyester polymer concrete, 155 mm (6.1 IN) wide, 100 mm (4 IN) ID with radiused bottom, having following attributes:
   a. Lengths: Nominal 0.5 meter (19.6 IN) and 1.0 meter (39.19 IN).
   b. Bottoms: Sloped to provide 0.6 percent slope.
   c. Anchoring ribs: Full length.
   d. Grate locking slots: Blind, vibration damping, thermoplastic.
   e. Interlocking ends.
2. Grates:
   a. Slotted ductile iron.
   b. Ductile iron anchor frames.
   c. Modle 503, severe point loads.
3. Accessories:
   a. End plates.
   b. Outlet plates.
   c. Strainer.
   d. Locking devices.
   e. Sealant.
   f. Polywall sidewall extensions.
   g. Installation devices.
   h. Catch basins, 900 series.

2.12 GARBAGE DISPOSAL

A. Housing, cast metal, insininsinkeratorerator.

B. Motor overload with manual reset.

C. Feed – continuous.

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D. Positive seal stopper.

E. Sink flange – stainless steel.

F. Motor – permanent magnet.

G. Waste elbow – ABS.

H. Impellers – stainless steel.

I. Bearings – permanently lubricated, sleeve type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install plumbing specialties in accordance with manufacturer's instructions.

B. Extend cleanouts to finished floor or wall surface. Ensure clearance at cleanout for rodding of drainage system.

C. Encase exterior cleanouts in concrete flush with grade.

D. Pipe relief from backflow preventer to nearest drain.

E. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories, sinks, and wash fountains.

F. Extend the trap seal primer piping form the manifold to each floor drain.

3.02 INSTALLATION OF TRENCH DRAINS

A. In accord with manufacturer's instructions.

B. Utilize manufacturer's approved installation device to assure proper joints, drawn tightly together by device.

C. The trench drain and its encapsulating concrete should be isolated from the expansion and contraction stress of the adjacent slabs.

END OF SECTION

SECTION 23 05 48 - VIBRATION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vibration control.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product Data: Submit manufacturer's technical product data and installation instructions for each type of vibration control product. Submit schedule showing size, type, deflection, and location for each product furnished.

PART 2 - PRODUCTS

2.01 BASIC CONSTRUCTION AND REQUIREMENTS

A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.

B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50 percent beyond the calculated operating deflection (e.g., 3 IN for 2 IN calculated deflection). The point of 50 percent additional deflection shall not exceed the recommended load rating of the isolator.

C. The lateral to vertical stiffness ratio (Kx/Ky) of spring isolators shall be between 0.8 and 2.0.

D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.

E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8 IN diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.

F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2 IN to 2-1/2 IN above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.

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G. Provide motor slide rails for belt-driven equipment.

H. All isolators, except M1, shall have provision for leveling.

2.02 MOUNTINGS

A. Type M1:

1. 0.75 IN thick waffled neoprene pad with minimum static deflection of 0.07 IN at calculated load and 0.11 IN at maximum load.
2. Units need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators.
3. Acceptable Manufacturers: Mason "Super W", Kinetics Amber/Booth Vibration Eliminator Co.

2.03 HANGERS

A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15 IN at calculated load and 0.35 IN at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
4. Acceptable Manufacturers: Mason "HD" or "WHD", Kinetics, Aeroflex, Vibration Eliminator Co.

B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Acceptable Manufacturers: Mason "30" or "W30", Kinetics, Amber/Booth, Aeroflex, Vibration Eliminator Co.

C. Type H3:

1. Vibration hangers shall have a steel spring in a neoprene cup with a grommet to prevent short circuiting of the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.

3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Hangers shall be capable of holding the load at a fixed elevation during installation. They shall have a secondary adjustment to transfer the load to the spring and maintain the same position.
6. Deflection shall be indicated by a pointer and scale.
7. Acceptable Manufacturer: Mason "PC30", Kinetics, Amber/Booth , Vibration Eliminator Co.

PART 3 - EXECUTION

3.01 PERFORMANCE OF ISOLATORS

A. General: Comply with minimum static deflections recommended by ASHRAE, for selection and application of vibration isolation materials and units as indicated.

B. Manufacturer's Recommendations: Except as otherwise indicated, comply with manufacturer's recommendations for selection and application of vibration isolation materials and units.

3.02 GENERAL INSTALLATION

A. Comply with manufacturer's instructions for installation and load application to vibration control materials and units.

B. Provide vibration isolation as indicated on the drawings and as described herein.

C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.

D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.

E. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

3.03 PIPE ISOLATION

A. The first three hangers from vibration-isolated equipment shall be type H1.

B. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.

C. Provide sufficient piping flexibility for vibrating refrigerant equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.

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D. Vibration isolators shall not cause any change in position of piping that will result in stresses in connections or misalignment of shafts or bearings. Equipment and piping shall be maintained in a rigid position during installation. Do not transfer load to the isolators until the installation is complete and under full operational load. Hanger H3 and Mounting M4 may be used instead of other products for this purpose.

E. Support piping to prevent extension of flexible connectors.

3.04 DUCTWORK ISOLATION

A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.

B. Provide flexible duct connections at all fan inlets and outlets and on the mechanical room side of all locations where ducts penetrate mechanical room walls. Refer to Specification Section 23 33 00 for specific requirements.

3.05 ADJUSTING AND CLEANING

A. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.06 VIBRATION CONTROL PRODUCT SCHEDULE

TYPE OF EQUIPMENT	**ISOLATOR TYPE**	**STATIC DEFLECTION**	**FLEXIBLE CONNECTIONS**
In-Line Supply Fans/Exhaust Fans	H2 or H3	0.75"	Ductwork per Section 23 33 00.
Fan Coil Units	N/A	N/A	Piping per this section
Computer Room Units	H2 or H3	0.75"	Ductwork per Section 23 33 00 and piping per this section.
Unit Heaters	H2 or H3	0.75"	N/A
Energy Recovery Units/Air Handling Units (Note 1)	M1	N/A	Ductwork per Section 23 33 00 and piping per this section
Condensing Units	M1	N/A	Piping per this section.
In-line pumps	H2 or H3	0.75"	N/A

Note 1: Internal fan isolation shall be determined by the energy recovery unit/air handling unit manufacturer. Isolation selected shall be a minimum of 98% efficient at the scheduled CFM and static pressure.

END OF SECTION

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing, adjustment and balancing of HVAC systems.
2. Testing, adjustment and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Sound measurement of equipment operating conditions.
5. Vibration measurement of equipment operating conditions.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 45 00 - Quality Assurance and Control.

C. Section 23 05 48 - Vibration Control.

D. Section 22 11 23 - Domestic Water Circulating Pumps.

E. Section 22 14 29 - Sump Pumps.

F. Section 23 12 20 - Chemical and Petroleum Pumps.

G. Section 23 31 10 - Ductwork.

H. Section 23 33 00 - Ductwork Accessories.

I. Section 23 37 00 - Air Outlets and Inlets.

1.03 REFERENCED STANDARDS

A. ASHRAE Systems Handbook: Chapter 37, Testing, Adjusting and Balancing, latest edition

1.04 SUBMITTALS

A. Submit name of adjusting and balancing agency for approval within 30 days after award of contract.

B. Submit test reports as a submittal under provisions of Section 01 33 00.

C. Submit test reports under provisions of Section 01 45 00.

D. Prior to commencing work, submit draft reports indicating adjusting, balancing and equipment data required.

E. Submit draft copies of report for review prior to final acceptance of work. Provide final copies for Buyer and for inclusion in operating and maintenance manuals.

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F. Provide reports in electronic format, and indexed. Include electronic copies of drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

G. Include detailed procedures, agenda, sample report forms, prior to commencing system balance.

1.05 REPORT FORMS

A. Submit reports on forms.

B. Forms shall include the following information:

1. Title Page:
    a. Company name.
    b. Company address.
    c. Company telephone number.
    d. Project name.
    e. Project location.
    f. Project Engineer.
    g. Project Buyer.
    h. Project altitude.
2. Instrument List:
    a. Instrument.
    b. Supplier.
    c. Model.
    d. Serial number.
    e. Range.
    f. Calibration date.
3. Test conditions for fans and pump performance forms, including the following:
    a. Settings for outside, return, and exhaust dampers.
    b. Condition of filters.
    c. Cooling coil wet and dry bulb conditions.
    d. Fan drive settings including settings and percentage of maximum pitch diameter.
    e. Other system operating conditions that affect performance.
4. System Diagrams including schematic layouts of air distribution systems. Present with single line diagrams and include the following:
    a. Quantities of outside, supply, return, and exhaust airflows.
    b. Duct outlet and inlet sizes.

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c. Terminal units.

d. Locations of duct traverse of duct layout.

5. Air Moving Equipment:

a. Location.

b. Supplier.

c. Model.

d. Unit Identification.

e. Supply air flow, specified and actual.

f. Return air flow, specified and actual.

g. Outside air flow, specified and actual.

h. Total static pressure (total external), specified and actual.

i. Inlet pressure.

j. Discharge pressure.

k. Fan RPM.

6. Exhaust/Supply Fan Data:

a. Location.

b. Manufacturer.

c. Model.

d. Air flow, specified and actual.

e. Total static pressure (total external), specified and actual.

f. Inlet pressure.

g. Discharge pressure.

h. Fan RPM.

7. Return Air/Outside Air Data:

a. Identification/location.

b. Design air flow.

c. Actual air flow.

d. Design return air flow.

e. Actual return air flow.

f. Design outside air flow.

g. Actual outside air flow.

h. Return air temperature.

i. Outside air temperature.

j. Required mixed air temperature.

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k. Actual mixed air temperature.

l. Design outside/return air ratio.

m. Actual outside/return air ratio.

8. Electric Motors:

a. Manufacturer.

b. HP/BHP.

c. Phase, voltage, amperage; nameplate, actual, no load.

d. RPM.

e. Service factor.

f. Starter size, rating, heater elements.

9. V-Belt Drive:

a. Identification/location.

b. Required driven RPM.

c. Driven sheave, diameter and RPM.

d. Belt, size and quantity.

e. Motor sheave, diameter and RPM.

f. Center to center distance, maximum, minimum, and actual.

10. Duct Traverse: Provide directly at the relief air inlet, supply air outlet, outside air inlet, and relief air outlet for each energy recovery unit and air handling unit.

a. Associated Energy Recovery Unit or Air Handling Unit identification.

b. System zone/branch.

c. Duct size.

d. Area.

e. Design velocity.

f. Design air flow.

g. Test velocity.

h. Test air flow.

i. Duct static pressure.

j. Air temperature.

k. Air correction factor.

11. Air Distribution Test Sheet:

a. Air terminal number.

b. Room number/location.

c. Terminal type.

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d. Terminal size.
e. Area factor.
f. Design velocity.
g. Design air flow.
h. Test (final) velocity.
i. Test (final) air flow.
j. Percent of design air flow.

12. Heating/Cooling Coils:
    a. System Identification.
    b. Location.
    c. Coil type.
    d. Airflow rate.
    e. Average face velocity.
    f. Air pressure drop.
    g. Outside air, wet and dry bulb temperatures.
    h. Return air, wet and dry bulb temperatures.
    i. Entering air, wet and dry bulb temperatures.
    j. Leaving air, wet and dry bulb temperatures.
13. Terminal Heat Transfer Units (Unit Heaters):
    a. Drawing symbol.
    b. Location.
    c. Manufacturer and model.
    d. Flow rate (cfm): specified and actual.
    e. Entering air temperature: specified and actual.
    f. Leaving air temperature: specified and actual.
    g. Air Btuh (cfm) x temperature rise x 1.09.
14. Energy Recovery Wheel:
    a. Drawing Symbol.
    b. Location.
    c. Primary Entering Air Temperature.
    d. Primary Leaving Air Temperature.
    e. Primary Air Pressure Drop.
    f. Primary Air Flow Rate .
    g. Secondary Entering Air Temperature.

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h. Secondary Leaving Air Temperature.

i. Secondary Air Pressure Drop.

j. Secondary Air Flow Rate .

k. Wheel RPM.

15. Duct Leakage Test:

a. Air system and fan.

b. Leakage class.

c. Test pressure.

d. Construction pressure.

e. Flow rate: specified and actual.

f. Leakage: specified and actual.

g. Statement that fire dampers, reheat coils and other accessories were included in the test.

h. Pass or Fail.

i. Test performed by.

j. Test witnessed by.

16. Air Flow Measuring Station:

a. Drawing symbol.

b. Service.

c. Location.

d. Manufacturer and model.

e. Size.

f. Flow rate: specified and actual.

g. Pressure drop: specified and actual.

17. Fire Dampers:

a. Damper and access door location.

b. System identification.

c. Type.

d. Size.

e. UL assembly number.

f. Fusible link temperature rating.

g. Manufacturer and model.

h. Operation pass/fail/reset.

18. Balancing Valves:

a. Drawing symbol.
b. Service.
c. Location.
d. Size.
e. Manufacturer and model.
f. Flow rate: specified and actual.
g. Pressure drop: specified and actual.

19. Hot Water Recirculating Pump:
    a. Drawing symbol.
    b. Service.
    c. Manufacturer, size, and model.
    d. Impeller size: specified and actual.
    e. Flow Rate: specified and actual.
    f. Pump Head: specified, operating and shut-off.
    g. Suction Pressure: operating and shut-off.
    h. Discharge Pressure: operating and shut-off.
20. Water Heater:
    a. Drawing symbol.
    b. Service.
    c. Location.
    d. Manufacturer and model.
    e. Capacity: specified, nameplate, and actual.
    f. Control Setting: specified and actual.
    g. Pressure drop: specified and actual.
    h. Entering water temperature: specified and actual.
    i. Leaving water temperature: specified and actual.

1.06 RECORD DOCUMENTS

A. Submit record documents.

1.07 QUALITY ASSURANCE

A. Agency shall be company specializing in the adjusting and balancing of systems specified in this Section with minimum 3 years documented experience.

B. Total system balance shall be performed in accordance with ASHRAE Systems Handbook, latest edition.

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1.08 SEQUENCING AND SCHEDULING

A. Sequence work to commence after completion of systems and schedule completion of work before substantial completion of project.

PART 2 - PRODUCTS

2.01 TESTING AND BALANCING EQUIPMENT

A. Testing and balancing equipment will not be turned over to the owner.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Before commencing work, verify that systems are complete and operable. Ensure the following:
   1. Equipment is operable and in a safe and normal condition.
   2. Temperature control systems are installed complete and operable.
   3. Proper thermal overload protection is in place for electrical equipment.
   4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
   5. Duct systems are clean of debris.
   6. Correct fan rotation.
   7. Fire and volume dampers are in place and open.
   8. Coil fins have been cleaned and combed.
   9. Access doors are closed and duct end caps are in place.
   10. Air outlets are installed and connected.
   11. Duct system leakage has been eliminated.

B. Report to Buyer any defects or deficiencies noted during performance of services.

C. Promptly report abnormal conditions in mechanical systems or conditions which prevent system balance.

D. If, for design reasons, system cannot be properly balanced, report as soon as observed.

E. Beginning of work indicates acceptance of existing conditions.

3.02 PREPARATION

A. Provide instruments required for testing, adjusting and balancing operations. Make instruments available to Engineer to facilitate spot checks during testing.

B. Provide additional balancing devices as required.

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3.03 INSTALLATION TOLERANCES

A. Adjust air handling systems to plus or minus 5 percent for supply systems and plus or minus 10% for return and exhaust systems from figures indicated.

3.04 TEMPERATURE CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Verify sequence of operation of control devices. Note the speed of response to input changes.

G. Confirm interaction of electrically operated switch transducers.

H. Confirm interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.05 ADJUSTING

A. Recorded data shall represent actually measured or observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Engineer.

3.06 AIR SYSTEM PROCEDURE - GENERAL

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

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D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 IN positive static pressure near the building entrances.

3.07 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure at least 24 IN downstream from the fan and upstream from fittings in ducts such as elbows and transitions.

b. Measure inlet static pressure of single-inlet fans at least 18 IN upstream from flexible connection and downstream from duct fittings.

2. Adjust fan speed higher or lower than design to achieve scheduled air flow. Make required adjustments to pulley sizes, to accommodate fan- speed changes.

3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating and economizer modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

C. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

END OF SECTION

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SECTION 23 05 99 - INSPECTION AND TESTING OF AIR RECEIVERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Responsibilities and procedures for inspecting and testing of air receivers and unfired pressure vessels. These vessels include equipment with an operating pressure that exceeds 15 LBS/psig and have a capacity of 30 GAL or more. These may include but are not limited to:

   a. Fixed air receivers in shops and yards of 30 GAL (4 CU FT) or more.

   b. Portable air tanks of 30 GAL (4 CU FT) or more.

B. Tanks that ARE NOT covered include:

1. Air and Vacuum chambers that are part of motor vehicle controls or air brake systems.
2. Hydraulic pump systems on jacks or arms.
3. Cylinders on hydraulic systems
4. Air tanks for air brake systems
5. Bulk oxygen storage tanks. (These are to be inspected annually by the Company providing the bulk service).

1.02 REFERENCED STANDARDS

A. Applicable Codes and Regulations shall be as follows:

1. American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code.
2. National Board Inspection Code ANSI / NB-23.
3. The original UPRR Chief Engineering Bulletin 127.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals shall include the company who will be performing the inspection.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 CERTIFIED INSPECTOR

A. The Inspector must:

1. Hold a valid National Board Commission License.

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2. Be qualified by written examination or other requirement under the applicable State laws and regulations. This information may be found at the respective States Department of Boiler Inspections.

3.02 INSPECTING AND TESTING OF PRESSURE VESSELS

A. Unfired pressure vessels must be inspected both internally and externally and tested before being placed in service and after any alteration or major repair. Where State regulations differ, observe the more stringent Inspection Interval (Contact your State Board for Boiler Inspections to determine the State requirements for unfired pressure vessels).

3.03 THICKNESS TESTS

A. The inspector will perform an ultrasonic thickness test or other type of non-destructive thickness test that will be accurate within ±1 percent or .001 IN or better.

B. For horizontal tanks there must be two (2) tests at the bottom and two (2) tests at the top of the shell and (2) tests in each head. For vertical tanks, perform two (2) tests in each head and four (4) tests at random areas of the shell.

C. At the time of the first testing they will need to permanently mark the test zones. Future tests should be conducted in those areas. To mark the zones they will need to:

1. Paint a red circle 3 IN DIA around each of the eight (8) test zones.
2. Label each zone one (1) through (8) for future testing reference.
3. On future tests note any reduction in the wall thickness in the Remarks / Comments section.

3.04 TESTING OF SAFETY AND RELIEF VALVES

A. The tests should be bench tests with the following requirements:

1. Perform the tests at a pressure not exceeding 110 percent of the valve's normal operating pressure.
2. Conduct at least 3 tests and record the highest activating pressure.
3. Record the re-seating pressure.
4. When the tests are complete, securely attach to the valve a tag that will show:
   a. The date the tests were completed.
   b. The highest activating pressure result.
   c. The lowest re-seating pressure.
   d. The initials of the person doing the tests.

3.05 TESTING OF GAUGES

A. Pressure gauges should register pressure up to double the intended working pressure of the equipment. All gauges should be removed for testing and service. The tests should be a bench tests with the following requirements.

1. Check all gauges against a dead-weight tester or a calibrated master gauge.

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2. Test the gauge at three pressure levels with one being the expected operating pressure.
3. Re-calibrate gauges at any time they are in error.
4. Securely attached to the gauges a tag showing the test dates and the initials of the person doing the tests.
5. All gauges that cannot be calibrated shall be removed from service and disposed of.

END OF SECTION

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SECTION 23 07 13 - DUCTWORK INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ductwork insulation.
2. Duct Liner.
3. Insulation jackets.

1.02 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product Data: Provide product description, including conductivity, density, temperature ratings, and fire resistance ratings.

C. Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable workmanship and installation standards will be achieved.

D. Submit list of insulation and jacket materials and thickness for each service, and locations.

1.03 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, or UL 723; unless otherwise indicated.

1.04 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of section 01 65 50.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 HRS.

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PART 2 - PRODUCTS

2.01 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' ('Ksi') value : ASTM C518, 0.34 at 75 DegF (0.049 at 24 DegC).
2. Maximum service temperature: 250 DegF (121 DegC).
3. Maximum moisture absorption: ASTM C553, 3.0-percent by weight.
4. Density: 0.75 LB/CU FT (12 kg/cu m).
5. Standard Fiber Glass Duct Wrap manufactured by Certainteed; Fiberglas All-Service Duct wrap manufactured by Owens-Corning Fiberglas Corp.; or approved equal.

B. Vapor Barrier Jacket:

1. Foil-Scrim-Kraft jacket, glass scrim reinforced laminate of aluminum foil facing bonded to kraft paper 0.0032 IN (0.081 mm) white vinyl.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive vapor barrier tape; Kraft paper reinforced with glass fiber yarn and bonded to aluminized film to match jacket, with pressure sensitive rubber based adhesive.

C. Fabrication Adhesive: Non-flammable, quick setting; Spark-Fas 85-20 or Quick-Tack 85-60 manufactured by Foster Products Corp.; Type J–545–F manufactured by Vimasco Corp.; or approved equal.

2.02 GLASS FIBER DUCT LINER, FLEXIBLE

A. Insulation: ASTM C1071, Type I; flexible, noncombustible blanket with surface coating.

1. 'K' ('Ksi') value: ASTM C518, 0.28 at 75 DegF (0.040 at 24 DegC).
2. Maximum service temperature: 250 DegF (121 DegC).
3. Maximum Moisture Absorption: ASTM C553, 1.0 percent by weight.
4. Maximum Velocity on Coated Air Side: 5,000 FT/min (25.4 m/sec).
5. Ultralite manufactured by Certainteed; PermaCote Linacoustic manufactured by Manville; or approved equal.

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B. Acoustical Performance; minimum sound absorption coefficient, ASTM C423 Type "A" mounting:

Octave	Liner Thickness, IN		
Frequency	1	1-1/2	2
12 0.04	0.16	0.22	
250	0.25	0.46	0.67
500	0.57	0.82	0.99
1000	0.78	0.94	1.02
2000	0.87	0.95	0.96
4000	0.89	0.91	0.92

C. Adhesive: Waterproof, quick setting; Spark-Fas 85-20 or Quick-Tack 85-60 manufactured by Foster Products Corp.; Type J-545-F manufactured by Vimasco Corp.; or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed and dry.

3.02 INSTALLATION

A. Insulation type and thickness, vapor barrier type, and jacket type: As scheduled on Drawings.

B. Install materials in accordance with manufacturer's instructions.

C. Insulated ductwork conveying air below ambient temperature and dual temperature ducts:

1. Provide insulation and vapor barrier.
2. Provide finish coating as specified, and where indicated.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ductwork conveying air above ambient temperature:

1. Provide with [or without] standard vapor barrier jacket.
2. Provide finish coating as specified, and where indicated.
3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
4. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

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E. For ductwork exposed in mechanical equipment rooms and in finished spaces below 10 FT (3 meters) above finished floor and where otherwise indicated, finish with canvas jacket sized for finish painting.

F. External Duct Insulation Application:

1. Secure insulation and vapor barrier with adhesive and seal joints with vapor barrier adhesive or tape to match jacket.
2. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

G. Duct Liner Application:

1. Install in accordance with SMACNA Standards.
2. Adhere insulation with 90 percent adhesive coverage.
3. Secure insulation with mechanical liner fasteners.
4. Seal and smooth joints.
5. Seal liner surface penetrations with adhesive.
6. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 DUCT INSULATION SCHEDULE

A. All rectangular supply air ductwork: 1-1/2 IN duct liner.

B. All round supply air ductwork: 2 IN, 1-1/2 LB density glass fiber flexible insulation.

C. All relief air ductwork: 1-1/2 IN duct liner.

D. All outdoor air ductwork: 2 IN duct liner.

END OF SECTION

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SECTION 23 07 19 - PIPING INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Piping insulation.

B. Jackets and accessories.

1.02 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: Provide product description, including conductivity, density, temperature ratings, and fire resistance ratings.

C. Manufacturer's Installation Instructions: Indicate procedures that ensure acceptable workmanship and installation standards will be achieved.

D. Submit list of insulation and jacket materials and thickness for each service, and locations.

1.03 QUALITY ASSURANCE

A. Materials: Flame spread/smoke developed rating of 25/50 or less in accordance with ASTM E84, NFPA 255, or UL 723; unless otherwise indicated.

1.04 QUALIFICATIONS

A. Applicator: Company specializing in performing the work of this section with minimum three years experience.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect, and handle products to site under provisions of section 01 65 50.

B. Deliver materials to site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic.

D. Protect insulation against dirt, water, chemical, and mechanical damage.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for minimum period of 24 HRS.

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PART 2 - PRODUCTS

2.01 GLASS FIBER

A. Insulation: ASTM C547; rigid molded, noncombustible.

1. 'K' ('ksi') value: ASTM C335, 0.23 at 75 DegF (0.035 at 24 DegC).
2. Minimum Service Temperature: -20 DegF (-28.9 DegC).
3. Maximum Service Temperature: 300 DegF (150 DegC).
4. Maximum Moisture Absorption: ASTM C553; 0.2 percent by volume maximum.
5. MicroLok manufactured by Manville, or approved equal.

B. All Service Vapor Barrier Jacket:

1. ASTM C921, White 35 LB kraft paper reinforced with glass fiber yarn and bonded to aluminized film with flame resistant adhesive.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm.
3. Secure with self sealing longitudinal laps and butt strips.

C. Fabrication Adhesive: Non-flammable, quick setting; Spark-Fas 85-20 manufactured by Foster Products Corp.; Drion 85-75 manufactured by Foster Products Corp.; or approved equal.

D. Reinforcing Membrane:

1. Woven synthetic fiber, PVA finish, 30 percent minimum embedded elongation; Mast-A-Fab manufactured by Foster Products Corp.; Elastafab 894 manufactured by Vimasco Corp. or approved equal.
2. Fibrous Glass Cloth: Untreated; 9 OZ/SQ YD (305 g/sq m) weight.

E. Vapor Barrier Mastic Finish:

1. Piping Service at or below ambient temperature: Single component, elastomeric coating containing Hypalon, white color, maximum 0.02 perm; Monolar 60-95 manufactured by Foster Products Corp.; or approved equal.
2. Piping Service above ambient temperature: Water based mastic, white color, minimum 3.0 perm; SealFas G-P-M 35-00 manufactured by Foster Products Corp.; WC-5 manufactured by Vimasco Corp.; or approved equal.

2.02 FLEXIBLE ELASTOMERIC THERMAL INSULATION

A. Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type I for tubular materials and Type II for sheet material.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultra-violet-Protective Coating: As recommended by insulation manufacturer.

2.03 MOLDED RIGID CELLULAR GLASS INSULATION

A. ANSI/ASTM C552; 0.35 maximum ‘K’ value at 75 DegF, moisture resistant, non-combustible; suitable for -100 DegF to 900 DegF.

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B. For below grade installations, use asphaltic mastic paper vapor barrier jacket.

C. For above grade installations, use self-seal all-purpose white kraft jacket.

2.04 HYDROUS CALCIUM SILICATE INSULATION

A. ASTM C533; rigid modled pipe insulation; asbestos free; 0.40 'K' vale at 300 DegF; 1200 DegF maximum service temperature; 16 gauge stainless steel tie wires on maximum 12 IN centers.

2.05 JACKETS

A. PVC Plastic Jacket: ASTM C921, One-piece molded type fitting covers and sheet material, white color, UV resistant.

1. Minimum Service Temperature: 0 DegF (-18 DegC).
2. Maximum Service Temperature: 150 DegF (66 DegC).
3. Moisture Vapor Transmission: ASTM E96; 0.05 perm.
4. Maximum Flame Spread: ASTM E84; 25.
5. Maximum Smoke Developed: ASTM E84; 50.
6. Thickness: 30 mil (0.76 mm).
7. Connections: Brush on welding adhesive or Pressure sensitive color matching vinyl tape .
8. 550 PVC manufactured by Ceel-Co, LoSmoke manufactured by Proto Corp., or approved equal.

B. Aluminum Insulation Jackets:

1. Insulation jackets shall be furnished and installed piping systems as indicated herein and on the drawings.
2. Fittings in insulated piping systems and piping or equipment where indicated shall be provided with an aluminum jacket. Piping systems where indicated to have aluminum jackets shall be insulated with the same aluminum jacketing material.
3. Factory prefabricated weatherproof aluminum jacket system consisting of preformed 0.020 IN thick aluminum sections fabricated with a continuous modified Pittsburg Z-Lock on the longitudinal seam and each butted section of jacketing is to be sealed with a butt strap, weather-tight system for butt joints. Special factory made jacket fittings shall be provided at all fittings, wherever possible. All jacketing shall have an integrally bonded polysurlyn moisture retarder over the entire surface in contact with the insulation. All joints shall be sealed with bead of silicon caulking. Aluminum jacket system shall be Lock-On or Z-Lock as manufactured by ITW or equivalent."

2.06 TANK AND EQUIPMENT INSULATION

A. Tank and equipment insulation shall be closed cell, flexible foamed plastic in sheet form. Insulation shall have a K factor of 0.28, maximum, at 75 DegF mean temperature and shall have a built-in vapor barrier."

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PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Insulation type and thickness, vapor barrier type, and jacket type: As scheduled on Drawings.

B. Install materials in accordance with manufacturer's instructions.

C. On exposed piping, locate insulation and cover seams in least visible locations.

D. Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Provide vapor barrier, factory applied or field applied.
2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe.
3. Provide finish coating of type specified for insulation used.
4. PVC fitting covers may be used with all service insulation jacket.
5. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
6. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
7. Insulate and vapor seal hangers, supports, anchors, and other equipment attached directly to cold surfaces to prevent condensation.

E. For insulated pipes conveying fluids above ambient temperature:

1. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
2. Provide finish coating of type specified for insulation used.
3. PVC fitting covers may be used with all service insulation jacket.
4. For hot piping conveying fluids 140 DegF (60 DegC) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
5. For hot piping conveying fluids over 140 DegF (60 DegC), insulate flanges and unions at equipment.

F. Inserts and Shields:

1. Application: Piping 1-1/2-IN (40 mm) diameter or larger.
2. Shields: MSS SP69; Factory coated galvanized between pipe hangers or pipe hanger rolls and inserts, ribbed with rolled edges for use with pipe hangers.
3. Insert Location: Between support shield and piping and under the finish jacket.

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4. Insert Configuration: Same thickness and contour as adjoining insulation; length:

Nom. Pipe Size (IN)	Insert Length (IN)
1/2 to 2-1/2	6
3 to 6	99
8 to 10	12
12 and over	18

G. Finish insulation at supports, protrusions, and interruptions.

H. For pipe exposed in mechanical equipment rooms, in the maintenance shop and in finished spaces below 10 FT (3 meters) above finished floor and where otherwise indicated, finish with PVC jacket and fitting covers.

I. For exterior applications, provide vapor barrier and aluminum jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with reinforced vapor barrier cement. Cover with aluminum jacket and fitting covers with seams located on bottom side of horizontal piping.

J. For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket and fitting covers with seams located on bottom side of horizontal piping.

3.03 INSULATION SCHEDULE

A. Domestic Cold Water (Potable and Non-Potable): 1 IN premolded fiberglass insulation with an all service vapor barrier jacket.

B. Domestic Hot Water and Circulating up to 140 DegF (Potable and Non-Potable):

1. Up to 1-1/2 IN Pipe Size: 1 IN premolded fiberglass insulation with an all service jacket.

2. Above 1-1/2IN Pipe Size: 1 1/2 IN premolded fiberglass insulation with an all service jacket.

C. Plumbing Vents within 10 FT from Roof Penetration: 1/2 IN premolded fiberglass insulation with an all service jacket.

D. Cooling Coil Condensate Drains and Dedicated Floor Drain Branch Piping, Sanitary and Indirect Waste Piping Conveying Fluids 55 DegF such as drains serving Ice Machines: 1/2 IN flexible elastomeric insulation.

E. Underground Domestic Hot Water and Circulating Lines: 1IN molded rigid cellular glass.

F. Insulation Inserts at Hangers: Match pipe insulation thickness - molded rigid cellular glass or hydrous calcium silicate insulation.

G. Refrigerant Liquid, Suction, and Hot Gas Piping:

1. Up to 1-1/2 IN Pipe Size: 1 IN flexible elastomeric insulation.

2. Above 1-1/2 IN Pipe Size: 1-1/2 IN flexible elastomeric insulation.

H. Lube Oil, Compressor Oil, Journal Oil, Nonpotable Water, Soap, Soap/Water, Recovered Oil, Locomotive Retention Fluid, Drain Oil Piping, and Level Control Valve Pilot Piping: 1 IN flexible elastomeric thermal insulation.

I. All piping installed outdoors and/or with the potential of exposure to sunlight under normal operating conditions shall include aluminum jacket.

END OF SECTION

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SECTION 23 09 00 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Instrumentation and control for HVAC systems.
2. Temperature control.
3. Ventilation control.
4. Heating control.
5. Cooling control.
6. Control wiring.
7. Panels and accessories.
8. Miscellaneous.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Union Pacific Railroad (UPRR) Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Division 23 - Heating, Ventilating, and Air-Conditioning (HVAC).

E. Section 23 05 53 - Mechanical Identification.

F. Section 23 09 00 - HVAC Instrumentation and Controls.

G. Section 23 09 93 - Sequence of Operation.

H. Section 23 31 10 -Ductwork.

I. Division 26 - Electrical.

1.03 REFERENCED STANDARDS

A. American Society of Heating Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

1. 62-1989, Ventilation for Acceptable Indoor Air Quality.

B. ASTM International (ASTM):

1. D1693, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

C. The Instrumentation, Systems, and Automation Society (ISA):

1. S5.1, Instrumentation Symbols and Identification.
2. S5.4, Standard Instrument Loop Diagrams.

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D. Scientific Apparatus Makers Association (SAMA):

1. PM C20.1, Process Measurement and Control Terminology.

1.04 QUALITY ASSURANCE

A. See Section 01 61 03.

B. Miscellaneous:

1. Controls to be in compliance with Section 26 05 00 for NEMA and NEC enclosure class requirements unless noted or specified otherwise.

2. Unless specifically noted otherwise, components of systems shall be industrial duty suitable for moist, corrosive environments.

3. Express control device performance requirements in terminology in accordance with SAMA PM C20.1. Process measurement and control terminology.

1.05 SYSTEM DESCRIPTION

A. Work shall be provided as an integrated operating system. HVAC control system shall use non-proprietary BACnet IP protocol.

B. Provide a complete system of automatic temperature control, thermostats, relays, valves, dampers operators and other associated controls and appurtenances required to maintain minimum conditions described in detail herein and on the drawings, together with thermometers, gauges, and other accessory equipment.

1. HVAC systems shall be controlled with direct digital controls (DDC) according to sequence contained in this section.

a. Additional points or software programming not listed but which are required to meet following sequences of operation shall be provided.

2. Assemble control system with complete system of wiring and accessory equipment to fulfill requirements of the contract documents.

C. Install system using competent mechanics under direct supervision of control manufacturer.

D. Controls, as set out in "Sequence of Operations" are designed to illustrate operating functions only.

1. Control sequence shall be considered supplementary to sequence of operation.

2. These minimum specified items, and any additional controls, not indicated but required to meet performance as outlined in the contract documents, shall be furnished and installed at no additional cost to the Owner and to make a complete system.

E. Sequence of Operations – General:

1. Sequence of operations indicated basic operating functions only. Contractor shall review drawings and submit manufacturer's recommendations subject to Engineer's approval. Refer to Section 23 09 93 for sequence of operations.

a. Airflow Measuring Stations:

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1) Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion

a) Provide airflow/temperature measurement devices where indicated on the plans.

b) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

(1) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.

(2) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

(3) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

(4) Devices using less than two thermistors in each sensor assembly are not acceptable.

(5) Devices using platinum wire RTDs are not acceptable.

(6) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.

(7) Pitot tubes and arrays are not acceptable.

(8) Vortex shedding devices are not acceptable.

c) All Sensor Probes:

(1) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.

(2) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

(3) Airflow measuring station assembly accuracy shall be +/-2 percent of Reading over the entire operating airflow range. Temperature accuracy shall be +/-0.15 DegF 0.07 DegC between -20 DegF-29 DegC and 160 DegF 71 DegC.

(4) The operating humidity range for each sensor probe shall be 0 - 99 percent RH (non-condensing).

(5) Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

(6) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

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d) Duct and Plenum Probes:

(1) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.

(2) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

(3) The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

e) Sensor Density:

Area (SQ FT m^2)	Total # of Sensors Required
< 20.2	4
20.2 to < 40.4	6
40.4 to < 80.75	8
80.75 to < 161.5	12
≥ 161.5	16

f) Transmitters:

(1) The transmitter shall have an integral 16 character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.

(2) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.

(3) The operating temperature range for the transmitter shall be -20 DegF to 120 DegF.

g) The transmitter shall be capable of communicating with other devices using one of the following interface options:

(1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0 - 10 VDC/4-20mA (4-wire)

(2) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

(3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

(4) LonWorks Free Topology.

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2. Current Measuring Devices:

   a. Current Switches for Constant Speed Motors:

   b. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

3. Current Switches for Motors Controlled by VFD:

   a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with N.O. output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

4. Hydrogen Sensors:

   a. Solid-state gas sensor/transmitter, NEMA 1 gasketed enclosure, normal operating temperature 0 - 120 DegF, normal relative humidity operation 5-95 percent, ± 5 percent accuracy, and detection range of 0 - 4.4 percent in air.

   b. Provide 4-20 mA output from the sensor to the DDC system.

   c. Provide local alarm whenever hydrogen level exceeds 1 percent.

   d. Install in accordance with OSHA requirements.

   e. Unit shall be factory calibrated and shall be re-calibrated after installation per manufacturer's recommendations.

5. Miscellaneous Devices:

   a. Control Relays:

      1) Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.

      2) Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.

6. Thermostat and Sensor Enclosures:

   a. Clear plastic guard with lock. Wire guard with tamperproof screws. Setpoint shall be adjustable with cover in place. Fasten to wall separately from thermostat. Provide guards in all corridors, gymnasiums, locker rooms, toilet rooms, assembly halls and as noted on the drawings.

   b. Heavy Duty Enclosure:

1) Perforated steel, tamperproof locking thermostat and control device enclosure.

2) Box shall be nominally 8 IN x 6 IN x 2 IN 200 x 150x50 mm deep or sized as required to fit devices to be enclosed.

3) Perforated cover shall be 16 gauge (1.52 mm) steel with maximum 3/16 IN 5 mm perforations on maximum 1/4 IN 6 mm staggered centers for a 55 percent free area.

4) Secure to wall from inside of box. Cover shall be secured by tamperproof screws to frame.

5) Color shall match electrical devices. Verify color with the Electrical Contractor.

c. Combination temperature and CO2 room/zone sensors:

1) Wall mounted combination sensors shall contain a space temperature sensor and carbon dioxide (CO2) sensors in a single, decorative housing. The CO2 sensor shall use single-beam absorption infrared diffusion technology (non-dispersive infrared), and shall have integral programming to perform automatic baseline calibration without user interface. The recommended manual recalibration period shall not be less than five years. Other features of wall-mounted combination sensors shall include:

a) Operating conditions: 60 to 90 DegF (15 to 32 DegC) and 0 to 95 percent RH, non condensing.

b) Power supply: 18-30 VAC, 50/60 Hz (18-42 VDC polarity protected).

c) CO2 sampling method: Diffusion.

d) CO2 sensor output: 4 to 20 mA or 0 to 10 V signal.

e) CO2 measurement range: 0-2000 ppm.

f) Sensitivity ±20 ppm.

g) Accuracy ±100 ppm at 60 to 90 DegF (15 to 32 DegC) and 760mm Hg.

h) CO2 sensor calibration: Single point calibration via pushbutton and LED.

2) Space temperature sensor: 10K ohm ±2 percent at 77 DegF (25 DegC) thermistor with pushbutton override (and a temperature setpoint adjustment potentiometer).

3) Combination sensors shall be provided with the manufacturer's recommended carbon dioxide calibration kit. The quantity shall be suitable to initially calibrate each sensor provided for the project.

d. Demand control ventilation:

1) Each variable-air-volume zone controller (terminal unit) shall monitor primary air flow, space temperature, air handler status and mode, supply air temperature (as applicable) and shall position its terminal damper based on its proportional-integral-derivative (PID) temperature control algorithm to maintain the desired zone temperature setpoint of 75 DegF (adjustable). Each zone controller shall include the inherent ability to override the temperature control loop and modulate the terminal's damper with a proportional-integral (PI) loop, based on a CO2 sensor with its associated setpoint schedule, in conjunction with the normal temperature control loop. The zoom controller shall be capable of maintaining a ventilation setpoint through a demand-controlled ventilation (DCV) algorithm in conjuction with the air-handling unit to fulfill the requirements of ASHRAE standard, 62-1989 "Ventilation for Acceptable Indoor Air Quality" (including Addendum 62a-1990).

2) The DCV control function shall determine the zone ventilation airflow based on the CO2 zone sensor input signal. When the DCV function is enabled, the zone controller shall override (increase) the primary airflow in order to provide additional ventilation if the airflow in order to prevent the CO2 sensor reading form exceeding the desired zone setpoint. The control algorithm shall use a proportional-integral (PI) algorithm to determine the required airflow in order to prevent the CO2 sensor from exceeding the desired zone setpoint.

3) Whenever the system air-handling unit (RTU-501) is operating, the system controller shall maintain the base ventilation rate (minimum ventilation rate) unless overriden by a pre-occupancy purge sequence or the DCV function.

4) All zone controllers shall be polled and the highest CO2 sensor reading shall be sent to the system controller. This CO2 reading shall be compared to the system CO2 setpoint. If the reading is below the system CO2 setpoint, the rooftop unit shall maintain the base ventilation rate. If the reading is above the setpoint, the rooftop unit damper controller shall modulate the outdoor air dampers open using a rooftop unit damper controller shall modulate the outside air dampers open using a proportional-integral (PI) loop to maintain the zone CO2 at the zone setpoint.

5) The system controller shall modulate the rooftop's gas preheat control to maintain the discharge air temperature setpoint if the mixed air temperature falls below the discharge air temperature setpoint. The outside air damper position shall close decreasing CO2 sensor signal down to the base ventilation rate. The zone controller (terminal unit) shall contain a provision to operate modulating type heat to maintain the space temperature at the midpoint between the heating and cooling setpoints during DCV operation. The zone controller shall have the capability to define a maximum primary airflow limit (ventilation) to protect the zone from overcooling for those units that do not include local heating. DCV control shall be automatically suspended if the overall space temperature falls below the heating setpoint and the outdoor air damper shall return to the base ventilation position.

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6) If RTU-501's economizer control determines that it is beneficial to use outdoor air for cooling, the economizer shall override the DCV algorithm to modulate the dampers to open to maximum position.

e. Operation shall be dependent upon the equipment mode of operation, so that the DCV function using the input signal form a CO2 sensor located in the conditioned space. Control functions shall include outdoor air damper modulation, monitoring, and alarm generation. The unit controller shall maintain an adjustable CO2 setpoint by overriding the mixed-air damper position and modulating the damper further open to provide the required ventilation. The DCV algorithm shall automatically limit the amount of outdoor air to prevent the mixed-air temperature from falling below 50 DegF The unit controller shall also have the ability to limit the maximum amount of outdoor air during DCV operation. If heating is available during DCV operation, the gas heating section shall modulate t maintain a minimum supply air temperature of 65 DegF, The unit controller shall also have the ability to limit the maximum amount of outdoor air during DCV operation. If heating is available during DCV operation, the gas heating section shall modulate to maintain a minimum supply air temperature of 65 DegF, if neither heating or cooling is required by the space. If the space temperature exceeds an adjustable high limit value or falls below an adjustable low limit value, or if the space humidity exceeds the humidity setpoint, the algorithm shall disable any DCV damper override and maintain the normal minimum ventilation setpoint or to the combined mixed-air temperature setpoint until the space temperature and/or space relative humidity returns to normal.

7. Administration Building exhaust fan (EF-506). Fan shall be constant speed and run continuously.

1.06 SYSTEM PERFORMANCE

A. Performance Standards: System shall conform to the following minimum standards over network connections:

1. Graphic Display: A graphic with 20 dynamic points shall display with current data within 10 seconds.

2. Graphic Refresh: A graphic with 20 dynamic points shall update with current data within 8 seconds.

3. Object Command: Devices shall react to command of a binary object within 2 seconds. Devices shall begin reacting to command of an analog object within 2 seconds.

4. Object Scan: Data used or displayed at a controller or workstation shall have been current within the previous 6 seconds.

5. Alarm Response Time: An object that goes into alarm shall be annunciated at the workstation within 45 seconds.

6. Program Execution Frequency: Custom and standard applications shall be capable of running as often as once every 5 seconds. Select execution times consistent with the mechanical process under control.

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7. Performance: Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per second. Select execution times consistent with the mechanical process under control.
8. Multiple Alarm Annunciations: Each workstation on the network shall receive alarms within 5 seconds of other workstations.
9. Reporting Accuracy: System shall report values with minimum end-to-end accuracy listed in Table 1.
10. Control Stability and Accuracy: Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

TABLE 1 Reporting Accuracy	
1) **Measured Variable**	2) **Reported Accuracy**
3) Space temperature	4) ±1 DegF (±0.5°C)
5) Ducted air	6) ±1 DegF (±0.5°C)
7) Outside air	8) ±2 DegF (±1.0°C)
Dew point	±3 DegF (±1.5°C)
9) Water temperature	10) ±1 DegF (±0.5°C)
11) Delta-T	12) ±0.25 DegF (±0.15°C)
13) Relative humidity	14) ±5% RH
15) Water flow	16) ±2% of full scale
Airflow (terminal)	±10% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
17) Air pressure (ducts)	18) ±25 Pa (±0.1 IN w.g.)
19) Air pressure (space)	20) ±3 Pa (±0.01 IN w.g.)
21) Water pressure	22) ±2% of full scale (see Note 2)
23) Electrical (A, V, W, power factor)	24) ±1% of reading (see Note 3)
Carbon monoxide (CO)	±5% of reading
Carbon dioxide (CO_2)	±50 ppm
Note 1: Accuracy applies to 10%–100% of scale	
Note 2: For both absolute and differential pressure	

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Note 3: Not including utility-supplied meters

TABLE 2 Control Stability and Accuracy			
Controlled Variable	**Control Accuracy**	**Range of Medium**	
Air pressure	±0.2 IN w.g. (±50 Pa) ±0.01 IN w.g.(±3 Pa)	0–6 IN w.g. (0–1.5 kPa) –0.1 to 0.1 IN w.g. (–25 to 25 Pa)	
Airflow	±10% of full scale		
Space temperature	±2.0 DegF (±1.0°C)		
Duct temperature	±3 DegF (±1.5°C)		
Humidity	±5% RH		
Fluid pressure	±1.5 psi (±10 kPa) ±1.0 IN w.g. (±250 Pa)	1–150 psi (0–1 MPa) (0–50 IN w.g.) differential	

1.07 WARRANTY

A. Warrant work as required in the General Conditions.

1.08 MAINTENANCE SERVICE AGREEMENT

A. A written proposal for a maintenance contract shall be provided to the Owner for on-site preventive maintenance services related to the Instrumentation and Control system. The cost of this maintenance contract shall not be included in the Contract Price.

B. This proposal shall be provided within 30 days after final acceptance for the purpose of entering a contract for annual maintenance subsequent to the first year of maintenance. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from date of issue.

C. This maintenance contract shall include all labor, parts, and emergency calls providing on-site response within 24 HRS, to provide complete system maintenance for a period of one year after the date of Substantial Completion of the system for all equipment and software provided as part of the scope of work.

D. Provide software updates throughout the maintenance contract period. Provide latest official released version for all software provided under this Contract. Owner shall have the latest software releases at the end of the maintenance contract period.

E. The maintenance contract shall also include a minimum of 4 preventive maintenance visits by qualified service personnel of the Supplier who is familiar with the type of equipment provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning and lubrication of system equipment and verification of correct operation.

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F. Visits to the sites to correct deficiencies under warranty shall not be included in this preventive maintenance service contract.

G. Emergency maintenance procedures or plant visits may coincide with a preventive maintenance visit, however, they shall not replace the work intended to be performed during a preventive maintenance visit. The Supplier shall have full responsibility for the system hardware preventive and corrective maintenance.

H. During the one-year maintenance period, observation of maintenance tasks performed under this agreement by plant personnel and the instruction of said personnel in the details of the maintenance work being performed, shall be provided.

1.09 MANUFACTURER SUPPORT

A. Provide a written proposal for a manufacturer support agreement for products specified herein for a minimum of 12 months starting at final completion of the project. The cost of this manufacturer support agreement shall not be included in the Contract Price unless part of the manufacturer's standard terms of sale. The support agreement shall be executed in the name of, and for the benefit of, the Owner. At a minimum, this agreement shall provide the Owner with:

1. 8 AM to 5 PM, 5 day per week manufacturer telephone support.
2. Access to the manufacturer's technical support website.
3. Software and firmware updates.

1.10 OWNERSHIP OF PROPRIETARY MATERIAL

A. All software provided under this Contract shall be licensed to the Owner at the time of purchase.

B. Project-specific software and documentation shall become the Owner’s property. This includes, but is not limited to:

1. Graphics.
2. Record drawings.
3. Database.
4. Application programming source code.
5. Documentation.

C. All software programs and documentation developed under this Contract shall be turned over to the Owner in format so programs can be adjusted, reconfigured, or re-programmed by the Owner or their representatives.

D. Turn over all keys and passwords to the system. Any passwords shall be turned over to the Owner and the Owner shall have full access to modify the system after final completion. Any changes made during or after testing, start-up, and commissioning shall be incorporated and provided to the Owner.

1. Change Administrator Level Control of system software to the Owner following start up to allow the Owner the ability to grant or restrict access to any user, including the system supplier and the installing contractor.

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PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 23 09 93 - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sequence of system operations.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

B. Division 23 - Mechanical Sections apply to this Section.

C. Division 26 - Electrical Sections apply to this Section.

1.03 REFERENCED STANDARDS

A. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilation Systems" where applicable to controls and control sequences.

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

PART 2 - PRODUCTS

2.01 TEMPERATURE CONTROLS

A. Provide a complete temperature control system including programmable logic controllers (PLC's). HVAC temperature controls shall be compatible with PLC equipment provided for process and equipment controls installed by process control contractors.

PART 3 - EXECUTION

3.01 DOMESTIC HOT WATER CIRCULATING PUMP

A. All circulating pumps shall be scheduled through the DDC system. When a particular circulating pump is scheduled to operate through the DDC system, it shall operate as needed through its associated aquastat. Refer to plans and Specification Section 22 11 23 for additional information.

3.02 ELECTRIC AND GAS FIRED DOMESTIC WATER HEATERS

A. Water heaters shall be provided with integral thermostats.

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3.03 COMPRESSED AIR SYSTEM

A. Air compressor shall be provided with an integral pressure switch.

END OF SECTION

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SECTION 23 11 23 - NATURAL GAS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Natural gas piping, accessories, and installation.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

1.03 REFERENCED STANDARDS

1. NFPA - 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product data for each gas piping specialty and special duty valve. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering gas piping system products which may be incorporated in the work include, but are not limited to, the following:

1. Gas Cocks:

a. Jenkins Bros.

b. Lunkenheimer Co.

c. Powell Co.

d. Stockham.

2.02 PIPE MATERIALS

A. Conform to NFPA 54 and with requirements specified herein. Supply piping to appliances or equipment shall be at least as large as the inlets thereof..

2.03 PIPE AND FITTINGS

A. Aboveground and Within Buildings and Vaults

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1. Pipe: Black steel in accordance with ASTM A53, Schedule 80, threaded ends for sizes 2 inches and smaller; otherwise, plain end beveled for butt welding.
2. Threaded Fittings: ASME B16.3, black malleable iron.
    a. Pipe thread tape: antiseize and sealant tape of polytetrafluoroethylene (PTFE).
3. Socket-Welding Fittings: ASME B16.11, forged steel.
4. Butt-Welding Fittings: ASME B16.9, with backing rings of compatible material.
5. Flanges and Flanged Fittings: ASME B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.
    a. Bolts and Nuts: Stainless steel bolting; ASTM A193, Grade B8M or B8MA, Type 316, for bolts; and ASTM A194, Grade 8M, Type 316, for nuts. Dimensions of bolts, studs, and nuts shall conform with ASME B18.2.1and ASME B18.2.2 with coarse threads conforming to ASME B1.1, with Class 2A fit for bolts and studs and Class 2B fit for nuts. Bolts or bolt-studs shall extend through the nuts and may have reduced shanks of a diameter not less than the diameter at root of threads. Bolts shall have American Standard regular square or heavy hexagon heads; nuts shall be American Standard heavy semi finished hexagonal.
    b. Gaskets: Fluorinated elastomer, compatible with flange faces.

B. Underground Polyethylene (PE) PE pipe and fittings are as follows:
1. Pipe: ASTM D2513, 100 psig working pressure, Standard Dimension Ratio (SDR), the ratio of pipe diameter to wall thickness, 11.5 maximum.
2. Socket Fittings: ASTM D2683.
3. Butt-Fusion Fittings: ASTM D2513, molded.
4. Provide detectable aluminum-foil plastic-backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of buried piping. Tape shall be detectable by an electronic detection instrument. Provide tape in rolls, 3 inch minimum width, color-coded yellow for natural gas, with warning and identification imprinted in bold black letters continuously and repeatedly over entire tape length. Warning and identification shall be "CAUTION BURIED GAS PIPING BELOW" or similar wording. Use permanent code and letter coloring unaffected by moisture and other substances contained in trench backfill material.

2.04 PIPING SPECIALTIES

A. Unions: ANSI B16.39, Class 150 black malleable iron; female pattern; brass to iron seat; ground joint.

B. Dielectric Unions: ANSI B16.39, Class 250; malleable iron and cast bronze; with threaded or soldered end connections suitable for pipe to be joined; designed to isolate galvanic and stray current corrosion.

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C. Pressure Regulator, self-contained with spring-loaded diaphragm pressure regulator, psig to inches water reduction, pressure operating range as required for the pressure reduction indicated, volume capacity not less than indicated, and threaded ends for sizes 2 inches and smaller, otherwise flanged.

D. Earthquake Automatic Gas Shutoff Valve, ASCE 25-16 and UL listed or AGA listed or International Association of Plumbing and Mechanical Officials (IAPMO) listed. The valve may be either pendulum or ball construction with actuator.

E. Risers shall be manufacturer's standard riser, transition from plastic to steel pipe with 7 to 12 mil thick epoxy coating. Use swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Provide remote bolt-on or bracket or wall-mounted riser supports.

F. Transition Fittings

1. Steel to Plastic (PE): As specified for "riser" except designed for steel-to-plastic with tapping tee or sleeve. Coat or wrap exposed steel pipe with heavy plastic coating.

2. Plastic to Plastic: Manufacturer's standard bolt-on (PVC to PE) plastic tapping saddle tee, UL listed for gas service, rated for 100 psig, and O-ring seals; Manufacturer's standard slip-on PE mechanical coupling, molded, with stainless-steel ring support, O-ring seals, and rated for 150 psig gas service; Manufacturer's standard fused tapping (PE-to-PE) tee assembly with shut-off feature.

G. Gas Equipment Connectors

1. Flexible Connectors: ANSI Z21.45.

2. Quick Disconnect Couplings: ANSI Z21.41/CSA 6.9.

3. Semi-Rigid Tubing and Fittings: ANSI Z21.69/CSA 6.16.

H. Valve Box: Provide street valve box with cast-iron cover and two-piece 5 ¼ inch shaft-slip valve box extension. Cast the word "Gas" into the box cover. Use valve box for areas as follows:

1. Roads and Traffic Areas: Heavy duty, cast iron cover.

2. Other Areas: Standard duty, concrete cover.

2.05 VALVES

A. Aboveground:

1. Gas Cocks 2 IN and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.

2. Gas Cocks 2-1/2 IN and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.

B. Belowground

1. Metallic Ball Valves ASME B16.33 or ASME B16.38 corrosion-resisting steel, with threaded or flanged ends. Provide polytetrafluoroethylene (PTFE) seats.

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2. PE Ball or Plug Valves ASME B16.40 and ASTM D2513, Class C materials (PE 2306 or PE 3406), strength rating and SDR matching PE pipe dimensions and working pressure.

2.06 HANGERS AND SUPPORTS

A. MSS SP-58, as required by MSS SP-69.

PART 3 - EXECUTION

3.01 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 IN and smaller, and with welded joints for 2-1/2 IN and larger.

3.02 PIPING INSTALLATIONS

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

3.03 FIELD QUALITY CONTROL

A. Pump shall be scheduled through the DDC system. When the pump is scheduled to be operation through the DDC system, the pump shall be turned on/off through a line voltage aqaustat to maintain heating water piping at 118 DegF (adj.).

END OF SECTION

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SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Refrigerant piping used for air conditioning applications.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product data for the following products:

1. Each type valve specified.
2. Each type refrigerant piping specialty specified.

C. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations and risers with oil traps.

1.04 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with provisions of the following codes:

1. ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.
2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

1. Refrigerant Valves and Specialties:
   a. Alco Controls Div, Emerson Electric.
   b. Danfoss Electronics, Inc.
   c. EATON Corporation, Control Div.
   d. Henry Valve Company.
   e. Sporlan Valve Company.

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2.02 PIPE AND TUBING MATERIALS

A. Copper Tubing: ASTM B 88, Type L, hard-drawn straight lengths.

2.03 FITTINGS

A. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

2.04 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (Silver).

2.05 VALVES

A. General: Isolation valve assemblies shall be UL-listed and designed to conform to ARI 760.

2.06 REFRIGERANT PIPING SPECIALTIES

A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to ARI 760.

B. Strainers: 500 psig maximum working pressure; forged brass body with monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 DegF maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.

D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit.

PART 3 - EXECUTION

3.01 PIPE APPLICATIONS

A. Use Type L or Type ACR hard drawn copper tubing with wrought copper fittings and brazed joints above ground, within building.

3.02 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 "The Safety Code for Mechanical Refrigeration."

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fitting as possible.

D. Insulate hot gas lines. Liquid lines are not required to be insulated.

E. Install horizontal hot gas lines with 1/8 IN per 10 FT downward slope to the condenser.

F. Use fittings for all changes in direction and all branch connections. Install piping at right angles or parallel to building walls.

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G. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

H. Install strainers immediately ahead of each expansion valve.

I. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.

J. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to condensers and evaporators.

3.03 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors are specified in Section 40 05 07 "Hangers and Support" Conform to the table below for maximum spacing of supports:

B. Install hangers with the following minimum rod sizes and maximum spacing:

NOM. PIPE SIZE - IN	**MAX. SPAN - FT**	**MIN. ROD SIZE - IN**
1 and smaller	7	3/8
1-1/8 thru 1-7/8	9	3/8
2 and larger	10	3/8

3.04 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

3.05 VALVE INSTALLATIONS

A. General: Install refrigerant valves in accordance with manufacturer's instructions.

B. Thermostatic expansion valves shall be integral with the chillers.

C. Install pressure regulating and relieving valves and piping as required by ASHRAE Standard 15.

3.06 CLEANING

A. Before installation of copper tubing, clean the tubing and fittings.

3.07 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Section 40 05 03 - Piping Materials and Methods.

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

END OF SECTION

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SECTION 23 31 10 - DUCTWORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sheet metal ductwork.
2. Flexible ducts.
3. Duct cleaning.

1.02 REFERENCED STANDARDS

A. ADC - Flexible Duct Performance & Installation Standards.

B. ASHRAE - Handbook 1989 Fundamentals; Chapter 32 - Duct Design.

C. ASHRAE - Handbook 1992 Systems and Equipment; Chapter 16 - Duct Construction.

D. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

E. ASTM A525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

F. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

G. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

H. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

I. SMACNA - Round Industrial Duct Construction Standards.

J. UL 181 - Factory-Made Air Ducts and Connectors.

1.03 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. SMACNA Pressure Class: All ducts are 2 IN WG pressure class, unless otherwise indicated on Drawings.

C. Seal Class: Seal class 'C' for all ducts of pressure class 2 IN WG and less.

1.04 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A standards.

1.05 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Indicate duct fittings, particulars such as materials, gauges, sizes, welds, hangers, and configuration prior to start of work for all duct systems.

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1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and protect products under provisions of Section 01 65 50.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: Non-combustible or conforming to UL 181 requirements for Class 0 air duct materials, unless otherwise indicated.

B. Steel ducts: ASTM A527 galvanized steel sheet, lock-forming quality, having G90 (Z 275) zinc coating on each side in conformance with ASTM A525.

C. Flexible ducts, nonmetallic, insulated: UL 181 Class 1 air duct, chlorinated polyethylene core, galvanized steel wire helix, 1-1/2 IN (40 mm) thick fiberglass insulation, reinforced metalized polyester vapor barrier, rated working pressure 6 IN WG (1500 Pa) positive and 1 IN WG (250 Pa) negative, rated velocity 4000 fpm (20 m/s) minimum.

1. Model: UPC#037 manufactured by Atco Rubber Products; M-KE manufactured by Flexible Technologies; or approved equal.

D. Fasteners: Rivets, bolts, or sheet metal screws, compatible with duct material.

E. Sealant - One part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20 DegF to +175 DegF, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. All other mastics shall be marked UL 181A-M.

1. Pressure sensitive tape used for sealing ductwork shall be minimum 2.5-wide, listed and marked UL 181A-P having minimum 60 OZ/IN peel adhesion to steel and service temperature range from -20 DegF to 250 DegF.

2. Joint sealers shall meet the volatile organic compound (VOC) limits of US Green Building Council LEED credit EQ 4.1 Low-Emitting Materials – Adhesives & Sealants (follow latest edition at the time of bidding) regardless of whether the project is trying to achieve LEED status or not.

F. Hangers and hanger rod: Select hanging system in accordance with SMACNA HVAC Duct Construction Standards; select hanger materials with corrosion resistance equal to or greater than the duct material.

2.02 SHEET METAL DUCTWORK- GENERAL

A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and ASHRAE handbooks, except as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

1. Factory fabricated duct joining system: As manufactured by Ductmate Industries; or approved equal.

B. No variation of duct configuration or sizes permitted except by written permission.

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C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where there is insufficient space for radius elbows and where rectangular elbows are shown, provide rectangular fittings with single thickness air foil turning vanes.

D. Increase duct sizes gradually, not exceeding 15 degrees divergence where possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

E. Branch connections and take-offs: Rectangular with 45 degree entry, or 45 degree diverging wye.

F. Connect flexible ducts to metal ducts using sheet metal collars and tape plus draw bands. Seal collars to main duct with duct sealant.

G. Use crimp joints with or without bead for joining round duct sizes 12 IN (300 mm) and smaller with crimp in direction of air flow.

H. Use double nuts and lock washers on threaded rod supports.

I. Sizes shown on plans are inside clear dimensions.

2.03 LOW PRESSURE DUCTWORK

A. Fabricated and support in accordance with SMACNA Low Pressure Duct Construction Standards and ASHRAE handbooks. Provide duct material, gages, reinforcing and sealing for operating pressures indicated.

B. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts. No variation of duct configuration or sizes permitted except by written permission from Engineer.

C. Provide easements where low pressure ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts maintaining original duct area.

2.04 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

E. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

1. Apply an adhesive coating on longitudinal seam sin ducts exceeding 2,500 FPM air velocity.

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F. Secure liner with mechanical fasteners 4 IN from corners and at intervals not exceeding 12 IN transversely around perimeter; at 3 IN from transverse joints and at intervals not exceeding 18 IN longitudinally.

2.05 ROUND DUCT FABRICATION

A. Round Ducts: Fabricate round supply ducts with spiral lockseam construction. Comply with SMACNA: "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

2.06 ROUND DUCT FITTINGS FABRICATION

A. Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figures 3-4 and 3-5 and with metal thicknesses specified.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, or pleated construction. Fabricate the bend radius of die-formed, gored and pleated elbows 1.5 times the elbow diameter. Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Mitered Elbows: Mitered elbows shall not be used.
2. Round Elbows – 8 IN and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60 and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2 IN DIA (e.g. 3-1/2 and 4-1/2 IN) elbows with gored construction.
3. Round Elbows – 9 through 14 IN: Gored or pleated elbows for 30, 45, 60 and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or1/2 IN DIA (e.g. 9-1/2- and 10-1/2 IN) elbows with gored construction.
4. Round Elbows – Larger than 14 IN: Gored elbows, except where space restrictions require a mitered elbow.
5. Dir-Formed Elbows for Sizes through 8 IN and All Pressures: 20 gauge with 2-piece welded construction.

2.07 FLEXIBLE DUCTS

A. Install and support in accordance with SMACNA Duct Construction Standards or ADC Standards.

B. Connections and joints: Use sheet metal collars or sleeves and tape plus stainless steel drawbands.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where indicated and where required for testing of systems.

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B. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

C. Diffusers to ducts with 5 FT (1.5 m) maximum length of flexible duct.

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

3.02 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints according to pressure classification and in accordance with SMACNA installation requirements.

B. Pressure Classifications Greater than 2 IN Water Gage: All transverse joints, longitudinal seams and duct penetrations with joint sealing materials.

C. Pressure Classification Through 2 IN Water Gage: All transverse joints and longitudinal seams with duct tape.

D. Seal externally insulated ducts prior to insulation installation.

3.03 HANGING AND SUPPORTING

A. Install rigid, rectangular metal duct with support systems indicated in SMACNA "HVAC Duct Construction Standards," Tables 4-1 through 4-4 and Figures 4-6 through 4-9.

B. Support horizontal ducts within 2 FT of each elbow and within 4 FT of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 FT and at each floor.

D. Upper attachments to structures shall have an allowable load not to exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated.

E. Install concrete insert prior to placing concrete.

F. Install powder actuated concrete fasteners after concrete is placed and completely cured.

3.04 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Section 23 33 00 - "Ductwork Accessories."

B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-8, 45 degree entry and conical type and as detailed.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," Figure 2-16 through 2-18 and as detailed.

D. Flexible Connections: Comply with SMACNA "HVAC Duct Construction Standards, Figure 2- 19 and as detailed.

3.05 FIELD QUALITY CONTROL

A. Disassemble, reassemble and seal segments of the supply air systems as required to accommodate leakage testing, and as required for compliance with test requirements.

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B. Conduct tests, at static pressures equal to the maximum design pressure of the system or the section being tested. If pressure classifications are not indicated, test entire system at the maximum system design pressure. Do not pressurize systems above the maximum design operating pressure Give seven (7) days advanced notice for testing.

C. Test and determine leakage from entire supply air rectangular duct system or section of the system by relating leakage to the surface area of the test section.

D. Maximum Allowable Leakage: As described in ASHRAE 1989 Handbook, "Fundamentals" Volume, Chapter 32, Table 6 and Figure 10. Comply with requirements for leakage classification 6 for pressure classifications greater than 2 IN water gauge and less than and equal to 10 IN of water gauge.

E. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

3.06 ADJUSTING

A. Adjust volume control devices as required by the testing and balancing procedures to achieve required air flow. Refer to Section 23 05 93 - "Testing, Adjusting, and Balancing" for requirements and procedures for adjusting and balancing air systems.

B. Vacuum duct systems prior to final acceptance to remove dust and debris.

3.07 ADJUSTING AND CLEANING

A. Clean duct system and force air at high velocity through duct to remove accumulated dust. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.08 ACOUSTICAL LINER SCHEDULE

A. Duct System Material Thickness in IN

B. All rectangular supply air ducts Liner 1-1/2 IN.

END OF SECTION

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SECTION 23 33 00 - DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Volume dampers.
2. Control dampers.
3. Damper operators.
4. Backdraft dampers.
5. Fire dampers.
6. Smoke dampers.
7. Flexible duct connections.
8. Duct access doors.
9. Duct test holes.

1.02 REFERENCED STANDARDS

A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.

B. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

C. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

D. UL 33 - Heat Responsive Links for Fire-Protection Service.

E. UL 555 - Fire Dampers and Ceiling Dampers.

F. UL 555S - Leakage Rated Dampers for use in Smoke Control Systems.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 33 00.

B. Provide product data for factory fabricated products or shop drawings for shop fabricated assemblies, including dampers and operators, fire and smoke dampers, and duct access doors.

C. Submit manufacturer's installation instructions under provisions of Section 01 33 00, for fire dampers, combination fire and smoke dampers, smoke dampers, and ceiling radiation dampers.

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PART 2 - PRODUCTS

2.01 VOLUME DAMPERS

A. Rectangular, low leakage type: 16 gage galvanized steel hat channel frame, 16 gage galvanized steel blades maximum 6 IN (150 mm) wide, parallel blade action. Synthetic bearings, 1/2 IN plated steel axles, elastomeric blade edge seals, flexible stainless steel or aluminum jamb seals, maximum leakage 12 cfm/SQ FT at 4 IN WG differential pressure in accordance with AMCA Standard 500, mill galvanized finish, suitable for velocity to 1500 fpm (7.6 m/s) and pressure to 2.5 IN WG (600 Pa).

1. Provide locking, indicating quadrant regulators. On insulated ducts mount quadrant regulators on stand-of brackets, bases or adaptors.

2. Model: CD 60 manufactured by Ruskin; 500 Series manufactured by Swartwout; VCD-3000 Series manufactured by Greenheck; AC-500 Series manufactured by Air Balance Inc.; or approved equal.

B. Round: Minimum 22 gage galvanized steel frame with rolled beads, minimum 22 gage galvanized steel blade, minimum 3/8 IN plated steel axle, swaged steel or nylon bearings, suitable for velocity to 1500 fpm (7.6 m/s) and pressure to 1 IN WG (250 Pa).

1. Provide locking, indicating quadrant regulators. On insulated ducts mount quadrant regulators on stand-off brackets, bases, or adapters.

2. Model: MDRS25 manufactured by Ruskin; Type 200 VCRD manufactured by Arrow United Industries; AC-112 manufactured by Air Balance Inc.; or approved equal.

2.02 CONTROL DAMPERS

A. Rectangular, aluminum: Extruded aluminum hat channel frame 0.125 IN (3 mm) thick, extruded aluminum airfoil blades maximum 6 IN (150 mm) wide, 1/2 IN plated steel axles, synthetic bearings, parallel blade action. Inflatable elastomeric blade edge seals, flexible metal jamb seals, anodized finish, maximum leakage 12 cfm/SQ FT at 4 IN WG differential pressure in accordance with AMCA Standard 500.

1. Provide damper operator as indicated on Drawings.

2. Model: CD-50 manufactured by Ruskin; 501 manufactured by Swartwout; AC-526 manufactured by Air Balance Inc.; VCD-3000 series manufactured by Greenheck; or approved equal.

B. Round, steel: Minimum 22 gage galvanized steel frame with rolled beads, double thickness galvanized steel blade, elastomeric blade edge seal, 1/2 IN DIA plated steel axle, stainless steel sleeve or oil-impregnated bronze bearings, suitable for pressure to 6 IN WG (1500 Pa), maximum leakage 0.15 scfm per inch of blade circumference at a pressure differential of 4 IN WG in accordance with AMCA Standard 500.

1. Provide damper operator as indicated on Drawings. On insulated ducts mount quadrant regulators on stand-off brackets, bases, or adapters.

2. Model: CDRS25 manufactured by Ruskin; AC-530 manufactured by Air Balance Inc.; Type 250 SRD manufactured by Arrow United Industries; or approved equal.

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2.03 DAMPER OPERATORS

A. Manual: Locking, indicating quadrant regulator. On insulated ducts mount quadrant regulators on stand-off brackets, bases, or adapters.

B. Electric, two-position: 120 or 24 volt, 60 Hz electric motor operator with integral spring to return damper to normal position, cast aluminum weatherproof housing, oil immersed gear train, UL listed, SPDT adjustable auxiliary limit switch.

1. Model: M445 M845 manufactured by Honeywell; MA-418 MA-318 manufactured by Siebe (Barber Colman); or approved equal.

2. Provided by temperature control.

C. Electric, modulating: 120 24 volt, 60 Hz modulating electric motor operator with integral spring to return damper to normal position, cast aluminum weatherproof housing, oil immersed gear train, internal transformer, UL listed, two adjustable auxiliary limit switches, minimum position potentiometer.

1. Model: M945 manufactured by Honeywell; or approved equal.

2. Provided by temperature control.

2.04 BACKDRAFT DAMPERS

A. Backdraft dampers, size 18 x 18 IN (450 x 450 mm) or smaller, furnished with air moving equipment, may be air moving equipment manufacturers standard construction, unless otherwise indicated in equipment specification.

B. Gravity dampers: Designed for vertical or horizontal (air flow up) mounting, minimum 0.081 IN (2 mm) thick extruded aluminum channel frame, minimum 0.05 IN (1.2 mm) thick extruded aluminum blades, synthetic elastomeric blade edge seals, synthetic bearings, concealed linkage, rear mounted screen, suitable for velocity to 1500 fpm (7.6 m/s).

1. Model: BD2/A2 manufactured by Ruskin; 402 manufactured by Swartwout; Type 655 manufactured by Arrow United Industries; or approved equal.

2.05 FIRE DAMPERS

A. Fabricate in accordance with NFPA 90A and UL 555, and as indicated. Provide dampers UL rated and labeled at 1-1/2 HRS at openings in walls and floors with less than a three hour fire rating. Provide dampers UL rated and labeled at 3 hours at openings in walls and floors with a fire rating of three hours or more.

B. Fabricate curtain type dampers of galvanized steel with interlocking blades; Provide stainless steel closure springs and latches for horizontal installations; Type B or C configuration with blades out of air stream , except for ducts less than 12 IN (300 mm) in height.

C. Fabricate multiple blade fire dampers with galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings, plated steel axles, plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.

D. Fusible links: UL 33, shall separate at 165 DegF (74 DegC), unless otherwise indicated on Drawings.

E. Where indicated, provide fire dampers UL-approved and Labeled as dynamic fire dampers.

F. Manufacturer: Ruskin; Greenheck; Air Balance Inc.; Phillips Aire; or approved equal.

2.06 SMOKE DAMPERS

A. Provide combination dampers rated and labeled to Leakage Class I and qualified to 250 DegF (121 DegC) elevated temperature in accordance with UL 555S.

B. Fabricate multiple blade dampers with galvanized steel or extruded aluminum frame and blades, oil-impregnated bronze or stainless steel sleeve bearings, plated steel axles, plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 IN DIA actuator shaft, silicone blade edge seals and flexible metal compression type jamb seals where required to meet Leakage Class specified.

C. Operators: Factory installed and approved in accordance with UL 555 and UL 555S. Two- position, normally closed action, electric type suitable to operate on 120 volt, 60 Hz.

D. Manufacturer: Ruskin; Air Balance Inc.; Greenheck; or approved equal.

2.07 FLEXIBLE DUCT CONNECTIONS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Indoor: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 OZ/SQ YD (1.0 kg/sq m), minimum 4 IN (100 mm) wide, crimped into 3 IN wide metal edging strip.

1. Model: Neoflex manufactured by Cain Manufacturing Co.; Ventglas manufactured by Ventfabrics; or approved equal.

2.08 DUCT ACCESS DOORS

A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards, and as indicated.

B. Review locations prior to fabrication.

C. Fabricate rigid and close-fitting doors of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 IN (25 mm) thick insulation with sheet metal cover.

D. Access doors smaller than 12 IN (300 mm) longest dimension may be removable type, secured with sash locks.

E. Provide two hinges and two sash locks for sizes up to 18 IN (450 mm) longest dimension, three hinges and two compression latches with outside and inside handles for sizes up to 24 x 48 IN (600 x 1200 mm). Provide an additional hinge for larger sizes. Full length piano type hinges are acceptable for doors with hinged side dimension up to 24 IN (600 mm).

F. Access doors with sheet metal screw fasteners are not acceptable.

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G. Provide transparent window of plexiglass, wireglass, or laminated safety glass where indicated on Drawings.

H. Manufacturer: Ruskin; Ventfabrics; CE Sparrow Co.; or approved equal.

2.09 DUCT TEST HOLES

A. Cut or drill temporary test holes in ducts as required. Cap with neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

B. Permanent test holes shall be factory fabricated, air tight gasketed flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

1. Model: 699 manufactured by Ventfabrics; or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Provide volume dampers at points on supply, return, and exhaust systems where indicated and where branches are taken from larger ducts and as required for air balancing.

C. Provide fire dampers and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.

D. Demonstrate re-setting of fire dampers to authorities having jurisdiction and Owner's representative.

E. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.

F. Provide 14 IN x14 IN duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated.

G. Provide duct test holes where indicated and where required for testing and balancing purposes.

END OF SECTION

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SECTION 23 34 00 - HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Heating, ventilating, and cooling equipment.

1.02 RELATED REQUIREMENTS

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

B. Division 01 - General Requirements.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Section 23 05 93 - Testing, Adjusting, and Balancing.

E. Section 23 09 00 - HVAC Instrumentation and Controls .

F. Section 23 31 10 - Ductwork.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI):

1. Steel Products Manual.

B. Air Movement and Control Association (AMCA).

C. Air Conditioning and Refrigeration Institute (ARI).

D. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

1. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."

E. Canadian Standards Association (CSA).

F. FM Global (FM).

G. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

H. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

I. National Roofing Contractors Association (NRCA).

J. Underwriters Laboratories, Inc. (UL):

1. 507, Standard for Electric Fans.

K. Building code:

1. International Code Council (ICC):

a. International Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.04 SUBMITTALS

A. Shop Drawings:

1. Submit under provisions of section 01 33 00.

2. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

c. Wiring diagrams.

d. Control diagrams.

e. Manufacturer's catalog cuts and technical data.

f. Corrosion-protection information.

g. Fan curves.

h. Sound data.

i. Vibration isolation.

j. Performance data on all equipment.

3. Certifications:

a. Provide certification of thickness of corrosion-protection coating.

B. Operation and Maintenance Manuals:

1. See Specification Sections 01 61 02 and 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

1.05 QUALITY ASSURANCE

A. Miscellaneous:

1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.

2. Corrosion protection of equipment to be as specified herein.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Inline fans:

a. Loren Cook.

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b. Aerovent.

c. Greenheck.

d. Twin City.

2. Industrial Ceiling fans:

a. Big Ass Fans.

b. MacroAir Fans.

3. Wall-mounted and ducted propeller-type fans:

a. Loren Cook.

b. Aerovent.

c. PennBarry Ventilator Co., Inc.

d. Greenheck.

e. Twin City/

4. Toilet room exhaust fans:

a. PennBarry Ventilator Co., Inc.

b. Loren Cook.

c. Greenheck.

d. Twin City.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 GENERAL

A. All Manufactured Units:

1. Comply with Specification Section 01 61 03 .

2. Factory wired and assembled.

3. Use fasteners made of same material as unit.

4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:

a. Type: As per ASHRAE HVAC Applications Handbook.

2.03 MANUFACTURED UNITS

A. In-Line Centrifugal Fans :

1. AMCA certified Class I, II, or III.

2. Non-overloading horsepower capability.

3. Materials:

a. Wheel, impeller hub and blades: Aluminum or stainless steel.

b. Housing, innertube and belt well: Aluminum or stainless steel.

c. Inlet cone: Aluminum or stainless steel.

d. Driver shaft: Solid stainless steel.

4. Airfoil design blades.
   a. All welded construction.
5. All welded housing, innertube and belt well.
6. Innertube construction:
   a. Isolates bearings and drive from airstream.
   b. Removable end covers.
7. Bearings:
   a. Cast iron pillow blocks.
   b. Concentric bearing locking collar for drive shafts 1 IN and larger.
      1) SKF "ConCentra."
      2) Dodge "D Lock."
   c. Regreaseable.
   d. 200,000 HR average life.
8. Motor:
   a. See Specification Section 01 61 03.
   b. Driver and driven sheaves:
      1) Keyed hub type.
      2) Drive sheaves: Fixed pitch diameter.
      3) Driver:
         a) Shipped with variable pitch diameter sheave.
         b) Fixed pitch diameter size based on approved test and balance reports.
      4) V-belt drives sized for 150 percent motor horsepower.
9. Adjustable motor base.
10. Automatic drive belt tensioner.
11. Flanged inlet and outlet.
12. Accessories:
    a. Weatherproof, louvered motor enclosure for exterior installation.
    b. Internal inlet damper with external control linkage.
    c. Stack hood.
    d. Cam type access door.
    e. Ceramic felt shaft seal.
    f. Extended grease links and fittings.
13. Size and capacity as scheduled on Drawings.

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14. Section 01 61 03.

B. Wall-Mounted and duct-mounted Propeller-Type Fans:

1. AMCA certified.
2. Industrial quality.
3. Materials:
    a. Propeller: Cast aluminum or aluminum.
    b. Venturi: Spun aluminum.
    c. Panel and supports: Aluminum or stainless steel.
    d. Drive shaft: Solid stainless steel.
    e. Sheaves: Cast iron.
4. Propellers:
    a. Statically and dynamically balanced.
    b. Airfoil design.
    c. Minimum four (4) blades.
5. Bearings:
    a. Cast iron pillow blocks.
    b. Concentric bearing locking collar for drive shafts 1 IN and larger.
        1) SKF "ConCentra."
        2) Dodge "D Lock."
    c. Regreaseable.
    d. 200,000 HR average life.
6. Welded reinforced motor base plate.
7. Adjustable motor base.
8. Motor:
    a. See Specification Section 01 61 03.
    b. Driver and driven sheaves:
        1) Keyed hub type.
        2) Drive sheaves: Fixed pitch diameter.
        3) Driver:
            a) Shipped with variable pitch diameter sheave.
            b) Fixed pitch diameter size based on approved test and balance reports.
        4) V-belt drives sized for 150 percent motor horsepower.
9. Automatic drive belt tensioner.
10. Accessories:

a. Inlet guard.
b. Outlet guard.
c. Heavy-duty automatic shutter.
d. Mounting adapter.
e. Bird screen.
f. Extended grease lines and fittings.

11. Size and capacity as scheduled on Drawings.

C. Industrial Ceiling Fan:

1. UL listed.
2. High volume, low speed.
3. Materials: .
   a. Steel Motor frame and mount with powder coated paint.
   b. Sprayproof and corrosion resistant .
4. Blades:
   a. Extruded aluminum alloy.
   b. Airfoil..
   c. Rolled edges.
   d. Weight balanced.
5. Bearing:
   a. Neoprene sealed ball bearings, upper and lower.
6. Motor:
   a. See Specification Section 01 61 03.
   b. UL 507, waterproof tested.
   c. Internal thermal overload protection.
   d. Totally enclosed.
   e. Direct drive or gear driven.
   f. Induction type inverter rated if fan provided with VFD.
7. Secondary cable support assembly.
8. Accessories:
   a. Solid state motor speed controller or VFD controller.
   b. Downrod and support as recommended by manufacturer.

D. Toilet Room Exhaust Fans:

1. AMCA certified.
2. UL listed.

3. Materials: Galvanized steel.
4. Centrifugal wheels.
5. Permanently lubricated motor.
6. Acoustically insulated housing.
7. Resilient rubber-in-shear vibration isolation.
8. Fan, motor, and wheel assembly removable from housing.
9. Duct flanged outlet.
10. Integral backdraft damper.
11. Minimum 85-percent free open area face grill.
12. Accessories:
    a. Integral exhaust grille.
    b. Wall cap.
13. Size and capacity as scheduled on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

3.02 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

3.03 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

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SECTION 23 34 23 - POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Centrifugal roof exhausters.
2. Ceiling exhaust fans.

1.02 REFERENCED STANDARDS

A. AMCA 99 - Standards Handbook.

B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.

C. AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal.

D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.

E. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.

F. NEMA MG1 - Motors and Generators.

G. NFPA 70 - National Electrical Code.

H. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial cooking Equipment.

I. UL 705 - Power Ventilators.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point clearly plotted, sound power levels at rated capacity, materials of construction, dimensions, and electrical characteristics and connection requirements.

C. Manufacturer's Installation Instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01 61 02.

B. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 EXTRA MATERIALS

A. Provide two sets of belts for each belt drive fan.

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PART 2 - PRODUCTS

2.01 PRODUCTS

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

1. Exhaust Fans:

a. Carnes Company, Inc.

b. Greenheck Fan Corp.

c. ACME.

d. PENN Ventilator Co.

e. Cook Co.

f. I.L.G. Industries, Inc.

2.02 CENTRIFUGAL ROOF EXHAUSTERS

A. Performance: As scheduled on Drawings.

B. Product Requirements:

1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

3. Fabrication: Conform to AMCA 99.

4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

C. Fan Unit: V-belt or direct driven as indicated, backward inclined wheel, with upblast spun aluminum housing; resilient mounted motor; 1/2 IN (13 mm) mesh, wire birdscreen; square base to suit roof curb with continuous curb gaskets.

D. Roof Curb: 12 IN (200 mm) high self flashing of galvanized steel or[aluminum with continuously welded seams, built in cant strips interior baffle with minimum 1 IN (25 mm) acoustic insulation, curb bottom, and factory installed nailer strip.

E. Electrical Characteristics and Components:

1. Electrical Characteristics as indicated on Drawings.

2. Motor: NEMA MG1, ODP.

3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

4. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor.

F. Backdraft Damper: Aluminum multiple blade construction, felt or vinyl edge seals, with nylon bearings; [Gravity] operated.

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G. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self aligning pre-lubricated ball bearings.

2.03 CEILING EXHAUST FANS

A. Performance as scheduled on Drawings.

B. Centrifugal Fan Unit: Direct driven with galvanized steel housing lined with 1/2 IN (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.

C. Electrical Characteristics and Components:

1. Electrical Characteristics as indicated on Drawings.

2. Motor: NEMA MG1, [ODP], permanently lubricated.

3. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

D. Grille: Molded white plastic or aluminum with baked white enamel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated steel or stainless steel lag screws to roof curb.

C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.

D. Provide sheaves required for final air balance.

E. Install backdraft dampers on inlet to roof exhaust fans.

F. Provide backdraft dampers on outlet from ceiling exhaust fans and in the wall/roof cap.

G. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan have been test run under observation.

3.02 CONNECTIONS

A. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.

B. Electrical Connections: The following requirements apply:

1. Electrical power wiring and grounding is specified in Division 26.

3.03 ADJUSTING, CLEANING AND PROTECTING

A. Adjust damper counterbalance for proper damper operation.

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B. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

END OF SECTION

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SECTION 23 37 00 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Diffusers.
2. Registers/grilles.
3. Door grilles.
4. Louvers.
5. Roof penthouses.

1.02 REFERENCED STANDARDS

A. ADC 1062 - Certification, Rating and Test Manual.

B. AMCA 500 - Test Method for Louvers, Dampers and Shutters.

C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

D. ARI 650 - Air Outlets and Inlets.

E. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.

F. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.03 QUALITY ASSURANCE

A. Test and rate performance of air outlets and inlets in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.

B. Test and rate performance of louvers in accordance with AMCA 500.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A.

1.05 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Provide product data for items required for this project.

C. Submit schedule of outlets and inlets indicating type, size, location, application, materials of construction, pressure loss, and noise level. Submit pressure loss and water penetration data for louvers.

D. Review requirements of outlets and inlets as to size, finish, and type of mounting prior to submitting product data and schedules of outlets and inlets.

E. Submit manufacturer's installation instructions under provisions of Section 01 33 00.

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PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Diffusers/Grilles:

a. Titus.

b. Price.

c. Nailor.

d. Carnes.

e. Krueger.

2. Louvers:

a. Ruskin.

b. Air Balance.

c. Greenheck.

d. Air Flow.

e. Louvers & Dampers, Inc.

f. Arrow.

2.02 RECTANGULAR CEILING DIFFUSERS

A. Rectangular, adjustable pattern, stamped, multicore type diffuser to discharge air in pattern indicated on Drawings with sectorizing baffles where indicated.

B. Provide border or frame type indicated on Drawings.

C. Fabricate of steel with baked enamel off-white finish.

D. Where indicated, provide duct mounted butterfly with wrench locking quandrants.

2.03 PERFORATED FACE CEILING RETURN GRILLES

A. Perforated face with fully adjustable pattern and removable face.

B. Provide border or frame type indicated on Drawings.

C. Fabricate of steel with steel frame and baked enamel off-white finish.

D. Where indicated, provide grille mounted OBD damper.

2.04 CEILING EXHAUST GRILLES

A. Streamlined blades, minimum depth 3/4 IN, maximum 3/4 IN (19 mm) spacing, with spring or other device to set blades, horizontal face.

B. Provide border or frame type indicated on Drawings with concealed mounting.

C. Fabricate of steel with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, with factory baked enamel, off white finish.

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D. Where indicated, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.05 WALL REGISTERS

A. Streamlined and individually adjustable double deflection blades, minimum depth 3/4 IN, 3/4 IN (19 mm) maximum spacing vertical and horizontal and face.

B. Provide border or frame type indicated on Drawings concealed mounting and gasket.

C. Fabricate of steel with 20 gauge (0.90 mm) minimum frames and 22 gauge (0.80 mm) minimum blades, with factory baked enamel off-white finish.

D. Where indicated, provide integral, gang-operated opposed blade dampers with removable key operator, operable from face.

2.06 DOOR GRILLES

A. V-shaped louvers of 20 gauge (0.90 mm) steel, 1 IN (25 mm) deep on 1/2 IN (13 mm) centers.

B. Provide 20 gauge (0.90 mm) steel frame with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.

2.07 LOUVERS

A. Provide storm proof louvers with vertical blades with built-in rain hooks, heavy channel frame with integral caulking slot, birdscreen with 1/2 IN (13 mm) square mesh for exhaust and 3/4 IN (19 mm) for intake, stainless steel anchors; louver depth as indicated on Drawings.

B. Fabricate 0.125 IN (3.1 mm) extruded aluminum, welded assembly, with factory finish of prime coat. Paint to match same color of the building.

C. Parallel blade damper, frame and blades of 0.08 IN thick aluminum, low leakage type with blade edge seals of vinyl or EPDM, air leakage less than 12 cfm/SQ FT at 4 IN WC differential pressure, tested in accordance with AMCA Standard 500.

D. Damper operators, electric two position with spring to fail closed. Operators suitable for 120 or 24 volt 60 Hz power supply. Operators provided by temperature control.

E. Furnish with flat flange for installation.

2.08 ROOF PENTHOUSES

A. Fabricate roof penthouses in accordance with SMACNA HVAC Duct Construction Standards.

B. Fabricate of galvanized steel, minimum 16 gage (1.50 mm) base and 20 gage (0.90 mm) hood minimum 0.0625 IN (1.50 mm) thick base and 0.050 IN (1.20 mm) thick hood; suitably reinforced welded construction; with removable hood; birdscreen with 1/2 IN (13 mm) square mesh for exhaust and factory baked enamel finish; color to be selected.

C. Mount unit on minimum 12 IN (300 mm) high curb base with insulation between duct and curb.

D. Make hood outlet area minimum of twice throat area.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Install items in accordance with manufacturers' instructions.

B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.

C. Install diffusers to flexible ductwork with airtight connection.

D. Provide balancing dampers on duct take-off to diffusers.

E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

END OF SECTION

UP-Pirate-0005521

SECTION 23 40 10 - AIR CLEANING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Disposable panel filters.
2. Filter frames.

1.02 REFERENCED STANDARDS

A. ANSI/UL 900 - Test Performance of Air Filter Units.

B. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Filter media, filter performance data, filter assembly and filter frames.

1.04 QUALITY ASSURANCE

A. Filter media shall be ANSI/UL 900 listed, Class 1 or Class 2, as approved by local authorities.

B. Provide all filters as product of one manufacturer.

C. Assemble filter components to form filter banks from products of one manufacturer.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01 61 02.

1.06 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products under provisions Section 01 61 02.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

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

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1. Air Filters:
    a. American Air Filter Co.
    b. Cambridge Filter Corp.
    c. Continental Air Filters.
    d. Farr Co.

2.02 DISPOSABLE PANEL FILTERS

A. Media: Thick fiber blanket, factory sprayed with flameproof, non-drip, non-volatile adhesive, nominal size as required 2 IN (50 mm) thick.

B. Rating: 400 fpm (2.03 m/sec) face velocity, 0.30 IN WG (80 Pa)

C. Casing: Cardboard frame with perforated metal retainer.

2.03 FILTER FRAMES

A. General: Fabricate filter frames and supporting structures of 16 gauge (1.50 mm) galvanized steel or extruded aluminum T-section construction with necessary gasketing between frames and walls.

B. Standard Sizes: Provide for interchangeability of filter media of other manufacturers; for panel filters, size as required filter media, minimum 2 IN (50 mm) thick.

C. Side Servicing Housings: Flanged for insertion into ductwork, of reinforced 16 gauge (1.5 mm) galvanized steel; access doors with continuous gasketing and positive locking devices on both sides; extruded aluminum tracks or channels for filters with positive sealing gaskets.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install air cleaning devices in accordance with manufacturer's instructions.

B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction.

D. Install filter gauge static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and level.

END OF SECTION

UP-Pirate-0005523

SECTION 23 54 10 - FORCED AIR FURNACES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Forced air furnaces.
2. Refrigerant cooling coil.
3. Humidifier.
4. Filter.
5. Controls.
6. Economizer.

1.02 REFERENCED STANDARDS

A. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

B. ANSI/ASHRAE - 90A - Energy Conservation in New Building Design.

C. ANSI/ASHRAE - 103 - Heating Seasonal Efficiency of Central Furnaces and Boilers, Methods of Testing.

D. ANSI/NEMA MG 1 - Motors and Generators.

E. ANSI/NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

F. ANSI/UL 207 - Refrigerant - Containing Components and Accessories, Non-Electrical.

G. ANSI/Z223.1 (NFPA 54) - National Fuel Gas Code.

H. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

I. ARI 520 - Positive Displacement Refrigerant Compressors, Compressor Units and Condensing Units.

J. ASHRAE 52 - Method of Testing Air Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

K. FS F-F 310A - Filter, Air Conditioning: Viscous Impingement and Dry Types, Replaceable.

L. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Submit shop drawings indicating assembly, required clearances, and location and size of field connections.

C. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

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D. Design data: Indicate refrigerant pipe sizing.

E. Manufacturer's Installation Instructions: Indicate rigging, assembly, and installation instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit operation data under provisions of section 01 33 04.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

1.05 QUALITY ASSURANCE

A. Perform Work in accordance with ANSI/ASHRAE 15.

B. Maintain one copy of each document on site.

1.06 WARRANTY

A. Provide five year warranty under provisions of section 07 78 34.

B. Warranty: Include coverage for heat exchangers and compressors.

1.07 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Division 01.

B. Provide two of each filter under provisions of Division 01.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Bryant.

B. Lennox.

C. Carrier.

D. York.

2.02 MANUFACTURED :UNITS

A. Configuration: Upflow type with natural gas burner and electric refrigeration.

B. Units: MIL-F-17104E; Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, gas burner or heater, controls, air filter, humidifier , refrigerant cooling coil with an extended plenum.

C. Construction and Ratings: In accordance with ARI 210/240. Testing: ASHRAE 14.

D. Performance Ratings: Energy Efficiency Rating (EER) not less than requirements of ANSI/ASHRAE 90A; seasonal efficiency to ANSI/ASHRAE 103.

E. Refer to Furnace Schedule. Heating capacities are sea level ratings. Cooling performance is based on ARI 210/240 test conditions.

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2.03 FABRICATION

A. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner .

B. Heat Exchanger: Aluminized welded construction.

C. Combustion Chamber: ANSI/UL 727; or ANSI/UL 729; welded stainless steel. secondary chamber.

D. Supply Fan: Centrifugal type rubber mounted with direct or belt drive.

E. Motor: ANSI/NEMA MG 1; 1750 rpm rubber multi-speed isolated hinge mounted.

F. Air Filters: FS F-F-300A; or FS F-F-310A; pleated glass fiber, disposable type in a filter housing. Refer to specification section "Air Cleaning."

2.04 BURNER

A. Natural Gas Burner: High efficiency (95 percent) atmospheric type with 2 IN PVC combustion air supply pipe, combination gas valve and pressure regulator incorporation manual shut- off, pilot valve, automatic 100 percent shut-off and thermo-couple pilot safety device, electronic pilot ignition, and 2 IN PVC Exhaust Pipe.

B. Burner Safety Controls: Thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

2.05 BURNER OPERATING CONTROLS

A. Room Thermostat: Cycles burner to maintain room temperature setting.

B. High Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature and re-energizes when temperature drops to lower safe value.

C. Control Supply Fan: Bonnet temperatures and independent of burner controls, manual switch for continuous fan operation.

2.06 HUMIDIFIER

A. Type: ARI 610; wetted plate, pan or drum, power type with float controlled water supply mounted on furnace return air plenum.

B. Accessories: Low voltage motor, transformer, bypass duct and damper, and replaceable evaporator media.

C. Room Humidistat: Electric, adjustable, to energize humidifier when fan operating, to maintain setting.

2.07 EVAPORATOR COIL

A. Coil: Copper tube aluminum fin assembly, galvanized drain pan, drain connection, refrigerant piping connections and factory installed thermostatic expansion valve.

2.08 ECONOMIZER

A. Mixing Damper Economizer box: Multi-Position Damper Box with modulating dampers and actuator. Damper blades edged with polyurethane or neoprene strips.

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B. Air Temperature Controlled Thermostat, Outdoor Air Thermostat, Transformer, relays, and night set-back controls to close outdoor air damper.

C. Cabinet: Heavy Gauge Steel with baked on enamel. Flanges for duct connections. Removable end panels for servicing.

D. Manufacturer, make and model: Lennox EMD-14-65 or approved equal.

2.09 REFRIGERATION OPERATING CONTROLS

A. Room Thermostat: Cycles compressor, condenser fan and supply fan to maintain room temperature setting.

B. Refrigerant Pressure Switch: Cycles condenser fan on when condenser refrigerant pressure is above 285 psig (1965 kPa) and off when pressure drops below 140 psig (965 kPa).

2.10 OPERATING CONTROLS

A. Electric solid state microcomputer based room thermostat with remote sensor.

B. Room thermostat to incorporate:

1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set-up for four separate temperatures per day.
4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
5. Short cycle protection.
6. Programming based on weekdays, Saturday and Sunday.
7. Switch selection features including imperial or metric display, 12 or 24 HR clock, keyboard disable, remote sensor, fan on-auto.
8. Battery Back-up.

C. Room thermostat display to include:

1. Time of day.
2. Actual room Temperature.
3. Programmed temperature.
4. Programmed time.
5. Duration of timed override.
6. Day of week.
7. System model indication: heating, cooling, auto, off, fan auto, fan on.
8. State (heating or cooling) operation.

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PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that floors are ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available for furnace. and condenser package. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install to NFPA 90A and ANSI/NFPA 90B.

C. Install gas fired furnaces to ANSI Z223.1 and (NFPA 54).

D. Provide PVC combustion air and exhaust connections.

E. Install humidifiers to ARI 630.

F. Mount furnaces installed on concrete bases.

END OF SECTION

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SECTION 23 55 33 - FUEL FIRED SPACE HEATERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gas fired unit heaters.
2. Controls.

1.02 REFERENCED STANDARDS

A. ANSI/ASHRAE 103 - Heating Seasonal Efficiency of Central Furnaces and Boilers, Methods of Testing.

B. ANSI/NEMA MG 1 - Motors and Generators.

C. ANSI/NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

D. ANSI/Z223.1 (NFPA 54) - National Fuel Gas Code.

E. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

C. Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

D. Manufacturer's Installation Instructions: Indicate rigging, assembly, and installation instructions.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of section 01 33 04.

B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.05 WARRANTY

A. Provide warranty under provisions of section 01 78 34.

1.06 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Division 01.

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PART 2 - PRODUCTS

2.01 UNIT HEATERS

A. Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger and controls.

B. Heating Capacity: As scheduled on Drawings. Gas heating capacity is sea level rating.

C. Air Handling:

1. Fan: Capacity as scheduled on Drawings.

2. Motor: ANSI/NEMA MG 1;

D. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.

E. Heat Exchanger: Aluminized welded construction.

F. Supply Fan: Propeller type with direct drive.

G. Gravity Draft Burner:

1. Gas Burner: Atmospheric type with adjustable combustion air supply, combination gas valve and pressure regulator incorporating manual shut-off, pilot valve, automatic 100 percent shut-off and thermocouple pilot safety device, electronic pilot ignition, vent damper, and draft diverter.

2. Burner Safety Controls: Thermocouple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.

H. Burner Operating Controls:

1. Room thermostat: Cycles fan and burner to maintain room temperature setting.

2. High Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on high bonnet temperature and re-energizes when temperature drops to lower value.

3. Fan Control: Thermostat cycles supply fan, with sub-base with fan auto-off-on switch.

I. Operating Controls:

1. Room Thermostat: 24 or 115 volt, to control burner operation, to maintain temperature setting. Include fan control switch (auto-on) include factory wired control power transformer for 24 volt controls.

J. Accessories:

1. Discharge Louvers: Individually adjustable horizontal louvers to match cabinet finish.

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PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that space is ready for installation of units and openings are as indicated on shop drawings.

B. Verify that proper power supply is available.

C. Verify that proper fuel supply is available for connection.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install to NFPA 90A and ANSI/NFPA 90B.

C. Install gas fired units to ANSI Z223.1 (NFPA 54).

D. Provide vent connections to ANSI/NFPA 211.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of equipment, including piping and electrical connections.

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

3.04 COMMISSIONING

A. Perform the following final checks before startup:

1. Verify that specified tests of piping systems are completed.
2. Check for lubricating oil in lubricated-type equipment.
3. Check safety valves for correct settings. Ensure settings are as specified.

B. Starting Procedures: Follow manufacturer's written instructions. If no instructions are prescribed by manufacturer, proceed as follows:

1. Energize circuits.
2. Start and run equipment through complete sequence of operations.
3. Check for excessive vibration and noise. Correct problems.
4. Check gas pressure.
5. Manually operate safety valves.
6. Adjust operating controls, including pressure settings.

C. Operate and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment discovered by service representative.

3.05 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventative maintenance.
2. Review data in the operation and maintenance manuals. Refer to section 01 33 04.
3. Schedule a 2 HR training session with Owner with at least 7 days' advance notice.

END OF SECTION

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SECTION 23 62 13 - AIR COOLED CONDENSING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Condensing unit package. (Part of computer room system).
2. Charge of refrigerant and oil.
3. Controls and control connections.
4. Refrigerant piping connections.

1.02 REFERENCED STANDARDS

A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.

B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.

C. ARI 365 - Commercial and Industrial Unitary Air Conditioning Condensing Units.

D. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

E. NEMA MG-1 - Motors and Generators.

F. NFPA 70 - National Electrical Code.

G. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

H. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.

I. UL 303 - Refrigeration and Air-Conditioning Condensing, and Air-Source Heat Pump Equipment.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

C. Submit product data under provisions of Division 01.

D. Submit product data indicating rated capacities, weights, materials of construction, finishes, specialties and accessories, electrical nameplate data, and wiring diagrams.

E. Submit design data under provisions of Division 01.

F. Submit design data indicating pipe and equipment sizing.

G. Submit manufacturer's installation instructions under provisions of Division 01.

1.04 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of section 01 33 04.

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B. Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of section 01 65 50.

B. Store and protect products under provisions of section 01 65 50.

C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

D. Protect units on site from physical damage. Protect coils.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. Units: Self-contained, packaged, factory assembled and prewired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.

B. Construction and Ratings: In accordance with ARI 210/240, UL 207 and UL 303.

C. Performance Ratings: Energy Efficiency Ratio (EER) tested and certified in accordance with ARI 210/240 and ARI 365.

D. Performance: As scheduled on Drawings.

2.02 CASING

A. House components in weatherproof galvanized steel casing with weather resistant, baked enamel finish.

B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors or removable access panels.

2.03 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Pressure test with leak detection gas, dehydrate, and seal.

B. Coil Guard: PVC coated steel wire or louvered panels.

2.04 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor with permanent lubricated ball bearings and built in thermal overload protection.

C. Motors: To NEMA MG-1.

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2.05 COMPRESSORS, 11 TONS CAPACITY AND LESS

A. Construction: Hermetic scroll or reciprocating type with heat treated forged steel or cast iron shafts, rings to prevent gas leakage, suction and discharge valves, and sealing surface immersed in oil.

B. Mounting: Statically and dynamically balance rotating parts and mount on vibration isolators.

C. Motor: Constant speed suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting, to NEMA MG-1. Furnish with starter, to NFPA 70.

D. Crankcase Heater: Evaporates refrigerant returning to crankcase during shut down.

2.06 REFRIGERANT CIRCUIT

A. Provide complete refrigerant circuit factory supplied and piped. Comply with ASHRAE 15.

B. Provide the following for each refrigerant circuit:

1. Filter dryer, replaceable core type.
2. Liquid line sight glass and moisture indicator.
3. Thermal expansion valve for maximum operating pressure.
4. Insulated suction line.
5. Suction and liquid line service valves and gage ports.
6. Liquid line solenoid valve.
7. Charging valve.
8. Discharge line check valve.
9. Compressor discharge service valve.
10. Condenser pressure relief valve.

C. Refrigerant: Fully charge completed system with R 410 A or R 407C.

D. Provide pre-insulated ACR copper refrigerant piping set.

2.07 CONTROLS, 11 TONS CAPACITY AND LESS

A. Unit mounted weatherproof steel control panel, containing power and control wiring, disconnect switch, factory wired for single point power connection.

B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer. Provide manual reset current overload protection. For each condenser fan, provide across the line starter with starter relay.

C. Provide the following safety controls arranged so that operating any one will shut down machine and require manual reset:

1. High discharge pressure switch.
2. Low suction pressure switch.

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3. Oil Pressure switch.

D. Provide the following operating controls:

1. Thermostat located in room cycles compressors and activates solenoid valves in refrigerant circuit.
2. Five minute off timer prevents compressor from short cycling.
3. Low ambient temperature controls.

E. Provide controls to permit operation down to 25 DegF (-4 DegC) ambient temperature.

1. Thermostat to cycle fan motors in response to outdoor ambient temperature.
2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
3. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.

F. Provide low voltage, programmable thermostat to control supply fan to maintain temperature setting.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions and NFPA 90A.

B. Provide for connection to electrical service.

C. Install units on concrete base.

D. Provide connection to refrigeration piping system and evaporators. Comply with ASHRAE 15.

3.02 MANUFACTURER'S FIELD SERVICES

A. Prepare and start systems under provisions of Division 01.

B. Provide initial and cooling season startup during first year of operation, including routine servicing and check out.

C. Supply initial charge of refrigerant and oil for each refrigerant circuit. Replace losses of refrigerant and oil.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of equipment, including piping and electrical connections.

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

3.04 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to demonstrate and train Owner's maintenance personnel as specified below.

1. Train Owner's Maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventive maintenance.
2. Review data in the operation and maintenance manuals. Refer to Section 01 33 04 "Operation and Maintenance Manuals."
3. Schedule a 2 HR training session with Owner with at least 7 days' advance notice.

END OF SECTION

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SECTION 23 80 00 - HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Heating, ventilating, and cooling equipment.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

B. Division 01 - General Requirements.

C. Section 01 61 02 - Basic Mechanical Requirements.

D. Section 01 61 03 - Equipment Basic Requirements.

E. Section 01 61 04 - Electrical Requirements for Mechanical Equipment.

F. Section 23 05 48 - Vibration Control.

G. Section 23 05 93 - Testing, Adjusting, and Balancing .

H. Section 23 09 00 - HVAC Instrumentation and Controls .

I. Section 23 09 93 - Sequence of Operation.

J. Section 23 31 10 - Ductwork.

K. Section 23 62 13 - Air Cooled Condensing Units.

L. Section 23 81 30 - Variable Refrigerant Volume (VRV) Systems.

M. Section 23 81 23 - Computer Room Air Conditioning Units.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI):

1. Steel Products Manual.

B. Air Movement and Control Association (AMCA).

C. Air Conditioning and Refrigeration Institute (ARI).

D. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):

1. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."

2. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.

3. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

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4. 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. Canadian Standards Association (CSA).

F. FM Global (FM).

G. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

H. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

I. National Roofing Contractors Association (NRCA).

J. Underwriters Laboratories, Inc. (UL):

1. 507, Standard for Electric Fans.

K. Building code:

1. International Code Council (ICC):

a. International Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.04 SUBMITTALS

A. Shop Drawings:

1. Submit under provisions of section 01 33 00.

2. Fabrication and/or layout drawings.

3. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

c. Wiring diagrams.

d. Control diagrams.

e. Manufacturer's catalog cuts and technical data.

f. Corrosion-protection information.

g. Fan curves.

h. Sound data.

i. Vibration isolation.

j. Control description.

k. Performance data on all equipment.

4. Certifications:

a. Provide certification of thickness of corrosion-protection coating.

B. Operation and Maintenance Manuals:

1. See Specification Sections 01 61 02 and 01 33 04 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

1.05 QUALITY ASSURANCE

A. Miscellaneous:
    1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
    2. Corrosion protection of equipment to be as specified herein.

1.06 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Heating coil - electric:
        a. Carrier.
        b. Daikin Applied.
        c. Trane.
        d. Johnson Controls.
    2. Unit heater - electric:
        a. Brasch.
        b. Chromalox.
        c. QMark.
    3. Energy recovery units – rotary enthalpy wheel type:
        a. Greenheck.
        b. Venmar.
        c. Carnes.
        d. Cook.
    4. Air-cooled condensing units - split system: Refer to specification section 23 62 13 for condensing units serving Computer Room Air Conditioning Units.

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a. Carrier.
b. Daikin Applied.
c. Trane.
d. Johnson Controls.

5. Air-Handling Units:
   a. Daikin Applied.
   b. Trane.
   c. Carrier.
   d. Johnson Controls.
6. Packaged Terminal Air Conditioning Equipment:
   a. Amana.
   b. LG.
   c. Mitsubishi.
   d. Trane.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 GENERAL

A. All Manufactured Units:
   1. Comply with Specification Section 01 61 03.
   2. Factory wired and assembled.
   3. Use fasteners made of same material as unit.

2.03 MANUFACTURED UNITS

A. Equipment Coils:
   1. Cooling coils - direct expansion:
      a. ARI certified.
      b. Material:
         1) Aluminum.
         2) Copper with aluminum fins for use in administration units only.
      c. Fin spacing: Minimum 80 fins per foot.
      d. Minimum standard operating limit: 250 psi.
      e. Size and capacity as scheduled.
   2. Heating coil - electric:
      a. ARI certified.
      b. 80-percent nickel, 20-percent chromium elements.

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c. Maximum heating density: 35 watts/SQ IN.

d. Built-in thermal protection.

e. Airflow switch.

f. Built-in circuit fusing.

g. Control voltage transformer.

h. Terminal block.

i. Magnetic contactor.

j. Fused disconnect switch.

k. SCR controller.

l. Single point electrical connection.

m. Size and capacity as scheduled on Drawings.

B. Unit Heater - Electric:

1. Type: Horizontal.
2. UL listed for non-rated areas.
3. Material:
   a. Cabinet: 18 GA steel.
   b. Heating elements: Copper-clad steel.
4. Fan motors:
   a. See Specification Section 01 61 03.
   b. Built-in automatic reset overload protection.
5. Dynamically balanced fan.
6. Built-in automatic reset cutout protection.
7. Accessories:
   a. Mounting bracket.
   b. 40 to 90 DegF, 5 DegF differential internal thermostat.
8. Electrical, fan motor, and airflow data as scheduled on Drawings.

C. Duct Heaters - Electric:

1. UL listed for zero clearance.
2. Materials:
   a. Frame: Stainless steel.
   b. Heating elements: 80-percent nickel and 20-percent chromium.
   c. Element terminals: Stainless steel.
   d. Insulators and bracket bushings: Non-porous ceramic.
   e. Terminal box: Aluminized steel.

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3. Heating elements:
    a. Coils: See paragraph(s) in Article 2.3, Equipment Coils.
4. Automatic reset thermal cutout.
5. Standard, manually replaceable, thermally operated secondary cutout.
6. Duct mounting: flanged.
7. Size and capacity as scheduled on Drawings.

D. Energy Recovery Unit (ERU) - Rotary Enthalpy Wheel Type:
1. Rotary type air-to-air total enthalpy wheel shall be furnished with desiccant coated aluminum heat transfer media.
2. Energy recovery component certified in accordance with ARI standard 1060-2001.
3. Unit shall have housing suitable for interior floor mounting or suspended installation with lifting lugs, integral heating and cooling with remote condenser where indicated on plans, drain connections side access panels and base frame.
4. Cabinet:
    a. 18 gauge Galvanized (G90) steel construction for components that do not receive a painted finish. Components that receive a painted finish per A/E specification shall be of 18 gauge type A60 galvanneal steel and shall be painted with a baked industrial enamel finish.
    b. Solid double wall construction with 1in. 3lb. density insulation where indicated on plans.
    c. Inlet and outlet configuration as indicated on plans.
5. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel.
6. Fans, forward curved, centrifugal type with statically and dynamically balanced impellers shall be supplied for both supply and exhaust. Blower assembly shall be mounted on heavy gauge rails and further mounted on 1.125in thick neoprene vibration isolation pads.
7. Factory mounted variable frequency drives on supply and exhaust fans for ease of balancing. Variable frequency drive shall operate at a constant speed to obtain airflows listed on plans.
8. Fan motor shall be thermally protected.
9. Factory-wired starters shall be furnished.
10. Backdraft dampers shall be supplied for both exhaust and supply airstreams.
11. Filter: The supply and exhaust air streams shall be filtered prior to entering the energy wheel by means of a 2", MERV 8 throw-away filters for all buildings except the Yard Building. For the Yard Building, provide MERV 13 filter in tandem. Refer to plans and specification section 23 40 10 for additional requirements.

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12. Cooling Coil:
    a. Where indicated on plans.
    b. Refer to paragraph on equipment coils.
13. Heating Coil:
    a. Electric heating coil where indicated on plans.
    b. Open coil heating elements.
    c. High grade Nickel-Chrome alloy coils.
    d. Corrosion resistant frame.
    e. Ceramic coil support busshings.
    f. SCR controller.
14. Control:
    a. Factory mounted DDC controller programmed for BACnet IP protocol with capability of communication with HVAC controls. Provide necessary software/hardware
    b. Refer to specification section 23 09 93 for ERU sequence of operation.
    c. The unit shall be compatible and controlled by the installed VRV system control panel.
    d. The unit shall be capable of the following method of control:
    e. Centralized control – The unit shall be operable by a centralized control without the need for a local remote controller to be connected.
    f. The unit shall be capable of the following modes of operation:
        1) Energy recovery.
        2) Bypass ventilation – The unit shall be capable of bypass ventilation which diverts air flow around the heat exchanger core. No energy recovery is performed.
        3) Auto Mode – The unit shall be capable of automatically determining the need for performing energy recovery or bypassing the heat exchanger core based on the current fan coil operation mode and the current indoor and outdoor temperatures.
        4) Fresh-up Mode (supply) – The unit shall be capable of entering Fresh-up Supply operation in which the incoming supply air ratio is greater than the exhaust air ratio.
        5) Fresh-up Mode (exhaust) – The unit shall be capable of entering Fresh-up Exhaust operation which in the incoming supply air ratio is less than the exhaust air ratio.
        6) Night Time Free Cooling – The unit shall be capable of Night Time Free Cooling in which the unit will automatically energize to lower the space temperature based on the current outdoor temperature, the current indoor temperature, current set point, and the operating state of the indoor fan coils.

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15. Factory mounted and wired phase and brown out protection.
16. Size and capacity as scheduled on Drawings.

E. Air-Cooled Condensing Units - Split System:
   1. Refer to specification section 23 62 13 for Condensing units serving Computer Room Air Conditioning Units.
   2. ARI rated.
   3. UL listed.
   4. Materials:
      a. Casing: Galvanized steel.
      b. Mounting/lifting rails: Steel.
      c. Outdoor coil: Seamless aluminum tubing and aluminum fins.
      d. Fan blades: Aluminum.
   5. Weatherproof casing:
      a. Hail screen for condenser coil.
      b. Access panels.
   6. Compressor:
      a. Hermetically sealed.
      b. Internal pressure protector.
      c. Crankcase heater.
      d. Internal spring mounts.
      e. Centrifugal oil pump.
      f. Built-in overload protection.
   7. Condenser fans and motors:
      a. Vertical discharge.
      b. Direct drive.
      c. Statically and dynamically balanced.
      d. Motor:
         1) See Specification Section 01 61 03.
         2) Permanently lubricated bearings.
         3) Built-in current and thermal overload protection.
   8. Built-in refrigerant filter dryer.
   9. Built-in liquid line and gas line service valves with gage ports.
   10. Outdoor coil:
      a. Fins mechanically bonded to tubing.

b. Lab tested to 2000 psi.

11. 24 V factory-wired controls to include fusing and control power transformer.
12. Size and capacity as scheduled on Drawings.

F. Air-Handling Units:

1. ARI certified.
2. UL listed.
3. Unit Construction:

a. Fabricate unit with 16 GA channel posts and panels secured with mechanical fasteners.

1) Seal all panels, access doors, and ship sections with permanently applied bulb-type gasket.

2) Loose shipped gasketing is not allowed.

b. Construct panels and access doors as a 2 IN nominal thick; thermal broke double wall assembly, injected with 1" expanded foam insulation.

1) Construct the outer panel and the inner liner of G90 galvanized steel.

c. Panel deflection:

1) Do not exceed L/240 ratio at 125 percent of design static pressure, maximum positive or negative 8 IN of static pressure.

2) Measure deflection at the midpoint of the panel height.

d. Casing leakage rate: Do not exceed 0.5 cfm per square foot of cabinet area at 6 IN of negative static pressure or 5 IN of positive static pressure.

e. Module to module assembly:

1) Provide an overlapping, full perimeter, insulated, internal splice joint sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.

f. Entire unit: Provide a 4 IN full perimeter base rail for structural rigidity and condensate trapping.

g. Access doors:

1) Flush mounted to cabinetry, with minimum of two (2), 6 IN long stainless steel piano-type hinges, latch and full size (4.5 IN minimum) handle assembly (provide inspection window for fan section).

2) Swing outward for unit sections under negative pressure (inward for unit sections under positive pressure).

3) Provide a secondary latch to relieve pressure and prevent injury upon access on doors limited from swinging inward (such as side access filter sections) on positive pressure sections.

h. Construct drain pans from microbial resistant coated galvanized steel or stainless steel with cross break and double sloping pitch to drain connection.

1) Provide drain pans under cooling coil section.

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2) Drain connection centerline: A minimum of 3 IN above the base rail to aid in proper condensate trapping.

3) Drain connections that protrude from the base rail are not acceptable.

4. Fan section:

a. Fans:

1) Double-width, double-inlet, multiblade centrifugal type.

2) Statically and dynamically balanced.

3) Hollow or Solid shafts.

4) Forward curved fans.

5) Die formed fan housing.

6) 200,000 HR grease lubricated ball-bearings.

5. Motors: See Specification Section 01 61 03.

6. V-belts and drives sized for 150 percent motor capacity.

7. Factory mounted variable frequency drives on supply fans for ease of balancing. Variable frequency drive shall operate at a constant speed to obtain airflow listed on plans.

8. Heating coil section:

a. Electric: See paragraph(s) in Equipment Coils.

9. Cooling coil section:

a. Direct expansion: See paragraph(s) in Equipment Coils.

10. Filter section:

a. Filters: Refer to plans and specification section 23 40 10 for requirements.

b. Non-insulated cabinet.

c. Access doors for filter removal.

11. Insulated drain pan with drain connections.

12. Control panel for electric heat:

a. Integral.

b. Controls and safety devices, factory-wired, in accordance with NFPA 70 requirements.

c. NEMA 12 construction.

13. Type: Draw through.

14. Size and capacity as scheduled on Drawings.

G. Packaged Terminal Air Conditioning Units:

1. Packaged, self-contained, through-the-wall air-cooled, terminal heat pump unit with wall sleeve, room cabinet, electric refrigeration system, electric heat, outside air louvers, remote thermostat.

2. Cabinet:
    a. Wall mounted, 18 gauge galvanized steel with epoxy coated finish, removable front panel with concealed latch. Color selection by the Architect/Owner.
    b. Discharge grille and access door: Integral front discharge grille with hinged door in top or front of cabinet for access to controls.
3. Wall Sleeves and Louvers:
    a. Wall sleeves: 15 gauge galvanized steel with protective mastic coating.
    b. Louver: Companion flanged anodized aluminum. Color selection by the Architect/Owner.
4. Refrigeration System:
    a. Direct expansion coil.
    b. Hermetically sealed compressor with internal spring isolation, external isolation, permanent split capacitor motor and overload protection.
    c. Condenser coil and fan.
    d. Reversing valve.
5. Air System: Centrifugal forward curved evaporator fans with permanent split capacitor motor, permanent washable filters, positive pressure ventilation damper with concealed manual operator.
6. Heating Coil: Electric Hot water.
7. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044 oz per $FT^2$1.3 g/m^2 of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8 IN 10 mm per footmeter.
8. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.
9. Controls:
    a. Remote mounted, weekly programmable thermostat with heat anticipator, off-heat-auto-cool, and high-low fan settings.
    b. Electric resistance heater shall be locked out when heating load can be met by heat pump alone with exception of outdoor defrost cycles.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

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C. Provide with full refrigerant charge.

3.02 FIELD QUALITY CONTROL

A. Comply with Specification Section 23 05 93.

3.03 ADJUSTING

A. Install new filters on units which have been running prior to acceptance of Project.

END OF SECTION

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SECTION 23 81 23 - COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air conditioning units.
2. Controls and control panels.

1.02 REFERENCED STANDARDS

A. ANSI/ASME - Boilers and Pressure Vessels Code.

B. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

D. ASHRAE 52 - Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

E. FS TT-C-490 - Cleaning Method and Pretreatment of Ferrous Surfaces for Organic Coatings.

F. UL - Underwriters Laboratories.

1.03 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Indicate water, drain, electrical, and refrigeration rough-in connections on shop drawings or product data.

D. Submit manufacturer's installation instructions.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of section 01 33 04.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.06 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

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C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

1.07 WARRANTY

A. Provide five (5) year manufacturer's compressor warranty under provisions of Section 01 78 34 Guarantees, Warranties, and Bonds.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Liebert.

B. Data Air.

C. Mitsubishi.

2.02 MANUFACTURED UNITS

A. Provide packaged, air cooled, factory assembled, pre-wired and pre-piped unit, consisting of cabinet, fans, filters, humidifier, controls.

B. Assemble floor mounted unit for up-flow air delivery in draw-through or blow-through configuration.

2.03 CABINET AND FRAME

A. Structural Frame: 14 gauge (1.8mm) welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings.

B. Insulation: Thermally and acoustically line cabinet interior with 1 IN (25 mm) thick acoustic duct liner.

C. Finish of Exterior Surfaces: FS TT-C-490 prepared, baked-on textured vinyl enamel; off- white color.

2.04 INDOOR UNIT

A. EVAPORATOR FANS AND MOTORS

1. Fans: Double inlet, forward curved centrifugal fans, statically and dynamically balanced, on steel shaft with self- aligning permanently lubricated ball bearings, and directly driven.

2. Motor: Drip proof, permanently lubricated ball bearing motor with built-in current and overload protection.

B. EVAPORATOR COILS

1. Alternate row circuits, direct expansion cooling coils of seamless copper tubes expanded into aluminum fins, in a flat face configuration.

2. refrigeration circuits, with hot gas mufflers, thermal expansion valve with external equalizer, liquid line solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves and charging valves, accumulator sized for liquid seal under light load.

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3. Mount coil assembly in stainless steel drain pan.

2.05 OUTDOOR UNIT

A. Condensing Units:

1. Refer to Section 23 62 13 for condensing units.

2.06 FILTERS

A. Media: Pleated, lofted, non-woven, reinforced cotton fabric or pleated fiberglass; supported and bonded to welded wire grid; enclosed in cardboard frame; 2 IN (50 mm) nominal thickness.

B. Rating: ASHRAE 52; 25-30 percent dust spot efficiency, 90-92 percent weight arrestance; 400 FT/min (2.03 m/sec) face velocity, 0.30 IN WG (75 Pa) initial resistance, 0.5 IN WG (125 Pa) recommended final resistance.

2.07 STEAM GRID HUMIDIFIER

A. The environmental control system shall be equipped with a steam generating humidifier that is controlled by the microprocessor control system. It shall be complete with disposable canister, all supply and drain valves, 1 IN (25.4mm) air gap on fill line, inlet strainer, steam distributor and electronic controls. The need to change canister shall be annunciated on the microprocessor wall box control panel. The humidifier shall have a capacity of 3 LB/HR (1.4kg/h). An LED light on the humidifier assembly shall indicate cylinder full, overcurrent detection; fill system fault and end of cylinder life conditions.

2.08 ELECTRICAL PANEL

A. Service Connections, Wiring, and Disconnect Requirements: Conform to Section 26 24 16 Panelboards.

B. Control Cabinet: NEMA 250; Integral in the condensing unit, UL listed, with access panel or door, grounding lug, combination magnetic starters with overload relays, and fusible control circuit transformer.

C. Disconnect Switch: By electrical.

2.09 MICROPROCESSOR CONTROL SYSTEM

A. Logic Circuitry: Microprocessor shall continuously monitor operation of process cooling system; continuously digitally display room temperature and room relative humidity; sound alarm on system malfunction and simultaneously display problem. When more than one malfunction occurs, flash fault in sequence with room temperature, remember alarm even when malfunction cleared, and continue to flash fault until reset.

B. Malfunctions: Power Loss, Loss of Air Flow, Clogged Air Filter, High Room Temperature, Low Room Temperature, High Humidity, Low Humidity, Compressor Overload, Low Pressure and, High Pressure.

C. Light Emitting Diodes Display: Control Power On, System On, Humidification, De-humidification taking place, Compressor operating.

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PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that system is ready to receive work and opening dimensions are as indicated on shop drawings and instructed by the manufacturer.

B. Verify that proper power supply is available.

3.02 INSTALLATION

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

B. Coordinate installation of computer room air conditioning units.

C. Provide adequate drainage connections for condensate and humidifier flushing system. Drain to nearest floor drain or mop sink.

D. Provide shut-off valves in humidifier water inlet.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of equipment, including piping and electrical connections.

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

3.04 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and to demonstrate and train Owner's maintenance personnel as specified.

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventive maintenance.
2. Review data in the operation and maintenance manuals.
3. Schedule a 2 HR training session with Owner with at least 7 days' advance notice.

END OF SECTION

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SECTION 23 81 30 - VARIABLE REFRIGERANT VOLUME (VRV) SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Variable capacity, heat recovery air conditioning system.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

B. Division 01 - General Requirements.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Section 23 05 93 - Testing, Adjusting, and Balancing.

E. Section 23 09 00 - HVAC Instrumentation and Controls.

F. Section 23 09 93 - Sequence of Operation.

G. Section 23 31 10 - Ductwork.

H. Section 23 80 00 - HVAC: Equipment.

1.03 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Trained Installer Certification.

C. Shop Drawings.

1. Wiring diagrams.
2. Control diagrams.

D. Product data.

E. Contract closeout information:

1. Operating and maintenance data.
2. Government instruction report.
3. Test reports.

1.04 QUALITY ASSURANCE

A. The installation shall be by a contractor certified by the equipment manufacturer.

B. Unit shall be ETL labeled.

C. System shall be AHRI-1230 certified.

D. The outdoor unit shall be factory charged with R410A.

E. Factory tested.

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F. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet, a total combined length of 3,280 FT of piping between the heat pump unit and fan coil units with 295 FT maximum vertical difference, without any oil traps or additional equipment.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store in clean dry place and protect from weather and construction traffic.

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

1.06 WARRANTY

A. Submit under provisions of section 01 78 34.

B. The units shall have the manufacturer's parts warranty for a period of ten (10) years from date of installation. All compressors shall have a parts warranty of ten (10) years (total) from date of installation. All warranty service work shall be performed by a factory trained service professional. Warranty shall be administered by the manufacturer or local manufacturer's representative. All service persons shall be factory trained and certified with a minimum of 3 years documented experience with the installed manufacturer's equipment. If the manufacturer or local distribution representative does not have a local service department, then the contractor shall assume all warranty obligations during this period. If warranty is a "contractor warranty" then it shall be clearly indicated in the equipment submittal. The contractor's factory certification shall be provided in the equipment submittal.

C. Installation Requirements:

1. The system must be installed by a factory trained contractor/installer. The bidders shall be required to submit training certification proof prior to award of contract. Should the installing contractor use a manufacturer other than the basis of design, all coordination related to differences between basis of design and the alternate manufacturer shall be the responsibility of the installing contractor including any required additional evaluation requirements by the engineering firm.

D. Units shall have a 10 year manufacturer's warranty from the date of installation.

E. Units shall have a 1 year labor warranty from the date of installation, executed by the installing Contractor

F. The compressors shall have a warranty of 10 years from the date of installation.

1.07 EXTRA STOCK

A. Provide clean filters in all units at time of installation.

B. Provide clean filters in all units at project final completion after all interior finishes are complete.

C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

1.08 OPERATING RANGE

A. The outside air cooling operating range shall be 23 DegF DB to 122 DegF DB.

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B. The outside air heating operating range shall be 0 DegF DB to 77 DegF DB.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Acceptable Manufacturers:

1. Variable Refrigerant Volume, Heat Recovery (VRV) Systems:

a. Base:

1) Daikin.

b. Optional:

1) Mitsubishi.

2) LG.

2. Other manufacturers desiring approval comply with Division 01 and requirements below:

a. Optional equipment supplier shall provide to the bidding Mechanical Contractor and Engineer a complete equipment data package.

1) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions.

b. Nominal performance data is not acceptable.

c. The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.

1) The Mechanical Contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment.

2) The Contractor bids an alternate manufacturer with full knowledge that the manufacturer's product may not be accepted or approved.

3) The installation shall be a contractor certified by the equipment manufacturer.

2.02 SYSTEM DESCRIPTION

A. The variable capacity, heat recovery, heat pump air conditioning system shall be a variable refrigerant flow split system. The system shall consist of multiple evaporators using PID control and inverter driven outdoor unit. The unit shall consist of direct expansion (DX), air-cooled heat pump air conditioning system, variable speed driven compressor multi zone split system. The outdoor unit may connect an indoor evaporator capacity of 50 - 130 percent to that of the outdoor unit capacity.

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2.03 OUTDOOR HEAT RECOVERY UNIT

1. Outdoor Unit - General: The outdoor unit is designed specifically for use with the manufacturer's components:

   a. Refrigerant: R410A.

   b. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant control. The refrigeration circuit of the outdoor unit shall consist of a compressor, motors, fans, condenser coil, electronic expansion valves, oil separators, service ports, liquid receivers, and accumulators.

   c. Both liquid and suction lines shall be individually insulated between the outdoor and indoor units.

   d. The connection ratio of indoor units to outdoor unit shall be 50 - 130 percent.

   e. The sound pressure dB(A) at rated conditions shall be a value no greater than 64 decibels at 4 FT from the outdoor unit at full load at fan height.

   f. The system shall automatically restart operation after a power failure and shall not cause any settings to be lost, thus eliminating the need for re-programming.

   g. The following safety devices shall be included on the outdoor unit: high pressure switch, control circuit fuses, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic as required to maintain oil levels at the outdoor unit.

   h. The outdoor unit shall be able to operate in heating mode to 0 DegF dry bulb ambient temperature without additional ambient controls.

   i. The outdoor unit shall have air cooled heat exchange coils constructed from copper tubing with aluminum fins. The systems shall have a single fan mounted on top of the coils. The coils shall be capable of being divided into sections to enable the outdoor unit to match the capacity required by the indoor units and to allow individual defrosting to take place as required.

   j. The outdoor unit shall have at least one inverter controlled compressor. The system shall use a control sequence to ensure that indoor loads are matched to the compressor capacity control.

   k. The refrigeration process of the outdoor unit will be maintained by pressure and temperature sensors controlling solenoid valves, check valves and bypass valves. The heating or cooling mode of the outdoor unit will be controlled using a combination of 2 and 3 way valves which shall reverse the cycle of the refrigerant to change the mode of the outdoor unit.

   l. Unit Cabinet: The outdoor unit model shall be completely weather proof and corrosion resistant. The outdoor unit shall be constructed from steel plate and treated with acrylic paint. Provide hail guards to protect equipment within cabinet.

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m. Fan:

1) The outdoor unit shall be furnished with direct drive variable speed propeller type fans.

2) The fans shall be a vertical discharge. The fan motors shall have inherent protection and permanently lubricated bearings and be mounted.

3) The fan motors shall be provided with a fan guard to prevent contact with moving parts.

n. Condenser Coil: The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond. Coil fins shall have a factory applied corrosion resistant finish.

o. Compressor:

1) The variable speed compressor shall be capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the outdoor unit.

2) The inverter driven compressor in each outdoor unit shall be DC, hermetically sealed, rotary type or scroll type compressor.

3) The capacity control range shall be a minimum of 20 to 100 percent of total capacity.

4) Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

5) Oil separators shall be standard with the equipment together with an oil balancing circuit.

6) The compressor shall be mounted to avoid the transmission of vibration.

2.04 BRANCH CIRCUIT CONTROLLERS/SOLENOID VALVE KITS /BRANCH SELECTOR

A. The unit shall be constructed from galvanized steel plate and be internally insulated with polyurethane foam. The connection to the system shall be either via brazed connection or flare nuts.

B. The unit shall be connected to the indoor units or group of indoor units via its own dedicated connection. This connection shall supply power and control signals to the solenoid valves in the unit.

C. The unit shall have integral controls and be factory assembled, wired, and piped.

D. The unit shall include an integral drain pan and condensate pump as required.

E. The unit electrical power shall be 208-230V/1-phase/60Hz.

F. Provide unit with at least two (2) additional unused connections for future expansion and maintenance. Provide isolation valves on all connections and caps on unused connections.

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2.05 INDOOR FAN COIL UNIT

A. General – Each indoor unit shall have a heat exchanger which shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger shall be controlled by an electronic proportional expansion valve. This valve shall be controlled by two pipe thermistors, a return air and discharge air thermistor and shall be capable of controlling the variable capacity of the indoor unit between at least 25 and 100 percent. The units shall be shipped from the factory fully charged with dehydrated air.

1. Unit type shall be as scheduled on the plans.

B. 4-Way Ceiling Recessed Cassette:

1. The indoor unit shall be a ceiling cassette indoor unit for installation into the ceiling cavity equipped with an air panel grille to be connected to indoor unit as scheduled and specified in this section. The indoor unit shall have a four-way air distribution type, ivory white, impact resistant, and washable decoration panel. The supply air shall be distributed via motorized louvers which can be horizontally and vertically adjusted from 0 degree to 90 degree angle.

2. Acoustic Performance: The indoor units sound pressure shall range from 27 dB(A) to 33 dB(A) at low speed measured at 5 feet from the unit.

3. Construction:

a. The indoor unit shall be completely factory assembled and tested. The unit shall include factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

b. The 4-way supply airflow shall be field modifiable to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

c. Return air shall be through the concentric panel, which shall include a filter.

d. The indoor units shall be equipped with a condensate pan and condensate pump.

e. All refrigerant lines shall be insulated separately from the outdoor unit.

f. The indoor units shall be equipped with a return air thermistor.

g. The indoor unit shall be separately powered with 208-230V/1-phase/60Hz.

4. Unit Cabinet:

a. The cabinet shall be space saving and shall be recessed into the ceiling.

b. Provide fresh air intake kit where used and indicated on the drawings. A branch duct knockout shall exist for branch ducting supply air.

c. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

5. Fan:

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a. The fan shall be direct-drive turbo fan type with statically and dynamically balanced impeller with high and low fan speeds available.

b. The airflow rate shall be adjustable and have high, medium and low fan settings.

c. The fan motor shall be thermally protected.

6. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

7. Coil:

a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

b. The refrigerant connections shall be flare connections. Coordinate condensate piping material with Hydronic Piping section.

8. Condensate Pump:

a. Contractor shall provide condensate pump as required to remove condensate from indoor unit. Coordinate pump requirements with electrical contractor.

b. A condensate pump with at least 18 IN lift shall be located below the coil in the condensate pan with a built in high level safety alarm to shut down the unit. Pump shall be provided if gravity drainage is not possible.

C. Ceiling Concealed Ducted:

1. The indoor unit shall be a built-in ceiling concealed indoor unit, ability to obtain external static pressure listed on the plans, for installation into the ceiling cavity. The unit shall be constructed of a galvanized steel casing to be connected to a heat pump outdoor unit. The indoor unit shall be manufactured for ducted horizontal discharge air with ducted horizontal return air configuration as shown on the plans. The maximum external static pressure shall be as scheduled on the drawings. The external static pressure setting shall be adjustable through switches on the unit to aid in balancing of the unit's airflow.

2. Acoustic Performance: The indoor units sound pressure shall range from 22 dB(A) to 31 dB(A) at low speed 5 feet from the unit.

3. Construction:

a. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. The unit shall have selectable swithc for adjustable static pressure capability.

b. All refrigerant lines shall be insulated separately from the outdoor unit.

c. The indoor units shall be equipped with a condensate pan and condensate pump. Provide pump if gravity drainage is not possible.

d. The indoor units shall be equipped with a return air thermistor.

e. The indoor unit shall be separately powered with 208-230V/1-phase/60Hz.

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f. Switch box shall be reached from the side or bottom for ease of service and maintenance.

4. Unit Cabinet:

   a. The cabinet shall be located in the ceiling and ducted to the supply and return openings.

   b. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

   c. The cabinet shall be factory insulated for use in un-conditioned indoor spaces.

   d. Concealed slim units where listed on the schedules shall be a maximum of 8 IN deep. All concealed units where listed on the schedules shall be a maximum of 12 IN deep.

5. Fan:

   a. The fan shall be direct-drive fan, statically and dynamically balanced impeller with high, medium and low fan speeds.

   b. The airflow rate shall be available in high and low settings.

   c. The fan motor shall be thermally protected.

6. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin. Filter may be integral or suitable for field installation in pre-fabricated filter box attached to the unit. Filter box shall be provided by the VRF manufacturer.

7. Coils:

   a. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

   b. The refrigerant connections shall be flare connections. Coordinate condensate piping material with Hydronic Piping section.

8. Condensate Pump:

   a. Contractor shall provide condensate pump as required to remove condensate from indoor unit. Coordinate pump requirements with electrical contractor. Condensate pump shall not require a separate electrical connection.

   b. A condensate pump with at least 18 IN of lift shall be located below the coil in the condensate pan with a built in high level safety alarm to shut down the unit. Provide pump if gravity drainage is not possible.

2.06 CONTROLS

A. GENERAL

1. The unit shall have controls provided with the unit by the manufacturer to perform input functions necessary to operate the system.

2. Computerized PID control shall be used to maintain room temperature within 1°= DegF of setpoint.

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3. The unit shall be equipped with a programmable drying cycle that dehumidifies while inhibiting changes in room temperature.

B. INDIVIDUAL VRF CONTROL

1. Each unit shall be supplied with a wall mounted thermostat controller. The controller shall have a backlit LCD display and be able to support the following display items and user input operations:
   a. On/Off control
   b. Automatic change of mode of operation
   c. Set point adjustment
   d. Reading of both heating and cooling set point temp
   e. Reading of actual room temp
   f. Fan speed setting
   g. Mode of operation on the unit display
   h. Individual Heating and Cooling (dual) set point adjustment
2. The controllers shall be capable of diagnostic use and provide malfunction codes to indicate the type of failure that has occurred.
3. The controllers shall be capable of accepting independent set points for cooling and heating operation. The use of a common set point is not allowable.
4. The system shall provide automatic change-over from heating to cooling mode of operation.
   a. If, in heating mode, the space temperature rises 1 degree above the cooling set point, the system shall change from heating to cooling mode. If, in cooling mode, the space falls 1 degree below the heating set point, the system shall change from cooling to heating mode.
5. Adjustable setback temperature
   a. The controllers shall allow for independent and adjustable setback temperature at each unit. The setback temperature (adjustable) shall determine the "override" temperature to start the system when in setback mode if the temperature rises or falls outside of the specified range.
6. The schedule of operation hours shall be controlled at the Central Controller.
7. Refer to plans , Specification Section 23 09 00, and Specification Section 23 09 93 for additional requirements.

C. CENTRAL CONTROLLER

1. This controller shall be wall mounted and hard wired, either directly to the control system or via gateway. It will be manufactured in ABS plastic with an LCD display and will be the manufacturer's standard color. The controller will be capable of individually controlling/displaying the following functions on at least 128 indoor units:
   a. Central control of set points, schedules, fan speed, and heat/cool mode.
   b. Scheduling of zones and individual units.

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c. Adjustable control of setback (override) temperature settings during occupied period

d. Adjustable temperature limits to restrict local wall mounted thermostat set point ranges.

e. Visible and audible alarm indication of any system malfunctions with descriptive error code.

f. External Digital input/output and display of external input values from outside air handling units.

g. External Analog input/output and display of external input values from outside air handling units.

h. Tiered hierarchy allowing for control of fan coil units independently or as a group.

i. Able to remotely disable of individual functions of the wall mounted controllers.

2. Provide floor plan layout on each central controller as well as accessible for remote control from the web.

   a. Floor plan shall represent the specific project building floor plan layout.

   b. Floor plan shall include capability to control indoor unit and auxiliary inputs/outputs for all of the outside air handling units. The floor plan shall be configured as indicated below.

      1) Up to four status to be assigned to the control point icon (room name, room temperature, set point, and mode).

      2) Status and control points to display on corresponding location zone served on floor plan.

      3) Digital input and output icons will display on/off status.

      4) Analog input icons will display analog values

3. Each central controller unit can be accessed either locally or remotely via standard Internet Explorer IE6 or IE7 software. The central controller will be able to indicate system alarms via volt free contacts as well as providing control points for other devices. Additionally, the central controller shall be able to monitor individual tenant's usage of heating and cooling demands, report alarm and conditions to nominated email address, and enable remote alteration of systems set points to registered users. All required software costs and licensing fess shall be included for the life of the systems.

4. Provide dedicated power supply for each controller.

5. Refer to plans for approximate location of central controllers. Coordinate exact final location of each central controller with the Owner/Architect. Coordinate location and quantity of power and technology outlets with the Electrical and Technology contractors after final locations are determined.

6. Refer to plans , Specification Section 23 09 00, and Specification Section 23 09 93 for additional requirements.

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D. SEQUENCE

1. Install a remote mounted thermostat.
2. The thermostat shall stage heating or cooling as required to maintain space setpoint at 72ºF (adj.).
3. Thermostat shall automatically change the indoor unit mode based on the space setpoint.

E. Wiring:

1. Wiring shall be in compliance with Division 16.
2. Control voltage between the indoor units and outdoor unit shall be 16 Vdc.
3. Use non-shielded 2-conductor cable.
4. Control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one outdoor unit with one (1) 2-cable wire.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The VRV system must be installed by a manufacturer's factory trained contractor/dealer.

B. Install in accord with manufacturer's instructions and recommendations.

C. Provide float switch at condensate drain pan to automatically shut-off the unit upon condensate overflow.

D. Provide new filters on units which have been running prior to acceptance of Project.

E. Test and balance systems in accordance with Specification Section 23 05 93.

3.02 FIELD QUALITY CONTROL

A. Perform the following field tests/inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.03 COMMISSIONING

A. Upon completion of the installation and field quality control, this Contractor shall load all system software and start up the system. This Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

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B. This Contractor shall perform tests to verify proper performance of components, routines, and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100 percent of the input and output points of the DDC system operation.

C. This Contractor shall prove that the controls network is functioning correctly and within acceptable bandwidth criteria and shall test the system with an approved protocol analysis tool. Provide a log and statistics summary showing that each channel is within acceptable parameters. Each channel shall be shown to have at least 25 percent spare capacity for future expansion.

D. Upon completion of the performance tests described above, repeat these tests, point by point, as described in the validation log above in the presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

E. System Acceptance: Satisfactory completion is when this Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.04 TRAINING

A. On-Site:

1. After completion of commissioning, the manufacturer shall provide 8 hours of training for four (4) Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

END OF SECTION

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SECTION 26 05 00 - ELECTRICAL BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic requirements for electrical systems.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 61 03 - Equipment: Basic Requirements.

B. Division 05 - Metals.

C. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

D. Section 26 05 33 - Raceways and Boxes.

1.03 REFERENCED STANDARDS

A. Aluminum Association (AA).

B. American Iron and Steel Institute (AISI).

C. ASTM International (ASTM):

1. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

3. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

D. ETL Testing Laboratories (ETL).

E. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C2, National Electrical Safety Code (NESC).

F. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

G. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

H. Underwriters Laboratories, Inc. (UL).

1.04 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.

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1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
2. General requirements:
   a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
   b. Clearly indicate the proposed items (by drawing schedule symbol: i.e. Light Fixture "D"), the manufacturer's name, supplier, catalog number, cuts, diagrams, drawings, capacities, characteristics and details in conformance with the drawings or schedules. The manufacturer shall certify capacities, dimensions and special features required.
      1) Clearly identify all optional accessories.
   c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
   d. Manufacturer's delivery, storage, handling and installation instructions.
   e. Product installation details.
   f. Shop submittals shall bear the stamp of the contractor and shall indicate that the contractor has reviewed and approved the shop submittals for the application. Shop submittals without the contractor’s signature indicating approval shall be returned without action.
   g. Indicate the Manufacturer's delivery time for the item after receipt of approval by the Engineer.
   h. See individual specification sections for any additional requirements.
3. Product technical data:

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a. Provide submittal data for all products specified in PART 2 of this Specification Section.

B. Operation and Maintenance Manuals:

1. Prior to final approval of the installation, obtain and submit to the Engineer, three (3) bound copies and one (1) electronic copy on Flash-drive of descriptive literature, maintenance and operation data, and parts lists of each item of electrical equipment requiring maintenance and special operation procedures, furnished and installed under the contract.

2. Turn over to the Engineer drawings, instructions and manuals supplied with equipment furnished by others.

1.06 QUALITY ASSURANCE

A. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 65 50.

B. Protect nameplates on electrical equipment to prevent defacing.

1.08 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.

1. Outdoor areas:

a. Wet.

b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

2. Indoor areas:

a. Dry.

b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

1.09 SITE ACCESS

A. Contractor and any sub-contractors shall comply with Union Pacific e-Railsafe including but not limited to background information and personnel credentials. Go to eRailsafe.com for information.

1.10 SAFETY

A. GENERAL

1. As part of Union Pacific Railroad's focus on safety, we want to make certain that our Contractors establish and maintain safe work practices, including the proper training of their employees. Union Pacific will not allow contractors to perform work on our property unless they have been properly trained for the work they are performing.

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2. Training for Engineering Department contractors falls into two primary categories:

   a. Regulatory Training:

      1) Training is required by federal, state or local workplace safety regulations. This training includes, but is not limited to:

         a) FRA Roadway Worker Protection (for those working within 25 FT of any track). This training is available from several sources, including other railroads, railroad industry training professionals and computer based training. Several internet web sites now offer RWP training for a modest fee, including:

            (1) www.railroadeducation.com

            (2) www.nrcma.org

            (3) UPRR does not endorse any specific RWP training program nor does it require contractor employees to be trained specifically on UP's On-Track Safety Program. However, we do require that our contractors properly train their employees on RWP as required by 49CFR214.343.

            (4) OSHA Fall Protection (for those working on elevated structures 6 FT or higher).

            (5) OSHA Confined Space Entry (for those working in confined spaces).

      2) Please note that Union Pacific Railroad does not provide regulatory training for contractors' employees but will assist contractors in locating training resources. The frequency of training is mandated in each regulation.

      3) Union Pacific Railroad insists on 100% compliance with all governmental regulations by its Contractors and their employees.

   b. UPRR Safety Training:

      1) Training is required for Engineering Department contractor employees or design consultants to perform work on UP property. This training is in addition to the regulatory training described above and is available in several different formats:

         a) Pamphlet entitled "Minimum Safety Requirements for UPRR Contractors". A PDF copy of the pamphlet is available at www.uprr.com/suppliers/sup_ovr/terms.shtml for download.

         b) Pamphlet entitled "UPRR Electrical Safety Rules" (Document #PB20502).

         c) Online Training program is available via www.contractororientation.com. The information presented is the same as the video and pamphlet; however, this web site also provides record keeping and testing services. Once a person completes the course, they are sent a wallet-size card showing successful completion.

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d) UPRR Safety Training must be completed every calendar year. Please note that this training does not meet the requirements for Roadway Worker Protection Training.

e) Contractors must furnish employees with documentation that they have completed the required regulatory and UPRR safety training. This can be accomplished by issuing cards denoting the employee's training, issuing list of employees who have completed specific training or by having available, at the job site, other forms of documentation.

f) Under government workplace safety regulation, each employer is responsible for the training of their employees. Union Pacific Railroad provides the necessary resources to train our employees and we expect the same from our contractors.

g) Contractors to UP also have oversight responsibilities for monitoring the training and compliance of employees of sub-contractors. Make sure that the sub-contractors you hire are familiar with and comply with the training requirements outlined above.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Substitutions for Materials Specified:

1. Materials and items of equipment furnished must meet the requirements of the drawings and specifications as to quality, performance, suitability and appearance.

2. Any proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, time requirements and the availability of repair, or replacement, parts may also be considered.

3. The Owner also reserves the right to reject, or accept, material, or equipment items, which fail to meet all of the stipulated requirements. Allow a suitable credit for a substitution. All substitutions and credits must be approved by the Engineer in writing.

4. The Engineer is the sole and final judge as to the suitability of substitution items. Approval of substitutions shall be in writing prior to installation.

5. The entire cost of all changes of any kind due to Contractor requested substitutions, will be borne by the Contractor.

C. Provide all components of a similar type by one (1) manufacturer.

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2.02 SELECTED SUPPLIERS AND MANUFACTURERS

A. Union Pacific has purchasing agreements with the following suppliers. Identify the project as being for Union Pacific Railroad to obtain pricing. Obtain the following materials from the indicated suppliers unless a specific supplier is indicated on the drawings. No substitutions shall be accepted unless indicated on the drawings.

1. Medium Voltage Pad Mount Switches:
    a. Manufactured by S&C Electric Company, Contact: Charles Spann, Telephone: 531-222-6957.
2. 600 Volt Distribution Equipment:
    a. Manufactured by Square D Equipment, Graybar, Contact: Kyle Naughton, Telephone: 402-592-7676.
3. High Mast Lighting:
    a. Manufactured by MUSCO Light Structure with 10 year performance warranty, Contact: Adam DeJong, Telephone: 800-825-6020 or Mike Winfrey, Telephone: 949-754-0503.
    b. Manufactured by Holophane, an Acuity Brands Lighting, Inc product with 10 year performance warranty, Contact: Michael Holloway, Telephone: 402-676-2809.
4. Area Lighting:
    a. Manufactured by Holophane Mongoose or GE Tiger, GEXPRO, Contact: Daniel Bilka, Telephone: 402-951-5615.
5. Lamps:
    a. Manufactured by Phillips, GEXPRO, Contact: Daniel Bilka, Telephone: 402-951-5615.
6. Lighting Contactors:
    a. Manufactured by Square D Equipment, Graybar, Contact: Kyle Naughton, Telephone: 402-592-7676.
7. UPS & TVSS:
    a. Manufactured by MGE, Power Protection Products, Contact: Brian Branigan, Telephone: 402-393-1223.
8. Engine Generator and Automatic Transfer Switches:
    a. Cummins, Contact: Darin Buskohl, Telephone 605-336-1715.
    b. CAT, Nebraska Machinery Co, Contact: Tracy Henke (less than 600kW), Telephone: 402-891-7656 or Tyler Harm (600kW and greater), Telephone: 402-891-7567.
    c. Generac Power Systems, HM Cragg, Contact: Mike Marcinek, Telephone: 402-334-0250.

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9. Oil-Filled Transformers:
    a. New Units:
        1) Manufactured by ABB, GE, or Eaton; Echo Electric, Contact: Alan Devereaux, Telephone: 402-330-9995; Gexpro, Contact: Daniel Bilka, Telephone: 402-951-5615; or Graybar, Contact: Kyle Naughton, Telephone: 402-592-7676.
    b. Refurbished Units:
        1) Manufactured by Solomon, Contact: Mike Loecker, Telephone: 800-234-2867.
10. Reclosers:
    a. Manufactured by Cooper Kyle W-group hydraulically controlled.
        1) Coordinate with Utility and Engineer before purchasing.
11. Recloser Bypass Switch:
    a. Manufactured by Cooper, ABB, or S&C.
12. Gang Operated Switch:
    a. Manufactured by Cooper, Hubbell, or S&C.
13. Overhead Cable Warning Marker Sphere:
    a. All sizes: TANA Manufacturing, P.O. Box 370, California, MO 65018.
    b. 36 IN& 20 IN sizes: P&R Technologies, P.O Box 554, Portland, OR 97207, Telephone: 503-292-8682.
14. Pole Banding: 4 IN safety yellow pole band from BriteStripe (part #BS364-Y), Graybar, Contact: Kyle Naughton, Telephone: 402-951-1315.

2.03 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
    1. Approved manufacturers:
        a. Modular strut:
            1) Unistrut Building Systems.
            2) Eaton B-Line.
            3) Globe Strut.
            4) Thomas & Betts Superstrut.
    2. Material requirements:
        a. Modular strut:
            1) All Strut shall be 1-5/8 IN minimum.
                a) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
                b) Stainless steel: AISI Type 316.

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c) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.

d) Aluminum: AA Type 6063-T6.

b. Mounting hardware:

1) Galvanized steel.

2) Stainless steel.

c. Anchorage per Division 5.

B. Field touch-up of galvanized surfaces.

1. Zinc-rich primer.

a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

2.04 MAINTENANCE MATERIALS

A. Provide the manufacturer's recommended renewable spare parts (e.g., power and control fuses).

1. Provide two sets of spare fuses for each piece of equipment that utilizes fuses for its overcurrent protection.

2. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:

1. NFPA 70.

2. IEEE C2.

3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.

1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.

2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:

1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.

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2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:

1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
   a. Light switch (to center): 48 IN.
   b. Receptacle in architecturally finished areas (to center): 18 IN.
   c. Receptacle on exterior wall of building (to center): 18 IN.
   d. Receptacle in non-architecturally finished areas (to center): 48 IN.
   e. Telephone outlet in architecturally finished areas (to center): 18 IN.
   f. Telephone outlet for wall-mounted phone (to center): 54 IN.
   g. Safety switch (to center of operating handle): 54 IN.
   h. Separately mounted motor starter (to center of operating handle): 54 IN.
   i. Pushbutton or selector switch control station (to center): 48 IN.
   j. Panelboard (to top): 72 IN.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.

1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
   a. 1 FT at grade, floor and roof level in any direction in the horizontal plane.
   b. 1 FT for equipment other than lighting at ceiling level in any direction in the horizontal plane.
   c. 1 FT for lighting fixtures at ceiling level in any direction in the horizontal plane.

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d. 1 FT on walls in a horizontal direction within the vertical plane.

e. Changes in equipment location exceeding those defined above require the Engineer's approval.

K. Provide electrical equipment support system per the following area designations:

1. Dry areas:

a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.

b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.

2. Wet areas:

a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.

b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.

3. Corrosive areas:

a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.

4. Highly corrosive areas:

a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.

1. See Specification Section 05 50 10.

2. Do not cut, or weld to, building structural members.

3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Equipment Identification:

1. Identify all panelboards and switchboards, disconnects, starters, equipment enclosures and components, with a permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller then 3/8" in height. Indicate equipment name, or designation and voltage, phase, and wire characteristics, i.e. 120/208V, 3P, 4W.
2. Identify all junction boxes 4" x 4" and larger with system, equipment served and/or circuit numbers. Adhesive plastic tape may be used for the purpose.
3. Tag all empty conduits at each end; identify system served, origin and terminal points.
4. Identify all terminal boxes and pull boxes, with embossed labels and clear overlay to identify item, system, service and contents.
5. Number all transformers according to transformer schedule. Label all transformers with kVA rating if not already labeled. Overhead transformer KVA rating shall be readable from the ground.
6. Medium Voltage cables shall be labeled at each termination site with Tech Products, Inc. Miniature Markers Product. The source/incoming cable shall be labeled with originating location of the cable and outgoing cable shall be labeled with the next equipment designation. The originating location and next equipment designation is permitted to identified by its railroad milepost location.
    a. Catalog #3DFYxx for letter and numbers.
    b. Catalog #PHF210 for the Poly Fastag holders.

R. Cleanup and Painting:

1. Clean the interior of all panelboards, pull boxes, and equipment and enclosures of the electrical work.
2. Wash and wipe clean all lighting fixtures, lenses and lamps.
3. All equipment shall have factory applied finish. Damaged finishes shall be refinished.

3.02 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:

1. See Specification Section 01 77 10.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.

1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.

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3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
4. Repair surfaces which will be inaccessible after installation prior to installation.
5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

END OF SECTION

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SECTION 26 05 09 - MOTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Motors.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions.

B. Section 01 61 03 – Equipment Basic Requirements.

C. Section 01 61 04 – Electrical Requirements for Mechanical Equipment.

D. Section 26 05 00 – Electrical Basic Requirements.

E. Section 26 24 19 – Motor Control Equipment.

F. Section 26 29 23 – Variable Frequency Drives Low Voltage.

1.03 REFERENCED STANDARDS

A. See Specification section 01 61 04 for additional information.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data.

a. Provide submittal data for all products specified in this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. Wire all permanently installed motors, starters and line voltage control systems, furnished under the contract, or by the Owner, unless specifically noted to the contrary. Check for proper rotation, proper lubrication and proper overload protection on all motors prior to start-up.

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B. Unless otherwise specified, motors shall be general purpose with open-type enclosures, and rated for a temperature rise of 40 DegC. Where motor horsepowers are specified in connection with equipment drive, the horsepowers specified shall be considered as minimums. The manufacturer furnishing motors shall, in all cases, verify motor horsepowers with the characteristic power curves of the driven. In no case shall the power requirement of the driven machine exceed the nominal nameplate rating plus the service factor of the motor furnished. Advantage shall not be taken of service factors for normal operation loading in the selection of the motors.

C. Except where otherwise specified with certain equipment items, motors smaller than 1/2 horsepower shall be rated single phase, 60 hertz, 115 volts, and motors 1/2 horsepower and larger shall be rated 3-phase, 60 hertz, 200, 230, or 460 volts as applicable. The motor voltages stated above are utilization, or nameplate, ratings for use on nominal system voltages of 120, 208, 240, and 480 respectively.

D. Single Phase motors shall be capacitor-start, split phase, or shaded pole-type, or as approved for individual application. Polyphase motors shall be squirrel-cage induction-type, with speed and torque as required for individual application.

E. Motor speeds, horsepower, classification as to splash-proof drip-proof, totally enclosed, etc., are in general specified with equipment drives as shown in the schedule on the drawings. Where not called for specifically, the Contractor shall obtain the information from the manufacturer of the equipment unit and have the application approved by the Engineer prior to ordering starters. Totally enclosed motors of all sizes shall be fan cooled.

F. Motors for V-belt drives shall be provided with slide rails. Motors for direct drive with couplings shall be doweled to the base plate at two points.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Alignment of all motors factory coupled to equipment and all motors field coupled to equipment shall be rechecked after all connections have been completed and after 48 hours of operation in designated service.

END OF SECTION

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SECTION 26 05 13 - MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Medium voltage cable (601 V and above).

b. Cable terminations and splices.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 08 13 - Acceptance Testing.

C. Section 26 05 19 - Wire and Cable: 600 Volt and Below.

1.03 REFERENCED STANDARDS

A. Association of Edison Illuminating Companies (AEIC).

1. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46kV.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 48, Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5kV Through 756kV or Extruded Insulation Rated 2.5 kV through 500 kV.

2. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

3. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

4. 400.3, Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment.

5. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V.

6. 495, Guide for Testing Faulted Circuit Indicators.

C. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):

1. WC 71/S-96-659, Standard for Non-Shielded Cables Rated 2001 - 5000 Volts for Use in the Distribution of Electric Energy.

2. WC 74/S-93-639, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

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D. InterNational Electrical Testing Association (NETA):

1. ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).
2. 70E, Standard for Electrical Safety in the Workplace.

F. National Institute for Certification in Engineering Technologies (NICET).

G. National Institute of Standards and Technology (NIST).

H. Occupational Safety and Health Administration (OSHA).

I. Underwriters Laboratories, Inc. (UL):

1. 486A-486B, Wire Connectors.
2. 1072, Standard for Safety Medium Voltage Power Cables.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
   a. Cable pulling plan and tension calculations.

B. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Cable pulling tension measurements.
3. Submit the following before terminating cables:
   a. Cable Technician qualifications.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Cable technician:
   a. Three (3) years experience in handling, terminating and splicing medium voltage cables.
   b. Specifically trained by a factory representative on the terminations and splices to be used on the project.

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1) If not trained on the products to be used, on-site training by the factory representative shall be performed before any terminations or splices are made.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Wire and cable:

a. Aetna Insulated Wire.

b. General Cable.

c. The Kerite Company.

d. The Okonite Company.

e. Priority Wire & Cable, Inc.

f. Prysmian Cable Corporation.

g. Southwire Company.

2. Lugs, connectors and terminations:

a. 3M Company.

b. Elastimold, a Thomas and Betts Company.

c. Joslyn/McLean.

d. Raychem.

e. Eaton Cooper Power Systems.

B. Submit request for substitution in accordance with Specification Section 26 05 00.

2.02 MEDIUM VOLTAGE CABLES

A. Ratings:

1. 15kV class unless otherwise indicated on the Drawings.

B. Standards:

1. NEMA/ICEA WC 74/S-93-639.

2. AEIC CS8.

3. UL 1072.

C. Conductor Material:

1. Regular or compressed concentric stranded copper or Aluminium as indicated on drawings.

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2. To prevent oxidation, fill the conductor strandings with an oxidation preventing compound.

D. Insulation:

1. Temperature rating: Type MV-105 per NFPA 70.
2. Ethylene-propylene-rubber (EPR).
3. 133 percent insulation level.

E. Shielding:

1. Shielding on cables rated above 2 kV consists of:
   a. Semiconductor conductor screen.
   b. Semiconductor insulation screen.
   c. Copper concentric neutral.

F. Neutrals:

1. Cables with a concentric copper neutral shall have full or 1/3 concentric neutral as required.
   a. Full on single phase circuit, one cable.
   b. 1/3 on three phase circuit with 3 cables triplexed.

G. Grounds:

1. Bare copper per Specification Section 26 05 19.

H. Jackets:

1. Jacket: Low Linear Density Polyethylene Jacket (LLDPE).
2. Color markings and terminology markings as indicated on drawings or as coordinated with engineer.

2.03 CABLE ACCESSORIES

A. Lugs and Connectors:

1. Lugs:
   a. Compression type for use with copper or aluminum.
   b. Standard: UL 486B for aluminum conductors.
   c. Voltage rating: Up to 35 kV.
   d. Current rating: Continuous operation at the rating of the cable.
   e. Material: Tin-Plated, High-Conductivity Aluminum.
   f. Number of holes: Two (2).
2. Splice connectors:
   a. Standard: UL 486B for aluminum conductors.
   b. Voltage rating: Up to 35kV.
   c. Current rating: Continuous operation at the rating of the cable.

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d. Material: Tin-plated Aluminum.

e. Barrel: Standard or Long with solid center stop.

B. Terminations:

1. Terminations must be provided in a kit, including skirts, stress control terminator, ground clamp, connectors, lugs and complete instructions for assembly and installation. Terminations must be the product of one manufacturer, suitable for the type, diameter, insulation class and level, and materials of the cable terminated. Do not use separate parts of copper or copper alloy in contact with aluminum alloy parts in the construction or installation of the terminator.

2. End caps:

a. Cold or hot shrink.

b. Used to environmentally seal and mechanically protect exposed cable ends.

3. Cold shrink kits:

a. Standard: IEEE 48, Class 1 termination.

b. Voltage rating: Same as the cable rating.

c. Current rating: Continuous operation at the rating of the cable.

d. One-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.

e. Suitable for contaminated indoor and outdoor locations.

4. Molded rubber kit:

a. Standard: IEEE 48.

b. Voltage rating: Same as the cable rating.

c. Current rating: Continuous operation at the rating of the cable.

d. One-piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.

e. Suitable for contaminated indoor and outdoor locations.

5. Elbow connectors:

a. Standard: IEEE 386.

b. Voltage rating: Same as the cable rating.

c. Current rating:

1) 200A Loadbreak.

2) 600A Deadbreak.

d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.

e. Deadfront type with:

1) Hot stick pulling eye.

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2) Grounding tab.

3) Test point.

f. Accessories to be constructed in a similar manner as the elbow connector:

1) Bushing inserts.

2) Bushing well plugs.

3) Feed thru inserts.

4) Protective caps.

C. Cable Shield Grounding Adapters:

1. Type: Molded rubber with constant force spring and solder-blocked tinned copper braid pigtail.

2. Waterproof, providing a positive seal for the cable jacket.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Do not install cable during wet conditions.

1. Prior to pulling cables, drain or pump out manholes and other low points if standing water is present.

2. Blow out conduits with dried compressed air if moisture is present in conduits.

3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.

a. If end caps are damaged, remove and install new end caps.

b. Do not remove end caps until ready to terminate or splice cable.

B. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

C. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for each shielded cable termination.

1. Select correct termination to match cable diameter and construction.

2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.

D. Splices:

1. No below grade splices are allowed in yards with concrete encased duct banks.

2. Splices are permitted when underground primary cable in conduit is installed direct buried in soil outside of yard.

E. The ground shield grounding adaptors shall be grounded:

1. Shirted and elbow terminators: Grounded to ground bar or cable loop in equipment.

2. Splices: Grounded to ground bar or rod in handhole.

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3. Connect with insulated, stranded #6 AWG wire.

3.02 FIELD QUALITY CONTROL

A. See Specification Section 26 08 13 for acceptance testing requirements.

B. Provide cable pulling plan showing proposed cable pulling direction for each pull.

C. Provide cable pulling tension calculations.

D. Provide measurement of tensions during the pull.

END OF SECTION

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SECTION 26 05 19 - WIRE AND CABLE 600 VOLT AND BELOW

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Building wire.

b. Power cable.

c. Control cable.

d. Instrumentation cable.

e. Wire connectors.

f. Insulating tape.

g. Pulling lubricant.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 08 13 - Acceptance Testing.

1.03 REFERENCED STANDARDS

A. Aluminum Association (AA).

B. ASTM International (ASTM):

1. G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

2. 1580, Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Marine Platforms.

C. Insulated Cable Engineers Association (ICEA):

1. S-58-679, Standard for Control Cable Conductor Identification.

2. S-76-474, Neutral-Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation Rated 600 Volts.

D. Instrumentation, Systems, and Automation Society (ISA):

1. MC96.1, Temperature Measurement Thermocouples.

2. SP50.02, Fieldbus Standard for Use in Industrial Control Systems Part 2: Physical Layer Specification and Service Definition.

E. National Electrical Manufacturers Association (NEMA):

1. ICS 4, Industrial Control and Systems: Terminal Blocks.

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F. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):

1. WC 57/S-73-532, Standard for Control Cables.
2. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.

G. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).
2. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

H. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA):

1. 598-C, Optical Fiber Cable Color Coding.

I. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):

1. 568, Commercial Building Telecommunications Cabling Standard.

J. Underwriters Laboratories, Inc. (UL):

1. 13, Standard for Safety Power-Limited Circuit Cables.
2. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
3. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
4. 467, Standard for Safety Grounding and Bonding Equipment.
5. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
6. 486C, Standard for Safety Splicing Wire Connections.
7. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
8. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
9. 1569, Standard for Safety Metal-Clad Cables.
10. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
11. 1666, Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
12. 2225, Cables and Cable Fittings for Use in Hazardous (Classified) Locations.
13. 2250, Standard for Safety Instrumentation Tray Cable.

1.04 DEFINITIONS

A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

B. Instrumentation Cable:

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1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
    a. Analog signal cable:
        1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 Vdc) signals, using No. 16 AWG and smaller conductors.
        2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.
    b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

D. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

E. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

F. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

G. Messenger Supported Cable (Multiplex Cable): A cable with one (1) or more insulated conductors supported by a messenger wire.

1.05 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
        1) Insulating tape.
        2) Cable lubricant.
    b. See Specification Section 26 05 00 for additional requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Building wire, power and control cable and multiplex cable:
    a. Advanced Digital Cable (ADC).
    b. Cerrowire.
    c. Encore Wire Corporation.
    d. General Cable.
    e. Nexans Cable.
    f. Okonite Company.
    g. Priority Wire & Cable, Inc.
    h. Service Wire.
    i. Southwire Company.
2. Shielded VFD cable:
    a. Belden Inc.
    b. General Cable.
    c. Nexans Cable.
    d. Okonite Company.
    e. Olfex Wire and Cable, Inc.
    f. Priority Wire and Cable (Prysmian).
    g. Rockbestos-Surprenant Cable Corp.
    h. Southwire Company.
3. Instrumentation cable:
    a. Analog cable:
        1) Alphawire.
        2) Belden Inc.
        3) General Cable.
4. Wire connectors:
    a. Burndy Corporation.
    b. Buchanan.
    c. Ideal.
    d. Ilsco.
    e. 3M Co.

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f. Teledyne Penn Union.

g. Thomas and Betts.

h. Phoenix Contact.

5. Insulating and color coding tape:

a. 3M Co.

b. Plymouth Bishop Tapes.

c. Red Seal Electric Co.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 MANUFACTURED UNITS

A. Building Wire:

1. Conductor shall be copper with 600 V rated insulation.

2. Conductors shall be stranded, except for conductor sizes 12 through 10 shall be solid.

3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.

5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:

1. Conductor shall be copper with 600 V rated insulation.

2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.

4. Number of conductors as required, including a bare ground conductor.

5. Individual conductor color coding:

a. ICEA S-58-679, Method 4.

b. See PART 3 of this Specification Section for additional requirements.

6. Conform to NFPA 70 Type TC .

C. Messenger Supported Cable (Multiplex Cable)

1. Factory Assembled with insulated conductors twisted around the messenger conductor in accordance with ICEA S-76-474.

2. Insulated Conductors

a. Aluminum with 600 V rated and sunlight and moisture resistant cross-linked polyethylene (XLPE) insulation.

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b. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

3. Individual Color Coding
   a. ICEA S-58-679, Method 4.
   b. See Part 3 of this specification section for additional requirements.
4. Messenger/Bare Neutral Conductor
   a. Aluminum conductor steel reinforced (ACSR).
   b. Same Size as insulated conductors.
5. Types
   a. Duplex: One (1) insulated conductor twisted around a messenger conductor.
   b. Triplex: Two (2) insulated conductors twisted around a messenger conductor.
   c. Quadruplex: Three (3) insulated conductors twisted around a messenger conductor.

D. Control Cable
1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
   a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
5. Individual conductor color coding:
   a. ICEA S-58-679, Method 1, Table E-2.
   b. See PART 3 of this Specification Section for additional requirements.
6. Conform to NFPA 70 Type TC .

E. Electrical Equipment Control Wire:
1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to UL 44 for Type SIS insulation.
5. Conform to UL 83 for Type MTW insulation.

F. Shielded VFD Cable:
1. Conductor shall be copper, stranded with 600 V rated insulation.

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2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Cables No. 1 AWG and less:
    a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type RHW-2 or XHHW-2 insulation with an overall PVC jacket.
    b. Shielding: 85 percent tinned copper braid, full size tinned copper drain wire and 100 percent foil shield.
    c. Number of conductors: 3 PH and 1 full size ground.
4. Cables No. 12 through 750 kcmil:
    a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
    b. Shielding: Continuous corrugated copper-free aluminum sheath covered with a PVC jacketor5 mil copper tape, longitudinally applied with a minimum overlap of 15 percent.
    c. Number of conductors: 3 PH and 3 equally spaced ground conductors.
5. Individual conductor color coding:
    a. ICEA S-58-679, Method 4.
    b. See PART 3 of this Specification Section for additional requirements.
6. When installed exposed outdoors, UL listed and marked as sunlight resistant.
7. For continuously corrugated cable, use manufacturer approved fittings.
8. Conform to NFPA 70, Type TC .

G. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
    a. Tinned copper conductors.
    b. 300 V or 600 V PVC insulation with PVC jacket.
    c. Twisted with 100 percent foil shield coverage with drain wire.
    d. Six (6) twists per foot minimum.
    e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
    f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.
3. Digital cable:
    a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
    b. Horizontal voice and data cable:
        1) Category 6 per TIA/EIA/ANSI 568.
        2) Cable shall be label-verified.

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3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

4) Conductors: No. 24 AWG solid untinned copper.

5) Rated CMP per NFPA 70.

c. Conform to NFPA 262 and NFPA 70 Type ITC.

4. Messenger Supported Cable (Multiplex Cable):

a. Factory assembled with insulated conductors twisted around messenger conductor in accordance with ICEA S-76-474.

b. Insulated conductors:

1) Aluminum with 600 V rated and sunlight and moisture resistant cross-linked polyethylene (XLPE) insulation.

2) Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

c. Individual conductor color coding:

1) ICEA S-58-679, Method 4.

2) See PART 3 of this Specification Section for additional requirements.

d. Messenger/bare neutral conductor:

1) Aluminum conductor steel reinforced (ACSR).

2) Same size as insulated conductors.

e. Types:

1) Duplex: One (1) insulated conductor twisted around a messenger conductor.

2) Triplex: Two (2) insulated conductors twisted around a messenger conductor.

3) Quadplex: Three (3) insulated conductors twisted around a messenger conductor.

H. Wire Connectors:

1. Twist/screw on type:

a. Insulated pressure or spring type solderless connector.

b. 600 V rated.

c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.

d. Phase and neutral conductors: Conform to UL 486C.

2. Compression and mechanical screw type:

a. 600 V rated.

b. Ground conductors: Conform to UL 467.

c. Phase and neutral conductors: Conform to UL 486A.

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3. Terminal block type:
    a. High density, screw-post barrier-type with white center marker strip.
    b. 600 V and ampere rating as required, for power circuits.
    c. 600 V, 20 ampere rated for control circuits.
    d. 300 V, 15 ampere rated for instrumentation circuits.
    e. Conform to NEMA ICS 4 and UL 486A.

I. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
    a. Insulating tape: Black.
    b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

J. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Permitted Usage of Insulation Types:
1. Type XHHW-2:
    a. Building wire and power and control cable in architectural and non-architectural finished areas.
    b. Building wire and power and control cable in conduit below grade.
2. Interior Applications: Type THHN and THHN -2:
    a. Building wire and power and control cable No. 10 AWG and smaller in architectural and non-architectural finished areas.
3. Exterior Applications: Type THWN and THWN-2
    a. Building wire and power and control cable No. 10 AWG and smaller in architectural and non-architectural finished areas.
4. Type SIS and MTW:
    a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Shielded VFD Cable:

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1. For wiring between a VFD and motor.

C. Conductor Size Limitations:

1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Feeder and branch power conductors for all exterior application shall not be smaller than No. 10 AWG unless otherwise indicated on the Drawings.
3. Wiring serving exterior lighting and equipment remote from building shall be minimum No 10 AWG.
4. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
5. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:

1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.

b. Conductors larger than No. 6 AWG:

1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:

a) Continuous colored outer finish along its entire length.

b) 3 IN of colored tape applied at the termination.

2) Insulated grounding conductor shall be identified by one (1) of the following methods:

a) Continuous green outer finish along its entire length.

b) Stripping the insulation from the entire exposed length.

c) Using green tape to cover the entire exposed length.

3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

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2. Power cables ICEA S-58-679, Method 4 with:
    a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
    b. Ground conductor: Bare.
3. Shielded VFD cable ICEA S-58-679, Method 4 with:
    a. Phase conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
    b. Ground conductor: Green color insulation or bare.
4. Control cables ICEA S-58-679, Method 1, Table E-2:
    a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
    b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
5. Messenger supported cables:
    a. ICEA S-58-679, Method 4 with insulated conductors identified with 3 IN of colored tape, per the Table herein, applied at terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.
2. Where field conditions dictate and written permission is obtained from the Engineer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
    a. The combinations shall comply with the following:
        1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
        2) 125 Vdc shall be isolated from all other AC and DC circuits.
        3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
    a. The combinations shall comply with the following:
        1) Analog signal circuits may be combined.
        2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.

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a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:

1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.

2) The neutral conductors may not be shared.

3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one (1) end only.

1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices and terminations for the following circuit types shall be made, above ground, in the indicated enclosure type.

1. Feeder and branch power circuits:

a. Device outlet boxes:

1) Twist/screw on type connectors.

b. Junction and pull boxes and wireways:

1) Twist/screw on type connectors for use on No. 8 and smaller wire.

2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.

c. Motor terminal boxes:

1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.

2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.

d. Manholes or handholes:

1) No splices shall be made in handholes or manholes.

2. Control circuits:

a. Junction and pull boxes: Terminal block type connector.

b. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.

3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.

a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.

b. Junction and pull boxes: Terminal block type connector.

c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.

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4. Messenger supported cable may be spliced or tapped, at support locations, with a compression type connector rated to connect an aluminum conductor to a copper conductor.
5. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Insulating Tape Usage:

1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

J. Color Coding Tape Usage: For color coding of conductors.

3.02 FIELD QUALITY CONTROL

A. Acceptance Testing:

1. See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 05 26 - GROUNDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for grounding system(s).

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 – Electrical Basic Requirements.

B. Section 26 05 19 – Wire and Cable - 600 Volt and Below.

C. Section 26 05 33 – Raceways and Boxes.

D. Section 26 08 13 – Acceptance Testing.

1.03 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.

C. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

a. Article 250, Grounding and Bonding.

b. Article 610, Cranes and Hoists.

D. Society of Cable Telecommunications Engineers (SCTE):

1. 77, Specification for Underground Enclosure Integrity.

E. Underwriters Laboratories, Inc. (UL):

1. 467, Grounding and Bonding Equipment.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data.

a. See Specification Section 26 05 00 for additional requirements.

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1.05 QUALITY ASSURANCE

A. Assure ground continuity is continuous throughout the entire Project.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ground rods and bars and grounding clamps, connectors and terminals:

a. Burndy.

b. Harger Lightning Protection.

c. Heary Brothers.

d. Joslyn.

e. Robbins Lightning Protection.

f. Thomas & Betts Blackburn.

g. Thompson.

2. Exothermic weld connections:

a. Erico Products Inc., Cadweld.

b. Harger Lightning Protection.

c. Thermoweld.

d. Thomas & Betts Furseweld.

3. Prefabricated composite test stations:

a. Quazite Composolite.

b. Armorcast Products Company.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 COMPONENTS

A. Wire and Cable:

1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.

2. Insulated conductors: Color coded green, per Specification Section 26 05 19.

B. Conduit: As specified in Specification Section 26 05 33.

C. Ground Bars:

1. Solid copper:

a. 1/4 IN thick.

b. 2 or 4 IN wide.

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c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.

2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.

D. Ground Rods:

1. 3/4 IN x 10 FT, or as indicated on the Drawings.
2. Copperclad:
   a. Heavy uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
   b. Corrosion resistant bond between the copper and steel.
   c. Hard drawn for a scar-resistant surface.

E. Grounding Clamps, Connectors and Terminals:

1. Mechanical type:
   a. Standards: UL 467.
   b. High copper alloy content.
2. Compression type for interior locations:
   a. Standards: UL 467.
   b. High copper alloy content.
   c. Non-reversible.
   d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
   a. Standards: UL 467, IEEE 837.
   b. High copper alloy content.
   c. Non-reversible.

F. Exothermic Weld Connections:

1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

G. Prefabricated Composite Material Test Stations:

1. Body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 15.
3. Open bottom.
4. Stackable design as required for 3 FT depth.
5. Cover:

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a. Engraved legend of "GROUND".

b. Lay-in non-bolt down.

6. Size: 12 IN round or 12 IN square.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves.
5. Do not splice grounding conductors except at ground rods.
6. Install ground rods and grounding conductors in undisturbed, firm soil.
   a. Install ground rod a minimum of 3' from disturbed soil.
   b. Provide excavation required for installation of ground rods and ground conductors.
   c. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
   d. Unless otherwise specified, connect conductors to ground rods with irreversible compression type connectors or an exothermic weld connection.
   e. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
   f. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.

B. Grounding Electrode System:

1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
2. Grounding conductor terminations:
   a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
   b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
   c. Piping systems use mechanical type connections.
   d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.

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e. At all above grade terminations, the conductors shall be labeled per Specification Section 26 05 19, paragraph 3.01.D.

3. Ground ring grounding system:

a. Ground ring consists of ground rods and a grounding conductor looped around the structure.

b. Placed at a minimum of 10 FT from the structure foundation and 2 FT-6 IN below grade.

c. Provide a minimum of four (4) ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.

d. Building/Structure grounding:

1) Bond building/structure metal support columns to the ground ring at all corners of the structure.

2) Bond alternate building/structure metal support columns along the perimeter of the structure to the ground ring.

e. Grounding conductor: Bare conductor, size as indicated on the Drawings or minimum #2 AWG.

f. Ground rod test stations:

1) Provided where grounding electrode is connected to ground ring.

2) Grounding conductors connected to ground rod with removable ground clamps.

C. Supplemental Grounding Electrode:

1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.

2. Metal light poles:

a. Connect metal pole to a ground rod.

b. Grounding conductor: Bare #6 AWG minimum.

3. Equipment support rack and pedestals mounted outdoors:

a. Connect metallic structure to a ground rod.

b. Grounding conductor: #6 AWG minimum.

4. Engine generator:

a. Connect generator frame to the ground ring at two locations (opposite corners of frame).

b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

5. Ground cranes and hoists in accordance with NFPA 70, Article 610.

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D. Low Voltage Transformer Separately Derived Grounding System:

1. Ground separately mounted step-down transformers per the below:

    a. Primary side equipment grounding conductor: Bond equipment grounding conductor from primary feeder to ground terminal bar in transformer.

    b. Supply side bonding jumper: bond ground terminal bar in transformer to ground terminal bar in service disconnect.

    c. Neutral conductor: bond XO terminal in transformer to the neutral terminal bar in the service disconnect

    d. System bonding jumper: bond ground terminal bar in service disconnect to neutral terminal bar in service disconnect.

    e. Grounding electrode conductor: bond neutral terminal bar in service disconnect to:

        1) Exterior applications

            a) Ground rod or ground ring.

        2) Interior applications

            a) Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic welds

            b) Closest water pipe using a mechanical type connection.

E. Raceway Bonding/Grounding:

1. All metallic conduit shall be installed so that it is electrically continuous.

2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.

3. NFPA 70 required grounding bushings shall be of the insulating type.

4. Provide double locknuts at all panels.

5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.

6. Provide bonding jumpers if conduits are installed in concentric knockouts.

7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

F. Equipment Grounding:

1. All utilization equipment shall be grounded with an equipment ground conductor.

G. Handhole Grounding:

1. Provide a ground rod and ground bar, when indicated or as needed, in each handhole with exposed metal parts.

    a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.

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2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

H. Pad Mounted Switch and Above Grade Sectionalizing Terminal Cabinet Grounding:

1. Provide a ground rod(s) in each enclosure with a minimum of 4 IN of rod exposed above the floor for connection to the rod.

a. Connect metal frame to the ground rod.

b. Connect medium voltage cable shields to the ground rod.

I. Pad Mounted Oil Filled Transformer Grounding:

1. Provide a ground ring around transformer with:

a. A minimum of four ground rods located at the corners.

b. A ground rod connected to the ring and located in the conduit stub up area.

c. Connect medium voltage cable shields to the ground rod.

d. Connect surge arrestor to the ground rod.

e. Connect the XO and ground pad to the ground rod.

f. Connect exposed metallic conduits to the ground rod.

3.02 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Owner.

B. Acceptance testing:

1. See NEC 250

2. See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 05 33 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
    a. Conduits.
    b. Conduit fittings.
    c. Conduit supports.
    d. Wireways.
    e. Outlet boxes.
    f. Pull and junction boxes.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical Basic Requirements.

B. Section 26 05 19 - Wire and Cable 600 Volt and Below.

C. Section 26 05 43 - Electrical Exterior Underground.

D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCED STANDARDS

A. Aluminum Association (AA).

B. American Iron and Steel Institute (AISI).

C. ASTM International (ASTM):

1. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. D2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Tube.
4. D2447, Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
5. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
6. D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
7. D3485, Standard Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.

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8. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
9. F512, Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.

D. National Electrical Manufacturers Association (NEMA):
1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
3. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
4. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
5. {TC 6&8, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installations.}

E. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
1. C80.1, Electric Rigid Steel Conduit (ERSC).
2. C80.3, Steel Electrical Metallic Tubing (EMT).
3. C80.5, Electrical Aluminum Rigid Conduit.
4. C80.6, Intermediate Metal Conduit (EIMC).
5. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

F. National Fire Protection Association (NFPA):
1. 70, National Electrical Code (NEC).

G. Underwriters Laboratories, Inc. (UL):
1. 1, Standard for Flexible Metal Conduit.
2. 6, Standard for Electrical Rigid Metal Conduit - Steel.
3. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
4. 94, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
5. 209, Standard for Cellular Metal Floor Raceways and Fittings.
6. 360, Standard for Liquid-Tight Flexible Steel Conduit.
7. 467, Grounding and Bonding Equipment.
8. 514A, Metallic Outlet Boxes.
9. 514B, Conduit, Tubing, and Cable Fittings.
10. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
11. 651A, Type EB and A Rigid PVC Conduit and HDPE Conduit.
12. 651B, Standard for Continuous Length HDPE Conduit

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13. 797, Electrical Metallic Tubing - Steel.
14. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
15. 884, Standard for Underfloor Raceways and Fittings.
16. 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
17. 1242, Standard for Electrical Intermediate Metal Conduit - Steel.
18. 1660, Liquid-Tight Flexible Nonmetallic Conduit.
19. 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

H. Building code:

1. International Code Council (ICC):

a. International Building Code and associated standards, {2006}{2009}{2012} Edition including all amendments, referred to herein as Building Code.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

3. Fabrication and/or layout drawings:

a. Identify dimensional size of pull and junction boxes to be used.

1.05 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Rigid metallic conduits:

a. Allied Tube and Conduit Corporation.

b. Triangle PWC Inc.

c. Western Tube and Conduit Corporation.

d. Wheatland Tube Company.

e. LTV Steel Company.

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2. PVC coated rigid metallic conduits:
    a. Thomas & Betts Ocal.
    b. Rob-Roy Ind.
3. Rigid nonmetallic conduit:
    a. Prime Conduit (Carlon).
    b. Cantex.
    c. Osburn Associates.
4. Flexible conduit:
    a. AFC Cable Systems.
    b. Anamet, Inc.
    c. Electri-Flex.
    d. Flexible Metal Hose Company.
    e. International Metal Hose Company.
    f. Triangle PWC Inc.
    g. LTV Steel Company.
5. Wireway:
    a. Hoffman Engineering Company.
    b. Wiegmann.
    c. Square D.
6. Conduit fittings and accessories:
    a. Appleton Electric Co.
    b. Carlon.
    c. Cantex.
    d. Crouse-Hinds.
    e. Killark.
    f. Osburn Associates.
    g. OZ Gedney Company.
    h. RACO.
    i. Steel City.
    j. Thomas & Betts.
7. Support systems:
    a. Unistrut Building Systems.
    b. Eaton B-Line.
    c. Kindorf.

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d. Minerallac Fastening Systems.

e. Caddy.

f. Thomas & Betts Superstrut.

8. Outlet, pull and junction boxes:

a. Appleton Electric Co.

b. Eaton Crouse-Hinds.

c. Killark.

d. O-Z/Gedney.

e. Thomas & Betts Steel City.

f. Raco.

g. Bell.

h. Hoffman Engineering Co.

i. Wiegmann.

j. Eaton B-Line.

k. Adalet.

l. Rittal.

m. Stahlin.

B. See also Selected Suppliers and Manufacturer's list in Specification Section 26 05 00, paragraph 2.A.

C. Submit request for substitution in accordance with Specification Section 26 05 00.

2.02 RIGID METALLIC CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):

1. Mild steel with continuous welded seam.

2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.

3. Threads galvanized after cutting.

4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.

5. Standards: NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):

1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:

a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.

b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.

2. Nominal 2 mil, minimum, urethane interior coating.

3. Urethane coating on threads.

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4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
    a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
    b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.

C. Electrical Metallic Tubing (EMT):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
4. Standards: NEMA/ANSI C80.3, UL 797.

2.03 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.

2.04 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vaportight.
4. Standard: UL 360.

2.05 WIREWAY

A. General:
1. Suitable for lay-in conductors.

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2. Designed for continuous grounding.
3. Covers:
    a. Hinged or removable in accessible areas.
    b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
1. 14 or 16 gage steel without knockouts.
2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Raintight (NEMA 3R) Wiring Trough:
1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.

D. Watertight (NEMA 4X rated) Wireway:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

E. Dusttight (NEMA 12 rated) Wireway:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.

2.06 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS :
1. General:
    a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
    a. Threaded steel or malleable iron.
    b. Gasketed or non-gasketed.
    c. Grounding or non-grounding type.
3. Bushings:
    a. Threaded, insulated metallic.
    b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.

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5. Couplings:
    a. Threaded straight type: Same material and finish as the conduit with which they are used on.
    b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. Cover:
        1) Clip-on type with stainless steel screws.
        2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
    a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
    b. Standard and mogul size.
    c. With or without drain and breather.
    d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
    a. Liquid tight and arc resistant.
    b. Electrically conductive so no bonding jumper is required.
    c. Dry and wet areas:
        1) Bronze braided covering over flexible brass core.
        2) Bronze end fittings.
        3) Zinc-plated steel or malleable iron unions and nipples.
    d. Corrosive areas:
        1) Stainless steel braided covering over flexible stainless steel core.
        2) Stainless steel end fittings.
        3) Aluminum unions and nipples.
11. Service entrance head:

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a. Malleable iron, galvanized steel or copper free aluminum.

b. Insulated knockout cover for use with a variety of sizes and number of conductors.

12. Expansion couplings:

a. 2 IN nominal straight-line conduit movement in either direction.

b. Galvanized steel with insulated bushing.

c. Gasketed for wet locations.

d. Internally or externally grounded.

13. Expansion/deflection couplings:

a. 3/4 IN nominal straight-line conduit movement in either direction.

b. 30-degree nominal deflection from the normal in all directions.

c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.

d. Internally or externally grounded.

e. Watertight, raintight and concrete tight.

14. Standards: UL 467, UL 514B, UL 886.

B. Fittings for Use with PVC-RGS:

1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS " and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:

1. Connectors:

a. Straight, angle and offset types furnished with locknuts.

b. Zinc plated steel.

c. Insulated gland compression type.

d. Concrete and raintight.

2. Couplings:

a. Zinc plated steel.

b. Gland compression type.

c. Concrete and raintight.

3. Conduit bodies (ells and tees):

a. Body: Copper free aluminum with threaded hubs.

b. Standard and mogul size.

c. Cover:

1) Screw down type with steel screws.

2) Gasketed or non-gasketed galvanized steel or copper free aluminum.

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4. Standard: UL 514B.

D. Fittings for Use with FLEX:

1. Connector:

a. Zinc plated malleable iron.

b. Squeeze or clamp-type.

2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT :

1. Connector:

a. Straight or angle type.

b. Metal construction, insulated and gasketed.

c. Composed of locknut, grounding ferrule and gland compression nut.

d. Liquid tight.

2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Nonmetallic PVC Conduit:

1. Coupling, adapters and conduit bodies:

a. Same material, thickness, and construction as the conduits with which they are used.

b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.

c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.

2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.

3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Weather and Corrosion Protection Tape:

1. PVC based tape, 10 mils thick.

2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.

3. Used with appropriate pipe primer.

2.07 ALL RACEWAY AND FITTINGS

A. Mark Products:

1. Identify the nominal trade size on the product.

2. Stamp with the name or trademark of the manufacturer.

2.08 OUTLET BOXES

A. Metallic Outlet Boxes:

1. Hot-dip galvanized steel.

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2. Conduit knockouts and grounding pigtail.
3. Styles:
    a. 2 IN x 3 IN rectangle.
    b. 4 IN square.
    c. 4 IN octagon.
    d. Masonry/tile.
4. Accessories:
    a. Flat blank cover plates.
    b. Barriers.
    c. Extension, plaster or tile rings.
    d. Box supporting brackets in stud walls.
    e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
1. Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
    a. "FS" or "FD".
    b. "Bell".
    c. Single or multiple gang and tandem.
    d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
5. Standards: UL 514A, UL 886.

C. See Specification Section 26 27 26 for wiring devices, wallplates and coverplates.

2.09 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four (4) sides.
3. Flat cover fastened with screws.

B. NEMA 3R Rated:
1. Body and cover: 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.

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2. Drip shield top and seam-free sides, front and back.
3. With or without concentric knockouts on bottom.
4. Slip-on removable cover fastened on bottom edge with screws or continuous hinged cover fastened with screws.

C. NEMA 4 Rated:
1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
6. Cover with oil resistant gasket.

D. NEMA 4X Rated (metallic):
1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.

E. NEMA 4X Rated (Nonmetallic):
1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
2. No knockouts.
3. External mounting flanges.
4. Hinged door with quick release latches and padlocking hasp.
5. Door with oil resistant gasket.

F. NEMA 7 and NEMA 9 Rated:
1. Cast gray iron alloy or copper-free aluminum with manufacturers standard finish.
2. Drilled and tapped openings or tapered threaded hub.
3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
4. External mounting flanges.
5. Grounding lug.
6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

G. NEMA 12 Rated:

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1. Body and cover:
    a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. Type 5052 H-32 aluminum, unpainted.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.

H. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

I. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
1. Material requirements.
    a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
    b. Stainless steel: AISI Type 316.
    c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.

B. Single Conduit and Outlet Box Support Fasteners:
1. Material requirements:
    a. Zinc plated steel.
    b. Stainless steel.
    c. Malleable iron.
    d. PVC coat malleable iron or steel: 20 mil PVC coating.
    e. Steel protected with zinc phosphate and oil finish.

2.11 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
1. See Specification Section 07 84 13.

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PART 3 - EXECUTION

3.01 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:

1. NFPA 70.
2. Manufacturer instructions.
3. All empty conduits shall be tagged per Specification Section 26 05 00, 3.01.Q.

B. Size of Raceways:

1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
   a. Conduit: 3/4 IN.
   b. Wireway: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:

1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.

1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
   a. Total nominal thickness: 40 mil.
4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.

1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.

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3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.

3.02 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.

1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.

2. Run in straight lines parallel to or at right angles to building lines.

3. Do not route conduits:

a. Through areas of high ambient temperature or radiant heat.

b. In suspended concrete slabs.

4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.

5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 315 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All rigid conduits within a structure shall be installed exposed except as follows:

1. As indicated on the Drawings.

2. Concealed above gypsum wall board or acoustical tile suspended ceilings.

3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.

4. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with approval of the Engineer's.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:

1. Between instrumentation and telecommunication: 1 IN.

2. Between instrumentation and 125 V, 48 V and 24 Vdc, 2 IN.

3. Between instrumentation and 600 V and less AC power or control: 6 IN.

4. Between instrumentation and greater than 600 Vac power: 12 IN.

5. Between telecommunication and 125 V, 48 V and 24 Vdc, 2 IN.

6. Between telecommunication and 600 V and less AC power or control: 6 IN.

7. Between telecommunication and greater than 600 Vac power: 12 IN.

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8. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.
9. Between 125 V, 48 V and 24 Vdc and greater than 600 Vac power: 2 IN.
10. Between 600 V and less AC and greater than 600 Vac: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.
   1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
   1. New construction:
      a. Sleeves and blockouts:
         1) Set in masonry walls during erection.
         2) Set in concrete walls and floors during forming.
      b. Sleeves not considered to structurally replace the displaced concrete.
   2. Conduits and accessories embedded in concrete where shown on the Contract Drawings:
      a. Shall not be considered to replace structurally the displaced concrete except as indicated in the following:
         1) Conduit and fittings shall not displace more than 4 percent of the area of the cross-section of a column on which stress is calculated or which is required for fire protection.
         2) Size and locate sleeves or conduits passing through floors, walls, or beams so as not to significantly impair the strength of the construction.
         3) Sleeves or conduits passing through floors, walls or beams may be considered as replacing the displaced concrete structurally in compression.
            a) Shall not be exposed to rusting or other deterioration.
            b) Nominal inside diameter shall not exceed 2 IN.
            c) Minimum spacing: 3 DIA OC.
      b. Shall not be larger in outside diameter than one-third the thickness of the slab, column or beam.
      c. Shall have a minimum spacing of 3 DIA OC.
      d. In reinforced concrete construction:
         1) Conduit shall not be run in beams.

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2) Place conduit after reinforcing steel has been laid.

3) The reinforcement steel shall not be displaced by the conduit.

4) Provide a minimum of 1-1/2 IN of cover over conduit, excluding surface finish.

5) Conduits parallel to main reinforcement shall be run near the center of the wall.

6) Conduits perpendicular to main reinforcement shall be run midway between wall or slab supports.

3.03 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:

1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Motor leads from a VFD: RGS.
5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:

1. Dry areas:
   a. RGS.
   b. EMT above 10 FT.
2. Wet areas:
   a. RGS.
3. Corrosive areas:
   a. PVC-RGS.
4. Highly corrosive areas:
   a. PVC-RGS.
   b. PVC-80.
5. NFPA 70 hazardous areas:
   a. RGS.

C. Permitted Raceway Types Per Routing Locations:

1. In stud framed walls:
   a. EMT.
2. In concrete block or brick walls:
   a. PVC-40.
3. Above acoustical tile ceilings:

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a. EMT.

4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
   a. PVC-40.
6. Through floor penetrations:
   a. RGS wrapped with factory applied weather and corrosion protection tape when emerging from concrete into areas designated as dry, wet, corrosive or highly corrosive.
   b. PVC-RGS in areas designated as wet, corrosive or highly corrosive.
7. Direct buried conduits and ductbanks:
   a. PVC-80.
   b. PVC-40.
   c. 90 degree elbows for transitions to above grade:
      1) PVC-RGS.
      2) RGS wrapped with applied weather and corrosion protection tape.
   d. Long sweeping bends greater than 15 degrees:
      1) PVC-RGS.
      2) RGS wrapped with applied weather and corrosion protection tape.
8. Concrete encased ductbanks:
   a. PVC-40.
   b. 90 degree elbows for transitions to above grade:
      1) PVC-RGS.
      2) RGS wrapped with factory applied weather and corrosion protection tape.
   c. Long sweeping bends greater than 15 degrees:
      1) RGS for sizes 2 IN and larger.
      2) Fiberglass long sweep bends are only allowed on plastic (PVC) ductbanks.

D. Flexible conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above ceilings in buildings. Flexible conduit shall not be used outside buildings.
   1. The maximum length shall not exceed:
      a. 6 FT to light fixtures.

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b. 3 FT to all other equipment.

E. Liquidtight flexible conduits shall be installed in buildings as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate. Liquidtight flexible conduits shall not be used outside buildings.

1. The maximum length shall not exceed:

a. 6 FT to light fixtures.

b. 3 FT to motors.

c. 2 FT to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate. HAZ-FLEX shall not be used outside buildings.

1. The maximum length shall not exceed:

a. 3 FT to motors.

b. 2 FT to all other equipment.

G. NEMA 1 Rated Wireway:

1. Surface mounted in electrical rooms.

2. Surface mounted above removable ceilings tiles of an architecturally finished area.

H. NEMA 3R Wiring Trough:

1. Surface mounted in exterior locations.

I. NEMA 4X Rated Wireway:

1. Surface mounted in areas designated as wet and or corrosive.

J. NEMA 12 Rated Wireway:

1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

K. Underground Conduit: See Specification Section 26 05 43.

3.04 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:

1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.

2. Filler plug and drain shall be accessible.

3. Pour the conduit seals in a two-step process.

a. Pour the seal and leave cover off.

b. After seal is dry, inspect for proper sealng, install cover and mark (for example, paint or permanent marker) as complete.

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B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
    1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.
C. Install Expansion Fittings:
    1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
    2. Elsewhere as identified on the Drawings.
D. Install Expansion/Deflection Fittings:
    1. Where conduits enter a structure.
        a. Except electrical manholes and handholes.
        b. Except where the ductbank is tied to the structure with rebar.
    2. Where conduits span structural expansions joints.
    3. Elsewhere as identified on the Drawings.
E. Threaded connections shall be made wrench-tight.
F. Conduit joints shall be watertight:
    1. Where subjected to possible submersion.
    2. In areas classified as wet.
    3. Underground.
G. Terminate Conduits:
    1. In metallic outlet boxes:
        a. RGS:
            1) Conduit hub and locknut.
            2) Insulated bushing and two (2) locknuts.
            3) Use grounding type locknut or bushing when required by NFPA 70.
        b. EMT: Compression type connector and locknut.
    2. In NEMA 1 rated enclosures:
        a. RGS :
            1) Conduit hub and locknut.
            2) Insulated bushing and two (2) locknuts.
            3) Use grounding type locknut or bushing when required by NFPA 70.
        b. EMT: Compression type connector and locknut.
    3. In NEMA 12 rated enclosures:
        a. Watertight, insulated and gasketed hub and locknut.
        b. Use grounding type locknut or bushing when required by NFPA 70.

4. In NEMA 4 and NEMA 4X rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut.
5. In NEMA 3R rated enclosures:
    a. Watertight, insulated and gasketed hub and locknut
6. In NEMA 7 and NEMA 9 rated enclosures:
    a. Into an integral threaded hub.
7. When stubbed up through the floor into floor mount equipment:
    a. With an insulated grounding bushing on metallic conduits.
    b. With end bells on nonmetallic conduits.

3.05 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
    1. Dry or wet and/or hazardous areas:
        a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
    2. Corrosive areas:
        a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
    3. Highly corrosive areas:
        a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
    4. Conduit type shall be compatible with the support system material.
        a. Galvanized steel system may be used with RGS and EMT.
        b. Stainless steel system may be used with RGS and PVC-RGS .
        c. PVC coated galvanized steel system may be used with PVC-RGS and PVC-40 and PVC-80.
B. Permitted single conduit support fasteners per area designations and conduit types:
    1. Architecturally finished areas:
        a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
        b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
        c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
    2. Dry or wet and/or hazardous areas:

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a. Material: Zinc plated steel, stainless steel and malleable iron.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

3. Corrosive areas:

a. Material: Stainless steel and PVC coat malleable iron or steel.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

4. Highly corrosive areas:

a. Material: PVC coat malleable iron or steel.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

5. Conduit type shall be compatible with the support fastener material.

a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.

b. Stainless steel system may be used with RGS and PVC-RGS.

c. PVC coated fasteners may be used with PVC-RGS and PVC-40and PVC-80.

d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

C. Conduit Support General Requirements:

1. Maximum spacing between conduit supports per NFPA 70.

2. Support conduit from the building structure.

3. Do not support conduit from process, gas, air or water piping; or from other conduits.

4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.

a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.

b. Conduit hangers:

1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.

c. Do not use suspended ceiling support systems to support raceways.

d. Hangers in metal roof decks:

1) Utilize fender washers.

2) Not extend above top of ribs.

3) Not interfere with vapor barrier, insulation, or roofing.

5. Conduit support system fasteners:

a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.

b. Do not use concrete nails and powder-driven fasteners.

3.06 OUTLET, PULL BOX, AND JUNCTION BOX INSTALLATION

A. General:

1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.
5. Label outlets, pullboxes, and junction box per Specification Section 26 05 00 paragraph 3.01.Q.

B. Outlet Boxes:

1. Permitted uses of metallic outlet boxes:
   a. Housing of wiring devices:
      1) Recessed in all stud framed walls and ceilings.
      2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
   b. Pull or junction box:
      1) Above gypsum wall board or acoustical tile ceilings.
      2) Above 10 FT in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
   b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
   b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

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C. Pull and Junction Boxes:

1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
    a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
    a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4 enclosure:
    a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
    a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
    a. Pull or junction box surface mounted in areas designated as Class I hazardous.
        1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
    a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

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SECTION 26 05 36 - CABLE TRAY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Cable tray and associated fittings and supports.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 07 84 13 - Firestopping.

B. Section 26 05 00 - Electrical: Basic Requirements.

C. Section 26 05 26 - Grounding.

D. Section 26 05 33 - Raceways and Boxes.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI).

B. ASTM International (ASTM):

1. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. A510, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
3. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
4. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
5. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

C. National Electrical Manufacturers Association (NEMA):

1. FG-1, Fiberglass Cable Tray Systems.
2. VE-1, Metal Cable Tray Systems.
3. VE-2, Metal Cable Tray Installation Guidelines.

D. Underwriters Laboratories, Inc. (UL).

1. 94, Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

E. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

F. Building code:

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1. International Code Council (ICC):
    a. International Building Code and associated standards, Latest Edition including all amendments, referred to herein as Building Code.

1.04 DEFINITIONS

A. Types of Cable Tray:
    1. Ladder: A prefabricated metal structure consisting of two (2) longitudinal side rails connected by individual transverse members of rungs.
    2. Wire-mesh: A rigid tray systems constructed from high strength wire spaced parallel with 2 IN longitudinal and 4 IN transverse wire, spot welded at all intersections.

1.05 SYSTEM DESCRIPTION

A. The following is a brief description of the types of the trays to be used.
    1. All Buildings: Wire-mesh, Ladder.

B. Miscellaneous:
    1. Cable tray systems are sized on the Drawings.
    2. When cable tray system size is not shown on the Drawings or scheduled, the cable tray shall be sized in accordance with the NFPA 70 and the requirements of this Specification Section.
    3. Cable tray runs, where shown, are diagrammatic and intended to be used as a guide, unless otherwise indicated on the Drawings.
        a. Site conditions may affect actual routing.
        b. Contractor shall coordinate routing and measurement with other trades and with equipment suppliers to avoid interference with equipment, piping, ductwork, etc.
        c. When not specifically shown on the drawings, the Contractor can provide cable tray per the following, with approval by the Engineer:
            1) Ladder tray in Prefabricated Electrical Rooms.
            2) Tray size and fill per NFPA 70.

1.06 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Product technical data.
        a. Provide submittal data for all products specified in PART 2 of this Specification Section.
        b. See Specification Section 26 05 00 for additional requirements.
    3. Fabrication and/or layout drawings:

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a. Routing, size and fittings.

b. Seismic location installation details.

B. Informational Submittals:

1. Cable tray fill calculations.

2. Cable schedule of cables in cable trays.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Metallic and nonmetallic cable tray systems:

a. Eaton B-Line.

b. T.J. Cope.

c. Husky/Burndy.

d. Thomas & Betts.

e. P-W Ind.

2. Wire-mesh cable tray systems:

a. Eaton B-Line.

b. T.J. Cope.

c. Husky/Burndy.

d. Cablofil.

e. Chalfant.

f. Niedex.

g. Thomas & Betts.

3. Telecommunications cable ladders:

a. Homaco.

b. Middle Atlantic Products.

4. Cable tray conduit and ground clamps and brackets:

a. Eaton B-Line.

b. P-W Ind.

c. O.Z. Gedney.

d. Thomas & Betts.

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B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 COMPONENTS

A. Wire-Mesh Tray:

1. Material:

a. Steel wires and fasteners: ASTM A510 carbon steel hot-dipped galvanized after fabrication per ASTM A123/A123M or electroplated per ASTM B633.

2. Fabrication:

a. Wires formed into a 2 IN by 4 IN mesh pattern with intersecting wires welded together.

b. The top of the side rails formed to create a safety system for the cables and installers (e.g., rounded transverse wire ends, top wire T welded to transverse wires).

c. Fittings (bends, risers, tees, etc.) to be constructed on-site using side action bolt croppers and fastened using spring action couplers or clamps with bolts and nuts.

d. Useable clear loading depth: Minimum 2 IN.

e. Useable clear loading width: As indicated in Drawings.

f. UL classified per NFPA 70 as an equipment grounding conductor.

2.03 ACCESSORIES

A. Accessories including but not limited to, splice plates, barrier strips, drop outs, box connector, end plate and conduit clamps to be the same material as the tray or other compatible material.

B. Covers and Associated Accessories:

1. Material: Same base material as tray.

2. Types: Solid flanged (flat), ventilated flanged (flat), peak flanged.

C. Cable Tray Ground Clamps:

1. Malleable iron or tin-plated extruded aluminum with zinc-plated steel screws.

2. Serrated edges to bite into and bond to the cable tray system.

D. Support system:

1. Material: See Specification Section 26 05 00 for material specifications.

2. See PART 3 of this Specification Section for material type.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with NEMA VE-2 and as recommended by the manufacturer's instructions unless otherwise indicated on the Drawings.

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B. Install cable tray, fittings and accessories, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.

C. Install cable tray systems as close as practical to the locations and elevations shown on the Drawings.

1. Minor changes (12 IN or less) in location or elevation may be made to avoid interference with piping, ductwork and equipment.

2. Obtain Engineer's approval prior to making major changes (greater than 12 IN) in location or elevation.

3. When cable tray is located adjacent to, beneath or near large piping or major equipment, or terminates at equipment; do not install cable tray until the installation of such piping and equipment is complete.

4. Insure openings are provided in walls that cable tray will penetrate.

5. Fire stop penetrations in fire rated walls.

a. Use a removable fire stopping system such as pillows.

D. Cable Tray Supports:

1. Provide supports at required locations to provide the loading capacity per the Contractor's fill calculations.

2. Cantilever bracket type when cable tray is installed adjacent to a wall.

3. Trapeze type hangers for all other applications.

4. For vertical runs in excess of 20 FT support the tray by angles bolted through the side rails and suspended from hanger rod, which is connected to a cantilevered support.

5. In seismic locations provide required supports and/or sway bracing per local Building Codes.

E. Permitted prefabricated bracket or trapeze type support system per area designations and tray material:

1. Dry or wet areas:

a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.

b. Aluminum system consisting of: Aluminum channels and fittings with stainless steel nuts and hardware and conduit clamps.

2. Corrosive areas:

a. Stainless steel system consisting of: Stainless steel channels and fittings, nuts and hardware and conduit clamps.

b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.

c. Fiberglass system consisting of: Fiberglass channels and fittings, nuts and hardware and conduit clamps.

3. Tray material shall be compatible with the support system material.

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a. Galvanized steel system may be used with zinc coated trays.

F. Whenever cable tray system spans a structural expansion joint provide one (1) of the following:

1. Expansion connector allowing a minimum of 1 IN straight-line movement of sections.

2. A 2 IN discontinuity (gap) in the cable tray to allow horizontal and vertical movement.

G. Maintain electrical continuity of the cable tray system.

1. Bolt connectors to each section or fitting.

2. Span expansion connectors by a bonding jumper.

3. Use one (1) of the following to bond conduits to the tray:

a. Conduits connected to the cable tray system by a one-piece conduit clamp shall be considered bonded to the cable tray system.

b. Terminate conduits connected to the cable tray system by a bracket and clamp assembly in an insulated grounding bushing and bond to the cable tray system.

4. Tighten all bolted connections to manufacturer's recommendations to ensure electrical continuity.

H. Cable Tray System Grounding:

1. See Specification Section 26 05 26.

I. Secure cables, in vertical runs of cable tray, with cable clamps or ties as near as practical to the top and bottom of the vertical run and at a maximum of 6 FT spacing over the length of the run.

1. Plastic wire ties to be UV resistant type.

J. Conduit terminating at a cable tray system:

1. See Specification Section 26 05 33.

K. Use flanged fittings to terminate cable tray systems at switchgear, motor control centers, and other equipment, unless indicated otherwise on the Drawings.

L. Install flat, solid, flanged covers on vertical cable tray to a minimum 6 FT above finished floor and walkways.

M. Cover cable tray systems passing under open grating type walkways and platforms.

1. Peak flanged.

N. Install barrier strips in cable tray systems containing both power and control wiring to physically separate the control cables from the power cables.

O. Cable Installation:

1. Conductors #4/0 AWG and less, shall be in a multi-conductor cable.

2. Conductors 250 kcmil and larger, shall be single conductor cables bundled together, Phase A, B, C and neutral and/or ground when required.

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3.02 FIELD QUALITY CONTROL

A. Tray Fill Calculations:

1. Cable tray fill shall not exceed NFPA 70 requirements.

a. The Contractor shall coordinate the installation of all cables and maintain cable fill calculations and schedule of cables in the trays.

B. Where galvanized steel cable tray is cut, drilled, or where the protective coating has otherwise been damaged during installation, immediately coat the exposed steel surface with a rust-inhibitor and a finish coat of zinc-rich paint.

C. Remove trash and accumulated dirt from the entire cable tray system at the completion of the project and install covers where applicable.

D. Tagging and warning signs:

1. Conductors shall be marked per Specification Section 26 05 19, paragraph 3.01.D.

END OF SECTION

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SECTION 26 05 43 - ELECTRICAL EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Handhole.

b. Underground conduits and ductbanks.

c. Steel casement pipe.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Division 03 – Concrete.

B. Section 03 09 00 – Concrete.

C. Section 26 05 26 – Grounding.

D. Section 26 05 33 – Raceways and Boxes.

E. Division 31 – Earthwork.

1.03 REFERENCED STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO):

1. HB, Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):

1. A536, Standard Specification for Ductile Iron Castings.

2. A139, Standard Specification for Electric-Fusion Welded Steel Pipe.

3. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.

C. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

D. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

E. Society of Cable Telecommunications Engineers (SCTE):

1. 77, Specification for Underground Enclosure Integrity.

1.04 DEFINITIONS

A. Direct-buried conduit(s):

1. Individual (single) underground conduit.

2. Multiple underground conduits, arranged in one or more planes, in a common trench.

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B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete (Slurry) envelope.

C. Steel casing pipe: An individual pipe used to protect single or electrical power or signal-type conduits.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

3. Fabrication and/or layout drawings:

a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

b. Provide cross-sectioned sketch of each concrete encased ductbank (if any).

1) Dimension spacing between conduits.

2) Dimension concrete envelope and reinforcing, where applicable.

c. Provide cross-section sketch of each direct-buried ductbank (if any).

1) Dimension from grade to direct buried ductbank.

2) Dimension from direct buried ductbank to other utilities in the route.

d. Precast cable trench (if any):

1) Provide dimensions, loading information, and installation instructions for underground cable trench system.

2) Provide detailed layout drawings showing the following as a minimum:

a) Physical dimensions of the system.

b) Dimension cable trench to other utilities in the path of the trench.

c) Dimension cable trench to site structures.

d) Cross-sectional sketch of the trench showing:

(1) Power cable runs.

(2) Control cable runs and support.

(3) Shielded I and C cable runs in RGS conduit.

(4) Trench grounding.

(5) Conduit exit for all cables.

3) Cable identification schedule for all cables run within the precast cable trench.

4) Verification of trench covers rated for vehicle crossing.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Precast handholes:
    a. Jensen Precast.
    b. Utility Vault Co.
    c. Oldcastle Precast, Inc.
    d. Lister Industries.
2. Handhole and ductbank accessories:
    a. Neenah.
    b. Unistrut.
    c. Condux International, Inc.
    d. Underground Devices, Inc.
3. Utility marker posts:
    a. Rhino Marking & Protection Systems
4. Electronic Ball Marker:
    a. 3M

B. Submit request for substitution in accordance with Specification Section 26 05 00.

2.02 HANDHOLES

A. Precast Handholes:

1. Steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with an 18 IN DIA, open sump with aluminum grate.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cover extension rings as required.
7. Cable pulling eyes opposite all conduit entrances.
    a. Coordinate exact location with installation contractor.

2.03 CONCRETE HANDHOLE ACCESSORIES

A. Cover and Frame:

1. Galvanized steel traffic cover, bolt down.
2. AASHTO live load rating: H-20.

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3. Cast the legend "ELECTRICAL 480V", "HIGH VOLTAGE", SIGNAL" or "COMMUNICATIONS" into handhole covers. Also include "UPRR" on legend.
    a. If the appropriate label is not cast into the cover at the time of manufacture, the contractor shall add a legend label to the cover by welding the individual letter onto the cover or by attaching a metal embossed label to the cover permanently by welding or other means.

B. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.

2.04 UNDERGROUND CONDUIT AND ACCESSORIES

A. Concrete: Comply with Division 03 Specifications.

B. Conduit: See Specification Section 26 05 33.

C. Duct Spacers/Supports:
    1. High density polyethylene or high impact polystyrene.
    2. Interlocking.
    3. Provide 2 IN minimum spacing between conduits.
    4. Accessories, as required:
        a. Hold down bars.
        b. Ductbank strapping.

2.05 STEEL CASEMENT PIPE

A. Grade B seamless black steel
    1. Minimum yield: 35,000 psi
    2. Minimum tensile: 60,000 psi
    3. Schedule 40 for sizes 6" and smaller
    4. Schedule 20 for sizes 8" and larger

2.06 STEEL CASEMENT PIPE ACCESSORIES

1. Casing spacers: PSI model PE or equal, as required
2. Pull-on casing end seal: PSI model S or equal, as required

PART 3 - EXECUTION

3.01 GENERAL

A. Drawings indicate the intended location of handholes and routing of ductbanks and direct buried conduit.
    1. Field conditions may affect actual routing.

B. Handhole Locations:
    1. Approximately where shown on the Drawings.

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2. As required for pulling distances. Under 600V, underground splices shall not be permitted. Over 600V, underground splices shall be permitted.
3. As required to keep pulling tensions under allowable cable tensions.
4. As required for number of bends in ductbank routing.
5. Shall not be installed in a swale or ditch.
6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of handholes.

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

D. Install handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Install and arrange cabling in handholes in a clean and workmanlike manner. Under 600V, no underground splices shall be permitted in handholes.

F. Comply with Division 31 for trenching, backfilling and compacting.

3.02 HANDHOLES

A. Precast Handholes:
1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
a. Grout or seal all joints, per manufacturer's instructions.
b. Support cables on walls by cable hooks:
c. In each handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
1) Drill opening in floor for ground rod.
2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
3) Utilize a ground bar in the handhole if the quantity of ground wires exceeds three (3).
a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
3. Place handhole on a foundation of compacted 1 IN crushed rock a minimum of 12 IN thick and 6 IN larger than handholes footprint on all sides.
4. Place 3M EMS 4 IN ball marker, catalog #1402-XR in handhole. Use a cable tie to secure ball marker to power cable.
5. Install so that the top of cover is 1/2 IN above finished grade.
6. After installation is complete, backfill and compact soil around handholes.
7. Handhole size:

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a. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.

3.03 UNDERGROUND CONDUITS

A. General Installation Requirements:

1. All buried conduits shall have a 6 IN wide warning tape installed - depth as indicated.
2. Ductbank types per location:
   a. Concrete encased ductbank (400psi Slurry):
      1) Under railroads.
      2) Under roads.
   b. Concrete encased ductbank (100psi Slurry):
      1) Conduits containing medium voltage cables.
      2) Pad mounted transformer secondaries.
      3) Plant process equipment feeders and controls.
   c. Steel casing pipe ductbank
      1) Under railroads.
      2) As noted on drawings.
   d. Direct-buried conduit(s) as noted on drawings.
3. Do not place concrete or soil until conduits have been observed by the Engineer or Engineer's designated on-site representative.
4. Do not place within 12 IN of any culvert.
5. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.
   a. Low points shall be at manholes or handholes where possible.
6. During construction and after conduit installation is complete; plug the ends of all conduits.
7. Provide conduit supports and spacers.
   a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
      1) 1 IN and less: 3 FT.
      2) 1-1/4 to 3 IN: 5 FT.
      3) 3-1/2 to 6 IN: 7 FT.
   b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
      1) 1 IN and less: 10 FT.
      2) 1-1/4 to 2-1/2 IN: 14 FT.
      3) 3 IN and larger: 20 FT.

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c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.

8. Stagger conduit joints at intervals of 6 IN vertically.
9. Make conduit joints watertight and in accordance with manufacturer's recommendations.
10. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.
    a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
11. Furnish manufactured bends at end of runs.
    a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 48 IN for conduits 3 IN trade size and larger.
    b. All long sweep elbows shall be rigid galvanized steel (RGS).
12. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
13. After the conduit run has been completed:
    a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
        1) Test mandrel:
            a) Length: Not less than 12 IN
            b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.
    b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
14. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 FT beyond ends of conduit.
15. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes or handholes.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
16. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable. Depth as indicated.
17. Placement of conduits stubbing into handholes shall be located to allow for proper bending radiuses of the cables.

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18. The location of all buried conduits longer than 660 FT shall be identified by above ground utility marker posts.
    a. Utility marker posts shall be placed a maximum of 1/8 mile apart. Marker posts shall be placed at vaults, hand holes, and on both sides of any under track or under road bore.
    b. Marker posts shall be Rhino 3 rail markers, 66", with Poly Tech coating, white, Item # FR66C-W, with decals pre-installed.
        1) Where power only is being installed without fiber the decals shall use artwork "SD-7636K".
        2) Where fiber only is being installed without power the decals shall use artwork "SD-8432K".
        3) Where power and fiber are both being installed the decals shall use artwork "SD-8431-K".

B. Concrete Encased Ductbank:
    1. Ductbank system consists of conduits completely encased in minimum 3 IN of red concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.
    2. Install so that top of concrete encased duct, at any point:
        a. Is not less than 36 IN below grade,
        b. And is not less than 54 IN below base of rail,
        c. And is below pavement sub-grading.
    3. For concrete/slurry encased ductbanks the encasement shall extend 10 FT either side of the area.
    4. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.
    5. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

C. Direct-Buried Conduit(s):
    1. Install so that the top of the uppermost conduit, at any point:
        a. Is not less than 36 IN below grade (under 600V) or 48 IN below grade (over 600V),
        b. And is not less than 54 IN below base of new rail,
        c. And is not less the distance listed below base of existing rail for the following installation types:
            1) Conduit(s) installed by horizontal directional drilling shall be 12 FT below base of existing rail,
            2) Conduit(s) installed by dry jack and bore shall be 60 IN (5 FT) below base of existing rail,
        d. And is below pavement sub-grading.

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2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.
    a. Maintain the separation of multiple planes of conduits by one of the following methods:
        1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 PSI) or concrete per Division 03 - Concrete.
        2) Install the multilevel conduits one level at a time.
            a) Each level is backfilled with the appropriate amount of soil and compaction to maintain the required separations.
3. Minimum buried depth per conduit type:
    a. Above 600V
        1) RGS – 48 IN
        2) PVC-RGS – 48 IN
        3) Schedule 80 PVC – 84 IN
        4) HDPE of equivalent wall thickness to schedule 80 PVC – 84 IN
    b. Below 600V
        1) RGS – 36 IN
        2) PVC-RGS – 36 IN
        3) Schedule 80 PVC – 42 IN
        4) HDPE of equivalent wall thickness to schedule 80 PVC – 42 IN

D. Steel Casement Pipe(s):
1. Install so that the top of the uppermost conduit within the casement, at any point:
    a. Is not less than 36 IN below grade (under 600V) or 48 IN below grade (over 600V),
    b. And is not less than 54 IN below base of new rail or 60 IN (5 FT) by jack and bore below base of existing rail,
    c. And is below pavement sub-grading.
2. Provide 4 IN minimum clearance between casement pipes.
3. Casement pipe shall be extended a minimum of 15' from centerline of track unless otherwise noted on drawings.

E. Conduits embedded in concrete structure (e.g., sidewalks, bridge decks) where shown on the Contract Drawings:
1. Shall not be considered to replace structurally the displaced concrete.
2. Shall not be larger in outside diameter than one-third the thickness of concrete.
3. Shall have a minimum spacing of 3 DIA OC.

END OF SECTION

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SECTION 26 05 98 - POWER DISTRIBUTION CENTER- GEAR HOUSES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material, design, fabrication and installation requirements for:

a. Power Distribution Center – Gear House.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 05 26 - Grounding.

C. Section 26 13 13 - Medium Voltage Metal-Clad Paralleling Switchgear

D. Section 26 22 13 - Dry-Type Transformers.

E. Section 26 24 16 - Panelboards.

F. Section 26 33 00 - Battery and Battery Charging Systems.

1.03 REFERENCED STANDARDS

A. American Institute of Steel Construction (AISC).

B. Air Movement and Control Association (AMCA).

C. American National Standards Institute (ANSI):

1. A250.8, SDI-100 - Recommended Specifications for Standard Steel Doors and Frames.

2. C2, National Electrical Safety Code (NESC).

3. C80.1, Rigid Steel Conduit - Zinc-Coated.

4. C80.3, Electrical Metallic Tubing - Zinc-Coated.

5. C82 Series, Standards for Electric Lamp Ballasts.

D. Air Conditioning and Refrigeration Institute (ARI).

E. ASTM International (ASTM):

1. A36, Carbon Structural Steel.

2. A276, Stainless Steel Bars and Shapes.

3. A666, Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

4. A924, General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.

5. F593, Stainless Steel Bolts, Hex Cap Screws, and Studs.

F. American Welding Society (AWS):

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1. D1.1, Structural Welding Code - Steel.

G. National Electrical Manufacturers Association (NEMA):

1. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
2. WD-1, Wiring Devices.
3. WD-6, Wiring Devices - Dimensional Requirements.

H. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):

1. WC 70/ICEA S-95-658, Non-Shielded Power Cable 2000 V or Less.

I. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).
2. 72, National Fire Alarm Code.

J. Occupational, Health and Safety Administration (OSHA):

1. 1910.145, Specification for Accident Prevention Signs and Tags.

K. Underwriters Laboratories, Inc. (UL):

1. 6, Rigid Metal Conduit.
2. 20, General Use Snap Switches.
3. 83, Thermoplastic-Insulated Wires and Cables.
4. 498, Attachment Plugs and Receptacles.
5. 514A, Metallic Outlet Boxes.
6. 797, Safety Electrical Metallic Tubing.
7. 924, Emergency Lighting and Power Equipment.
8. 935, Fluorescent Lamp Ballasts.
9. 943, Ground-Fault Circuit-Interrupters.
10. 1029, High Intensity Discharge Lamp Ballasts.
11. 1570, Fluorescent Lighting Fixtures.
12. 1572, High Intensity Discharge Lighting Fixtures.

1.04 DEFINITIONS

A. Power Distribution Center (PDC): Skid mounted, factory fabricated, environmentally controlled, walk-in enclosure used to house low or medium voltage electrical gear.

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1.05 SYSTEM DESCRIPTION

A. The PDC will used to provide an air conditioned and heated enclosure for the MEDIUM-VOLTAGE METAL-CLAD PARALLELING SWITCHGEAR as specified in 26 13 13, BATTERY AND BATTERY CHARGING SYSTEMS as specified in 26 33 00, dry type transformers, panelboards, control and communication systems and related equipment/systems specified, required and as indicated on the Drawings.

1.06 SUBMITTALS

A. Shop Drawings:
   1. See Section 26 05 00.
   2. Product technical data.
      a. Doors and hardware.
      b. Cleaning and painting system.
      c. HVAC equipment.
      d. HVAC calculations.
      e. Electrical equipment.
   3. Fabrication and/or layout drawings.
      a. Structural drawings including but not necessarily limited to:
         1) Plan view.
         2) Skid detail.
         3) Elevations.
         4) Stair or landing details.
         5) Anchor bolt pattern.
         6) Foundation load drawing showing location, direction and magnitude of loads applied to foundation.
      b. Shipping split information.
      c. HVAC equipment layout and wiring diagrams.
      d. Electrical equipment layout and wiring diagrams.
   4. Certifications.
      a. Certification, stamped by a Professional Structural Engineer registered in the State where the project is located, stating the enclosure has been designed in accordance with the specified criteria and loads.
      b. Certification, stamped by a Professional Mechanical Engineer registered in the State where the project is located, stating the HVAC system has been designed in accordance with the specified criteria and loads.
      c. Certification, stamped by a Professional Electrical Engineer registered in the State where the project is located, stating the PDC electrical system has been designed in accordance with the specified criteria and loads.

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B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.

C. Miscellaneous:

1. Project list of similar projects dating back a minimum of 3 years.
2. Statement that factory tests were performed.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. The supplier shall have manufactured Power Distribution Centers for similar applications for a minimum of 5 years.
2. Welders shall be certified through the AWS D1.1 4G position.

1.08 DELIVERY, STORAGE, AND HANDLING

A. See Section 26 05 00.

1.09 SITE CONDITIONS

A. Building Code:

1. Uniform Building Code (UBC).

B. Design outside temperatures:

1. High: refer to Special Conditions
2. Low: refer to Special Conditions

C. Design outside relative humidity:

1. High: refer to Special Conditions
2. Low: refer to Special Conditions

D. Altitude above sea level: refer to Special Conditions

E. Roof Live Loads: Per Building Code.

F. Wind Loads:

1. Design structure for wind loading as set forth in the Building Code. Project site conditions are as follows:
    a. Basic wind speed: refer to Special Conditions
    b. Site exposure: refer to Special Conditions

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G. Seismic (Earthquake) Loads:

1. Design structure for seismic forces as set forth in the Building Code. Project site conditions are as follows:

   a. Seismic zone: refer to Special Conditions

   b. Site-structure resonance: 2.0 unless analysis, submitted to and approved by the Engineer, shows a lesser value may be used.

H. Floor Live Loads:

1. 150 PSF minimum uniformly distributed.

2. Concentrated load for the specific floor mounted equipment to be installed.

I. Auxiliary Loads:

1. Other superimposed loads shall be considered as part of the design requirements and combined with the normal design (dead, live, seismic and wind) loads. Auxiliary loads include but not limited to:

   a. Switchgear, switchboards and/or panelboards.

   b. Step down transformers.

   c. Battery systems.

   d. Cable trays with associated conductors.

2. Magnitude and location of auxiliary loads as shown on Drawings and as specified.

   a. Contractor to coordinate and verify magnitude and location of auxiliary loads before fabrication.

PART 2 - PRODUCTS

2.01 MANUFACTURED UNITS

A. General:

1. Designed and fabricate PDC for outdoor use per the site conditions specified in paragraph SITE CONDITIONS.

2. Proposed PDC dimensions, door locations and equipment layout are shown on the drawings. Actual dimensions and layout to be coordinate with exact equipment to be installed in the PDC and manufacturer's recommended working clearance (e.g. around drawout circuit breakers; aisle depth to allow to breakers to pass each other), and NEC and NESC working clearances.

3. Welding: AWS D1.1.

4. Fastening hardware shall be zinc plated or stainless steel.

5. Design and fabricate building to minimize or prevent loss of conditioned air and to prevent entry of blowing rain, sleet, snow, moisture or vermin.

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6. All switches, outlets, lights, HVAC equipment, panelboards, etc. shall be installed and wired by the manufacturer, such that a single, 480v, 3-phase circuit, installed by electrical contractor and indicated on the drawings, shall energize the entire PDC electric distribution system.
    a. Provide final loads to engineer.
7. Provide concrete slab sized to actual dimensions of PDC and as indicated in the structural drawings and specifications.

B. Structure Frame and Base:

1. Integral welded steel structure base. Bolting shall be permissible for removable panels, doors and door hardware.
2. Welded seamless construction utilizing ASTM A36 structural steel members composed of wide flange, channel angle and tube shapes. Construct remaining frame of square tubular steel. Size members and arrange for proper strength, such that structure is able to withstand the stress and loads which will result when lifting the complete factory fabricated and equipped assemblies.
3. Suitable for installation on a concrete pad or piers.
4. Expansion Anchor Bolts:
    a. Stainless steel, Type 304, 314 or 316 with matching nut and washer.
    b. ASTM A276, A666 and F593.
    c. Provide minimum edge distance cover and spacing as recommended by manufacturer, or as indicated on Drawings whichever is larger.
        1) Minimum embedment as recommended by manufacturer or eight diameters of bolt, whichever is larger.
        2) Notify Engineer if required depth of embedment cannot be achieved at a particular anchor bolt location.
        3) Follow manufacturer's recommendations for installation and torque.
    d. Submit manufacturer's load test data to verify at least the anchor bolt capacities at the following embedment depths:
        1) Data must be based on actual tests performed in unreinforced mass of concrete of not more than 4000 psi compressive strength.
        2) Capacity must be at a concrete temperature of at least 130 DegF.

ANCHOR BOLT DIAMETER (IN)	EMBEDMENT (IN)	MINIMUM ULTIMATE TENSION CAPACITY (KIP)
3/8	3	4.8
1/2	4	8.1
5/8	5	11.4
3/4	6	15.4
7/8	7	20.1
1	8	24.7

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1-1/4	10	34.3

e. Expansion anchor bolts:

1) Kwik Bolt by Hilti, Inc.

2) Trubolt by ITW Ramset/Red Head.

3) Powerbolt by Power Rawl.

C. Floor:

1. Minimum of 3/16 IN steel plate with reinforcement below.
2. Continuously welded seams.
3. Provide gasketed and galvanized cover plates secured to the floor with screws for the cable or conduit cutouts under electrical equipment

D. Exterior Roof:

1. Minimum: 14 GA galvanized steel panels.
2. ASTM A924, G90.
3. Self-framing interlocking design.
4. Gabled with a minimum slope of 1/4 IN per foot.

E. Interior Ceiling:

1. Minimum: 16 GA galvanized steel panels.
2. ASTM A924, G90.
3. Self-framing interlocking design.

F. Walls:

1. Exterior walls.
   a. Minimum: 14 GA galvanized steel panels.
   b. ASTM A924, G90.
   c. Self-framing interlocking design.
   d. Welding of galvanized steel or rivets shall not be an acceptable method of exterior fastening.
2. Interior walls.
   a. Minimum: 16 GA galvanized steel panels.
   b. ASTM A924, G90.
3. Completely frame bulkhead penetrations with 1/4 IN aluminum coverplates with neoprene gasket. Make all wall penetrations in the walls prior to bending with the appropriate machinery. No manual cutting of wall penetrations via jigsaw, plasma torch, etc. shall be permitted.

G. Personnel and Equipment Doors:

1. Personnel doors:

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a. 36 IN x 84 IN.

b. Quantity and location as indicated on Drawings (1 minimum).

2. Equipment doors:

a. 48 IN x 84 IN.

b. Minimum 12 IN removable transom.

c. Quantity and location as indicated on Drawings (1 minimum).

3. 1-3/4 IN thick.

4. ANSI A250.8 Level 3, Model 2 and physical performance level A, insulated minimum R10.

5. Galvannealed per ASTM A924, A60 coating.

6. Doors shall be compatible with door hardware as required.

7. If only two doors are provided they shall be located at opposite ends of the gear house.

8. Hardware:

a. Provide panic hardware and keyed locks.

b. Hinges:

1) Three, non-removable pin type.

2) Stainless steel.

3) Minimum: 4-1/2 IN x 5 IN.

c. Weather strip.

d. Automatic closer with built-in hold open device and all weather fluid.

e. Threshold.

9. Frame:

a. Minimum: 14 GA steel.

b. Galvannealed per ASTM A924, A60 coating.

10. OSHA style danger sign: "DANGER, HIGH VOLTGE, KEEP OUT".

H. Electrical Gear Rear Access Doors (if required):

1. Minimum: 14 GA galvanized steel.

2. Insulated with metal inner skin over insulation welded to door.

3. Drip shields/water flashing.

4. Gasketed.

5. Stainless steel hinge.

6. 3-point latching system with stainless steel padlockable handles.

7. Hold open device.

8. OSHA style danger sign: "DANGER HIGH VOLTAGE".

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I. Insulation:

1. Roof, walls and floor insulation: Minimum R-11 flame retardant or flame resistant insulation.
2. Secured to exterior walls and floor.

J. Painting:

1. Clean, prime and paint all surfaces.
2. Paint Systems - General:
   a. P=prime coat. F1, F2 . . . Fn = first finish coat, second finish coat … nth finish coat.
   b. If two finish coats of same material are required, Contractor may, at his option and by written approval from paint manufacturer, apply one coat equal to mil thickness of two coats specified.
   c. Products specified are manufactured by Tnemec.
3. Exterior surfaces:
   a. Manufacturer standard harsh condition paint system.
   b. Color: as noted on the drawings.
4. Interior wall and ceiling:
   a) Manufacturer Standard for interior.
   b. Color: as noted on the drawings.
5. Interior floor color:
   a. Waterborne Epoxy-Amine Adduct Skid Resistant Primer and Waterborne Epoxy-Amine Adduct Top Coat.
      1) Prime coat(s):
         a) P1=1 coat, 4 mils, Series 287 Enviro-Tread (Waterborne Epoxy-Amine Adduct), VOC=1.78
         b) P1 Additive = 1 coat, 4 mils, 287-300c Skid Resistant Sand (10 LBS per GAL of mixed material)
      2) Finish coat:
         a) F1=1 coat, 4 mils, Series 287 Enviro-Tread (Waterborne Epoxy-Amine Adduct), VOC=1.78
   b. Color: as noted on the drawings.

K. Heating, Ventilating and Air Conditioning:

1. HVAC system sized considering:
   a. Ambient site conditions.
   b. Dimensions of the building.
   c. Solar heat generated within the building.
   d. Heat generated by the equipment within the building.

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e. Sensible cooling capacity, not the total cooling capacity, will maintain an ambient temperature within the building between 55 DegF and 80 DegF.

f. One or more air conditioning unit(s) as required for the required capacity.

g. Ventilation system with one or more exhaust fan(s) and motorized intake louvers that provide an economy cooling feature when air conditioning unit is not required and emergency ventilation in the event of failure to the air conditioning unit.

2. Packaged air conditioning units:

a. ARI certified.

b. UL listed.

c. Materials:

1) Casing: Heavy gage steel.

2) Casing insulation: 1 IN, 3/4 LB fiberglass blanket.

d. Casing: Removable access panels.

e. Fan section:

1) Fans:

a) Twin blower, multiple centrifugal type.

b) Statically and dynamically balanced.

c) Solid shafts.

d) Forward curved fans.

e) Die formed fan housings.

f) Permanently lubricated ball bearings.

f. Motors: See motor paragraph within this specification.

g. Direct drive.

h. Cooling coils – direct expansion:

1) ARI certified.

2) Material:

a) Aluminum.

b) Copper with aluminum fins for use in administration units only.

3) Fin spacing: Minimum 80 fins per foot.

4) Minimum standard operating limit: 250 psi.

5) Size and capacity as required.

i. Filter section:

1) Filters: 30 percent 2 IN pleated.

2) Access doors for filter removal.

j. Drain pan with drain connections.

k. Control: See Environmental Control Panel (ECP) paragraph within this specification.

3. Motor - NEMA design squirrel cage induction type:

a. Designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.

b. Permanently lubricated sealed bearings conforming to ABMA standards with built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.

c. Premium efficient type that are measured in accordance with NEMA MG-1.

d. Motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DegC ambient.

e. Design motors for continuous duty.

f. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 percent greater than the maximum HP requirements of the driven equipment over its entire operating range.

1) As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.

g. Motor enclosure and winding insulation application:

1) DPFG: dry locations or within equipment housings.

2) TEFC: wet locations.

4. Environmental Control Panel (ECP):

a. Permits the automatic selection of the appropriate function (heating, air conditioning or economy cooling) based on an adjustable, pre-selected maximum (for cooling) and minimum (for heating) temperature setting on the panel.

b. Operator-selectable timed thermostat that will permit manual override of the automatic selection by the operator to a temporary selection of temperature. The timer will return the control to the automatic selection after eight hours.

c. Each function, heating, air conditioning, or ventilation interlocked to prevent the simultaneous operation of more than one function.

d. A pre-selected temperature indicates an air conditioning failure and initiates the emergency ventilation system and disables the air conditioning function.

e. Normally open alarm contacts for emergency ventilation and power failure conditions.

f. Visible indication of the following functions: automatic operation, manual operation, power on, heat on, air conditioner on, economy cooling on, emergency venting on.

L. Electrical Equipment:

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1. Distribution equipment:
    a. See Drawings for one-line diagram and floor plan layout. Note that drawings are not to scale – provide floorplans based on actual equipment sizes – provide working clearances per NEC.
    b. See Section 26 24 16 for panelboards.
        1) Provide minimum quantity of one (1) - 48 Circuit, 208V, 3-phase, kaic as calculated (minimum 20kaic) panelboard for gear house lighting, receptacle and air conditioning, and battery charger loads. Provide 480V-208V 2-phase xfmr. Provide minimum ten (10) spare 20A, 1-pole breakers. Provide ampacity as calculated plus an additional 25% minimum. Provide panel schedule and calculated loads to engineer.
    c. See Section 26 22 13 for dry-type transformers.
    d. See Section 26 28 16 for safety switches.
2. Grounding:
    a. Locate a stainless steel ground pad or lug in opposite corners of the base.
    b. Provide grounding electrode system per the drawings and Section 26 05 26.
    c. Provide green grounding conductor in all HVAC, lighting and receptacle conduits.
3. Gear House Power: HVAC, lighting and receptacles to be powered from distribution equipment as described above.
4. Lighting:
    a. Interior luminaires:
        1) Fluorescent twin tube with wrap around prismatic diffuser, F32T8 lamps and emergency electronic ballast with 90 minutes runtime.
        2) ANSI C82.1, UL 935, 1570.
        3) Illumination: Minimum of 30 footcandles at 30 IN above floor. Controlled by 2- or 3-way switches as required at each personnel door.
    b. Interior emergency lighting units:
        1) Two head (lamp) continuously charged battery powered unit.
        2) UL 924.
        3) Located above each personnel door.
    c. Exterior luminaires:
        1) Minimum 5000 lumen LED wall pack with emergency backup battery.
        2) ANSI C82.4, UL 1029, 1572.
        3) Located above each door and as indicated on the drawings. All luminaires controlled by a photocell.
5. Wiring devices:
    a. Switches:

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1) Switches shall be located adjacent to each personnel and equipment door.
2) Toggle type, quiet action, Standard Specification grade.
3) Self grounding with grounding terminal.
4) Solid silver cadmium oxide contacts.
5) Rugged urea housing and one-piece switch arm.
6) Rated 20 A, 120/277 Vac.
7) Switch handle color: Ivory.
8) UL 20, 514A; NEMA WD-6.
9) Coverplate: Zinc plated malleable iron or galvanized steel..

b. Receptacles:
1) Receptacles shall be located adjacent to each personnel door indoor and exterior.
2) Duplex, straight blade, Standard Specification grade.
3) Brass triple wipe line contacts.
4) One piece grounding system with double wipe brass grounding contacts and self grounding strap.
5) Rated 20 A, 125 Vac.
6) High impact nylon body.
7) Receptacle body color: Ivory.
8) Types:
a) Interior/Exterior: Feed-through type ground fault circuit interrupter with test and reset buttons.
9) Configuration: NEMA 5-20R.
10) Coverplate:
a) Interior: Zinc plated malleable iron or galvanized steel.
b) Exterior: Weather resistant zinc plated or aluminum, gasketed, self-closing cover, heavy duty, while in use - using stainless steel spring.
11) Standards: UL 498, 514A, 943; NEMA WD-1, WD-6.

6. Conduit:
a. Minimum 3/4 IN.
b. Electrical metallic tubing:
1) ANSI C80.3, UL 797
2) Interior applications.
c. Rigid galvanized steel:
1) ANSI C80.1, UL 6

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2) Exterior applications.

7. Outlet boxes:
   a. Recessed locations:
      1) Hot-dip galvanized steel.
      2) Conduit knockouts and grounding pigtail.
      3) NEMA OS 1, UL 514A.
   b. Surface mounted locations:
      1) Zinc plated cast iron or die-cast copper free aluminum with manufacturers standard finish.
      2) Threaded hubs and grounding screw.
      3) UL 514A.
8. Conductors for building HVAC, lighting and receptacles:
   a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
   b. Minimum 12 AWG for power and 16 AWG for control.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests:
   1. Continuity test of all wiring installed.
   2. Operational/functional test of HVAC system, lights and receptacles.
   3. Perform factory tests as indicated for distribution equipment as specified in associated Division 26 specification.

2.03 MAINTENANCE MATERIALS

A. Two separate one-quart containers of touchup paint, of each type and color of finish paint.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Connect PDC to support foundation as required by manufacture's recommendations and submitted drawings.

3.02 FIELD QUALITY CONTROL

A. Provide a seven day notice to OWNER and ENGINEER prior to testing. All testing to be witnessed by OWNER or ENGINEER.

B. Field Tests.
   1. Operational/functional test of HVAC system, lights and receptacles.

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2. Perform field tests as indicated for distribution equipment as specified in associated Division 26 specification.

END OF SECTION

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SECTION 26 08 13 - ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic requirements for acceptance testing.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 13 13 - Medium Voltage Metal-Clad Paralleling Switchgear.

B. Section 26 32 14 - Engine Generator Diesel.

C. Section 26 33 00 - Battery and Battery Charging Systems.

1.03 REFERENCED STANDARDS:

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

2. 400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field Environment.

B. InterNational Electrical Testing Association (NETA):

1. ATS-2013, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.

C. Nationally Recognized Testing Laboratory (NRTL).

D. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):

1. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

B. General for all equipment:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Qualifications of testing firm and personnel to include:

a. Company resumes with similar experience.

b. Individual Resumes demonstrating qualifications and experience.

1) Copies of all Certifications and Licenses.

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3. Testing plan for:
    a. Electrical Equipment.
    b. Electrical Connections.
    c. Control Systems.
4. Prior to energizing equipment:
    a. Coordinated phasing diagram.
    b. Photocopies and pdf format of continuity tests.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. A testing firm shall be used for any testing and analysis the contractor is not qualified or capable of performing
    a. The testing firm shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of the equipment or systems being evaluated.
    b. The testing firm shall be regularly engaged in the testing of electrical equipment, installations, and systems.
    c. The testing firm shall use personnel who are regularly employed for testing services.
    d. The testing firm shall be a NETA Accredited Company designated by the InterNational Electrical Testing Organization.
2. Field personnel:
    a. Technicians performing electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
    b. As an alternative, field personnel may be certified by the equipment manufacturer.
3. Testing personnel:
    a. Technicians shall be certified in accordance with ANSI/NETA ETT-2010, Standard for Certification of Electrical Testing Technicians. Each supervising technician shall hold a current certification, Level III or higher, in electrical testing.
    b. As an alternative, supervising technician may be certified by the equipment manufacturer.

B. Phasing Diagram:

1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.

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a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

PART 2 - PRODUCTS

2.01 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. General:

1. Employ and pay for services of in-house qualified personnel and testing firm and equipment manufacturer's field service representatives.
2. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
3. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
4. Provide testing of electrical equipment and connections in accordance with the Electrical specifications.
5. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
   a. Contract Drawings and Specifications.
   b. Related construction change documentation.
   c. Approved Shop Drawings.
   d. Approved Operation and Maintenance Manuals.
   e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plan:

1. Approved in accordance with Shop Drawing submittal schedule.
2. Included as a minimum:
   a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
   b. List and description of testing and analysis equipment to be utilized.
   c. List of all equipment to be testing, including:
      1) Name and tag numbers identified in the Contract Documents.

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2) Manufacturer's serial numbers.

3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:

1. Minimum calibration frequency:

a. Field analog instruments: Not more than 6 months.

b. Field digital instruments: Not more than 12 months.

c. Laboratory instruments: Not more than 12 months.

d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.

2. Carry current calibration status and labels on all testing instruments.

3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:

1. Provide reports with tabbed sections for each piece of equipment tested.

2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.

a. Include legible copies of all forms used to record field test information.

3. Prior to start of testing, submit one (1) copy of preliminary report format for Engineer review and comment

a. Include data gathering and sample test report forms that will be utilized.

4. In the final report, include as a minimum, the following information for all equipment tested:

a. Equipment identification, including:

1) Name and tag numbers identified in the Contract Documents.

2) Manufacturer's serial numbers.

3) Other pertinent manufacturer identification,

b. Date and time of each test.

c. Ambient conditions including temperature, humidity, and precipitation.

d. Visual inspection report.

e. Description of test and referenced standards, if any, followed while conducting tests.

f. Results of initial and all retesting.

g. Acceptance criteria.

h. "As found" and "as left" conditions.

i. Corrective action, if required, taken to meet acceptance.

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j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.

k. Instrument calibration dates of all instruments used in testing.

5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:

1. Perform testing on Electrical equipment and connections in accordance with the Electrical specification requirements.

2. Testing of motors:

a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 50 HP or above.

b. Ensure motor has been lubricated.

c. Bump motor to check for correct rotation.

3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Other Testing:

1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.

2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.

a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

G. Infrared Thermography Testing Program:

1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.

a. Perform on all rotating and reciprocating equipment having drivers 25 HP or greater.

b. Perform on electrical equipment and connections: See Specification Section 26 08 13.

2. Additional requirements for infrared thermography monitoring and testing equipment:

a. Temperature range: -10 to 350 DegC.

b. Accuracy: +/-2 percent or 2 DegC, whichever is greater.

c. Repeatability: +/-1 percent or 1 DegC, whichever is greater.

d. Temperature indication resolution: 0.1 DegC.

e. Minimum focus distance: 0.3 meters.

f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows.

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3. Perform inspection per ASTM E1934.
    a. Operate VFD driven equipment at 100 percent speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DegC per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DegC above the equipment and/or bearing manufacturers published criteria.
6. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

H. Equipment Vibration Monitoring and Testing Program:
1. Perform vibration monitoring and testing for equipment specified in other Divisions during the Equipment Demonstration Period.
2. Provide vibration testing on all rotating and reciprocating equipment having driver 25 HP and greater.
3. Additional requirements for vibration monitoring and testing equipment:
    a. Frequency response: 0.18 Hz to 25 kHz.
    b. Resolution: 6400 lines.
    c. Amplitude range: 18 bit for 96 dB dynamic range.
    d. Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
    e. Capable of two-place computer balancing.
    f. Requirements for vibration sensor:
        1) Sensitivity: +/- 5 percent at 25 DegC= 100 mV/g.
        2) Acceleration range: 80 g peak.
        3) Amplitude nonlinearity: 1 percent.
        4) Frequency response:
            a) +/- 5 percent = 3-5000 Hz.
            b) +/- 10 percent = 1-9000 Hz.
        5) Permanently attach vibration test and monitoring mounting pads to mechanical equipment at location recommended by the equipment manufacturer or as recommended by the testing firm.
        6) Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria.
        7) Acceptability of pumping equipment to be based on HI 9.6.4 criteria.
        8) Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

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4. Utilize an Engineer approved testing agency to perform vibration monitoring and testing on equipment defined in the schedule as shown on the drawings.
5. Permanently attach vibration test and monitoring mounting pads to the equipment at locations recommended by the equipment manufacturer or as recommended by the vibration testing agency.
6. Utilize mounting pads suitable for permanent installation and for incorporation into a predictive maintenance program.
7. For variable speed equipment provide vibration testing at 1 Hz increments throughout entire operating range.
8. Diagnosis to include, but is not limited to the following:
    a. Unbalance.
    b. Misalignment.
    c. Bent shaft.
    d. Journal bearing related problems.
    e. Rolling contract bearing problems.
    f. Mechanical looseness.
    g. Resonance.
    h. Foundation flexibility.
    i. Electrically induced problems.
    j. Pump problems.
    k. Fan problems.
    l. Coupling problems.
    m. Drive belt problems.
    n. Gear problems.
    o. Centrifugal compressor problems.
    p. Electric motor induced vibration from VFD or VFD carrier frequency.
9. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.
10. Tolerances for pumping equipment shall be per HI published standards.
11. Repair or replace equipment shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
12. Document testing with written report.
    a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.

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3.02 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchgear and Switchboards:

1. Perform inspections and tests per NETA ATS 7.1.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Weatherproof switchgear/switchboards:
      1) Verify correct location, operation and current draw of heaters.
      2) Verify correct operation of thermostat.

B. Transformers - Small Dry Type:

1. Perform inspections and tests per NETA ATS 7.2.1.1.
2. Perform the following additional tests:
   a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Engineer.
4. Record as-left tap connections.

C. Transformers - Liquid Filled:

1. Perform inspections and tests per NETA ATS 7.2.2. except the following:
   a. Bushing power factor.
   b. Core insulation resistance.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
4. Adjust tap changer setting as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Engineer.
5. Record as-left tap changer setting.

D. Cable - Low Voltage:

1. Perform inspections and tests per NETA ATS 7.3.2.

E. Cable - Medium Voltage:

1. Perform inspections and tests per NETA ATS 7.3.3.
2. Perform both Dielectric Withstand and Baseline Diagnostic Tests.

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F. Cable - Optical Fiber:

1. Perform inspections on tests per NETA 7.25 and TIA/EIA/ANSI 455-78-B, including:

   a. Optional time domain reflectometer test.

   b. Power attenuation test.

   c. Gain margin test.

G. Medium Voltage Source Transfer System;

1. Perform applicable inspections and test per:

   a. NETA ATS 7.5.1.2 Switches, Air , Medium Voltage, Metal-Enclosed Interrupter Switches.

   b. Manufacturer's instructions.

H. Medium Voltage Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.3.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3. Perform the following optional tests per NETA ATS:

   a. Control wiring insulation resistance.

   b. Minimum trip and close voltage.

   c. Overpotential.

   d. Power factor.

4. Perform the following additional tests:

   a. High-potential vacuum integrity test per manufacturer's recommendations.

I. Low Voltage Power Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.1.2.

   a. Tests shall include primary current injection testing of all breakers at final settings.

   b. Where short-time or instantaneous settings on large frame breakers are beyond the current capability of field testing, primary injection tests at reduced currents shall be permitted if combined with secondary injection calibration test of trip unit at final settings.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3. Perform the following additional tests:

   a. Shunt trip devices minimum tripping voltage.

4. Record as-left settings.

J. Low Voltage Molded Case Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.1.1.

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2. Components:
    a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
    b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
    c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

K. Protective Relays:
1. Perform inspections and tests per NETA ATS 7.9.
    a. Tests to be performed using secondary injection of 3 PH current and potential at final settings.
    b. Test at manufacturer's recommended test points and critical timing points identified on relay setting sheet.
2. Perform all tests identified as optional per NETA ATS.
3. Perform the following additional tests:
    a. Verification of direct trip of associated lockout relay or circuit breaker(s) by using relay test function or shorting trip contact at relay case.
    b. Microprocessor-based relays:
        1) Complete commissioning procedure per manufacturer's instructions, followed by tests of each relay element at final settings.
        2) Verification of all internally-programmed logic.
    c. Verification of all auxiliary input and output signals.
    d. Verification of power supply/self-diagnostic alarm contact and remote annunciation.
4. Record as-left settings.

L. Instrument Transformers:
1. Perform inspections and tests per NETA ATS 7.10.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
    a. Dielectric withstand test on potential transformers.

M. Metering:
1. Perform inspections and tests per NETA ATS 7.11.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

N. Grounding:

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1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

O. Ground Fault Protection:
1. Perform inspections and tests per NETA ATS 7.14.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
   a. Control wiring insulation resistance.
4. Perform the following additional tests for four-wire systems:
   a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
   b. Verify no tripping for unbalanced load on each feeder and each main breaker.
   c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
   d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
   e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

P. Motors:
1. Perform inspections and tests per NETA ATS 7.15.

Q. Motor Controllers:
1. Perform inspections and tests per NETA ATS 7.16 and 7.17.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

R. Generators (small generators):
1. Perform inspections and tests per NETA ATS 7.15.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
   a. Load and cycle crank test per Specification Section 26 32 14.

S. DC Power Systems:
1. Perform inspections and tests per NETA ATS 7.18.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:

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a. Cell impedance test.

T. Control System Functional Test:

1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance and proper operation of the system in normal and emergency scenarios.
4. Perform the following tests:
   a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
   b. Verify the correct operation of all sensing devices, alarms and indicating devices.

END OF SECTION

SECTION 26 09 13 - ELECTRICAL METERING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Digital metering equipment.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 08 13 - Acceptance Testing.

1.03 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C57.13, Standard Requirements for Instrument Transformers.

B. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

C. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):

1. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.

D. National Fire Protection Association (NFPA):

1. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.

E. Underwriters Laboratories, Inc. (UL):

1. 508, Standard for Safety Industrial Control Equipment.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

a. Provide submittal data for all products specified in PART 2 of this Specification:

b. See Section 26 05 00 for additional requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

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2. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Eaton.
2. General Electric Company.
3. Square D Company.

2.02 DIGITAL METERING DEVICES

A. General:

1. Direct reading metered or calculated values.
2. Microprocessor based.
3. Integral LED or LCD display.
4. Current and potential transformers as required.
5. Integral fusing.
6. Operating temperature: 0 DegF to 150 DegF.
7. Standards:
   a. NEMA/ANSI C12.20.
   b. UL 508.

B. Type 'C' High Range Meter:

1. Model: Square D Powerlogic or equal.
2. Display the following minimum electrical parameters (accuracy):
   a. RMS current per phase (+0.2 percent full scale).
   b. RMS voltage line-to-line and line-to-neutral (+0.2 percent full scale).
   c. Real power (W): 3 PH total (+0.4 percent full scale).
   d. Apparent power (VA): 3 PH total (+0.4 percent full scale).
   e. Reactive power (VAR): 3 PH total (+0.4 percent full scale).
   f. Power factor (+1.0 percent).
   g. Frequency (+0.04 percent).
   h. Percent current individual harmonic and total harmonic distortion (50th).
   i. Percent voltage individual harmonic and total harmonic distortion (50th).
   j. Watt-hours (0.5 percent).
   k. VAR-hours (1.0 percent).

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l. VA-hours (0.5 percent).

m. Ampere demand (+0.2 percent full scale).

n. Watt demand (+0.4 percent full scale).

o. VAR demand (+0.4 percent full scale).

p. VA demand (+0.4 percent full scale).

3. NEMA/ANSI C12.20, Class 0.2 revenue accuracy.

4. Communication ports and protocols: 100BASE-TX or better Ethernet Communications , and/or Modbus TCP and/or as required for a functioning system.

5. Supply voltage: 120 Vac.

2.03 ACCESSORIES

A. Communication Cable:

1. Belden as indicated on drawings or manufacturer recommended cable.

2. Ethernet cable shall conform with CATEGORY 6 or better specifications. Individual Ethernet cable distances shall not exceed 100 meters.

3. Standard: NFPA 262.

B. Software:

1. Power management and control software.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

1. Provide all equipment as necessary to provide a complete and functioning system.

2. Coordinate with the Owner on final computer screen layouts, trending requirements and printouts.

B. Meter Types:

1. Type C meters: Connected to 13.8kV breakers and 480V main breakers, unless otherwise indicated on the Drawings.

a. Provide integral to equipment as indicated.

b. Provide 125Vdc or 120Vac as available.

c. If meter needs to be provided adjacent to equipment, provide enclosure, NEMA rated as appropriate.

C. Master Control Display Configuration:

1. See Specification 26 13 13.

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2. Type C meter shall have a data screen with the following minimum data as applicable for the capabilities of that type of meter:
    a. Voltage line-to-line for each phase and an average.
    b. Voltage line-to-neutral for each phase and an average.
    c. Current for each phase, neutral and average and peak demands.
    d. Kilowatts (kW)for each phase, total, demand and peak demand.
    e. Kilovolt-amperes (kVA) for each phase, total, demand and peak demand.
    f. Kilovolt-amperes reactive (kVAR) for each phase, total, demand and peak demand.
    g. Power factor for each phase and total.
    h. Frequency.
    i. Voltage total harmonic distortion for each phase.
    j. Current total harmonic distortion for each phase.
    k. Energy (kWhr) for each phase and total.
    l. A seven (7) day kW, kVA and kVAR trend average.
    m. Peak demands shall be resettable by the operator.
3. Meter Types shall have the following 15 minute trending graphs.
    a. Duration: Adjustable, with a seven (7) day default.
    b. Phase A current: Minimum, maximum and average.
    c. Phase B current: Minimum, maximum and average.
    d. Phase C current: Minimum, maximum and average.
    e. Neutral current: Minimum, maximum and average.
    f. Phase A Watts: Minimum, maximum and average.
    g. Phase B Watts: Minimum, maximum and average.
    h. Phase C Watts: Minimum, maximum and average.
    i. Watts total.
    j. Phase A Voltamps: Minimum, maximum and average.
    k. Phase B Voltamps: Minimum, maximum and average.
    l. Phase C Voltamps: Minimum, maximum and average.
    m. Voltamps total.
    n. Phase A power factor: Minimum, maximum and average.
    o. Phase B power factor: Minimum, maximum and average.
    p. Phase C power factor: Minimum, maximum and average.
    q. Power factor total.

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3.02 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 8 HRS of on-site training in the operation and maintenance of the metering system and its components.

END OF SECTION

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SECTION 26 09 16 - ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
2. Control devices (timers, relays, contactors, etc.).
3. Control panels and operator stations.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 09 10 – Control Panels

1.03 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
3. ST 1, Specialty Transformers (Except General-Purpose Type).

B. Underwriters Laboratories, Inc. (UL):

1. 508, Standard for Safety Industrial Control Equipment.
2. 508A, Standard for Safety Industrial Control Panels.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification:
    b. Control panel bill of material.
    c. See Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings.
    a. Control panel interior and exterior layout.
    b. Control panel wiring diagrams.

B. Operation and Maintenance Manuals:

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1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.

1.05 QUALITY ASSURANCE

A. Miscellaneous:

1. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A.
    a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Pilot devices and relays:
    a. Allen Bradley
    b. Idec.
    c. Potter & Brumsfield.
    d. Time Mark.
    e. ATC Diversified Electronics.
2. Lighting Contactors:
    a. Square D Company
3. Contactors:
    a. Eaton.
    b. General Electric Company.
    c. Square D Company.
4. Photocells and time clocks:
    a. Grasslin.
    b. Tork.
    c. Intermatic.
    d. Paragon.
5. Alarm devices:
    a. Edwards Signaling.
    b. Federal Signal Corp.

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6. Terminal blocks:
    a. Phoenix Contact.
    b. Allen-Bradley.
7. Enclosures:
    a. Hoffman Engineering Co.
    b. Wiegmann.
    c. Eaton B-Line.
    d. Adalet.
    e. Stahlin.

2.02 PILOT DEVICES

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.
2. Heavy-duty NEMA 4/13 watertight/oiltight.
3. Heavy-duty NEMA 4/4X corrosion resistant.
4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
5. Mounting hole: 30.5 mm.
6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
7. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
2. Maintained contact type.
3. Knob or lever type operators.

C. Pushbuttons:
1. Non-illuminated type:
    a. Protective boot.
    b. Momentary contact.
    c. Standard flush and mushroom operators.
    d. Green colored buttons for START or ON and red color for STOP or OFF.
    e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.
2. Illuminating type:
    a. Protective boot.

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b. Momentary contact.

c. Standard flush operator.

d. Serves as both pushbutton control and indicating light.

e. Green colored lenses for START or ON and red color for STOP or OFF.

f. Resistor-type full voltage light unit with lens and panel gasket.

D. Indicating Lights:

1. Allowing replacement of bulb without removal from control panel.
2. Lamp: LED, 120 V or 24 V as required.
3. Full voltage type.
4. Push-to-test indicating lights.
5. Glass lens.
6. Color code lights as follows:
   a. Green: OFF or stopped; valve open.
   b. Amber: Standby; auto mode; ready.
   c. Red: ON or running; valve closed**.**

2.03 RELAYS

A. General Requirements:

1. Standards: NEMA ICS 2, UL 508.

B. Control Relays:

1. General purpose (ice cube) type:
   a. Plug-in housing.
   b. Clear polycarbonate dust cover with clip fastener.
   c. Coil voltage: 120 Vac or as required.
   d. Contacts:
      1) 10 amp continuous.
      2) Silver cadmium oxide.
      3) Minimum of 3 SPDT contacts.
   e. Sockets: DIN rail mounted.
   f. Internal neon or LED indicator is lit when coil is energized.
   g. Manual operator switch.
2. Industrial type:
   a. Coil voltage: 120 Vac or as required.
   b. Contacts:
      1) 10 amp, NEMA A600 rated.

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2) Double break, silver alloy.

3) Convertible from normally open to normally closed or vice versa, without removing any wiring.

4) Expandable from 2 poles to 12 poles.

c. Provide contacts for all required control plus two spares.

C. Time Delay Relays:

1. General purpose type:

a. Timing modes: On and Off delay, interval, one shot and repeat cycle.

b. Plug-in housing.

c. Polycarbonate dust cover with clip fastener.

d. Coil voltage: 120 Vac or as required.

e. Contacts:

1) 10 amp continuous.

2) Silver cadmium oxide.

3) Two normally open and two normally closed DPDT contacts.

f. Sockets: DIN rail mounted.

g. External timing adjustment knob.

h. Timing ranges: 0.05 seconds to 16.65 HRS.

i. Repeat accuracy: +1 percent.

2. Solid State industrial type:

a. Timing modes: On and Off delay and repeat cycle.

b. Industrial housing.

c. Coil voltage: 120 Vac or as required.

d. Contacts:

1) 5 amp, NEMA B150 rated.

2) Silver alloy.

3) Convertible On Delay and Off Delay contacts.

4) One normally open and one normally closed timed contacts.

5) One normally open and one normally closed instantaneous contacts.

e. Furnish with "on" and "timing out" indicators.

f. External timing adjustment knob.

g. Timing ranges: 0.05 seconds to 10 HRS.

h. Repeat accuracy: +1 percent.

3. Mechanical industrial type:

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a. Timing modes: On and Off delay.

b. Coil voltage: 120 Vac or as required.

c. Contacts:

1) 10 amp, NEMA A600 rated.

2) Double break, silver alloy.

3) Convertible On Delay and Off Delay contacts.

4) Convertible normally open and normally closed timed contacts.

5) Convertible normally open instantaneous contacts.

d. External timing adjustment knob.

e. Timing ranges: 0.2 - 60 sec or 5 - 180 sec.

f. Repeat accuracy: Greater than +10 percent.

2.04 LIGHTING CONTACTORS

A. General Requirements

1. Lighting contactor as specified on the Drawings. Custom built by Square D.

a. 30 A fused overcurrent device = Model #8903REQ3948G1

b. 50 A fused overcurrent device = Model #8903REQ3948G2

c. 100 A fused overcurrent device = Model #8903REQ3948G3

d. 30 A breaker overcurrent device = Model #8903REQ3948G4

e. 50 A breaker overcurrent device = Model #8903REQ3948G5

f. 100 A breaker overcurrent device = Model #8903REQ3948G6

2.05 CONTACTORS

A. General Requirements:

1. Standards: NEMA ICS 2, UL 508.

B. Lighting and Remote Control Switches:

1. Electrically operated, electrically held.

2. Coil voltage: 120 Vac or as required.

3. Contacts: Totally enclosed, double-break silver-cadmium-oxide.

4. Rated for ballasted lighting, tungsten and general use loads.

5. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.

6. Auxiliary control relays, as indicated on Drawings or as specified.

7. Auxiliary contacts, as indicated on Drawings or as specified.

C. Definite Purpose:

1. Coil voltage: 120 Vac or as required.

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2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
3. Resistive load and horsepower rated.
4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
5. Auxiliary contacts, as indicated on Drawings or as specified.

2.06 PHOTOCELLS AND TIME CLOCKS

A. Photocells:
1. Weatherproof enclosure.
2. Adjustable turn-on range, initially set at 1.0 footcandles.
a. Turn-off level approximately three times turn-on.
3. Provide time delay device to eliminate nuisance switching.
4. Voltage, amperage and/or wattage ratings as required for the application.

B. General Requirements for Time Clocks:
1. Separate manual on-off operation without disturbing automatic settings.
2. Enclosure:
a. NEMA 1 for indoor locations.
b. Stand alone or DIN rail for mounting in control panel.
c. NEMA 3R or 4 for exterior locations.
3. Voltage, amperage and/or wattage ratings as required for the application.

C. Astronomical Clocks:
1. Adjustable for the installed latitude.
a. Settings for astro on/astro off, astro on/time off or time on/astro off.
2. 365 day programmable using solid state technology with block programming.
3. Minimum of 72 HR carryover power utilizing rechargeable battery or capacitor.
4. Minimum of 48 events per week, 16 individual holiday overrides daylight savings or standard time selectable, automatic leap year correction.

2.07 ALARM DEVICES

A. Alarm Horns:
1. Vibrating horn type.
2. PLC compatible as required.
3. Heavy-duty die cast housing with corrosion resistant finish.
4. Adjustable volume: 78 to 103 dB at 10 FT.
5. Voltage: 120 Vac or as required.

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6. Enclosures/mountings:
    a. Flush wall or panel mounting in dry areas.
    b. NEMA 4X panel mounting in wet areas.
    c. Surface mounting in dry areas.
    d. NEMA 4X surface mounting in wet areas.
    e. NEMA 4X, hazardous location surface mounting in wet and hazardous areas.
        1) Fixed volume: 97 dB at 10 FT.

B. Alarm Lights:
1. Panel mounted:
    a. Strobe type.
    b. Shatter resistant polycarbonate lens and base.
    c. Lens color as indicated on Drawings.
    d. NEMA 4X enclosure.
    e. PLC compatible.
    f. Voltage: 120 Vac.
2. Wall mounted:
    a. Heavy-duty strobe type.
    b. Weatherproof shatter resistant polycarbonate lens and cast base.
    c. Optically designed fresnel lens with color as indicated on Drawings.
    d. Immune to shock and vibration, no moving parts.
    e. Xenon flash tube providing a minimum of 65 single flashes per minute.
    f. Mounting: Wall or corner wall brackets.
3. Hazardous and corrosive locations:
    a. Heavy-duty strobe type.
    b. Weatherproof and rated for the indicated hazardous location.
    c. Body: Zinc plated cast iron or cast copper free aluminum and/or coated with 20 mils of PVC.
    d. High impact glass dome with guard.
    e. Shatter resistant polycarbonate lens with color as indicated on Drawings.
    f. Immune to shock and vibration, no moving parts.
    g. Xenon flash tube providing a minimum of 65 single flashes per minute.
    h. Mounting: Wall bracket or pendant.

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2.08 MISCELLANEOUS DEVICES

A. Run Time Meters:

1. Six-digit wheels including a 1/10 digit.
2. Non-reset type.
3. Time range in hours.
4. Automatic recycle at zero.
5. Accuracy: 1 percent.
6. Sealed against dirt and moisture.
7. Tamperproof.

2.09 TERMINATION EQUIPMENT

A. General Requirements:

1. Modular type with screw compression clamp.
2. Screws: Stainless steel.
3. Current bar: Nickel-plated copper alloy.
4. Thermoplastic insulation rated for -40 to +90 DegC.
5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
6. End sections and end stops at each end of terminal strip.
7. Machine-printed terminal markers on both sides of block.
8. Spacing: 6 mm.
9. Wire size: 22-12 AWG.
10. Rated voltage: 600 V.
11. DIN rail mounting.

B. Standard-type block:

1. Rated current: 30 A.
2. Color: Gray body.

C. Bladed-type disconnect block:

1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
2. Rated current: 10 A.
3. Color:
   a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
   b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-type block:

1. Electrically grounded to mounting rail.

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2. Terminal ground wires and analog cable shields.
3. Color: Green and yellow body.

E. Fuse Holders:

1. Blocks can be ganged for multi-pole operation.
2. Spacing: 9.1 mm.
3. Wire size: 30-12 AWG.
4. Rated voltage: 300 V.
5. Rated current: 12 A.
6. Fuse size: 1/4 x 1-1/4.
7. Blown fuse indication.
8. DIN rail mounting.

2.10 ENCLOSURES

A. Control Panels:

1. NEMA 4 rated:
   a. Seams continuously welded and ground smooth.
   b. No knockouts.
   c. External mounting flanges.
   d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
   e. Cover with oil resistant gasket.
2. NEMA 4X rated:
   a. Body and cover: 14 GA Type 304 or 316 stainless steel.
   b. Seams continuously welded and ground smooth.
   c. No knockouts.
   d. External mounting flanges.
   e. Hinged door and stainless steel screws and clamps.
   f. Door with oil-resistant gasket.
3. NEMA 7 and 9 rated:
   a. Cast gray iron alloy or copper-free aluminum.
   b. Drilled and tapped openings or tapered threaded hub.
   c. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   d. External mounting flanges.
   e. Grounding lug.

f. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

4. NEMA 12 enclosure:
   a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts.
   c. External mounting flanges.
   d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   e. Flat door with oil resistant gasket.
5. Control panel miscellaneous accessories:
   a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
   b. Interiors shall be white or light gray in color.
   c. Wire management duct:
      1) Bodies: PVC with side holes.
      2) Cover: PVC snap-on.
      3) Size as required.
   d. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
   e. Split covers when heavier than 25 LBS.
   f. Floor stand kits made of same material as the enclosure.
   g. Weldnuts for mounting optional panels and terminal kits.
   h. Ground bonding jumper from door, across hinge, to enclosure body.
6. Standards: NEMA 250, UL 508.

B. Operator Control Stations:
1. NEMA 4/13 rated:
   a. Die cast aluminum body with manufacturers standard finish.
   b. Gasketed die cast aluminum cover with manufacturers standard finish.
   c. Number of device mounting holes as required.
2. NEMA 4X rated:
   a. Type 304 or 316 stainless steel body.
   b. Gasketed Type 304 or 316 stainless steel cover.
   c. Number of device mounting holes as required.

3. NEMA 7 and 9 rated:
    a. Zinc plated cast iron or die-cast copper free aluminum, with threaded hubs, grounding screw and with manufacturers standard finish.
    b. "EDS" or "EFS" style.
    c. Single or multiple gang or tandem.
    d. Accessories: 40 mil PVC exterior coating and two (2) mil urethane interior coating.

2.11 MAINTENANCE MATERIALS

A. Provide 100 percent replacement lamps for indicating lights.

B. Provide 10 percent replacement caps for indicating lights.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Control Panels:
    1. Size as required to mount the equipment.
    2. Permitted uses of NEMA 4 enclosure:
        a. Surface mounted in areas designated as wet.
    3. Permitted uses of NEMA 4X enclosure:
        a. Surface mounted in areas designated as wet and/or corrosive or highly corrosive.
    4. Permitted uses of NEMA 7 enclosure:
        a. Surface mounted in areas designated as Class I hazardous.
    5. Permitted uses of NEMA 12 enclosure:
        a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas.

C. Operator Control Stations:
    1. Permitted uses of NEMA 4/13 enclosure:
        a. Surface mounted in areas designated as dry and/or dusty architecturally or non-architecturally finished areas and wet.
    2. Permitted uses of NEMA 4X enclosure:
        a. Surface mounted in areas designated as wet and/or corrosive or highly corrosive.

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3. Permitted uses of NEMA 7 enclosure:

   a. Surface mounted in areas designated as Class I hazardous with PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

3.02 FIELD QUALITY CONTROL

A. See Section 26 05 00.

END OF SECTION

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SECTION 26 09 43 - RADIO OPERATED LIGHTING CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Radio Operated lighting control

PART 2 - PRODUCTS

2.01 MATERIALS

A. UP standard radio operated lighting control for areas indicated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Radio control panel may be integrated with lighting contactor(s) to control specified areas.

END OF SECTION

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SECTION 26 10 00 - MEDIUM VOLTAGE ELECTRICAL DISBRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Medium and secondary voltage, overhead electrical power distribution and demolition and upgrading of existing overhead electrical power distribution, and the following:

   a. Conductors, connectors, and splices.

   b. Wood poles and crossarms.

   c. Hardware and accessories.

   d. Lightning arresters.

   e. Cutouts, switches, and fuses.

   f. Distribution transformers.

B. Pole details shall be as indicated on UPRR Electrical Construction Manual.

C. Drawings and general provision of the contract, including General and Supplementary Condition apply to this section.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 – Electrical Basic Requirements.

B. Section 26 05 13 – Medium Voltage Cable.

C. Section 26 08 13 – Acceptance Testing.

D. Section 26 12 13 – Pole-Mounted Distribution Transformers.

E. Section 26 12 19 – Pad-Mounted Distribution Transformers.

F. Section 26 18 19 – Medium Voltage Lightning Arresters.

G. Section 33 71 14 – Overhead Electric Service.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI):

1. O5.1, Wood Poles – Specifications and Dimensions

B. ASTM International (ASTM):

1. ASTM B 1

2. ASTM B 8

3. ASTM B 230

4. ASTM B 232/B 232M

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C. American Wood Protection Association (AWPA):

1. P8.
2. P9.

D. Department of Agriculture, Rural Utilities Service (RUS):

1. 202-1.
2. 345-67.
3. 1728H-701.

E. Edison Electric Institute (EEI).

F. Insulated Cable Engineers Association (ICEA):

1. S-70-547
2. S-76-474, Neutral-Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation Rated 600 Volts.

G. Institute of Electronic and Electronics Engineers, Inc. (IEEE):

1. C135.1, Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction.
2. C135.2, Standard for Threaded Zinc-Coated Ferrous Strand-Eye Anchor Rods and Nuts for Overhead Line Construction.
3. C2, National Electrical Safety Code.

H. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

I. Underwriters Laboratories, Inc. (UL):

1. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
2. 486B,

1.04 DEFINITIONS

A. ACSR: Aluminum conductor, steel reinforced

B. BIL: Basic impulse level, stated in kilovolts

C. Cable: A conductor with insulation, a stranded conductor with or without insulation and other covering (single-conductor cable), or a combination of insulated from one another (multi-conductor cable).

D. Conductor: Material in the form of a wire or cable, suitable for carrying electrical current.

E. HDPE: High-density polyethylene

F. Insulated: Separated from other conducting surfaces by a dielectric (including air space) that offers high resistance to the passage of current.

G. Insulator: Insulating material in a form designed to support a conductor physically and to separate it electrically from another conductor or object.

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H. Sag: The distance measured vertically from a conductor to the straight line joining its two points of support, measured at the midpoint of the span, unless otherwise indicated.

1. Final Sag: The sag of a conductor under specified conditions of loading and temperature applied after it has been subjected, for an appreciable period, to the loading prescribed for the loading district in which it is situated, or equivalent loading, and the loading removed. Final sag includes the effect of inelastic deformation (creep).

2. Initial Unloaded Sag: The sag of a conductor before the application of an external load.

I. Secondary: Conductors and components for circuits operating at the utilization voltage of 600 volts or less.

J. Service: Set of insulated conductors extending from a pole to the metering point or service entrance connection at the location of utilization of electricity.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data.

a. Provide submittal data for all products specified in this Specification Section.

1) Including the following:

a) Conductors.

b) Poles.

c) Crossarms.

d) Insulators.

e) Switches.

f) Cutouts.

g) Reclosers

h) Transformers.

i) Metering components

j) Lightning Surge Arresters.

k) Guy Assemblies.

b. See Specification Section 26 05 00 for additional requirements.

B. Qualification Data: For manufacturer.

C. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

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2. The content of the Operation and Maintenance Manuals.
    a. Instruction and maintenance manual for the equipment and components covered in this section.
    b. Product technical data provided in the submittal.
    c. Factory test reports where available by the manufacturer.
    d. Acceptance testing report for switches and reclosers.

D. Listing Documentation: Indicated products comply with RUS listing requirements specified in "Quality Assurance" Article.

E. Maintenance Data: For Switches, Reclosers, Transformers to include in maintenance manuals specified in Specification Section 26 05 00.

F. Material Certificates: For the following items, signed by manufacturers:
    1. Wood poles.
    2. Concrete poles.
    3. Wood crossarms.

G. Time-Current Coordination Curves: Illustrate optimum coordination of protective devices involved in the Work of this section. See Specification Section 26 99 00 for additional requirements.

H. Field quality-control test reports.

I. Source Quality-Control Test Reports: Factory inspection reports of wood poles.

1.06 QUALITY ASSURANCE

A. Electrical Components Normally Covered by Listing and Labeling Services: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Overhead-Line Components, Devices, and Accessories: Currently listed in RUS Informational Publication 202-1 without restriction for the intended application.

C. Comply with IEEE C2, except where stricter requirements are indicated or where local requirements that are stricter apply.

D. Strength of Line and Line Components Selected by Contractor: Provide grades of construction and strength required by IEEE C2 for conditions encountered at Project site for heavy line loading, unless otherwise indicated.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Wood Pole Storage and Handling: Comply with ANSI O5.1. Do not use pointed handling tools capable of producing indentations greater than 1 inch (25 mm).

1.08 SITE CONDITIONS

A. 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 Owner not less than two days in advance of proposed utility interruptions.

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2. Do not proceed with utility interruptions without Owner's written permission.

1.09 SEQUENCING AND SCHEDULING

A. Coordinate with utility supplying electricity to lines specified in this Section, and make arrangements for final connections by utility.

B. Coordinate with UPRR Telecom for system that will have cables supported by poles installed according to this Section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Conductors:
   a. Florida Wire & Cable, Inc.
   b. General Wire & Cable Company.
   c. Kerite.
   d. Okonite Company.
   e. Southwire Company.
   f. Priority Wire & Cable, Inc.
2. Connectors and Splices:
   a. AB Chance Company; Hubbell, Inc.
   b. Connector Manufacturing Company.
   c. Cooper Power Systems; Eaton.
   d. Hubbell, Inc.; Anderson Electrical Products, Inc.
   e. Hubbell, Inc.; Fargo Manufacturing Company.
   f. MacLean Power Systems.
   g. 3M Company
3. Wood Poles:
   a. Bell Lumber & Pole Company.
   b. Brown Wood Preserving, Company.
   c. Cox Industries Inc.
   d. McFarland Cascade; a Stella Jones Company.
   e. Thomasson Company.
4. Crossarms:
   a. Brooks Manufacturing Company.
   b. Cox Industries, Inc.

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c. Hughes Brothers, Inc.

5. Lightning Surge Arresters:
   a. Cooper Power Systems; Eaton.
   b. General Electric Company; Transmission Systems.
   c. MacLean Power Systems.
   d. Ohio Brass Company, Hubbell, Inc.
   e. Tyco Electronics/Raychem.
6. Cutouts, Switches, and Fuses:
   a. ABB Inc.; Distribution Automation Equipment Division.
   b. AB Chance Company; Hubbell, Inc.
   c. Cooper Power Systems; Eaton.
   d. S&C Electric Company.
7. Pole-Line Hardware and Accessories:
   a. AB Chance Company; Hubbell, Inc.
   b. Aluma-Form, Inc.
   c. Cooper Power Systems.
   d. Dixie Metal Products, Inc.
   e. Joslyn Hi-Voltage Corp.; High Voltage Equipment Division.
   f. MacLean Power Systems.
   g. Porcelain Products Co.
   h. Thomas & Betts Corporation; Utility Division.
8. Reclosers:
   a. Cooper Power Systems, type VW.
9. Distribution Transformers:
   a. See Specification Section 26 05 00, 26 12 13, and 26 12 19.

2.02 MATERIALS

A. Conductors, Connectors and Splices

1. Medium-Voltage Line Conductors
   a. Bare – Aluminum Conductor, Steel Reinforced (ACSR), complying with ASTM B 232/B 232M.
2. Conductors and Neutral
   a. Minimum conductor size shall be #4 AWG and stranding shall be 6/1 (Al/Stl) unless otherwise approved by the UPRR Manager of Electrical Design.
3. Neutral-Supported, Secondary Service-Drop Cable

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a. Insulated conductors with bare neutral, complying with ICEA S-76-474, and using cross-linked thermosetting polyethylene (XLP) complying with NEMA WC 7.

1) Secondary-Voltage Triplex Conductors: Phase conductors, aluminum, concentrically stranded, crosslinked polyethylene insulation. Neutral messenger shall be ACSR. Comply with ASTM B 230 and ANSI/ICEA S-76-474.

2) Secondary-Voltage Quadruplex Conductors: Phase conductors, aluminum, concentrically stranded, crosslinked polyethylene insulation. Neutral messenger shall be ACSR. Comply with ASTM B 230 and ANSI/ICEA S-76-474.

4. Connectors, Splices and Conductor Securing and Protecting Components

a. Items include wire clamps, ties, conductor armor, connectors and terminals. Listed for the specific applications and conductor types and combinations used. Descriptions as follows for various applications:

1) Copper to Copper: Copper alloy complying with UL 486A.

2) Aluminum Composition to Aluminum Composition: Aluminum alloy complying with UL 486B.

3) Copper to Aluminum Composition: Type design for this purpose complying with UL 486B.

4) Taps for Medium-Voltage Line Conductors: Hot-line clamps, stirrups listed for the combination of materials being connected.

5) Connectors and Splices for Secondary Conductors: Listed and labeled for the conditions and materials involved in each application.

6) Splices under Tension: Compression type with strength exceeding the conductors being spliced. Mid-span splices are not permitted for new construction.

7) Splices and Terminations for Covered Conductors: Types as recommended by conductor manufacturer for conductor and covering combination and for specific materials and physical arrangement of each splice.

8) Splice and Terminations for Insulated Medium-Voltage Conductors: Comply with requirements in Specification Section 26 05 13.

5. Wood Poles

a. Poles shall be ASA Class 2 or 3 Douglas Fir or Southern Yellow Pine of lengths and classes indicated. The wood species Western Red Cedar is not permitted for substitution. The poles shall be roofed and tagged only. Poles shall not be gained or drilled unless otherwise indicated. Set poles at depths as indicated on the "Minimum Dimensions and Setting Depths for Poles" detail in the UPRR Electrical Construction Manual.

b. Description: Wood pole shall comply with ANSI O5.1.

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c. Pressure treat poles with Pentachlorophenol, Dichloro-octyl-isothiazolinone (DCOI), or Copper Naphthenate per standards of the American Wood Preservers Association and EEI Specifications.

d. Roof poles before treatment. If pole gains are to be required subsequent to treatment, metal gain plates shall be provided.

e. The quality of each pole shall be ensured with "WQC" (Wood Quality Control) brand on each pole.

f. The manufacturer's pole marking shall include the pole length, pole class, year of manufacture, and pole species. The pole marking location shall be 10 feet from pole butt for poles 50 feet long or less.

g. Wood poles machine trimmed by turning, conforming to ANSI O5.1 and RUS Bulletin 345-67.

h. Factory Operations: Machine trim pole by turning smooth, full length. Roof pole before pressure treatment.

6. Crossarms

a. Description: Solid-wood distribution type, complying with RUS REA Bulletin 1728H-701 for specified construction grade and IEEE C2 for required climbing space and wire clearances.

1) All crossarms shall be 3-1/2 IN x 4-1/4 IN x 8 FT-0 IN long standard EEI distribution type, predrilled for steel pins and double arming bolts per standard EEI dimensions. Crossarms shall be pressure treated with Pentachlorophenol, Dichloro-octyl-isothiazolinone (DCOI), or Copper Naphthenate per standards of the AWPA and EEI Specifications.

2) All other wood members shall be specified on the plans and shall be pressure treated with Pentachlorophenol, Dichloro-octyl-isothiazolinone (DCOI), or Copper Naphthenate per standards of the AWPA and EEI Specifications.

b. Crossarm Braces:

1) Galvanized, flat, ferrous-metal units; 1/4 inch (6 mm) thick by 1-1/4 inches (30 mm) wide, minimum, with length to suit crossarm dimensions.

7. Hardware and Accessories

a. Ferrous-metal items include, but not limited to bolts, nuts, washers, crossarm gains and braces, insulator pins, anchor rods, anchors, eyebolts, staples, and equipment brackets.

1) Comply with ANSI C135.1, ANSI 135.2, ANSI 135.4, ANSI 135.14, ANSI 135.22, ANSI 135.33, RUS Informational Publication 202-1 listings.

b. Guy Strand Assemblies: Cable attachments. Include strain insulators where indicated by IEEE C2. Assemblies shall have uniform minimum breaking strength for components of each assembly.

1) Cable: Seven strand, zinc-coated steel complying with ASTM A 475.

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2) Cable Termination: Thimble eye.

c. Anchor and Anchor-Rod Assemblies: Hot-dip galvanized steel.

1) Anchors: Expanding or Power-installed screw type.

2) Anchor Rods for Manual Installation: Treaded rod with integral twin thimble eye.

3) Anchor Rods for Power-Installed Screw Anchors: ASTM A 53/A 53M, Schedule 80 pipe with coupling and twin thimble eye.

d. Guy Markers

1) Round vinyl or PVC material, orange color, 96 IN long. Shatter resistant at temperatures below 0 degrees F (minus 18 deg C).

e. Insulator Brackets

1) Hot-dipped galvanized steel, style as indicated, designed to hold vertical post or pin-type insulators with two-bolt attachment to pole.

f. Secondary Insulator Racks:

1) Hot-dip galvanized steel, style as indicated, with smooth, rounded 12-gage struts designed to support 2 spool insulators for attachment of secondary drop conductors. Spool spacing of 4 inches (100 mm).

g. Pole Riser Shields

1) Rigid Galvanized Steel conduit sized per drawings.

2) Galvanized steel with boot.

h. Insulators

1) Units 6kV and above shall be free from radio interference.

2) Porcelain insulators shall be wet process type complying with the following types:

a) Pin: ANSI C29.5 for voltage specified on the drawings. They shall be as specified on the drawings and shall be suitable with standard 1 IN nylon threaded steel support pins. Ties shall be made per standard RUS recommendations. Performed tie wraps are preferred for conductor attachment.

b) Line Post: ANSI C29.7. Include mounting stud of length suitable for each mounting arrangement used.

c) Suspension: ANSI C29.2

d) Guy Strain: ANSI C29.4, Fiberglass reinforced, epoxy finished.

e) Secondary Spool: ANSI C29.3, Class 53-2.

3) Polymer-composite, fiberglass-reinforced insulators shall comply with the following:

a) Line Post: Comply with CEA L WIG-02.

b) Dead End/Suspension: Comply with CEA L-WIG-01.

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c) Guy Strain: Fiberglass reinforced, epoxy finished. Designed specifically for use in guy assemblies.

8. Termination Kits
   a. Termination kits shall be 3M, 15kV, QT-III, 7640 series. Select proper size termination kit for the application. Cable shall be protected by rigid metallic conduit unless otherwise noted.
9. Grounding Materials
   a. Comply with Specification Section 26 05 26 "Grounding" using material intended for purpose without restriction.
      1) Conductors: No. 6 soft drawn copper complying with ASTM B 8 unless specified otherwise.
      2) Ground Rods: ¾ IN x 10 FT long minimum copper-clad conforming to UL 467.
      3) Ground Conductor Protectors: PVC molding, 8 FT long minimum.
10. Lighting Arresters
    a. See Specification Section 26 18 19 for additional information.
11. Cutouts, Switches and Fuses
    a. Medium-voltage disconnects, protective and bypass units shall be rated for the line-to-line voltage of the systems in which installed unless higher ratings are indicated on the drawings.
       1) BIL Rating: 95kV.
       2) Switch rating: 600 amp RMS and load interrupting.
       3) Momentary Current rating of switching Devices: 20kA asymmetrical at nominal system operating voltage.
       4) Group-Operated, Load interrupter Switches: three pole, single throw units, non-fused, manually operated by handle insulated mechanical linkage.
          a) High pressure contact type complying with ANSI C37.32.
          b) Factory preassembled to suit specific configuration and mounting conditions for the project.
          c) Operating Handle: Padlock equipped.
          d) Current Interrupting Rating: Equal to continuous rating of switch.
       5) Fuse Characteristics: Time-current characteristics for each set of fuses selected according to written recommendations of manufacturer of component protected by the fuses and coordinated with upstream and downstream protective devices. Prepare time-current coordination curves according to IEEE 242 that illustrate optimum coordination of devices in this project.
    b. Fuse Cutouts

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1) Open type, rated 100 amps continuous and complying with ANSI C37.42.

2) Fuses: Enclosed link, Type T complying with ANSI C37.42.

3) Fuse Current Rating: 150 percent of the transformer full-load current unless otherwise noted.

c. Non-fused Switches

1) Single-pole, manual units rated 100 amps RMS continuous.

d. Group-Operated, Load Interrupter Switches: Non-fused, three pole, single-throw units, manually operated by handle through insulated mechanical linkage.

1) High-pressure contact type, complying with ANSI C37.32.

2) Factory assembled to suit specific configuration and mounting conditions for this project.

3) Operating Handle: Torsional control mechanism, paddlock equipped.

4) Current Interrupting Rating: Equal to continuous rating of switch.

12. Distribution Transformers

a. See Specification Section 26 12 13"Pole Mounted Distribution Transformers" and Specification Section 26 12 19 "Pad Mounted Distribution Transformers" for additional information.

13. Reclosers

a. Automatic outdoor, oil-interrupter unit designed for pole-line application and complying with IEEE C37.60 with fused bypass switch.

b. Control: Hydraulic.

c. Operating Power for Contacts: Stored energy derived internally from source electrical line.

d. Voltage Rating: Equal to or greater than rated system voltage as recommended by manufacturer.

e. BIL Rating: 110 kV.

f. Continuous Current Rating: As indicated on the drawings.

g. Minimum Tripping Time-Current Setting and Reclosure Interval: Coordinated with upstream and downstream protective devices and selected according to IEEE 242. Prepare time-current coordination curves that illustrate optimum coordination of devices in this project.

h. Sequence of Operation: Unit senses phase-to phase overcurrent and trips open, controlled by adjustable time-current settings, and then recloses after adjustable time interval. Capability of two fast and two slow reclosing cycles followed by lockout, including trip and lockout of non-faulted phases, after last unsuccessful reclosure.

i. Bushings: Creepage distance shall exceed nominal value standard for unit rating by at least 75%.

j. Mounting Hardware

1) Galvanized steel.

2) Stainless Steel.

k. Tank and Cover

1) Heavy-gage steel tank and aluminum cast cover with exterior paint coating finish complying with ANSI C57.12.28 including manufacturer's standard color finish coat.

l. Provide with fused recloser bypass switch, fuses sized as indicated on the drawings.

14. Pole Banding

a. Bands shall be self-adhering, plastic, reflective, 4 IN wide safety yellow pole bands from BriteStripe (part #BS364-Y) completely around the pole diameter. The bands shall be securely affixed with #6 aluminum nails or non-rusting screws for a permanent installation.

15. Pole Numbers

a. Numbers shall be metal, at least 3 IN high and affixed to poles with #6 aluminum nails.

16. Aerial Markers

a. Markers shall be molded acrylic plastic or molded ABS plastic. Markers shall be Danger Orange in color with the coloring agent incorporated into the molded material. Where recommended by the manufacturer, other colors may be submitted for approval. Provide provisions for attaching to the cables being provided. Where applicable, provide corona effect protection.

1) Markers for cables over 50 FT above top of rail shall be 36 IN in diameter.

2) Markers for cables below 50 FT but above 29.5 FT above top of rails shall be 20 IN in diameter.

3) Markers for cables below 29.5 FT shall be 12 IN in diameter.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements: Conduct routine tests of transformers, medium-voltage switches, etc. according to referenced standards.

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: Conduct routine tests of transformers, medium voltage switches, according to referenced standards.

B. Factory Inspections: Engage a qualified independent timber inspection agency to inspect poles and crossarms before and after preservative treatment and report results of inspection.

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PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall locate and protect all existing utility lines and piping in the area of construction. Contractor shall locate all underground utility lines and piping before digging. Contractor shall field verify locations of existing conduits, poles, hand holes, etc.

3.02 PREPARATION

A. Clear the right of way to maintain minimum clearances required by IEEE C2, unless drawings indicate greater clearances or as required by state or local codes or regulations. If no minimum requirements are mandated, maintain a minimum of 15 FT on both sides horizontally and below medium-voltage conductors and 5 FT on both sides horizontally and below secondary-voltage conductors. Remove overhanging branches.

3.03 INSTALLATION

A. General Requirements

1. Verify dimensions by field measurement, and identify locations of poles, guy anchors, and other equipment and features. Also identify locations of connection to new and existing supply lines and to primary and secondary services. Notify Owner of discrepancies and field conditions that are not indicated and that will affect installation.
2. Install underground power and metering circuits and those indicated to be raceway according to Specification Section 26 05 13 "Medium Voltage Cable" and make splices and terminations for those circuits accordingly.
3. Ground equipment according to Specification Section 26 05 26 "Grounding".

B. Pole and Crossarm Installation

1. Pole Orientation
   a. Align curve of curved wood poles with straight-line runs of three or more poles. Align gained surfaces perpendicular to runs.
2. Elevation of Line above Grade
   a. Install poles with top at same elevation unless grade changes dictate elevation change in poles unless noted below.
   b. Poles supporting primary lines crossing tracks shall be 55 FT long unless otherwise indicated.
   c. Poles supporting secondary lines (with or without communication lines) shall be 45 FT long unless otherwise indicated.
3. On level ground, set poles so tops of consecutive poles vary not more than 60 IN in elevation.
   a. Shorten wood poles by cutting off the top and make cuts to shed water. Apply preservative to cuts.
4. Set poles according to the following:

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a. Make pole holes vertical, uniform in diameter and larger enough to permit effective use of tamping bars all around. Bore or excavate holes with an average diameter at grade less than twice the diameter of the pole at the same grade.

b. Pole setting Depth: In good soil, refer to the "Minimum Dimensions and Setting Depths for Poles" detail in the UPRR Electrical Construction Manual. In poor soil, coordinate depth with UPRR Manager of Electrical Design.

c. For poles on slopes, the indicated hole depth is from finished grade at lowest side of hole.

d. Set poles in alignment and plumb except at dead ends, angles, and points of extra strain; rake poles against conductor strain 1 IN minimum, 2 IN maximum (after conductors are installed at required tension) for each 10 FT of pole length. Rake poles so they will not lean or bend in direction of strain when loaded.

e. Backfill poles in 6 IN maximum lifts and thoroughly tamp each layer before starting the next layer.

1) If sufficient backfill material isn't available or in sandy or sandy foam soils with low compression strength, OsmoSet High-Density Foam or equal is permitted to be used for pole setting and straightening foam backfill.

f. Place surplus earth around pole in a conical shape and tamp thoroughly to provide drainage away from pole.

g. Set poles so alternate crossarm gains face in alternate directions except at terminals and dead ends; place gains on last two poles on side facing terminal or dead end.

5. Field treat factory treated poles and crossarms as follows:

a. Poles Treated More Than One year before installation: Treat portion from 24 IN above ground line to butt.

b. Field Bored Holes and Field Cut Gains and Pole Tops: Treat cut portions.

c. Unused Holes: Treat and plug with treated wood dowel drive pins.

d. Engage the services of a technician certified according to Part 1 of this Section to apply treatment. Comply with requirements in AWPA standards that govern original factory treatment for field applied treatment chemicals and application.

6. Crossarm Installation

a. Set line crossarms at right angle to line for straight runs and for angles 45 degrees and more. Bisect angles less than 45 degrees.

b. Buck Arms: Install at corners and junction poles unless otherwise indicated.

c. Double Crossarms: Install at dead ends, corners, angles and line crossings.

d. Equipment Arms: Locate below lines and set parallel or at right angles to them whichever provides best climbing angle.

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e. Gains: Install factory cut or metal pole gains only. Do not cut gains in field without specific written approval.

C. Hardware and Accessories Installation

1. Existing poles on which contractor works shall have steps removed below 8 FT above grade.
2. Install washers against wood and under nuts including eyenuts and locknuts.
3. Install nuts and locknuts wrench tight on threaded connections.
4. Install guys to resist unbalanced loads including those developed at angles, corners and dead ends. Install two or more guys if a single guy will not provide adequate strength. Install separate guys if unbalanced loads are separated by 36 IN or more.
    a. The down guy shall not be greater than 60 or less than 35 degrees from horizontal unless detailed otherwise.
5. Protect guy strands from damage. Replace damaged guy strands. Install guy insulators where required to comply with IEEE C2 clearance requirements and elsewhere where indicated.
6. Select guy anchors having adequate strength and holding area to suit anchor load and soil conditions at location of that anchor.
    a. Soil Anchors: Align anchors in soil with guy. Set anchor rod pointing at guy attachment on pole and rod projecting 6 to 9 IN from ground.
7. Guy Markers shall be installed at anchor end of guys. Clamp to guy strand or anchor at top and bottom of marker.
8. Pole bands shall be mounted 3 to 4 FT above grade. Bands shall be installed between any risers or equipment and the pole. Bands shall not be installed around risers or other equipment.
9. Pole numbers shall be installed on all new and existing poles which are reused as part of this project. The pole numbering scheme shall be according to the drawing(s) or pole schedule.
    a. All poles designated as Primary shall have numbers attached horizontally to the pole.
    b. All Secondary poles shall have the numbers attached vertically to the pole.
    c. Pole numbers shall be located on the pole side visible from an access road where an access road is present. The pole numbers shall not be installed in a location visible only from the track side.
    d. If there is no pole numbering scheme on the drawing(s), or the existing numbers conflict with the design drawing(s), a numbering plan (created according to the UPRR Pole Numbering Procedure) shall be submitted to the UPRR Electrical Design Group Project Engineer for approval prior to numbering the poles.
10. Aerial Marker Ball Installation

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a. All new and replacement aerial power cables that cross track(s) shall be marked to enhance the visibility of the cables with aerial cable markers.

b. Markers shall be installed on the lowest hanging conductor.

c. Where applicable, provide corona effect protection.

D. Insulator Installation

1. Medium-Voltage Line Application

a. Install pin type, except install suspension type at corners, angles, dead ends and other locations where horizontal forces exceed rated values for pin or line post units.

1) Install suspension insulators and hardware that have mechanical strength exceeding rated breaking strength of attached conductors.

2) Install horizontal line-post insulators for armless construction.

b. Post Insulator Conductor Support: Where installed horizontally and for line angles more than 15 degrees, install clamp-top conductor clamps.

c. Install spool-type insulators for secondary lines mounted on clevis attachments or secondary racks.

d. Guy Strain Type: Install porcelain units.

E. Lightning Surge Arresters

1. Install lightning surge arresters to protect distribution, reclosers, group operated, load-interrupter switches, aerial-to-ground transitions and other indicated items.

F. Cutout, switch and Fuse Installation

1. Hook-Stick-Operated Switches: Install to maximize safe operating access.

2. Group-Operated, Load-Interrupter Switches and Air-Break Switches

a. Operating Handle Location: Install operating handle 42 IN above finished grade.

b. Locking Provisions: Install padlock at hasp. Turn two sets of keys over to UP.

G. General Conductor Installation

1. Handle and string conductors to prevent cuts, gouges, scratches, kinks, flattening or deformation. Remove damaged sections and splice conductors at the poles.

a. String new conductors to initial sag table values recommended by manufacturer for type and size of conductor.

b. Conductors Reinstalled or Resagged: String to final sag values recommended by manufacturer for type and size of conductor.

2. Connection, Splices and Terminations: Provide kits listed for the specific type of connection and combination of materials used in the connection or recommended for the specific use by the manufacturer of material on which applied.

a. Splice Location: Do not install within 10 FT of a support.

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b. Line Conductors and Service Drops: Install so strength exceeds ultimate rated strength of conductor.

c. Splices and Terminations of Covered Conductors: Comply with manufacturer's written instructions.

d. Splices and Terminations of Insulated Conductors of Self-Supported, Medium-Voltage Cable: Comply with manufacturer's written instructions.

H. Medium-Voltage Line Conductor Installation

1. Application: Install bare conductors unless otherwise indicated.

2. Armor Rod: Install to protect conductors if line conductors are supported by insulators.

3. Flat Aluminum Armor Wire: Install to protect conductors if they are supported by, or attached to, galvanized or coated iron or steel clamps or fittings.

4. Support line conductors and taps as follows:

a. Use wire ties for conductor attachment to pin and vertical post insulators, unless otherwise indicated.

b. Install wire ties tight against conductor and insulator, and turn ends back to eliminate exposed wire ends.

c. Use wire clamps on horizontal post, dead end and suspension insulators unless otherwise indicated.

3.04 FIELD QUALITY CONTROL

A. Field Tests: Perform the following tests and inspections and prepare test reports.

1. Furnish instruments and equipment required for tests that comply with NETA ATS.

2. Guy Anchors: Test one of each type and capacity installed, plus additional units specifically indicated for testing. Apply rated pull-out force in the same pull direction applied by the guy at the test location.

a. Acceptable Test Results: Denoted by movement of less than 3/8 inch (10 mm) by the holding component of the anchor in the earth or other medium in which it is installed.

b. Replace or reinstall, at Owner's option, all anchors of same type and capacity as anchor type that fails this test.

3. Ground Resistance: Comply with Specification Section 26 05 26 "Grounding". Measure resistance of each separate grounding electrode, including pole grounds. Also measure resistance of separate grounding electrode systems before bonding together.

a. Perform tests and obtain acceptable results before energizing any portion of overhead electrical distribution system.

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b. Results and Follow-up: If ground resistance for a single ground electrode or pole ground, tested individually, exceeds 25 ohms, add a ground electrode not less than 10 feet (3 m) away and interconnect with No. 2 AWG minimum bare conductor buried at least 12 inches (300 mm) below furnished grade.

4. Aerial Conductor Sag and Tension: Observe procedures used to verify that initial stringing sags and tensions comply with IEEE C2 and conductor manufacturer's Product Data and written recommendations.

5. Self-Supported, Medium-Voltage Cable: After installation and while cable is isolated, after terminations are installed and before connecting or energizing, apply dc voltage between each phase conductor and grounding connections of sheath or metallic shield. Comply with applicable NEMA WC 70 for method, voltage, duration, pass-fail performance, and other test criteria. Perform other field inspections and tests recommended by manufacturer.

6. Neutral-Supported, Secondary Service Drop: Test for insulation resistance while cable is isolated, before connecting or energizing. Minimum acceptable resistance is 100 megohms.

7. Existing Surge Arresters: Disconnect and measure resistance between line and ground terminals with a megger rated 600 V or more. Acceptable resistance values are 300 megohms and more.

8. New Surge Arresters, Cutouts and Switches: Inspect after installation and connection to wiring. Verify that ratings and characteristics match approved submittals and comply with system requirements. Verify that installation complies with requirements and that clearances of units and connecting wiring comply with IEEE C2 requirements.

   a. Verify proper grounding of metallic equipment parts.

   b. Fuses and Disconnect Links: Verify that ratings and characteristics match submittals and comply with system arrangements.

   c. Switches:

      1) Manually operate each cutout and switch at least three times to verify proper operation.

      2) Verify correct contact alignment, blade penetration, travel stops and arc interrupter operation.

   d. Group-Operated, Load-Interrupter Switches and Air-Break Switches:

      1) Perform mechanical operator tests according to manufacturer's written instructions.

      2) Test resistance to ground of parts to be energized. Acceptable value is 200,000 megohms.

      3) Perform contact-resistance test across each switch blade contact set. Refer to manufacturer's data for acceptable contact resistance.

   e. Verify that clearances of energized parts and connecting wires comply with IEEE C2.

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f. Distribution Transformers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

1) Inspect for physical damage, cracked insulators, leaks, tightness of connections and overall mechanical and electrical integrity.

2) Perform pre-energized inspections and tests recommended by manufacturer.

3) Verify proper equipment grounding.

4) Verify that clearances of terminals and connecting wires comply with IEEE C2.

g. Reclosers: Inspect after installation and connection to wiring and verify that ratings and characteristics match approved submittals and comply with system requirements. Verify the integrity and good condition of unit.

1) Perform mechanical operation and contact alignment tests according to manufacturer's written instructions.

2) Verify tightness of accessible bolted connections

3) Inspect for correct insulating liquid level.

4) Perform overpotential test of vacuum contact assemblies.

5) Measure electrical contact resistance.

6) Perform overpotential test of recloser unit.

7) Test protective functions including tripping time-current characteristics. Adjust to required settings.

8) Measure time delay for each reclosing interval and adjust to required level.

9) Verify lockout in unsuccessful reclosing.

10) Verify reset time and adjust to required value.

11) Verify instantaneous overcurrent trip and lockout and adjust to required value.

12) Sample insulting level liquid and check for visual condition. Test for dielectric breakdown voltage.

13) Verify that clearances of terminals and connecting wires comply with IEEE C2.

B. Remove and replace malfunctioning units and retest as specified above.

3.05 ADJUSTING

A. Distribution Transformers: Set voltage taps as directed by Owner.

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3.06 CLEANING

A. After completing equipment installation, inspect equipment. Remove spots, dirt and debris. Repair damaged finish to match original finish. For distribution transformer, use tank touchup paint provided by manufacturer.

   1. Clean enclosures internally on completion of installation according to manufacturer's written instructions.

   2. Clean and vacuum all debris inside panels and other electrical equipment.

B. Remove all debris at site and return site surface to original or better condition.

3.07 DEMONSTRATION

A. Training:

   1. Provide TWO days of the manufacturer's technical representative's time for the training of the Owner's personnel.

END OF SECTION

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SECTION 26 12 13 – POLE-MOUNTED DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution pole-mounted transformers.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical Basic Requirements.

B. Section 26 05 13 - Medium Voltage Cable.

C. Section 26 08 13 - Acceptance Testing.

D. Section 26 10 00 - Medium Voltage Electrical Distribution.

E. Section 26 18 19 - Medium Voltage Lightning Arresters

F. Section 33 71 14 - Overhead Electric Service.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. FM Global (FM).

C. Institute of Electronic and Electronics Engineers, Inc. (IEEE):

1. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.
2. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
3. C57.12.20, Standard for Overhead Type Distribution Transformers, 500kVA and Smaller: High Voltage 34500 Volts and Below; Low Voltage, 7970/13800Y Volts and Below
4. C57.12.31, Standard for Pole Mounted Equipment – Enclosure Integrity
5. C57.12.35, Standard Bar Coding for Distribution Transformers and Step-Voltage Regulators
6. C57.12.70, Standard Terminal Markings and Connections for Distribution and Power Transformers.
7. C57.12.80, Standard Terminology for Power and Distribution Transformers.
8. C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
9. C57.91, Guide for Loading Mineral-Oil-Immersed Transformers and Step-Voltage Regulators
10. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).

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D. National Electrical Manufacturers Association (NEMA):

1. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
2. TP 2, Standard Test Method for Measuring the Energy Consumption of Distribution Transformers.

E. Department of Energy:

1. 10 CFR Part 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule

F. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings.
   a. Outline Drawings including dimensions, weigh and identification of all components and features.
   b. Nameplate drawing.
4. Certifications:
   a. Letter stating compliance with current Department of Energy efficiency requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
   a. The mechanics and administration of the submittal process.
2. The content of Operation and Maintenance Manuals:
   a. Instruction and maintenance manual.
   b. Product technical data provided in the submittal.
   c. Outline drawing updated for as-built conditions.
   d. Actual impedance data.
   e. Factory test report.
   f. Acceptance testing report.

C. Informational Submittals:

UP-Pirate-0005725

1. See Specification Section 26 05 00 for additional requirements for the mechanics and administration of the submittal process.
2. Factory test report.

1.05 DELIVERY, STORAGE, AND HANDLING.

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. ABB.
2. Eaton, Cooper Power Systems.
3. GE.
4. Solomon.

2.02 SINGLE PHASE TRANSFORMERS

A. General:
1. Transformer to be designed and constructed in accordance with IEEE C57.12.00, IEEE C57.12.20, IEEE C57.12.70, IEEE C57.12.80.

B. Ratings and configurations:
1. Type: Outdoor, pole-mounted, liquid-immersed, self-cooled.
2. Operation and application: Step-up or Step-down operation.
3. Voltage and kVA Ratings: As specified on the Drawings.
4. Number of phases: One (1).
5. Frequency: 60 Hz.
6. Polarity: ANSI standard.
7. Percent impedance: ANSI standard.
8. Basic Impulse Level (BIL):
   a. Primary: refer to Transformer Schedule
   b. Secondary: refer to Transformer Schedule
9. Temperature rise: 65 DegC.
10. Efficiency: Meet all current Department of Energy rules.
11. Sound Rating: Per NEMA TP 1
12. Connections:

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a. Primary: Two high voltage porcelain or polyester bushings with cu/al eyebolt terminals. One of the bushings shall be utilized for neutral/ground connection on single phase line to neutral applications.

b. Secondary: Low voltage porcelain or glass polyester bushings with cu/al eyebolt terminals.

1) Where multiple secondary taps are required, 4-hole maximum spade style terminals are permitted to be added to the bushings.

13. Tap-changer: De-energized type on H-winding, five (5) total, two (2) 2.5 percent above and two (2) 2.5 percent below nominal tap.

C. Components:

1. Core and Coil:

a. Core Material: Aluminum or copper.

b. Windings designed to reduce losses.

c. Insulating materials rated for 120 DegC class.

2. Tank and Terminal Cabinet Enclosure:

a. Sealed-tank construction.

b. Tank covers shall have a slope for moisture run-off. The covers shall have an insulated coating capable of withstanding 15kV at a 2000 volt/sec rate of rise, tested per ASTM D 149.

c. Tank bottom shall have a rolled edge and tank wall base which are three layers thick.

d. Units shall be provided with lifting lugs.

e. No exposed screws, bolts, or other fastening devices that are externally removable.

f. Automatic pressure relief device.

g. Stainless steel NEMA ground pads.

3. Unit protection:

a. Conventional unit: Overcurrent and overvoltage protection shall be provided by externally mounted surge arresters and fused cutout switches.

4. Finish:

a. Manufacturer's standard corrosion protection system.

b. Light Gray. Munsell Notation 5BG7.0/0.4, ANSI 70

5. Dielectric Fluid:

a. Tested for compatibility with the transformer.

b. Mineral Oil, Certified Non-PCB.

c. Permanently affix nameplate to outside of tank stamped "Non PCB".

6. Accessories:

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a. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacture.

b. Single and triple transformer mounting brackets sized for transformers being installed.

2.03 SURGE ARRESTORS

A. Standards: IEEE 386 and IEEE C62.11.

B. Voltage Class: As indicated on the Drawings.

C. Arrestor MCOV Rating: refer to Transformer Schedule or Construction Details

2.04 SOURCE QUALITY CONTROL

A. Factory Tests: At a minimum provide all routine tests as specified in IEEE C57.12.00 in accordance with IEEE C57.12.90.

2.05 MAINTENANCE MATERIALS

A. Touch-up paint.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install transformer as detailed on the Drawings and in accordance with manufacturer's instructions.

B. Transformer locations as shown on the Drawings are intended to be used as a guide.

1. Field conditions may affect actual transformer location.

2. Coordinate final location with Owner.

C. Grounding shall be per the Drawings and in accordance with local codes and standards and in compliance with the NEC.

D. See Specification Section 26 05 13 for cable termination requirements.

E. Record transformer data after installation and provide to the Project Manager.

F. Label transformers per Specification Section 26 05 00, paragraph 3.01.Q.

3.02 ADJUSTMENTS AND CLEANING

A. Repaint marred and scratched surfaces with touch up paint to match original finish.

3.03 TESTING

A. Device functionality test shall be performed.

B. Each transformer shall receive all standard routine tests as required by ANSI C57.12.00 and performed as specified by ANSI C57.12.90.

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

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END OF SECTION

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SECTION 26 12 19 – PAD-MOUNTED DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution pad-mounted transformers.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical Basic Requirements.

B. Section 26 08 13 - Acceptance Testing.

C. Section 26 05 13 - Medium Voltage Cable.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. FM Global (FM).

C. Institute of Electronic and Electronics Engineers, Inc. (IEEE):

1. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V.

2. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

3. C57.12.25, Transformers - Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with Separable Insulated High-Voltage Connectors; High Voltage, 34 500 Grdy/19 920 Volts and Below; Low-Voltage, 240/120 Volts; 167 kVA and Smaller

4. C57.12.34, Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVa and Smaller) - High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below.

5. C57.12.70, Standard Terminal Markings and Connections for Distribution and Power Transformers.

6. C57.12.80, Standard Terminology for Power and Distribution Transformers.

7. C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.

8. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).

D. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

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1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings.
    a. Outline Drawings including dimensions, weigh and identification of all components and features.
    b. Nameplate drawing.
4. Certifications:
    a. Letter stating compliance with current Department of Energy efficiency requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
2. The content of Operation and Maintenance Manuals:
    a. Instruction and maintenance manual.
    b. Product technical data provided in the submittal.
    c. Outline drawing updated for as-built conditions.
    d. Actual impedance data.
    e. Factory test report.
    f. Acceptance testing report.

C. Informational Submittals:

1. See Specification Section 26 05 00 for additional requirements for4 the mechanics and administration of the submittal process.
2. Factory test report.

1.05 DELIVERY, STORAGE, AND HANDLING.

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

UP-Pirate-0005731

1. ABB
2. Eaton
3. GE
4. Solomon

2.02 THREE-PHASE TRANSFORMER

A. General:

1. Transformer to be designed and constructed in accordance with:
   a. IEEE C57.12.00, IEEE C57.12.28, IEEE C57.12.34, IEEE C57.12.70, IEEE C57.12.80.

B. Ratings and Configuration:

1. Type: Outdoor, pad-mounted, liquid-immersed, self-cooled, compartmental type.
2. Operation and application: Step-up or Step-down operation.
3. Configuration:
   a. Dead-front, loop-feed primary.
4. Voltage and kVA Ratings: As specified on the Drawings.
5. Number of phases: Three (3).
6. Frequency: 60 Hz.
7. Polarity: ANSI standard.
8. Percent impedance: ANSI standard.
9. Basic impulse level (BIL):
   a. Primary: refer to Transformer Schedule
   b. Secondary: refer to Transformer Schedule
10. Temperature rise: 65 DegC.
11. Efficiency: Meet all current Department of Energy rules.
12. Connections:
    a. Delta or Wye: As indicated on the Drawings.
    b. Primary: 200 ampere bushing wells and inserts for loadbreak elbows. 600 ampere one-piece bushing/well for deadbreak elbows.
    c. Secondary:
       1) Less than 500 kVA: Four-hole, screw-on, set screw stud terminal with plastic cover, bar type minimum or as required.
       2) 750 – 1500 kVA: Six-hole, screw-on, set screw stud terminal with plastic cover, bar type minimum or as required.
       3) 2000 kVA and greater: Twelve-hole, screw-on, set screw stud terminal with plastic cover, bar type minimum or as required.

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4) Removable ground strap on neutral terminal.

13. Tap-changer: De-energized type on H-winding, five (5) total, two (2) 2.5 percent above and two (2) 2.5 percent below nominal tap.
14. Sectionalizing oil immersed load break primary switch:
    a. See drawings for rating and positions.

C. Components:

1. Core and Coil:
    a. Core material: Aluminum or copper.
    b. Windings designed to reduce losses.
    c. Insulating materials rated for 120 DegC class.
    d. For grounded wye to grounded wye application, the core assembly shall be a 5-legged distributed-gap, wound core.
        1) For ratings above 2500 kVA, a stacked core design may be utilized.
    e. Core material: High-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses.
        1) Magnetic flux densities are to be kept well below saturation to allow for a minimum 10 percent overvoltage excitation.
        2) Properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.
    f. Core frame:
        1) Designed to provide maximum support for the core and coil assembly.
        2) Welded or bolted to ensure maximum short-circuit strength.
    g. Designed and manufactured to meet the short circuit requirements of ANSI C57.12.90.
    h. Vacuum processed and energized or baked in an oven prior to tanking to set the epoxy coating on the insulating paper and remove moisture from the insulating prior to vacuum filing.
2. Tank and Terminal Cabinet Enclosure:
    a. Carbon steel reinforced with external internal or sidewall braces, with all seams and joints continuously welded.
    b. Design the tank and attacked components to withstand pressures greater than the required operating design value without permanent deformation.
    c. Sealed-tank construction:
        1) 1000kVA and below: Bolted main tank cover.
        2) 1500kVA and above: Welded main cover and bolted tamper-resistant handhole.
    d. Lifting lugs welded to tank.

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e. Steel divider between high-voltage (right side) and low-voltage (left side) compartments.

f. No exposed screws, bolts, or other fastening devices that are externally removable.

g. Tamper resistant per IEEE 57.12.28.

h. Cabinet depth: IEEE standard or 24 IN minimum.

i. No openings through which foreign objects such as sticks, rods, or wires may contact live parts.

j. 1 IN upper fill plug.

k. 1 IN drain valve with sampling device.

l. Automatic pressure relief device.

m. Grounding pads:

1) 500kVA: Two (2) steel pads with one (1) hole.

2) Above 500kVA: Two (2) stainless steel pads with two (2) holes.

3. Door:

a. Each compartment will have removable, three-point latching hinged doors equipped for latching in the open position.

b. The high-voltage compartment door will have a fastening device that is accessible only through the low-voltage compartment.

c. The hinge assemblies made of corrosion-resistant material.

1) Provide stainless-steel hinge pins of 3/8 IN minimum diameter.

d. Both compartment doors capable of securing with a single padlock having a maximum 1/2 IN DIA shackle.

e. Door secured with a penta head bolt with collar.

4. Overcurrent protection:

a. Provide an expulsion-type, bayonet fuse (under oil, user serviceable) in series with the current limiting fuse.

b. Internal partial-range current limiting backup fuse.

c. Provide full range protection two fuse system.

d. Dual element, expulsion-type, Bay-O-Net fuse.

1) Under oil, field replaceable.

2) In series with current limiting fuse.

3) Provide Bay-O-Net assembly with flapper valve.

4) Provide metal drip shield on drip guard.

5. Finish:

a. Manufacturer's standard corrosion protection system in accordance tihe IEEE C57.12.28.

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b. Dark "padmount" green. Munsell number 7GY 3.29/1.5

6. Dielectric Fluid:
   a. Tested for compatibility with the transformer.
   b. Mineral Oil, Certified Non-PCB.
   c. Permanently affix nameplate to outside of tank stamped "Non PCB".
7. Accessories:
   a. Liquid level indication.
   b. Dial-type thermometer.
   c. Provisions for pressure vacuum gauge.
   d. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacture.
   e. Cable parking stands, one per bushing.
   f. Provisions for secondary metering.

2.03 SINGLE PHASE TRANSFORMERS

A. General:
   1. Transformer to be designed and constructed in accordance with IEEE C57.12.00, IEEE C57.12.25, IEEE C57.12.70, IEEE C57.12.80.

B. Ratings and configurations:
   1. Type: Outdoor, pad-mounted, liquid-immersed, self-cooled, compartmental type.
   2. Operation and application: Step-up or Step-down operation.
   3. Configuration:
      a. Dead-front, loop-feed primary.
   4. Voltage and kVA Ratings: As specified on the Drawings.
   5. Number of phases: One (1).
   6. Frequency: 60 Hz.
   7. Polarity: ANSI standard.
   8. Percent impedance: ANSI standard.
   9. Basic Impulse Level (BIL):
      a. Primary: refer to Transformer Schedule
      b. Secondary: refer to Transformer Schedule
   10. Temperature rise: 65 DegC.
   11. Efficiency: Meet all current Department of Energy rules.
   12. Sound Rating: Per NEMA TP 1
   13. Connections:

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a. Primary: 200 ampere bushing wells and inserts for loadbreak elbows.

b. Secondary: Four-hole, screw-on, set screw stud terminal with plastic cover, bar type.

14. Tap-changer: De-energized type on H-winding, five (5) total, two (2) 2.5 percent above and two (2) 2.5 percent below nominal tap.

C. Components:

1. Core and Coil:

a. Core Material: Aluminum or copper.

b. Windings designed to reduce losses.

c. Insulating materials rated for 120 DegC class.

2. Tank and Terminal Cabinet Enclosure:

a. Sealed-tank construction.

b. No exposed screws, bolts, or other fastening devices that are externally removable.

c. No openings through which foreign objects such as sticks, rods, or wires may contact live parts.

d. 16 IN deep cabinet (minimum)

e. Automatic pressure relief device.

f. Stainless steel NEMA ground pads.

3. Door: Hinged flip-top.

4. Unit protection:

a. Provide unit protection with a partial-range current limiting fuse on each primary phase (under oil, factory replaceable only).

b. Provide an expulsion-type, bayonet fuse (under oil, user serviceable) in series with the current limiting fuse.

5. Finish:

a. Manufacturer's standard corrosion protection system.

b. Dark "padmount" green. Munsell number 7GY 3.29/1.5

6. Dielectric Fluid:

a. Tested for compatibility with the transformer.

b. Mineral Oil, Certified Non-PCB.

c. Permanently affix nameplate to outside of tank stamped "Non PCB".

7. Accessories:

a. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacture.

b. Fiberglass Ground Sleeve Box pad to increase cable termination height and cable storage.

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1) Material: Fiberglass Reinforced Composites (FRC) incorporating fire retardant polyester resins and a UV stabilizer coating.

2) Height: 18 IN minimum.

2.04 SURGE ARRESTORS

A. Standards: IEEE 386 and IEEE C62.11.

B. MOV gapless elbow type or parking stand type.

C. Elbow Connector:

1. One-piece design, comprised of an insulation layer and outer shield constructed of EPDM rubber.

2. 200A, dead front, load break type with hot stick pulling eye and grounding tab.

D. Voltage Class: As indicated on the Drawings.

E. Arrestor MCOV Rating: refer to Special Conditions

2.05 SOURCE QUALITY CONTROL

A. Factory Tests: At a minimum provide all routine tests as specified in IEEE C57.12.00 in accordance with IEEE C57.12.90.

2.06 MAINTENANCE MATERIALS

A. Touch-up paint, two (2) separate one (1) quart containers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install on pad as detailed on the Drawings and in accordance with manufacturer's instructions.

B. Transformer locations as shown on the Drawings are intended to be used as a guide.

1. Field conditions may affect actual transformer location.

2. Coordinate final location with Owner.

C. Install three-phase transformers on concrete pad per detail on the Drawings.

D. Install single-phase transformers on ground sleeve box pad or concrete pad per detail on the Drawings.

E. See Specification Section 26 05 13 for cable termination requirements.

F. Label transformers per Specification Section 26 05 00, paragraph 3.01.Q.

G. All conductors shall be marked per Specification 26 05 19, paragraph 3.01.D.

3.02 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

END OF SECTION

UP-Pirate-0005737

SECTION 26 13 13 - MEDIUM VOLTAGE METAL-CLAD PARALLELING SWITCHGEAR

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Medium voltage metal-clad switchgear.

b. Medium voltage circuit breakers and associated protective relays.

c. Medium voltage fuses.

d. Generator Controls.

e. Master Controls.

f. Field Services.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 10 14 00 - Identification Devices.

B. Section 26 05 00 - Electrical: Basic Requirements.

C. Section 26 05 98 - Power Distribution Center – Gear Houses.

D. Section 26 08 13 - Acceptance Testing.

E. Section 26 09 13 - Electrical Metering Devices.

F. Section 26 09 16 - Control Equipment Accessories.

G. Section 26 13 23 - Sectionalizing Equipment.

H. Section 26 33 00 - Battery and Battery Charging Systems.

I. Division 40 - Process Interconnections.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. Institute of Electrical and Electronics Engineers (IEEE).

1. C37.04, Standard Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

2. C37.06, Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis -Preferred Ratings and Related Required Capabilities for Voltage Above 1000 V.

3. C37.11, Standard Requirements for Electrical Control for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.

4. C37.20.2, Standard for Metal-Clad Switchgear.

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5. C37.90, Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
6. C57.13, Requirements for Instrument Transformers.
7. C62.11, Standard for Metal-Oxide Surge Arresters for AC Power Circuits (> 1 kV).

C. National Electrical Manufacturers Association (NEMA):
1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. SG 4, Alternating-Current High-Voltage Circuit Breakers.

D. Underwriters Laboratories, Inc. (UL):
1. 44, Thermoset-Insulated Wires and Cables.

1.04 SYSTEM DESCRIPTION

A. Switchgear configured to parallel multiple generators and to parallel on site generation and to provide open transition between generator and utility.

B. Contractor shall refer to drawings for equipment operating voltage.
1. Generators will match system voltage and be provided with neutral resistors or reactors sized per ANSI and NEMA standards to limit single phase-to-ground fault current to the three-phase fault current value.

C. Switchgear, controls and other equipment as specified and indicated in the contract documents shall be provided in a Power Distribution Center - Gear House. All layouts, clearances, calculations and coordination shall be provided. Supply one complete package as specified and indicated in the contract documents.
1. See Specification Section 26 05 98.

1.05 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Submittal data for all products specified in PART 2 of this Specification Section.
1) See Specification Section 26 05 00 for additional requirements.
b. Bill of material.
c. Instrument transformer performance curves and data.
d. Nameplate data for all equipment.
e. Mounting details and loading information for concrete foundation design.
f. Installation instructions and procedures.
3. Fabrication and/or layout drawings:

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a. General arrangement plan view showing door swings, cable entrance locations, shipping splits, etc.

b. Cross sections, elevations and details.

c. Mimic bus layout.

d. Complete single-line and three-line diagrams.

e. AC and/or DC schematics of breaker control, protective relaying, etc.

f. Point-to-point/terminal block wiring diagrams.

4. Test reports:

a. Certified reports of all design tests shall be available upon request.

b. Certified reports of all factory production tests.

c. Results of all field tests.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

3. Fabrication and/or layout drawing shall also be provided in electronic format (MicroStation or AutoCAD).

4. Provide recommended spare parts list in paper format and electronic format in either MS Word or MS Excel.

5. Relay Setting Sheets.

C. Informational Submittals:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Factory Acceptance Test (FAT):

a. FAT test plan.

3. Field Performance and Demonstration:

a. Field Performance and Demonstration plan.

4. Protective Coordination Study.

a. Relay setting sheets.

5. Submit proposed functional performance test procedure to Engineer for review a minimum of six (6) weeks before scheduling testing specified in PART 3 of this Specification Section.

6. Record of test results, inspections and procedures witnessed or performed by factory service representative.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. History of service in similar applications for not less than three (3) years.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

1.08 PROJECT/SITE CONDITIONS

A. Switchgear assembly shall perform as intended under the following conditions without damage to equipment, structure, or derating:

1. At ambient temperatures from -30 DegC through +40 DegC.
2. At altitude through 3300 FT.

B. Switchgear shall be suitable for installation in the space available (see Drawings).

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Circuit breakers:
   a. ABB.
   b. Eaton.
   c. General Electric.
   d. Siemens.
   e. Square D Company.
2. Instrument transformers:
   a. ABB.
   b. ITI.
3. Protective relays:
   a. As scheduled.
4. Utility grade control switches:
   a. Electroswitch Series 24.
   b. GE SB Series.
5. Test switches:
   a. ABB.
   b. States Electric.

B. Submit request for substitution in accordance with Specification Section 26 05 00.

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2.02 METAL-CLAD SWITCHGEAR

A. Ratings:

1. Operating voltage: As indicated on the Drawings.
2. Rated maximum voltage: As indicated on the Drawings
3. Amperage: As indicated on the Drawings.
4. Number of phases: 3.
5. Frequency: 60 Hz.
6. Short circuit current: 18 kA RMS SYM at maximum voltage.
7. Basic impulse level (BIL): 95 kV.
8. Comply with IEEE C37.06 for ratings not specified.

B. Construction:

1. Standards: IEEE C37.20.2, NEMA SG 4.
2. Individual, freestanding, vertical sections housing various combinations of circuit breakers and auxiliaries and bolted together to form a rigid metal-clad switchgear assembly.
3. Front and rear access.
4. Vertical sections isolated from adjoining sections by grounded metal barriers.
5. Circuit breakers, buses, instrument transformers, control power transformers, and cable terminations isolated from each other by grounded metal barriers.
6. Provide shutters that close automatically when the circuit breaker is in the test position, disconnected position or withdrawn.
7. Provide rails to allow withdrawal of the circuit breakers to the test, disconnected and withdrawn positions from the operating position.
    a. Provide means to padlock the racking mechanism in the fully withdrawn position.
8. Provide fully equipped spaces for future and spare circuit breakers shown on the Drawings, complete with relays, current transformers, control devices, and all internal wiring connected to field wiring terminal boards to permit future installation of circuit breakers with a minimum of work required in the switchgear cubicles.
9. Enclosure:
    a. NEMA 1, minimum.
    b. Hinged, gasketed and removable front doors over each circuit breaker or auxiliary equipment compartment.
        1) Doors shall be able to be closed with the breaker in the fully withdrawn position.
        2) Provide access to racking mechanism through door to allow racking with door closed.

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3) Door shall have a bonding wire across hinge to structure.

c. Bolted on rear covers for each vertical section.

1) Half-height.

2) With lifting handles.

d. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.

C. Buses:

1. Material: Tin- or silver-plated copper rectangular bars.
2. Insulation: Void-free heat shrink or fluidized epoxy coating.
3. Bus supports, stand-off insulators and through-bushings: Porcelain or epoxy.
4. Main bus: Amperage rating as indicated on the Drawings.
5. Ground bus: 1/4 x 2 IN copper, minimum, continuous over length of the switchboard.
6. Provisions for future extension from both ends of lineup.
7. Bus joints, when required, fully insulated and connected using through bolts and conical spring-type washers for maximum conductivity.
8. Arrange buswork so that Phase A, B and C are arranged from left to right (viewed from the front of the switchgear), front to back or top to bottom.

D. Control Power:

1. Individual generator controls: 24 Vdc from engine starting system.
2. Master controls: 125 Vdc supplied from external sources.
3. Switchgear trip and close power: 125 Vdc from external sources.
4. Provide a single external connection point for each bus and for each control assembly.
5. Separate internal circuits with individual overcurrent devices required for:
   a. Trip circuit: Each circuit breaker.
   b. Close circuit: Each circuit breaker.
   c. Bus differential and lockout relays: Each bus.
6. Provide a diode-based “best battery” circuits for the main and tie and generator circuit breakers to allow trip and close power to be supplied from either bus.
7. Provide a power supervision relay on the load side of each overcurrent device.
   a. Contacts wired in series or parallel to provide a common DC Power Failure alarm for each bus.

2.03 COMPONENTS

A. Circuit Breakers.

1. Standards: IEEE C37.04, IEEE/ANSI C37.06, IEEE/ANSI C37.11.

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2. Ratings:
    a. Rated voltage: 15 kV.
    b. Continuous current: As indicated on the Drawings.
    c. Frequency: 60 Hz.
    d. Short Circuit Current: 50 kA RMS SYM at 15 kV.
    e. Duty cycle: Two (2) unit operations with 15 second interval between operations (CO - 15s - CO).
    f. Rated interrupting time: 5 cycles.
3. Vacuum type interrupter.
4. Silver-plated copper primary disconnecting contacts.
5. Horizontal drawout type.
6. Operated by a motor-charged stored energy spring mechanism.
    a. Normally charged by an electric motor with an emergency manual handle.
7. Silver-plated copper secondary contacts automatically engage in the connected position and are manually engaged in the test position.
8. Interlocks:
    a. Prevent closing of a breaker between connected and test positions.
    b. Trip breaker upon insertion or removal from enclosure.
    c. Discharge stored energy mechanisms upon insertion or removal from enclosure.
9. Control voltages:
    a. 125 Vdc closing power, closing control and tripping.
    b. From external DC supply as specified and indicated on Drawings.
10. Auxiliary and control devices:
    a. One (1) trip coil.
    b. One (1) close coil.
    c. Auxiliary contacts: Minimum of twelve (12) “a” and twelve (12) “b.”
    d. Cell mounted auxiliary contacts as required: MOC and TOC type.
    e. Contact wear indicators.
    f. Manual trip button.
    g. Manual close button.
    h. Open-Close indicator.
    i. Manual spring charging capability.
    j. Spring charge-discharge indicator.
    k. Event counter.

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l. Nameplate.

11. Auxiliary devices mounted on switchgear:

a. Breaker control switch.

b. Red and green indicator lights indicating breaker contact position.

B. Control Switches:

1. General:

a. Double-sided, double-wiping, knife-type rotary contacts.

b. Silver plated contacts.

c. Engraved escutcheon plate.

2. Breaker control:

a. Three (3) position, spring return: Close, Trip and Normal.

b. Red and green mechanical target on escutcheon plate.

c. Pistol-grip handle.

3. Lockout Relays:

a. Two (2) position: Trip and Reset.

b. Manual reset.

c. Red and green mechanical target on escutcheon plate.

d. Pistol-grip handle.

C. Auxiliary Control Devices:

1. Selector switches, pushbuttons, indicating lights and control relays as specified in Specification Section 26 09 16.

D. Metering:

1. Owner:

a. See Specification Section 26 09 13 for meter requirements.

E. Current Transformers:

1. Standard: IEEE C57.13.

2. Current ratios: As required.

3. Window type current transformers shall be accessible from front of cubicle to permit changing or adding, without disconnecting bus joints.

4. Accuracy, minimum: Standard relay accuracy as listed in IEEE C37.20.2.

5. Ground sensor current transformers:

a. Window type.

b. Single ratio: 50/5.

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6. Connections:
    a. All taps wired out to shorting terminal block.
    b. Connections between CTs made at shorting terminal block, not behind shutters.
    c. Ground connections made at shorting terminal block.

F. Potential Transformers:
    1. Standard: IEEE C57.13.
    2. Voltage ratio: As required.
    3. Drawout mounted with primary and secondary disconnecting contacts and automatic grounding in open position.
    4. Primary current-limiting fuses.
    5. Secondary fuses or circuit breaker.
    6. Mechanical and thermal ratings coordinated with breaker ratings.
    7. Accuracy class: 0.3 at burden W thru Z and 0.6 at burden ZZ.
    8. Thermal burden rating: Exceed maximum connected burden.

G. Test Switches:
    1. Base and cover constructed of polycarbonate insulating material.
    2. Semi-flush, through panel mounting with screw or stud type terminal connections on rear of switches separated by polycarbonate barriers.
    3. Provide 120V, 20A circuit from Gear House panelboard for test circuit power.
    4. Individual switches:
        a. Ratings: 600 V, 30 amp.
        b. Knife blade type separated by insulated barriers.
        c. Phenolic insulated handle with provisions for identification cards.
        d. Provisions for horizontal interlocking bar.
        e. Types:
            1) Potential (transformer) non-shorting.
            2) Current (transformer) non-shorting with test jack.
            3) Current (transformer) shorting, make-before-break.
    5. Test plugs:
        a. Provide one (1) separate source test plug for each switchgear lineup.
        b. Provide one (1) series test plug for each different test switch configuration for each switchgear lineup.
    6. ABB Type FT-1 or equal.

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H. Heavy-duty (Utility) Terminal Blocks:

1. General:

a. Ratings: 600 V, 30 amps.

b. Molded one-piece thermoplastic body.

c. Washer head terminal screws to accommodate up to a #10 AWG wire.

2. Current transformer shorting terminal blocks:

a. Short circuiting strip for shorting screws and screw "parking stations."

b. GE Type EB-27.

3. Non-shorting terminal blocks:

a. GE Type EB-25.

I. Battery and Battery Charging System:

1. See Specification Section 26 33 00.

J. Surge Arresters:

1. Standard: IEEE C62.11.

2. MCOV rating: As indicated on the Drawings.

3. Metal oxide type, station class.

K. Control Wire:

1. Conductor shall be copper with 600 V rated insulation.

2. Conductors shall be stranded.

3. Minimum #12 AWG.

4. Surface mark with manufacturers name or trademark, conductor size, insulation type and UL label.

5. Conform to UL 44 for type SIS or MTW insulation.

L. Wire Terminators:

1. Ratings: 600 V.

2. Tin plated high strength copper alloy.

3. Solderless, non-insulated, ring type.

2.04 CONTROLS – GENERAL REQUIREMENTS

A. Provide one (1) generator control assembly for each engine generator and one (1) master control assembly for the system.

1. Master Control Assembly:

a. Free-standing control panel or integrated into switchgear assembly.

2. Generator control assembly:

a. Integrated into switchgear assembly.

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B. Provide control assemblies for all generators indicated, including future generators.

1. Make provisions for future generator control in system controls so that a minimum of work and re-commissioning is required to integrate an additional engine-generator into the system.

C. Free-standing Control Panel Construction:

1. Fully front-accessible.
2. Indoor drip-proof enclosure.
3. Painted sheet steel with rigid structural frame.
4. Full-length hinged door with 3-point roller-cam latching mechanism and wind brace.
5. Provisions for anchoring to control room floor and to back wall.

D. Wiring:

1. 600 V copper type SIS or MTW.
2. Minimum #12 AWG for potential and current circuits.
3. Ring terminal connectors for current, potential and DC voltage conductors.
4. Labeled at both ends to correspond to the schematic and wiring diagrams.
5. Provide segregation of wiring between voltage levels and signal types:
   a. DC and AC potential and current circuits.
   b. 24 Vdc digital signals.
   c. 24 Vdc analog signals.
   d. RTD and thermocouple circuits.

E. Terminal Boards:

1. 600 V, 30 A, screw-clamp type with center marker strip for all current, potential and DC voltage wiring; GE Type EB-25.
2. Provide for all field wiring and inter-unit connections.
3. Provide for internal wiring of control panel as required.
4. Segregate field wiring terminal boards from internal and inter-unit wiring terminal boards.

F. Arrangement of Controls and Indicators:

1. Provide color-coded mimic bus, minimum 1/2 IN wide bright plastic laminate, continuous between control panels to show arrangement and connections of generators, circuit breakers, and feeders.
2. Arrange operator controls and indicators in an intuitive manner following the mimic bus and logical groupings.

G. Connect all generator control panel equipment current circuits to metering current transformers in switchgear.

1. Relaying current transformers are dedicated to generator protection relay.

2.05 MASTER CONTROLS

A. General:

1. Master control assembly provides system control functions.
2. Includes the items listed below as a minimum, plus all other items and components required for specified performance and function.

B. Operator Interface Station

1. The Operator Interface Station shall be located in the PDC. The Station shall be as described in Specification 26 05 98.

C. Circuit breaker control switches with indicator lights shall be located on the Mimic One Line Diagram in the PDC. The control switches shall be for the Utility Main, Generator and Tie circuit breakers, and the feeder circuit breakers.

D. For circuit breaker testing only, control switches and indicating lights shall be mounted on the door of each circuit breaker. These test switches shall be capable of tripping and closing the circuit breakers only when the circuit breaker is racked out to the TEST position.

E. Over/under frequency and over/under voltage sensors to detect abnormal condition on generator bus.

1. Over/under frequency and overfrequency failure causes alarm horn to sound and red fail lamp to light.
2. Underfrequency condition initiates load shedding as well as sounding alarm horn and lighting red fail lamp.

F. Regulated power supply derived from 125Vdc switchgear station battery system.

1. Provide proper operation over input voltage range of 115 to 130 Vdc.
2. Provide diode-based “best battery” selector to provide control power supply and downstream of the overcurrent protection on each separate branch of the 125Vdc supply.
3. Provide over- and undervoltage monitoring of control power supply and downstream of the overcurrent protection on each separate branch of the 125 Vdc supply.

2.06 CONTROL SYSTEM INTERFACE

A. Operator interface to the PLC based control system shall be via a 21” touchscreen LCD panel PC. Panel PLC shall be mounted in front of the low-voltage cabinet in the switchgear section which shall be accessible to the operator without having to enter the high-voltage side. Panel PC shall be equipped with the following features:

1. Intel Core i5 CPU
2. 8 GB RAM SO-DIMM
3. 2 X 2.5” SATA HDDs in RAID configuration
4. RS-232 and RS-485 serial ports
5. Gigabit Ethernet ports

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6. Windows 7 OS
7. IP 65 compliant
8. UL listed

B. Acceptable manufacturers include:
   1. Advantech model PPC-4211 W
   2. Owner approved equal

C. Panel PC shall be loaded with the latest version of Rockwell Automation FactoryTalk View SE HMI software. Vendor shall purchase licenses for FactoryTalk View SE Server and FactoryTalk View Studio configuration software for developing and testing the HMI applications. All licenses shall be turned over to the Owner following final acceptance of equipment by Owner. Vendor shall also provide RSLinx Enterprise. Provide a single-point open Ethernet/IP or Modbus TCP interface to the panel PC to transfer and display all generator and system control, status, alarm, and shutdown data points on the HMI screen.

D. A separate alarm summary screen shall be provided on the HMI that lists all active and operator acknowledged but not cleared alarms. Once an alarm has been cleared by the PLC it shall be removed from the alarm summary screen but shall be stored in the historical data screen. Historical alarm and event logging shall be set up by the vendor.

E. The main screen on the HMI shall display the Paralleling Switchgear data and the SCADA network showing the North and South loops with all Sectionalizing Switchgear. The operator shall be able to press any switchgear graphic which shall take the operator to a separate screen displaying all I/O points associated with that switchgear. On this screen the operator shall be able to open and close any switch or read power meter data associated with that switchgear. Power meter data shall also be displayed on the main screen. All screens shall have a navigation button that shall take the operator to the main screen as well as a navigation button to take the operator to the alarm summary screen. Popup shall also be provided as applicable.

F. The vendor shall follow Union Pacific WINC HMI Standards for developing HMI graphics. It shall be the vendors responsibility to obtain the standards document from Union Pacific or the Engineer. The standard provides guidelines to an HMI developer including but not limited to default colors, symbols, text and screen layout. The HMI developer shall be expected to adhere to these standards. Any deviation from the standards shall be brought to the Owner's attention for resolution by the Owner.

2.07 CONTROL COMPONENTS

A. General Requirements:
   1. Solid state devices:
      a. Meet or exceed transient overvoltage withstand test and surge withstand capability tests (SWC) per IEEE C37.90.
      b. In addition, where UL standards exist for components, devices and/or assemblies, such standards apply.

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2. Provide control relays suitable and adequately rated for intended service in control system.
    a. Provide relays used in low-voltage, low-current DC control circuits with gold flashed contacts to ensure positive contact make.
    b. Relays used for other than logic and dry contact switching to have contact ratings suitable for make and carry of their duty current at voltage of operation.
    c. Provide plug-in type relays for control circuit duty with retaining clips and transparent plastic or glass covers.
        1) Clearly mark relays for control voltage.

B. Use utility-grade control switches for the following applications:
    1. Circuit breaker control circuits, including breaker control switches, synchroscope switches, and auto/manual selector switches.
    2. Instrument selector switches.
    3. Engine mode selector switches.

C. Use industrial-grade, heavy-duty, oil-tight control switches for low-voltage, low-current applications.

D. Programmable Logic Controllers (PLCs) – If indicated on Drawings :
    1. Generator controls shall be comprised of power supply, single CPU, and single I/O connections on a common backplane or extended backplanes.
    2. Master controls shall utilize redundant power supplies, CPUs and I/O in a hot standby configuration.
        a. PLC failure or power supply failure in mid-sequence shall not interrupt control action.
    3. Power supplies shall separately fed from the 125Vdc station batteries.
    4. CPUs shall be of sufficient memory to effectively double the computing requirements of the processor without running out of memory.
    5. Scan rates shall not exceed 30 msec.
    6. CPUs shall have a separate programming port that shall not be connected to any other device thus held in reserve for programming functions only.
    7. CPUs shall be programmable in ladder logic or some other higher-level language.
    8. PLC hardware and software shall be fail safe.
        a. If a failure occurs with the individual engine PLC, the engine controls and circuit breakers still operate manually and the PLC failure will be alarmed.
    9. Acceptable manufacturers:
        a. Rockwell Automation ControlLogix 1756-L72
        b. Modicon (Schneider Electric) Momentum
        c. Owner approved equal

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E. Ethernet Switches:

1. Ethernet switches shall be rack-mount fixed configuration switches.
2. Compact 1 rack unit (RU)
3. Rugged design for industrial Ethernet application
4. Fanless convection cooling
5. Front and read LED panels allowing reverse mounting and easy reading of switch status
6. Switches shall support common Industrial Ethernet protocols
7. Acceptable manufacturers:
   a. Cisco Industrial Ethernet 3010 series or;
   b. Owner approved equal

F. Router:

1. Provide a rack-mount router for future connection to Owner's network.
2. Router shall be connected to the Ethernet switches and be equipped to transmit data to the Owner network (future).
3. Router shall have built-in firewall and gigabit Ethernet switching capability.
4. Acceptable manufacturers:
   a. Cisco 2900 series

G. Network Rack Unit:

1. Provide a 6U wall-mounted rack which shall house the Ethernet switches and router.
2. Adjustable mounting depths with front vertical rackmount rails
3. Ventilated or clear front door and side panels for increased airflow
4. Locking, removable side panels
5. Locking, reversible front door
6. Acceptable manufacturers:
   a. Tripplite model SRW6U
   b. APC (Schneider Electric) model NetShelter WX 6U
   c. Owner approved equal

2.08 PROTECTIVE RELAYING

A. General:

1. Microprocessor based multi-function type, unless otherwise specified.
2. Mounting: Semi-flush.
3. Functions: As indicated and specified in the contract documents.
4. Utility grade IEEE C37.90.

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5. Protective relays shall be provided with drawout construction or test switches for testing, maintenance and interchange flexibility.
    a. Test switches or test blocks shall be provided in each current, potential circuit and trip circuit.
6. Protective Coordination:
    a. The supplier shall perform a protective coordination study for all relays in the switchgear.
    b. The study shall be closely coordinated with the Engineer, including a minimum of one (1) meeting.
    c. The supplier shall do all programming of the relays based on the approved coordination study.

B. Protective relays indicated on the drawings and scheduled below are not intended as part of the automatic control system except where specifically indicated as providing signals to the PLC.
1. Vendor shall provide all sensors and relays necessary for control system operation independently of these relays.
2. Utility protection relay will provide communication to Master Control Panel to indicate line voltage and/or frequency outside of acceptable range.
3. Generator protection relay may provide contact closure to Master Control Panel to indicate generator line voltage and frequency within acceptable range.

C. Relay Schedule:
1. Utility protection relay (Device UPR):
    a. Schweitzer Engineering Laboratories SEL-351-7.
    b. Beckwith Electric M-3450.
2. Generator protection relay (Device GPR):
    a. Schweitzer Engineering Laboratories SEL-300G.
    b. General Electric SR-489.
    c. Beckwith M-3425A.
    d. Basler GPS-100.
3. Feeder protection relay: (Device FPR):
    a. Schweitzer Engineering Laboratories SEL-351.
    b. General Electric SR-750.
    c. Beckwith M-3410.
    d. Basler BE1-851.
4. Bus differential (Device 87B): Basler Electric BE1-87B.
5. Lockout relay (Device 86): Electroswitch Series 24 LOR.
6. Synchronism-check relay (Device 25C): Basler Electric BE1-25.

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D. Tripping Schemes:

1. All overcurrent and fault protection relay functions directly trip the circuit breakers through trip contacts or lockout relay contacts in the breaker control circuit.
    a. These functions do not go through the PLC.
2. Feeder relays shall direct trip feeder circuit breakers.
3. Feeder protection relays (FPR) will have two (2) setting groups, one (1) enabled when the bus is supplied from the utility or the utility and on-site generation; the other enabled when the bus is supplied only from the on-site generation.
4. Bus differential relays shall direct trip associated lockout relay.
    a. Lockout relay shall direct trip and block close of all circuit breakers connected to the bus.
5. Paralleling Switchgear Main Breaker protection relay (UPR) shall be provided with two (2) trip output contacts:
    a. One (1) contact will be actuated by relay elements providing backup protection for faults inside the plant, that is, in the forward direction viewed from the utility source.
        1) This contact shall direct trip utility lockout relay 86M, which shall direct trip and block close of the affected utility breaker and the tie breaker.
    b. One (1) contact will be actuated by relay elements providing protection from faults on the utility system when the generation is in parallel with the utility.
        1) Contact will direct trip the utility breaker, but will not trip the lockout relay.
        2) Provide an input signal from breaker auxiliary contacts that will be programmed to enable this output contact only when generation is in parallel.
6. Generator protection relay (GPR) shall be provided with two (2) trip output contacts:
    a. One (1) contact will be actuated by relay elements providing backup protection for system faults not related to internal failure of the generator.
        1) This contact will direct trip the utility breaker, but will not trip the lockout relay.
    b. One (1) contact will be actuated by relay elements providing protection for internal generator faults.
        1) This contact shall direct trip generator lockout relay 86G, which shall direct trip and block close of the generator circuit breaker, de-energize the field, and shutdown the engine.

E. Provide the following additional inputs and outputs to each UPR and GPR:

1. Breaker status 52a contact.
2. Auxiliary output contact for Trip No. 1 available for possible future use.

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3. Auxiliary output contact for Trip No. 2 available for possible future use.
4. Relay failure to PLC.
    a. Failure of any intertie relay shall prevent parallel operation of generation with that feeder.
    b. Failure of generator protection relay shall prevent operation of that generator.

F. Synchronism Check:
1. Provide synchronism check function with contacts hard-wired in breaker close circuit, requiring sync-check permissive for close for utility main, bus tie and transformer tie circuit breakers.
2. Paralleling Switchgear main breakers, sync-check element in MPR:
    a. Live Line - Dead Bus.
3. Bus Tie Breaker, discrete relay:
    a. Live Line - Dead Bus.
    b. Dead Line - Dead Bus.
    c. Dead Line - Live Bus.
4. Generator Breakers, sync-check element in GPR:
    a. Live Line - Live Bus.
    b. Live Line - Dead Bus.

G. Provide breaker auxiliary contacts wired to field wiring terminal boards for generator parallel signal to utility protection relays.

2.09 ACCESSORIES

A. Mimic Bus:
1. Plastic mimic bus placed on the face of the switchgear depicting incoming lines, outgoing lines, breakers, generators, voltage transformers and control power transformers.
2. Blue in color.
3. Fastened with countersunk screws.

B. Circuit breakers accessories for testing, inspection, maintenance and operation:
1. Tool to charge closing springs manually.
2. Portable lift crane for removing breakers.
3. Lifting yoke.
4. Test jumper for electrically operating the breaker while out of its compartment.
5. Wall-mountable test station for operating breakers separately from the switchgear.
    a. Trip and close controls.
    b. Power on and breaker status indicator lights.

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c. Flexible cable and connection plug.

6. Levering crank to crank breakers between Test and Connected positions.
7. Rail extensions.
8. Other maintenance tools or equipment recommended by breaker manufacturer.

C. Draw-out manual switchgear ground and test device to permit hot-stick voltage testing, phasing checks and application of protective grounds to the bus or line side terminals of each breaker compartment from the front of the switchgear.

1. Rated for the short circuit withstand rating of the switchgear.
2. Quantity of two (2) devices.
3. For devices without integral mechanical grounding, provide each device with a three-phase set of mating protective ground cables, rated for the withstand capability of the switchgear.

D. Digital Metering Package:

1. Digital meters, per Specification Section 26 09 13. Meters will be sent to the supplier for incorporation into the switchgear.
2. The supplier will be responsible for any additional CT's or PT's required for the meter.

2.10 SOURCE QUALITY CONTROL

A. Switchgear shall be completely assembled and wired at factory, with functional checks of all wiring and controls, and then disassembled as required for shipment.

B. Factory Tests:

1. Make design tests specified in IEEE C37.20.2.
2. Make production tests specified in IEEE C37.20.2, including:
   a. Low frequency withstand, 1 minute.
   b. Mechanical operations.
   c. Grounding of instrument transformer cases.
   d. Control wiring continuity.
   e. Control wiring insulation.
   f. Polarity verification.
   g. Sequence tests.
3. Complete functional test of assembled switchgear and control system with simulated voltage for utility and generator.
   a. Verify all programming and wiring.
4. Functional test to be witnessed by Engineer and Owner.

2.11 MAINTENANCE MATERIALS

A. Extra Materials: Furnish paint for touch up and application instructions.

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B. Spare Parts:

1. Spare current limiting fuses:

   a. For potential transformers: Four (4) spares for each fuse type and size.

2. Spare fuses for AC auxiliary and DC control power: Four (4) spares for each type and size used in switchgear.

3. Indicating lamps (LED and incandescent type): 25 spare lamps.

2.12 FACTORY ACCEPTANCE TEST

A. The purpose of the Factory Acceptance Test (FAT) shall be to verify the communication and handshaking between all Modbus TCP modules with the Master PLC located in the Paralleling Switchgear. The FAT shall ensure that the various Modbus TCP modules and the main PLC function as a fully integrated system as called out in the Contract Documents.

B. The hardware tested shall be the actual hardware to be installed at site.

C. Prior to commencement of FAT, the Paralleling Switchgear vendor shall test the operation of the PLC, Ethernet switch, panel PC and associated HMI graphics.

D. After all SCADA components to be installed in the low-voltage section of the Paralleling Switchgear have been tested, the Paralleling Switchgear vendor shall coordinate with the Sectionalizing Switchgear vendor about the factory acceptance test. The Sectionalizing Switchgear vendor shall ship the Modbus TCP modules and Ethernet switches which are to be installed in each Sectionalizing Switchgear to the Paralleling Switchgear vendor's factory location. Sectionalizing Switchgear vendor shall bear all shipping and handling costs as well as shipping and handling costs from the factory back to the Sectionalizing Switchgear vendor's facility.

E. Factory Acceptance Test shall take place at the Paralleling Switchgear vendor's factory.

F. Paralleling Switchgear vendor shall make provisions for one SCADA programmer to be available for the entire duration of the FAT. The SCADA programmer available for the FAT shall be the same programmer involved in the programming of the PLC and HMI thereby having familiarity with the project. The programmer shall coordinate with the Sectionalizing Switchgear vendor's programmer to make any necessary corrections and/or changes to the logic to get the system and communication network to be fully operational for a successful FAT.

G. FAT duration shall be ONE week. FAT shall commence on a Monday and shall be completed the following Friday of that week. Paralleling Switchgear vendor shall coordinate the FAT schedule and date with the Sectionalizing Switchgear vendor and shall provide at least a 30 day notice to the Owner and Engineer.

H. Paralleling Switchgear vendor shall coordinate with the Sectionalizing Switchgear vendor and shall submit a detailed FAT procedure to the Owner and Engineer for review. All Owner and Engineer comments shall be incorporated into the FAT procedure prior to commencement of FAT.

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I. At the FAT the vendor shall demonstrate operation and communication of at least 4 discrete inputs and 4 discrete outputs at each switchgear Modbus TCP module. It shall be demonstrated that the operator is able to open and close switches from the touchscreen panel PC located in the Paralleling switchgear SCADA cabinet. To simulate this, indicating lights shall be wired to those outputs that are to be tested. Toggle switches shall be wired to the inputs that are to be tested. A simulated Modbus RTU input shall be used to test the power meters. The Owner shall be able to randomly choose to test any discrete input or output at the Owner's discretion. All test benchboards, pilot lights, fiber optic patch cords, handheld meters, etc. shall be provided by the Paralleling Switchgear vendor. The toggle switch and pilot light benchboard shall be permitted to be removed and wired to each Modbus TCP module as the FAT progresses. Thus a benchboard consisting of about 10 toggle switches and 6 pilot lights shall be sufficient for the FAT.

J. The Factory Acceptance Test shall be deemed complete only after all the Modbus TCP modules have been tested to be able to successfully communicate (read and write) data to and from the Master PLC in the Paralleling Switchgear cabinet.

K. Minor issues and incompletions found during the FAT shall be recorded in the FAT punch-list. All items in the punch-list shall be completed prior to final shipment at site.

L. A separate FAT shall be performed to demonstrate the paralleling control logic which shall require simulated inputs for the generator supplied controller. The vendor shall provide a 30 day notice to the Engineer and Owner prior to commencement of the FAT to enable the Engineer and Owner to make travel arrangements. The vendor shall submit a FAT test plan for this portion of the FAT to the Owner and Engineer at least 30 days prior to commencement of the FAT.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Arrange switchgear as shown on the Drawings.

C. Indoor Locations:

1. NEMA 1 enclosure, minimum.
2. Do not provide a housekeeping pad.
3. Provide floor sills (C channels) set level (within 1/8 IN) on steel floor of PDC.
4. Securely bolt or weld switchgear to floor sills.

D. Miscellaneous:

1. Neatly lace all control wires and have flexibility at hinge locations.
2. Paint any scratched surfaces with touch-up paint.
3. Tag switchboard, all devices shall be marked per Specification Section 26 05 00, paragraph 3.01.Q. All conductors shall be marked per Specification 26 05 19, paragraph 3.01.D.

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3.02 SEQUENCE OF OPERATION

A. Refer to Drawings for Generator Sequence of Operation.

B. General:

1. The generator switchgear control system provides for automatic and manual control of the Paralleling Switchgear main circuit breakers, tie circuit breaker, generators, generator circuit breakers and Sectionalizing Gear motorized operators in the following modes of operation:

a. Automatically re-energize the buses from paralleled generators on loss of both utility sources.

b. Manually-initiated automatic parallel operation of generators.

c. Manually initiated testing of automatic operation.

d. Manual operation of generators and circuit breakers on system PLC failure.

1) Manual control will be though the HMI and control switches.

e. In addition to the required monitoring and control functions outlined herein the HMI shall display/control:

1) Sectionalizing gear.

C. System Operator Controls (The following shall be performed with the engine-generator control panel HMI):

1. System master selector - AUTO or MANUAL:

a. In AUTO position, control is by the system PLC per sequences described in the drawings and specifications.

b. In MANUAL position :

1) Manual control will be though the HMI and control switches.

c. Alarm at HMI when switch is in MANUAL position.

2. Return mode selector switch (AUTO/MANUAL):

a. In AUTO position, return to normal conditions occurs automatically when dictated by PLC logic and timing functions as specified.

b. In MANUAL position, return to normal conditions occurs when PLC logic conditions are satisfied and operator initiates local or remote return-to-normal signal.

3. Load demand control selector - ENABLE or DISABLE:

a. In ENABLE position, number of generators remaining on line in emergency or test modes is automatically matched to load as described below.

b. In DISABLE position, all available generators remain on line regardless of load.

4. Load shed control selector - ENABLE or BYPASS (keyed switch):

a. In ENABLE position, load shedding based on bus overload and underfrequency is enabled.

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b. In BYPASS position, load shed signals are disabled.

5. System test selector:

a. Three (3) position maintained contact switch with MODE 1 - OFF - MODE 2 legend.

b. In MODE 1 position, initiates system test with interruption of load.

1) Coordinate with Test Modes paragraph below.

c. In MODE 2 position, initiates system test without interruption of load.

1) Paralleling with Utility is not permitted at this time.

d. In OFF position test is terminated.

D. Indicator Lights:

1. For each breaker control switch provide red (closed) and green (open) indicator lights.

2. Flashing amber light to indicate automatic controls are blocked by breaker trip condition.

3. Solid amber light to indicate return to normal enabled.

E. Safety Interlocks:

1. Refer to Drawings.

F. Load Demand Control Mode:

1. Manually initiated automatic sequence to avoid extended operation of engines at light load after system has stabilized in standby operation.

2. Operator selects number of units to take off line.

3. Load on selected engines is automatically reduced, generator circuit breakers open, engines go through cooldown cycle and shutdown.

4. One (1) off-line engine is automatically started and synchronized if load on remaining units exceeds a preset level for a preset time delay.

5. All off-line units are automatically started and synchronized if any of the following occur:

a. A pre-alarm or shutdown condition occurs on any on-line generator.

b. An overload condition is detected on any on line generator.

c. Generator bus frequency drops below a preset level.

G. Return of Utility Service - Open Transition:

1. When acceptable utility voltage and frequency has returned to the line side of the main circuit breaker and is maintained for an adjustable (initial setting: 15 minutes) period of time, the system will transfer the load from the generators back to the utility by opening the tie breaker, all generator circuit breakers, and then closing the main circuit breakers.

2. After the generator circuit breakers open, the engines will enter a cooldown cycle and shut down, and the system will return to normal conditions.

H. Test Modes:

1. Operator initiates tests of system operation through Master Control System.
2. Test Mode 1: Test signal simulates loss of acceptable utility voltage on only the selected source and system automatically transfers to the other source with an interruption to the effected bus.
3. Test Mode 2: Test signal simulates loss of acceptable utility voltage at both sources, and system automatically operates circuit breakers and generators to transfer plant load from utility to generators with an interruption to both buses during generator starting period.
4. Test Mode 3: Test signal simulates loss of acceptable utility voltage at both sources, and system automatically operates circuit breakers and generators to exercise generators with portable load bank. (Portable load bank not specified to be included with this system). Load bank will be terminated to generator swing buss in paralleling gear as indicated.
5. Test is automatically terminated when test switch is returned to neutral position or remote test signal is removed and system automatically returns to normal conditions as described above.

I. Load Shed:

1. Sustained current overload or short-duration underfrequency condition of on-line generators shall initiate load shed signal to open Sectionalizing Equipment downstream 13.8kV actuated switches not serving critical loads.
   a. See 26 13 23
2. Load shed signal is sustained until generator load and bus frequency have returned to normal for an adjustable period and load shed condition is reset by operator pushing the reset button at the master or remote controls.
3. Load shed signal to be sent to SG-A2-2, SG-A8-2, SG-A10-2, SG-A12-2, SG-A15-2, and SG-B8-2. All loads shed simultaneously.

J. Fault On Switchgear Bus:

1. Fault is cleared and bus is isolated by appropriate differential and lockout relays.
2. Locked out breakers are no longer PLC controllable.
3. Alarm is annunciated.

K. Generator Circuit Breaker Fail to Close on PLC command:

1. Fail to Sync/Close alarm annunciated.
2. System automatically advances sequence to close next generator circuit breaker.

L. Utility Circuit Breaker Fail to Close on PLC command:

1. Fail to Sync/Close alarm is annunciated.
2. Load remains on generators.

M. Circuit Breaker Fail to Open on PLC command:

1. Fail to Sync/Close alarm annunciated.

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N. Utility or Generator Breaker Fail to Open on Protective Relay Trip:

1. Breaker failure logic trips all breakers on that bus.
2. Locked out breakers are no longer PLC controllable.
3. Fail to Trip/Breaker Failure alarm is annunciated.

O. System PLC Fault or Power Failure:

1. Alarm is annunciated.

3.03 FIELD QUALITY CONTROL

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Provide complete field acceptance testing of the switchgear and control system per Specification Section 26 08 13.

1. Submit completed acceptance testing reports before scheduling performance test and demonstration.

C. Perform a complete field performance test and demonstration:

1. To be witnessed by Engineer and Owner.
2. To follow a written test procedure.
   a. Submit test procedure for Engineer review.
   b. Procedure shall cover all operating modes of the system including contingency modes such as breaker trip, breaker fail, PLC fail, etc.
   c. Procedure shall be step-by-step and define each action to be taken and expected response of system.
   d. Acceptance criteria shall be satisfactory operation of the system per specified sequence of operation in all modes without debugging, programming changes, troubleshooting, or other un-specified operator intervention.
   e. Any failure during demonstration shall require a complete retest.
   f. Any program change shall require a complete retest.
   g. Contractor shall successfully execute the test procedure independently prior to scheduling the demonstration for Engineer and Owner; any failure during demonstration will result in Contractor responsibility for Owner's and Engineer's expenses for retesting.

3.04 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the Owner with 4 HRS minimum of on-site training in the operation and maintenance of the switchgear and its components.

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B. A qualified SCADA technician shall provide the Owner with a one (1) day on-site training in the operation, configuration, programming, troubleshooting and maintenance of the SCADA components including the PLC, HMI and Ethernet switches. Training shall include information on how to set up and configure a new off-the-shelf PLC components, panel PC and/or Ethernet switch to replace an existing one in the network. Training shall be performed by the same SCADA programmer performing the FAT and project programming.

END OF SECTION

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SECTION 26 13 23 - SECTIONALIZING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pad mounted sectionalizing switchgear.
2. Sectionalizing terminal cabinets.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 05 13 - Medium Voltage Cable.

C. Section 26 13 13 - Medium Voltage Metal-Clad Paralleling Switchgear.

1.03 REFERENCED STANDARDS

A. Institute of Electronic and Electrical Engineers (IEEE):

1. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
2. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
3. C57.12.28, Standard for Pad-Mounted Equipment – Enclosure Integrity.
4. C62.11, Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV).

B. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
        1) Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of switchgear indicated.
    b. Nameplate data.
    c. See Specification Section 26 05 00 for additional requirements.

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3. Fabrication and/or layout drawings:
    a. General arrangement plan view showing door swings, cable entrance locations, etc.
    b. Shop Drawings: The manufacturer shall furnish, with each metal-enclosed switchgear assembly, a set of drawings complete with a bill of material. The drawings shall include typical front and open side views for each module as well as typical components, their positions, and available space for cable termination; an anchor bolt plan with dimensions; a single-line diagram; and appropriate wiring diagrams.
    c. Coordination Drawings: Show the following:
        1) Underground conduit stub-up locations.
        2) Dimensioned concrete base, outline of switchgear, and required NESC clearances.
        3) Ground rod and grounding cable locations.
4. Test reports:
    a. Certified reports of all factory production tests.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Record of test results, inspections and procedures witnessed or performed by factory service representative.

D. Manufacturer Seismic Qualification Certification: Submit certification that switchgear assembly and components will withstand seismic forces defined for this project. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.05 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 26 05 00.

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PART 2 - PRODUCTS

2.01 PAD MOUNTED SECTIONALIZING SWITCHGEAR

A. Manufacturers

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

a. S&C Electric Company.

B. General:

1. Live front construction similar to PMH style.
2. Dead front construction similar to PME style.
3. Configuration: As indicated on the Drawings.

C. Ratings:

1. Voltage: 15 kV class (14.4kV).
2. Amperage: 600A Switches, 200A Fuses.
3. Number of phases: 3.
4. Number of wires: 3.
5. Frequency: 60 Hz.
6. Short circuit:

a. Fault closing and momentary: 22.4 kA.

b. Short time (1 second): 14 kA.

c. Peak Withstand: 36 kA.

d. RMS Symmetrical: 14 kA.

7. Basic impulse level: 95 kV.

D. Construction:

1. Standards: IEEE C37.20.3 and IEEE C57.12.28.
2. Enclosure:

a. Heavy-duty channelized galvanized-steel construction with stainless steel hardware.

b. Domed roof.

c. Full length removable doors with:

1) Stainless steel hinges and hardware.

2) Positive 3-point latching system.

3) Automatically latching door holders.

4) Recessed Pentahead locking actuator

d. Lifting provisions.

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3. Full length steel barriers separate side-by-side compartments.
4. Fiberglass-reinforced polyester barriers (front, interphase and end) for all fuses and switches.
5. Recessed lockable switch handle pocket.
6. Folding switch handles for all switches, secured inside switch operating pockets.
7. Shaft lock for each switch so switch can be locked in open or closed positions.
8. Grounding provisions in each section.
9. Viewing window for viewing switch position.
10. Nameplate with circuit diagram, switchgear ratings, manufacturer name and date of manufacture.
11. Compartmental and phase identification labels.
12. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
    a. Finish color: Dark green.
13. Accessories:
    a. Storage rack for fuses in each fuse compartment.
    b. Mounting provisions for fault indicator in each switch compartment with viewing window in door.
    c. Key interlocks on fuse compartment doors.
    d. Mounting provisions for surge arrestors.
    e. Insulated parking stands in dead front construction styles
    f. Base spacer to increase cable termination height:
        1) Material: Steel.
        2) Height: 12 IN.
    g. Ground sleeve to increase cable termination height.
        1) Material: Fiberglass Reinforced Composites (FRC) incorporating fire retardant polyester resins and a UV stabilizer coating.
        2) Height: 36 IN minimum.

E. Buses:
1. Material: Tin-plated aluminum or silver-plated copper.
2. Bus supports, stand-off insulators and sleeves: Porcelain or epoxy.

F. Connector Bushings:
1. Loadbreak connectors.
    a. Voltage Rating: 15kV.
    b. Continuous: 200A.
    c. Fault Closure/Short Time: 10kA.

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2. See 26 05 13 for connections.

G. Load Interrupter Switches:

1. Three-pole, two-position, gang operated.
2. Manual quick-make, quick-break utilizing a heavy-duty coil spring to provide openings and closing energy.
3. Arc extinguishing system.
4. Insulating barriers between each phase and enclosure.
5. Form C position indication switches.
    a. Refer to I/O list, as required

H. Fuses:

1. Current limiting.
2. E-rated.
3. Size as indicated on the Drawings.

I. Surge Arresters:

1. Standards: IEEE 386 and IEEE C62.11.
2. MCOV rating: 7.65 kV for 12.47kV Systems. 8.4kV for 13.2 kV and 13.8kV systems. Consult drawings or project engineer for other system voltages.
3. Metal oxide varistor elbow type.

J. Fault Interrupter Switches:

1. 600Amp continuous at 14.4kV.
2. Controlled circuit interruption.
    a. De-ionization Action.
    b. No external arc of flame.
3. Short Circuit Rating: 25kA
4. Motor actuated where indicated.
    a. CPT: Sized as required.

K. Accessories:

1. A packaged kit of paint and refinishing materials with complete instructions, shall be provided for touch-up in the field.
2. Shotgun clamp stick (6 ft.–5 1/2 in., 8 ft.–5 1/2 in.) in length shall be provided, complete with canvas storage bag.

2.02 SECTIONALIZING TERMINAL CABINETS

A. Manufacturers

1. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

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a. Single Phase

1) Eaton Cooper Power

2) Hoffman

3) Maysteel

4) Hubbell

b. Three Phase

1) Eaton Cooper Power

2) Hoffman

3) Maysteel

4) Hubbell

B. Configuration:

1. As indicated on the Drawings.
2. Single phase or Three phase, as indicated on the Drawings
3. Junctions as indicated on the Drawings.

C. Enclosure:

1. Material: Heavy-duty Galvanized steel or Stainless steel if required by site conditions.
2. Tamperproof per IEEE and ANSI standards.
3. Recessed Pentahead locking means.
4. Hinged cover.
5. Universal cable junction mounting plates.
6. Parking stands.
7. Ground nuts.
8. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
   a. Finish color: Dark green.
9. Ground sleeve to increase cable termination height.
   a. Material: Fiberglass Reinforced Composites (FRC) incorporating fire retardant polyester resins and a UV stabilizer coating.
   b. Height: 18 IN minimum.

D. Multi-point Cable Junctions:

1. Standard: IEEE 386.
2. Voltage Class: 15 kV.
3. Current rating: 600A.
4. Connector Elbows: 200A loadbreak or 600A deadbreak as required.

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5. Bushing: One piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
6. Bus: Electrical grade plated aluminum.
7. Bracket: Stainless steel with ground lug and parking stands.

2.03 SOURCE QUALITY CONTROL

A. Switchgear factory tests in accordance with IEEE and ANSI standards.

2.04 MAINTENANCE MATERIALS

A. Touch-up paint.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The installation work required shall consist of transporting, setting, shimming, leveling, installing anchor bolts, grouting the base, and all other work necessary to energize the switchgear or sectionalizing terminal cabinets.

B. Install in accordance with manufacturer's instructions.

C. Arrange as shown on the Drawings.

D. Install Pad Mounted Sectionalizing Switchgear and Sectionalizing Terminal Cabinet with Ground Sleeve.

E. Miscellaneous: Paint any scratched surfaces with touch-up paint.

3.02 WARNING SIGNS

A. All external doors shall be provided with "Caution - High Voltage - Keep Out" signs. The inside of each door shall be provided with a "Danger - High Voltage - Keep Out - Qualified Persons Only" sign. Any barriers used to prevent access to energized live parts shall be provided with "Danger - High Voltage - Keep Out - Qualified Persons Only" signs.

3.03 LABELS

A. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.

B. All equipment shall have a suitable nameplate as specified in Specification Section 26 05 00, paragraph 3.01.Q. The nameplate shall be mounted on the exterior face of the equipment.

C. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings; the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing capability and amperes rating.

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D. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of the front and rear doors (or set of double doors), and on the inside of each switch-operating-hub access cover.

E. All conductors shall be marked per Specification 26 05 19, paragraph 3.01.D.

3.04 FIELD QUALITY CONTROL

A. Contractor shall require the manufacturer of the switchgear to provide the services of a qualified engineer on site to inspect, check, adjust and operate the installed equipment just prior to or at the time the equipment is placed into service. Manufacturer's engineer shall be on site a minimum of 8 hours to commission the equipment and instruct the Owner's personnel on the proper operation and maintenance of the unit. Such action shall not relieve the Contractor of his responsibility to provide the equipment properly installed and in proper operating condition.

B. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

END OF SECTION

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SECTION 26 18 19 - MEDIUM VOLTAGE LIGHTNING ARRESTERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Medium voltage lightning arresters.

B. Pole details shall be as indicated on UPRR Electrical Construction Manual.

C. Drawings and general provision of the contract, including General and Supplementary Condition apply to this section.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 – Electrical: Basic Requirements.

B. Section 26 08 13 – Acceptance Testing.

C. Section 26 10 00 – Medium Voltage Electrical Distribution.

D. Section 26 12 13 – Pole-Mounted Distribution Transformers.

E. Section 33 71 14 – Overhead Electric Service.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. UL 467, Grounding and Bonding Equipment.

C. Institute of Electronic and Electronics Engineers, Inc. (IEEE):

1. C2, National Electrical Safety Code (NESC).

2. C62.1, Standard for Gapped Silicon Carbide Surge Arresters for Alternating Current Power Circuits.

3. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).

D. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

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c. Descriptive information which states conformance to codes, recognized testing, or manufacturing standards.

d. Manufacturer's name and catalog cuts listing type, model number, duty-cycle voltage rating, MCOV rating and other performance data including BIL and recommended voltage range.

B. Informational Submittals:

1. See Specification Section 26 05 00 for additional requirements for the mechanics and administration of the submittal process.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

2. Comply with UL 467.

B. Comply with NFPA 70; for overhead line construction and medium voltage underground construction, comply with IEEE C2.

1.06 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

a. Cooper Power Systems; Eaton.

b. General Electric Company; Transmission Systems.

c. MacLean Power Systems.

d. Ohio Brass Company, Hubbell, Inc.

e. Tyco Electronics/Raychem.

2.02 MATERIALS

A. General: Provide lightning arresters at the locations shown on the Drawings. Arresters shall be metal-oxide type and conform to ANSI C62.1 and ANSI C62.11.

B. Ratings: Provide lightning arresters with suitable voltage rating for the system voltage. Arresters shall be distribution, intermediate, or station class as specified or as shown on the Drawings.

C. Distribution Class, Heavy Duty: Provide arresters rated heavy duty in accordance with ANSI C62.11 with a skirted ethylene propylene rubber housing and stainless steel terminal connections. Line and ground conductors shall not be smaller than No. 4 AWG copper. Provide Ohio Brass No. PDV-100 series or equal.

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D. Line and ground terminals shall be 3/8-16 thread. All external metal parts (excluding mounting bracket and associated hardware) shall be stainless steel. Line and ground end nut shall be brass.

E. Line and ground conductors shall not be smaller than No. 6 AWG solid to No. 2 stranded.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements: Per ANSI C62.11 (latest edition).

2.04 ACCESSORIES

A. Brackets, mounting apparatus and accessories shall be per UPRR Electrical Construction Manual.

2.05 SOURCE QUALITY CONTROL

A. Factory Tests: Per ANSI C62.11 (latest edition).

PART 3 - EXECUTION

3.01 INSTALLATION

A. Handle arresters with care. Do not drop, jar or handle roughly. Never install a damaged arrester. Inspect unit carefully.

B. Provide primary side connections as required by the construction or installation of equipment. Provide ground connections to the counterpoise, ground rod, or grounding system. Provide all mounting brackets required. Install in accordance with manufacturer's recommendations.

C. Install arrester so that no undue mechanical stress is applied to the arrester.

3.02 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 22 13 - DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Dry-type transformers, 300 kVA and less. Primary voltages of 750V and less.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 05 26 - Grounding.

1.03 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C57.12.01, Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin-Encapsulated Windings.
2. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.

B. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. ST 20, Dry-Type Transformers for General Applications.
3. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.

C. Underwriters Laboratories, Inc. (UL):

1. 506, Standard for Safety Specialty Transformers.
2. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings.
    a. Nameplate drawing.
4. Certifications:
    a. Sound level certifications.

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B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Square D Company.

2.02 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Ventilated or non-ventilated, air cooled, two (2) winding type.

B. Cores:

1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.

2. Magnetic flux densities are to be kept well below the saturation point.

C. Coils: Continuous wound with electrical grade aluminum.

D. Ventilated Units:

1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.

2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.

E. Furnish Taps for Transformers as follows:

1. 1 PH, 2 kVA and below: None.

2. 1 PH, 3 to 25 kVA: Two (2) 5 percent FCBN.

3. 1 PH, 25 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

4. 3 PH, 3 to 15 kVA: Two (2) 5 percent FCBN.

5. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.

F. Sound Levels:

1. Manufacturer shall guarantee not to exceed the following:

a. Up to 9 kVA: 40 dB.

b. 10 to 50 kVA: 45 dB.

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c. 51 to 150 kVA: 50 dB.

d. 151 to 300 kVA: 55 dB.

G. Efficiency:

1. Ventilated, 15 kVA and larger: Energy efficient meeting minimum efficiency requirements of US Department of Energy, 10 CFR Part 431, April 18, 2013, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers; Final Rule effective January 1, 2016.

H. Insulating Material (600 V and below):

1. 3 to 15 kVA units: 185 DegC insulation system with a 115 DegC rise.

2. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.

I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.

J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.

K. Standards: IEEE C57.96, NEMA ST 20, UL 506, UL 1561.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Indoor Locations:

1. Provide ventilated type for 15 kVA units and above.

2. Provide non-ventilated type for less than 15 kVA units and below and where indicated on the Drawings.

3. Mount less than 15 kVA units where indicated on Drawings

4. Mount 15 kVA units and above where indicated on Drawings.

5. Provide rubber vibration isolation pads.

C. Outdoor Locations:

1. Provide non-ventilated type.

2. Mount non-ventilated type on 6" cast-in-place concrete pad unless indicated differently on Drawings.

D. Enclosures: Painted steel in all areas, except stainless steel in highly corrosive areas.

E. Ground in accordance with Section 26 05 26.

END OF SECTION

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SECTION 26 24 13 - SWITCHBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Low voltage (750V and less) switchboards.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 09 13 - Electrical Metering Devices.

C. Section 26 09 16 - Control Equipment Accessories.

D. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

E. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).

1.03 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. PB 2, Deadfront Distribution Switchboards.

B. Underwriters Laboratories, Inc. (UL):

1. 891, Standard for Safety Dead-Front Switchboards.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
3. See Specification Section 26 05 00 for additional requirements.
4. Fabrication and/or layout drawings:
    a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
    b. Front elevation and plan drawing of the assembly.
    c. Three-line or single line and schematic diagrams.
    d. Conduit space locations within the assembly.

B. Operation and Maintenance Manuals:

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1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings updated with as-build conditions

C. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Ground fault protection system test report signed by the projects supervising electrical foreman.

1.05 QUALITY ASSURANCE

A. Verify the space required for the switchboard is equal to or less than the space allocated.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Square D Company.

2.02 SWITCHBOARDS

A. Ratings:
1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
2. Assembly short circuit current and interrupting device rating of 65 KAIC RMS symmetrical minimum or as indicated on the Drawings.
3. When low voltage power circuit breakers are utilized, the switchboard shall have a 30 cycle withstand rating corresponding to the breaker rating.
4. Service Entrance Equipment rated.
5. 100 percent rated breakers installed.
6. Ground Fault Protection, as required or indicatd by Drawings.

B. Construction:
1. Standards: NEMA PB 2, UL 891.
2. Completely enclosed, dead-front, self-supporting metal structure.
3. Vertical panel sections bolted together.
4. Frames bolted together to support and house bus, cables and other equipment.

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5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
6. All sections rear aligned.
7. Devices front removable and load connections front accessible for mounting switchboard against a wall.
8. NEMA 1 rated enclosure for indoor, dry locations or as indicated on Drawings.
9. NEMA 3R rated weatherproof enclosure for wet/damp locations or as indicated on Drawings:
    a. Nonwalk-in type with sloping roof downward toward rear.
    b. Thermostatically controlled space heaters to minimize internal condensation.
    c. Power for heater derived internal to the switchboard.
10. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturers standard paint.

C. Buses:
1. Material: Tin-plated aluminum or silver-plated copper.
2. Main horizontal bus:
    a. Fully rated and continuous over length of switchboard with all three (3) phases arranged in the same vertical plane.
    b. Sufficient size to limit temperature rise to 65 DegC over average air temperature outside the enclosure of 40 DegC.
3. Neutral bus: Fully rated and continuous over length of switchboard.
4. Ground bus: 1/4 x 2 IN copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
    a. Individually mounted insulated case circuit breaker.
2. Feeder overcurrent protective devices:
    a. Group mounted molded case circuit breaker.
3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
4. Factory installed.
5. Means to padlock all main and feeder devices in the open position.

E. Surge Protective Device: Externally mounted, see Specification Section 26 43 13.

F. Metering:
1. Power monitor:

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a. Through cabinet mounting.

b. See Specification Section 26 09 13 for meter requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Arrange switchboard as shown on the Drawings.

C. Indoor, dry locations:

1. NEMA 1 enclosure.

2. Install on 4" minimum concrete housekeeping pad or as indicated on Drawings, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

D. Outdoor damp/wet locations:

1. NEMA 3R enclosure.

2. Install on 6" minimum concrete pad or as indicated on Drawings, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

E. Miscellaneous:

1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.

2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.02 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 26 28 00.

END OF SECTION

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Lighting and appliance panelboards.
2. Power distribution panelboards.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

C. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).

1.03 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. PB 1, Panelboards.

B. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

C. Underwriters Laboratories, Inc. (UL):

1. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
2. 67, Standard for Panelboards.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
    a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

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a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

3. Panelboard schedules with as-built conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Square D Company.

2.02 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:

1. Current, voltage, number of phases, number of wires as indicated on the Drawings.

2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.

3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating or as indicated in the schedule.

4. Service Entrance Equipment rated when indicated on the Drawings.

C. Construction:

1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

2. Multi-section panelboards: Feed-through or sub-feed lugs.

3. Main lugs: Solderless mechanical type approved for copper and aluminum wire.

D. Bus Bars:

1. Main bus bars:

a. Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.

b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.

2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.

3. Neutral bus bars: Insulated 100 percent rated or as indicated on the Drawings, and with solderless mechanical type connectors.

E. Enclosure:

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1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Lighting and appliance panelboard:
    a. Trims supplied with hinged door over all circuit breaker handles.
    b. Trims for surface mounted panelboards, same size as box.
    c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
    d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
    e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
    f. Clear plastic cover for directory card mounted on the inside of each door.
    g. NEMA 3R or NEMA 12 rated: Door gasketed. The door shall be capable of being padlocked in the closed position.
4. Power distribution panelboard:
    a. Trims cover all live parts with switching device handles accessible.
    b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
    c. Clear plastic cover for directory card mounted front of enclosure.
    d. NEMA 3R or NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike. The door shall be capable of being padlocked in the closed position.

F. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
    a. Molded case circuit breaker, bolt-in type.
2. Branch overcurrent protective devices:
    a. Mounted molded case circuit breaker, bolt-in type.
    b. Tandem or half-size circuit breakers shall not be permitted.
3. See Section 26 28 00 for overcurrent and short circuit protective device requirements.
4. Factory installed.

G. Integral surge protective device (where indicated): See Specification Section 26 43 13.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

C. Provide NEMA 1, NEMA 3R or NEMA 12 rated enclosure as indicated on the Drawings.

D. Provide each panelboard with a typed directory:

1. Identify all circuit locations in each panelboard with the load type and location served. Unused circuit breakers shall be labeled “spare”.

2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on the Drawings.

3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings.

E. Prior to final inspection, clean all panelboard interiors, adjust trims, covers and locks. If necessary, refinish fronts to original condition. Do not use compressed air to assist in cleaning.

F. Balance load on all panelboards so phases are balanced to within 15% of each other.

END OF SECTION

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SECTION 26 24 19 - MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Separately mounted motor starters (including those supplied with equipment).
2. Manual motor starters.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 29 23 - Variable Frequency Drives - Low Voltage.

C. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

D. Section 26 43 13 - Low Voltage Surge Protective Devices (SPD).

E. Section 26 09 13 - Electrical Metering Devices.

F. Section 26 09 16 - Control Equipment Accessories.

1.03 REFERENCED STANDARDS:

A. International Electrotechnical Commission (IEC).

B. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
2. ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
3. ICS 3, Medium-Voltage Controllers Rated 2001 to 7200 V AC.

C. Underwriters Laboratories, Inc. (UL):

1. 508, Standard for Industrial Control Equipment.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
    a. Provide submittal data for all products specified in PART 2 of this Specification Section.
    b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
    a. Separately mounted combination starters:

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1) Unit ladder logic wiring for each unit depicting electrical wiring and identification of terminals where field devices or remote control signals are to be terminated as indicated on the Drawings and/or loop descriptions.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings updated with as-built conditions.
4. Provide a Table that includes the following data for all motors controlled in an MCC or separately mounted starter:
   a. Equipment tag number.
   b. Starter type and size.
   c. Motor nameplate HP.
   d. Motor nameplate FLA.
   e. Motor nameplate RPM.
   f. Motor nameplate safety factor.
   g. Overload heater type and model number.
   h. Overload heater settings/size.
   i. MCP or CB type/model number.
   j. MCP or CB setting/size.
5. Electronic files in CAD format of all drawings and diagrams.

1.05 QUALITY ASSURANCE

A. Miscellaneous:

1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Square D Company.

B. Submit request for substitution in accordance with Specification Section 26 05 00.

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2.02 SEPARATELY MOUNTED COMBINATION STARTERS

A. Standards:

1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Enclosure:

1. NEMA 4 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
2. NEMA 4X rated:
    a. Body and cover: Type 304 or 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
3. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Front operating handle padlockable in the OFF position.
    f. Accessories: 40 mil PVC exterior coating.
4. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

C. Operating Handle:

1. With the door closed the handle mechanism allows complete ON/OFF control of the unit disconnect and clear indication of the disconnect status.
2. Circuit breaker and MCP operators includes a separate TRIPPED position.
3. Mechanical interlock to prevent to prevent the opening of the door when the disconnect is in the ON position with a defeater mechanism for use by authorized personnel.
4. Mechanical interlock to prevent the placement of the disconnect in the ON position with the door open with a defeater mechanism for use by authorized personnel.
5. Padlockable in the OFF position.
6. Exceptions: NEMA 7 and NEMA 9 enclosures.

D. External mounted overload relay pushbutton.

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E. Control Devices:

1. Provide control devices as indicated on the Drawings per Specification Section 26 09 16.

a. The following devices are the minimum required unless otherwise indicated on the Drawings:

1) Three-position switch (HAND-OFF-AUTO).

2) Red ON indicator light.

3) Green OFF indicator light.

2. Devices will be accessible with the door closed.

F. Control Power Transformer:

1. 120V secondary.

2. Fused on primary and secondary side.

3. Sized for 140 percent of required load.

G. Fault Current Withstand Rating: Equal to the rating of the electrical gear from which it is fed.

H. Motor Starters: See requirements within this Specification Section.

I. Disconnect Switch, Overcurrent and Short Circuit Protective Devices:

1. Motor circuit protector.

2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

3. Factory installed.

2.03 MOTOR STARTERS

A. Standards:

1. NEMA ICS 2.

2. UL 508.

B. Full Voltage Non-Reversing (FVNR) Magnetic Starters:

1. NEMA full size rated contactor.

a. NEMA half sizes and IEC contactors are not permitted.

2. Double-break silver alloy contacts.

3. Overload relays:

a. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset. Provide trip delay relay adjustable from 1-10 seconds, unbalance adjustment from 2 to 10%, and repeat accuracy of 1% of full accuracy, with automatic reset, capable of operating either shunt trip breakers or motor control circuits.

4. Interlock and auxiliary contacts, wired to terminal blocks:

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a. Holding circuit contact, normally open.

b. Overload alarm contact, normally open.

c. Normally open auxiliary contact, for remote run status.

d. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.

e. Two (2) additional normally open spare field replaceable auxiliary contacts.

C. Full Voltage Reversing (FVR) Magnetic Starters:

1. Two (2) FVNR starters with one (1) overload relay assembled together.

2. Mechanically and electrically interlocked to prevent line shorts and the energizing of both contactors simultaneously.

3. See FVNR paragraph for additional requirements.

D. Full Voltage Two-Speed (FV2S) Magnetic Starters:

1. Two (2) FVNR starters with two (2) overload relays assembled together.

2. Configured for two (2) winding or one (1) winding consequent pole motors.

3. See FVNR paragraph for additional requirements.

E. Reduced Voltage Autotransformer (RVAT) Starter:

1. Closed transition design using three (3) contactors and two (2) or three (3) autotransformers.

2. Transformer taps: 50, 65 and 80 percent, factory set at 65 percent.

3. NEMA full size rated contactor.

a. NEMA half sizes and IEC contactors are not permitted.

4. Double-break silver alloy contacts.

5. Overload relays:

a. Ambient insensitive, adjustable solid state type with phase loss protection, phase imbalance protection and manual reset.

6. Interlock and auxiliary contacts, wired to terminal blocks:

a. Holding circuit contact, normally open. Provide trip delay relay adjustable from 1-10 seconds, unbalance adjustment from 2 to 10%, and repeat accuracy of 1% of full accuracy, with automatic reset, capable of operating either shunt trip breakers or motor control circuits.

b.

c. Overload alarm contact, normally open.

d. Normally open auxiliary contact, for remote run status.

e. Additional field replaceable auxiliary contacts as required per the Sequence of Operation.

f. Two (2) additional normally open spare field replaceable auxiliary contacts.

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7. Rated for continuous 115 percent of the full load current of the motor that is installed.
8. Bypass contactor to be engaged after motor is at full speed.

F. Variable Frequency Drives: See Specification Section 26 29 23.

2.04 MANUAL MOTOR STARTERS

A. Standards:
1. NEMA 250, NEMA ICS 2.
2. UL 508.

B. Quick-make, quick-break toggle mechanism that is lockable in the OFF position.

C. Types:
1. Horsepower rated, for ON/OFF control.
2. Horsepower rated, for ON/OFF control and thermal overload protection.
a. Switch to clearly indicate ON, OFF, and TRIPPED position.

D. Voltage and current ratings and number of poles as required for the connected motor.

E. Enclosures:
1. NEMA 1 rated:
a. Galvanized steel or steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.
b. With or without concentric knockouts.
2. NEMA 4 rated:
a. Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out or cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
b. No knockouts
c. With external mounting flanges.
3. NEMA 4X rated:
a. Type 304 or 316 stainless steel.
b. No knockouts
c. With external mounting flanges.
4. NEMA 7 and NEMA 9 rated:
a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
b. Drilled and tapped openings or tapered threaded hub, external mounting flanges.
c. Accessories: 40 mil PVC exterior coating.
5. NEMA 12 rated:

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a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturer's standard paint inside and out.

b. No knockouts, external mounting flanges.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated on the Drawings and in accordance with manufacturer's recommendations and instructions.

B. Mounting height for surface mounted equipment: See Specification Section 26 05 00.

C. Overload Heaters:

1. Size for actual motor full load current of the connected motor.

2. For motors with power factor correction capacitors, size to compensate for the capacitors effect on load current.

D. Combination and Manual Starter Enclosures:

1. Permitted uses of NEMA 1 enclosure:

a. Surface or flush mounted in architecturally finished areas.

b. Surface mounted above 10 FT in areas designated as dry in architecturally and non-architecturally finished areas.

2. Permitted uses of NEMA 4 enclosure:

a. Surface mounted in areas designated as wet.

3. Permitted uses of NEMA 4X enclosure:

a. Surface mounted in areas designated as wet and/or corrosive.

4. Permitted uses of NEMA 7 enclosure:

a. Surface mounted in areas designated as Class I hazardous.

b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

5. Permitted uses of NEMA 9 enclosure:

a. Surface mounted in areas designated as Class II hazardous.

b. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

6. Permitted uses of NEMA 12 enclosure:

a. Surface mounted in areas designated as dry.

7. Motors above 20 horsepower or as required by the local utility shall have soft start reduced voltage starters as per paragraph 2.03. Coordinate starter with the motor provided.

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3.02 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 26 13 - PACKAGE POWER SUPPLY

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Package power supply consisting of a transformer and panelboard.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 05 26 - Grounding.

C. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.03 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C57.96, Loading Dry-Type Distribution and Power Transformers.

B. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. PB 1, Panelboards.
3. ST 20, Dry-Type Transformers for General Applications.

C. Underwriters Laboratories, Inc. (UL):

1. 67, Standard for Safety Panelboards.
2. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
   a. Nameplate drawing.
   b. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Operation and Maintenance Manuals:

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1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Square D Company.

2.02 PACKAGED POWER SUPPLY

A. General:
    1. Standards: IEEE C57.96, NEMA PB 1, NEMA ST 20, UL 67 and UL 1561.
    2. Package power supply includes a main primary circuit breaker, an encapsulated dry-type transformer and a secondary panelboard with main circuit breaker.

B. Ratings:
    1. Single or three (3) phase as indicated on the Drawings.
    2. KVA and voltage ratings as indicated on the Drawings.
    3. Suitable for use as service entrance equipment.

C. Transformer:
    1. Non-ventilated, air cooled, two (2) winding type.
    2. Core and coil assembly encapsulated in a proportioned mixture of resin and aggregate to provide a moisture proof, shock resistant seal.
    3. Cores:
        a. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
        b. Magnetic flux densities are to be kept well below the saturation point.
    4. Coils: Continuous wound with electrical grade aluminum and grounded to the enclosure.
    5. Insulation system: 185 DegC with a 115 DegC rise.
    6. Taps: Two (2) 5 percent FCBN.
    7. Sound levels:
        a. Manufacturer shall guarantee not to exceed the following:
            1) 9 kVA and less: 40 dB.
            2) 10 to 30 kVA: 45 dB.

D. Panelboard and Protective Devices:

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1. Bus: Aluminum or copper.
2. Factory installed wiring between primary breaker and transformer, secondary breaker and transformer and distribution section.
3. 480 Vac primary circuit breaker: 18,000 amp minimum interrupting rating.
4. 240 Vac or less secondary circuit breaker: 10,000 amp minimum interrupting rating.
5. Feeder breakers:
    a. Bolt-in type with 10,000 amp minimum interrupting rating.
    b. See Section 26 28 00 for additional requirements.

E. Enclosure:
1. Main, secondary and feeder circuit breakers enclosed with a padlockable hinged door.
2. Wiring compartment suitable for conduit entry and large enough to allow convenient wiring.
3. Totally enclosed, NEMA 3R, steel finished with a rust inhibitor primer and manufacturer's standard paint.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Ground in accordance with Section 26 05 26 or as indicated on the Drawings.

END OF SECTION

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Light switches.

b. Receptacles.

c. Device wallplates and coverplates.

d. Occupancy sensors.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 05 33 - Raceways and Boxes.

C. Section 26 24 19 - Motor Control Equipment.

1.03 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

2. WD 1, General Color Requirements for Wiring Devices.

3. WD 6, Wiring Devices - Dimensional Requirements.

B. Underwriters Laboratories, Inc. (UL):

1. 20, General-Use Snap Switches.

2. 498, Standard for Attachment Plugs and Receptacles.

3. 514A, Metallic Outlet Boxes.

4. 894, Standard for Switches for Use in Hazardous (Classified) Locations.

5. 943, Ground-Fault Circuit-Interrupters.

6. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.

7. 1449, Standard for Surge Protective Devices.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

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a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Light switches and receptacles:

a. Hubbell.

b. Pass & Seymour/Legrande.

c. Eaton Crouse-Hinds.

d. Appleton Electric Co.

e. Killark

f. Midwest.

2. Occupancy sensors:

a. Cooper Controls.

b. Lighting Design and Control (LD&C).

c. Watt Stopper.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 LIGHT SWITCHES

A. General requirements unless modified in specific requirements paragraph of switches per designated areas or types:

1. Toggle type, quiet action, Industrial Specification Grade.

2. Self grounding with grounding terminal.

3. Back and side wired or factory supllied plug connector with wire leads.

4. Solid silver cadmium oxide contacts.

5. Rugged urea housing and one-piece switch arm.

6. Rated 20 A, 120/277 Vac.

7. Switch handle color:

a. Normal power:

1) White for interior areas in commercial buildings, office and locker buildings, gate houses, offices within industrial buildings, and other non-industrial areas.

2) Gray for industrial buildings and facilities, shops, warehouses and all exterior and weatherproof locations.

8. Types as indicated on the Drawings:
    a. Single-pole.
    b. Double-pole.
    c. 3-way.
    d. 4-way.
9. Standards: UL 20, UL 514A, NEMA WD 6.

B. Architecturally Finished Areas:
1. Wallplate:
    a. White colored high impact thermoplastic or nylon.
    b. Single or multiple gang as required.

C. Dry Non-architecturally Finished Areas:
1. Coverplate:
    a. Zinc plated malleable iron or galvanized steel.
    b. Single or multiple gang as required.

D. Wet Non-architecturally Finished Areas:
1. Coverplate:
    a. Gasketed zinc plated malleable iron or aluminum with stainless steel screws utilizing rocker, front mounted toggle or pull type switch.
    b. Single or multiple gang as required.

E. Corrosive Areas:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate:
    a. Gasketed zinc plated malleable iron or copper free aluminum with stainless steel screws utilizing rocker, front mounted toggle or pull type switch.
    b. Single or multiple gang as required.

F. Highly Corrosive Areas:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate:
    a. PVC-RGS conduit system:
        1) PVC coated zinc plated malleable iron or copper free aluminum with stainless steel screws utilizing rocker, front mounted toggle or pull type switch.
        2) Single or multiple gang as required.
    b. PVC conduit system:
        1) Gray colored high impact thermoplastic.

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2) Single or multiple gang as required.

G. Hazardous Areas:

1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Switch enclosed in separate sealing chamber.
   a. Sealing chamber has prewired factory sealed pigtail leads.
3. Coverplate:
   a. Zinc plated malleable iron or copper free aluminum with stainless steel screws utilizing rocker or front mounted toggle type switch.
   b. Single or multiple gang as required.
4. Standards: UL 894.

2.03 RECEPTACLES

A. General requirements unless modified in specific requirements paragraph of receptacles per designated areas:

1. Straight blade, Industrial Specification Grade.
2. Brass triple wipe line contacts.
3. One-piece grounding system with double wipe brass grounding contacts and self grounding strap.
4. Back and side wired.
5. Rated 20 A, 125 Vac.
6. High impact nylon body.
7. Receptacle body color:
   a. Normal power:
      1) White for interior areas in commercial buildings, office and locker buildings, gate houses, offices within industrial buildings, and other non-industrial areas.
      2) Gray for industrial buildings and facilities, shops, warehouses and all exterior and weatherproof locations.
   b. Isolated ground
      1) Orange
8. Types as indicated on the Drawings:
   a. Normal: Self grounding with grounding terminal.
   b. Ground fault circuit interrupter: Non-feed-through type with test and reset buttons.
   c. Isolated ground: Grounding terminal insulated from metal mounting yoke.
9. Duplex or simplex as indicated on the Drawings.

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10. Configuration: NEMA 5-20R.
11. Standards: UL 498, UL 514A, UL 943, NEMA WD 1, NEMA WD 6.

B. Architecturally Finished Areas:
   1. Wallplate: White (or gray colored plates shall be installed over gray color devices)colored high impact thermoplastic or nylon.

C. Dry Non-architecturally Finished Areas:
   1. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

D. Wet Non-architecturally Finished Areas:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

E. Exterior Locations:
   1. Coverplate: Weatherproof (NEMA 3R) while in use, gasketed, copper-free aluminum, 2.5 IN minimum cover depth.

F. Corrosive Areas:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Yellow.
   3. Coverplate:
      a. Zinc plated malleable iron or galvanized steel.
      b. Single or multiple gang as required.

G. Highly Corrosive Areas:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Yellow.
   3. Coverplate:
      a. PVC-RGS conduit system:
         1) PVC coated zinc plated malleable iron or copper free aluminum.
         2) Single or multiple gang as required.
      b. PVC conduit system:
         1) Gray colored high impact thermoplastic.
         2) Single or multiple gang as required.

H. Hazardous Areas:
   1. Rated for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups F and G.
   2. Factory-sealed receptacle/switch/coverplate.

a. Zinc plated malleable iron or copper free aluminum with stainless steel screws and gasketed spring-loaded cover.

3. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.

a. Ordinary nonhazardous plug shall not activate the receptacle.

4. Standard: UL 1010.

I. Welding Receptacles: Provide and install Siemens 60A 3pole disconnect switch and receptacle combination, fuse block enclosures and thread lubrication as noted below. All material with the exception of the lubrication shall be purchased through Echo Electric, Alan Devereaux, phone 402-330-9998 for UPRR National Contract Pricing.

1. Siemens 60A 3 pole disconnect switch and receptacle combination. catalog number HNF362JCH.

2. Killark cord cap for each welder, catalog number VP6485 60A

3. Provide and apply Killark "LUB-G" type lubrication or equal to receptacle thread surfaces to prevent galling between the receptacle and locking ring threads.

4. Custom fuse boxes shall be installed near panelboards where welding receptacle circuits originate. Fuse box shall be installed in series with all welding receptacle circuits.

a. Single circuit version: Catalog number A1412CHQR-UPRR CUSTOM#1.

1) Sample Part List: Hoffman A1412CHQR enclosure, Hoffman A1412 din rail, one 3 phase Class J fuse block, three 60A Class J fuses.

b. Double circuit version: Catalog number A1412CHQR-UPRR CUSTOM#2.

1) Sample Part List: Hoffman A1412CHQR enclosure, Hoffman A1412 din rail, two 3 phase Class J fuse block, six 60A Class J fuses.

c. Triple circuit version: Catalog number A1412CHQR-UPRR CUSTOM#3.

1) Sample Part List: Hoffman A1412CHQR enclosure, Hoffman A1412 din rail, three 3 phase Class J fuse block, nine 60A Class J fuses.

J. Isolated Ground Receptacles:

1. Approved Manufactures:

a. Pass & Seymour – Catalog# IG5362

b. Hubbell – Catalog# IG5362

K. Special Purpose Receptacles:

1. NEMA configuration as indicated on the Drawings.

2. Coverplate: See requirements per area designations herein.

2.04 MISCELLANEOUS WIRING DEVICES

A. Manual Motor Starters: Horsepower rated with or without thermal overloads, see Specification Section 26 24 19.

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2.05 OCCUPANCY SENSORS

A. Low Voltage Passive Infrared Ceiling Sensor:

1. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
2. Analog and digital processing to provide immunity to RFI and EMI.
3. Temperature compensated, dual element sensor and a multi-element lens with a minimum field of view of 110 degrees.
4. Daylight filter or compensation for short wavelength infrared wave from the sun.
5. Cover up to 300 SF at normal mounting heights.
6. System voltage: 24 Vdc through power pack, or 120, 240 0r 277 Vac.
7. Adjustable time delay set at 30 minutes
8. Adjustable sensitivity set at maximum.
9. Adjustments and mounting hardware under a removable cover.
10. Parallel wiring of multiple sensors to allow coverage of large areas.

B. Passive Infrared Wall Switch:

1. Wattstopper DSW-100 Self contained control system that replaces a standard toggle switch.
    a. Latching air gap relay switching mechanism, compatible with electronic ballasts, compact fluorescent and inductive loads.
2. Detection of changes in the infrared energy: Sensor to respond only to those signals caused by human motion.
3. Analog and digital processing to provide immunity to RFI and EMI.
4. Temperature compensated, dual element sensor and a multi-element Fresnel lens.
5. Cover up to 300 SF for walking motion, with a field of view of 180 degrees.
6. System voltage: 120 Vac or 277 Vac.
7. No minimum load.
    a. 0 to 500 watts incandescent, 0 to 800 watts fluorescent or 1/6 HP at 120 Vac, 60 Hz.
    b. 0 to 1200 watts fluorescent or 1/3 HP at 277 Vac, 60 Hz.
8. DIP switch to control the following functions:
    a. Built-in light level feature adjustable from 8 to 180 foot candles.
    b. AUTOMATIC-ON or MANUAL-ON operation.
    c. Time delay adjustable from 30 seconds to 30 minutes.
    d. High/low sensitivity adjustments.
9. Adjustments and mounting hardware under a removable, tamper resistant cover.
10. Normal operation: OFF and AUTO.

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C. Ultrasonic Ceiling Sensor:

1. Detection of Doppler shifts in transmitted ultrasound.
2. Ultrasonic sensing is volumetric in coverage with a frequency of 32 kHz and automatically adjust the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled areas.
3. Temperature and humidity resistant, 32 kHz tuned ultrasonic receivers.
    a. Receivers have less than a 6 dB shift in the humidity range of 10 percent to 90 percent and less than a 10 dB shift in the temperature range of -20 to 60 DegC.
4. DIP switch to control the following functions:
    a. Override-ON function for use in the event of failure.
    b. Time delay adjustable from 15 seconds to 30 minutes.
    c. High/low sensitivity adjustments.
5. Cover 360 degrees and hallway and corridor sensors shall cover up to 90 linear feet.
6. Additional single-pole, double-throw isolated relay with normally open, normally closed, and common outputs rated at 1 amp for 24 Vdc.
    a. The isolated relay is for use with HVAC control, data logging and other control options.

D. Power Pack:

1. Self contained transformer and relay module.
2. Dry contacts capable of switching:
    a. 20 amp ballast load, 13 amp incandescent, 1 HP at 120 Vac, 60 Hz.
    b. 20 amp ballast at 277 Vac, 60 Hz.
3. 24 Vdc, 100 mA output.
4. Capable of parallel wiring without regard to AC phases on primary.
5. Used as a standalone, low voltage switch or wired to sensor for auto control.
6. Low voltage Teflon coated leads, rated for 300 V, suitable for use in plenum applications.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Mount devices where indicated on the Drawings and as scheduled in Specification Section 26 05 00.

C. See Specification Section 26 05 33 for device outlet box requirements.

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D. Where more than one (1) receptacle is installed in a room, they shall be symmetrically arranged.

E. Provide blank plates for empty outlets.

F. Occupancy Sensors:

1. Locations and quantity of sensors shown on the Drawings are diagrammatic and indicate only the rooms and spaces to be provided with sensors.

2. Verify sensor type, quantity, location, aiming and sensitivity with manufacturer's recommendations.

3. All controlled spaces shall be tested to insure 90 to 100 percent coverage of the controlled space.

   a. If test fails, adjust sensitivity, re-aim, relocate, and/or add sensor(s) as required at no cost to Owner.

4. Power supplies and slave units if required shall be located above accessible ceilings.

END OF SECTION

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SECTION 26 28 00 - OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Low voltage circuit breakers.
2. Low voltage fuses.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 08 13 - Acceptance Testing.

1.03 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
2. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
3. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
4. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
5. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.

B. National Electrical Manufacturers Association (NEMA):

1. AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures. (Equivalent to UL 489)

C. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

D. Underwriters Laboratories, Inc. (UL):

1. 248-1, Low-Voltage Fuses - Part 1: General Requirements.
2. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
3. 248-8, Low-Voltage Fuses - Part 8: Class J Fuses.
4. 248-10, Low-Voltage Fuses - Part 10: Class L Fuses.
5. 248-12, Low-Voltage Fuses - Part 12: Class R Fuses.
6. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

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7. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
8. 1053, Standard for Ground-Fault Sensing and Relaying Equipment.
9. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
10. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.04 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. See Specification Section 26 05 00 for additional requirements.

C. Informational Submittals:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. Ground fault protection system test reports signed by the projects supervising electrical foreman.
   3. Reports:
      a. As-built condition of all circuit breakers that have adjustable settings.
   4. Power system study: See Power System Analysis Specification Section 26 99 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Circuit breakers:
      a. Square D Company.
   2. Fuses:
      a. Eaton Bussmann, Inc.
      b. Littelfuse, Inc.

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B. Submit request for substitution (fuses only) in accordance with Specification Section 01 33 00.

2.02 CIRCUIT BREAKERS

A. Molded Case Type:

1. General:

a. Standards: NEMA AB 1, UL 489.

b. Unit construction.

c. Over-center, toggle handle operated.

d. Quick-make, quick-break, independent of toggle handle operation.

e. Manual and automatic operation.

f. All poles open and close simultaneously.

g. Three (3) position handle: On, off and tripped.

h. Molded-in ON and OFF markings on breaker cover.

i. One-, two- or three-pole as indicated on the Drawings.

j. Current and interrupting ratings as indicated on the Drawings.

k. Bolt on type.

1) All 20 Amp breakers shall be switching duty (SWD) type.

2) Provide HACR type breakers for use with air conditioning, heating and refrigeration equipment having motor group combinations.

2. Thermal magnetic type:

a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.

b. Frame size 150 amp and below:

1) Non-interchangeable, non-adjustable thermal magnetic trip units.

c. Frame sizes 225 to 400 amp (trip settings less than 400A):

1) Interchangeable and adjustable instantaneous thermal magnetic trip units.

d. Ground Fault Circuit Interrupter (GFCI) Listed:

1) Standard: UL 943.

2) One- or two-pole as indicated on the Drawings.

3) Class A ground fault circuit.

4) Trip on 5 mA ground fault (4-6 mA range).

3. Solid state trip type:

a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.

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b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
    1) Standard rating.
    2) Interchangeable current sensor or rating plug.
    3) Adjustable long time pick-up setting.
        a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
    4) Adjustable short time pick-up setting.
    5) Adjustable instantaneous pick-up.
    6) Fixed ground fault pick-up, when indicated on the Drawings.
c. Frame size 1600 amp and above:
    1) 100 percent rated.
    2) Interchangeable current sensor or rating plug.
    3) Adjustable long time pick-up setting.
        a) Adjustable from 50 to 100 percent of the current sensor or rating plug.
    4) Adjustable long time delay setting.
    5) Adjustable short time pick-up setting.
    6) Adjustable instantaneous pick-up setting.
    7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
    8) Adjustable ground fault delay setting, when indicated on the Drawings.

4. Motor circuit protector:
    a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
    b. Sized for the connected motor.

B. Insulated Case Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: NEMA AB 1, UL 489.
3. 100 percent rated.
4. Manually operated (MO) unless electrically operated (EO) is indicated on the Drawings.
5. Electrically operated breakers:
    a. 120 Vac operators.
    b. Close/open pushbuttons.
    c. Red and green indicators to indicated breaker position.

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d. AC source: Control power transformer internal to the switchgear.

6. Motor driven operator for charging mechanism with open, close and charge push button.
7. Draw out construction:
   a. Roll out type operated by removable crank handle and interlocked with the door.
   b. Four (4) positions: Connected, test, disconnected and removed.
8. Current and interrupting ratings as indicated on the Drawings.
9. Selective override circuit on breakers with short time settings and without instantaneous settings that allow selectivity up to the breakers RMS symmetrical short time rating.
   a. The selective override circuit shall allow the breaker to ride through a fully offset (asymmetrical) fault equal to its RMS symmetrical short time rating in a system having an X/R ration of 6.6 with a maximum single phase peak current of 2.3 times the RMS symmetrical short time range.
10. Frame size 400 amp and above:
    a. Interchangeable current sensor or rating plug:
    b. Adjustable long time pick-up setting.
       1) Adjustable from 50 to 100 percent of the current sensor or rating plug.
    c. Adjustable long time delay setting.
    d. Adjustable short time pick-up setting.
    e. Adjustable instantaneous pick-up setting.
    f. Adjustable ground fault pick-up setting, when indicated on the Drawings.
    g. Adjustable ground fault delay setting, when indicated on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:

1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
   a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
   b. Frame sizes 400 amp and larger shall be solid state trip type.

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c. Frame sizes 1000 amp and above shall include integral ground fault protection.

d. Motor circuit protectors sized for the connected motor.

2. Insulated case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:

a. Set current sensor or rating plugs long time pick-up setting so that the indicated trip level is near the 75 percent trip point.

b. Frame sizes 1000 amp and above shall include integral ground fault protection.

E. Fuses:

1. UL Class L: Use for main and feeder devices over 600 amps.

2. UL Class RK-1 (fast acting): Use for 600A and smaller.

3. UL Class RK-1 (dual element): Use for motor feeder and branch circuit devices.

4. UL Class RK-5: Use for motor feeder and branch circuit devices.

F. Testing:

1. Acceptance testing: See Specification Section 26 08 13.

END OF SECTION

SECTION 26 28 16 - SAFETY SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Safety switches.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.03 REFERENCED STANDARDS

A. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

B. Underwriters Laboratories, Inc. (UL):

1. 98, Enclosed and Dead-Front Switches.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. Provide a table that associates safety switch model number with connected equipment tag number.
   c. See Specification Section 26 05 00 for additional requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:

1. Square D Company.

2.02 SAFETY SWITCHES

A. General:

1. Non-fusible or fusible as indicated on the Drawings.
2. Suitable for service entrance when required.
3. NEMA Type HD heavy-duty construction.
4. Switch blades will be fully visible in the OFF position with the enclosure door open.
5. Quick-make/quick-break operating mechanism.
6. Deionizing arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one (1) common component.
8. Clear line shields to prevent accidental contact with line terminals.
9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
    a. Red and easily recognizable.
    b. Padlockable in the ON and OFF position. If field drilled, paint holes to prevent corrosion.
    c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.
10. Provide fuse rejection clip.

B. Ratings:

1. Horsepower rated of connected motor.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:

1. Neutral kits.
2. Ground lug kits.
3. Auxiliary contact kits with 1 N.O. and 1 N.C. contact.

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D. Enclosures:

1. NEMA 1 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
2. NEMA 3R rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
3. NEMA 4 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
4. NEMA 4X rated (metallic):
    a. Body and cover: Type 304 or 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
5. NEMA 4X rated (nonmetallic):
    a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
6. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Operating handle padlockable in the On and OFF position.
7. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:

1. Fuses.
2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

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F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.

1. The VFD is to be disabled with the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:

1. Surface in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 3R enclosure:

1. Surface mounted in exterior location.

F. Permitted uses of NEMA 4 enclosure:

1. Surface mounted in areas designated as wet.

G. Permitted uses of NEMA 4X metallic enclosure:

1. Surface mounted in areas designated as wet and/or corrosive.

H. Permitted uses of NEMA 4X nonmetallic enclosure:

1. Surface mounted in areas designated as corrosive.

2. Surface mounted in areas designated as highly corrosive.

I. Permitted uses of NEMA 7 enclosure:

1. Surface mounted in areas designated as Class I hazardous.

2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

J. Permitted uses of NEMA 9 enclosure:

1. Surface mounted in areas designated as Class II hazardous.

2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

K. Permitted uses of NEMA 12 enclosure:

1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

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SECTION 26 29 23 - VARIABLE FREQUENCY DRIVES LOW VOLTAGE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Variable frequency drives (VFDs) for operation of inverter duty motors.
2. Variable frequency drives (VFDs) for operation of standard motors.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions.

B. Section 01 61 03 - Equipment: Basic Requirements.

C. Section 23 00 00 – Heating, Ventilating, and Air Conditioning (HVAC).

D. Section 26 05 00 - Electrical: Basic Requirements.

E. Section 23 09 93 – Sequence of Operation.

F. Section 40 00 00 – Process Interconnections.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. ETL Testing Laboratories (ETL).

C. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
2. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
3. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

D. National Electrical Manufacturer's Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. MG 1, Motors and Generators.

E. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC):
   a. Article 430, Motors Motor Circuits, and Controllers.

F. Occupational Safety and Health Administration (OSHA).

G. Underwriters Laboratory, Inc. (UL):

1. 508, Standard for Industrial Control Equipment.
2. 508A, Standard for Industrial Control Panels.

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1.04 DEFINITIONS

A. Variable Torque (VT):

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.

2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

B. Constant Torque (CT):

1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.

2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

C. Constant Horsepower:

1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.

2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

D. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

E. Standard Motor: An AC induction motor that fails to comply with one (1) or more requirements of NEMA MG 1 Part 31.

F. Low Voltage: 600 Vac or less.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Provide a schedule for each VFD including the following information:

a. Equipment Tag Number.

b. VFD Complete Catalog Number.

c. VFD Amp Frame Size.

d. Variable or Constant Torque Rating Basis.

e. Rated Input Current.

f. Rated Continuous Output Current.

g. Rated Short Circuit Current.

h. VFD cable type specified (shielded or non-shielded).

i. VFD Maximum Motor Lead Length for the type of cable used.

j. Motor Manufacturer.

k. Motor Frame Size.

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l. Motor Full Load Amps.

m. Motor Service Factor.

n. As installed motor Lead Length.

o. VFD options provided to meet harmonic or motor protection specifications.

3. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.

4. Product technical data:

   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.

   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.

   c. Manufacturer's installation instructions.

   d. Manufacturer's programming and operating instructions.

   e. See Specification Section 26 05 00 for additional requirements.

5. Fabrication and/or layout drawings:

   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.

   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.

   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.

   d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.

   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.

6. Certifications:

   a. Submit with Shop Drawings:

      1) Identification and location of closest authorized service organization.

      2) Harmonic analysis at each point of common coupling (PCC) per Harmonic Protection Requirements in PART 2 of this specification section.

   b. Submit prior to shipment:

      1) Certified factory test reports confirming compliance with specified requirements.

   c. Submit after installation:

      1) Certified field service reports showing:

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a) Each VFD is operational.

b) Each VFD and its driven equipment motor are compatible.

c) Each VFD responds correctly to the input control signals.

d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.

e) Measured harmonic levels per Harmonic Protection Requirements in PART 2 of this specification section.

f) Measured motor terminal peak voltages per Motor Protection Requirements in PART 2 of this specification section.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.
3. Approved copy of VFD schedule per Submittals requirements.
4. Manufacturer's instruction manuals.
5. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
6. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
7. Recommended spare parts list.
8. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
   a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
3. VFD Supplier shall maintain an authorized service organization within 300 miles of the Project Site.

B. Coordination:

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1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
    a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
2. Motor and VFD coordination: See Specification Section 01 61 03.
3. VFD shall be supplied complete with all required control components.
    a. Provide control as indicated:
        1) On the electrical drawings.
        2) As specified in this Specification Section.
        3) As specified in the HVAC control system sequences of operation.
            a) See Specification Section 23 09 93.
    b. VFD manufacturer shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
        1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
    c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.
4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
    a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
    b. Equipment which reduces clear working space below the minimums established by the NFPA 70 shall not be acceptable.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Allen Bradley.
    2. ASEA Brown Bovari (ABB).
    3. Eaton.
    4. General Electric Company.
    5. Square D Company.
    6. Toshiba.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

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2.02 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately-mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.

1. Motor control.
2. Motor overload protection.
3. Motor and motor branch circuit short circuit and ground fault protection.
4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an "engineered" or "configured" drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:

1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 percent of base speed of the driven equipment.
2. VFDs shall be compatible with the application they will be used in:
   a. Inverter duty induction motors.
   b. Standard induction motors.
   c. Special purpose submersible induction motor/pump.
3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
   a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
4. VFDs shall be designed to operate successfully under the following site conditions:
   a. Ambient:
      1) Temperature: 0-50 DegC.
      2) 95 percent non-condensing relative humidity.
   b. Elevation: refer to Special Conditions
      1) At elevations above 3,300 FT above MSL, equipment must be derated by the manufacturer.

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c. Power supply characteristics:

1) 480Vac, 3 PH, 60 Hz, 3 wire, (+/- 10 percent).

2) Effectively grounded.

B. Ratings and Performance Specifications:

1. Voltage rating:

a. Nominal: 460 or 480Vac, 3 PH, 60 Hz.

b. Range for continuous full load operation: +/-10 percent of nominal.

c. Voltage imbalance tolerance for full load operation: 3 percent minimum.

2. Current ratings:

a. Continuous:

1) Equal to or greater than the motor nameplate full load.

b. Short-term overload:

1) VT: 110 percent for 1 minute.

2) CT: 150 percent for 1 minute.

3) Permissible for 1 minute every 10 minutes continuously.

c. Short circuit:

1) 65,000 A RMS SYM, minimum as indicated on the Drawings.

2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.

3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.

3. Efficiency:

a. 97 percent, minimum, at full speed and full load.

b. 93 percent, minimum at 1/2 speed and full load.

4. Displacement power factor:

a. 95 percent, minimum from 50 percent to 100 percent speed and load.

5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.

6. Frequency drift:

a. +0.5 percent of set frequency.

7. Speed regulation (motor dependent): 3 percent.

8. Speed range: 10:1.

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9. Control type:
    a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
        1) When operating under voltage boost.
        2) At frequencies over 60 Hz.

C. Operational Features:
1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25 percent of rated voltage, or single phase condition: 4 second, minimum.
3. Controls power loss ride-through: 500 msec, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
    a. Minimum of three (3) settings.
    b. Adjustable bandwidth, 1 - 5 Hz.
8. Capable of operating without the motor connected for start-up and troubleshooting.

D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
2. Independent maximum and minimum speeds for forward and reverse operation.
3. Start frequency and hold time.
4. Independent linear acceleration and deceleration time.
5. Preset "jog" speed.
6. Three (3) critical frequency bands.
7. One (1) preset speed selectable by logic input.
8. Volts/Hertz ratio.
9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.
14. Ground fault pickup.
15. DC injection level and time.

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E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:

1. General:

a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:

1) Input under voltage.

2) Input over voltage.

3) Input under frequency.

4) Input over frequency.

5) Input Phase loss.

6) DC Bus under voltage.

b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.

1) Over temperature.

2) Blown fuse.

3) Component failure.

4) Overload.

5) Short circuit.

6) Ground fault.

7) DC Bus over voltage.

8) External safety input (e.g., motor thermal protection).

9) Logic fault.

c. When automatic shutdown occurs, VFD shall restart immediately upon reset, whether automatic or manual.

d. VFD shall hold cause of trip data for a minimum of four (4) shutdowns in memory.

1) Data to be accessible through the keypad, local communication link and remotely.

2. Input protection:

a. Input circuit breaker or current-limiting fuses with externally operable disconnect.

1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.

2) Handle padlockable in the OFF position.

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b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.

c. Incoming line transient suppression.

1) 6000V peak per IEEE C62.41.

2) Phase-to-phase and phase-to-ground protection.

d. Sustained over voltage trip.

3. Internal protection:

a. Surge suppression and power device snubbers.

b. Power devices rated at 2.5 times line voltage.

c. Instantaneous over current trip.

d. DC bus over voltage trip.

e. Power device over temperature trip.

f. Control logic circuit malfunction trip.

4. Output protection:

a. Inverse-time overload trip:

1) UL Class 10 characteristic.

b. Over voltage trip.

c. Over frequency trip.

d. Short circuit trip.

1) Line to line and line to ground.

e. Ground fault trip.

2.04 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.

1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 Vac or 24 Vac or 24 Vdc.

1. 120 Vac supplied by CPT in the VFD.

a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.

b. CPT shall have two (2) fuses on the primary side and one (1) fuse on the secondary side.

c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.

2. 24 Vac or 24 Vdc supplied by Class 2 power supply in the VFD.

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a. Power supply shall have minimum additional capacity of 33 percent greater than that required by control devices.

b. Provide two (2) current-limiting fuses on the AC supply to the power supply.

c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:

1. Door mounted sealed keypad, membrane type with LED or LCD display.

a. Messages shall be in English and engineering units.

b. Drive operating parameters shall be programmable.

c. Menu driven.

d. Password security.

e. Display fault and diagnostic data.

f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.

g. Gold plated plug-in contacts.

2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.

a. Minimum indications:

1) Run.

2) Stop.

3) Ready.

4) Alarm.

5) Fault.

6) Local control.

7) Remote control.

8) Control source local.

9) Control source remote.

10) Speed indication.

b. Minimum control functions:

1) Local/Remote switch.

2) Stop button.

3) Start button.

4) Reset button.

5) Speed control buttons.

3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.

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a. On occurrence of more than one (1) condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:

1. Local portable computer interface via USB or Ethernet communications port:
   a. Capability to:
      1) Start-Stop VFD.
      2) Control VFD Speed.
      3) Access fault and diagnostic data.
2. Analog and discrete inputs:
   a. Speed reference (setpoint) signal 4-20 mA DC.
   b. Isolated process PID controller with user-programmable setpoint, gain, rate, reset and span for accepting a remote 4-20 mADC process variable signal.
3. Analog and discrete outputs:
   a. 4-20 mADC output for remote speed indication, as a function of frequency, calibrated 0 to 100 percent.
   b. Drive FAULT contacts.
   c. Drive RUNNING contacts.
   d. Drive selector switch in REMOTE status contacts.
4. Contacts:
   a. Contacts shall be rated 2 A inductive at 120 Vac.
   b. All contacts shall be wired to field wiring terminal boards.
5. As shown on the VFD Control schematics, drive shutdown on external fault input:
   a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
   b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
   c. For submersible pump/motors incorporate the temperature/leak detection monitor and shut down.
   d. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.
6. Network communications capability:
   a. Provide VFD with communication card, protocol and required programming for digital communication of all VFD program and operational parameters to plant control system via:
      1) Ethernet/IP.
      2) Modbus TCP/IP

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b. Refer to Specification Section 23 and Specification Section 40 for additional requirements.

2.05 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a "dedicated system" in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from either or both the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).

1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.

2. Current distortion: IEEE 519 Table 10.3, based on $I_{SC}/I_L < 20$.

C. Point of Common Coupling (PCC) shall be considered:

1. Building service entrance switchgear, switchboard or MCC.

2. Each MCC, switchboard, switchgear, or panelboard supplying a VFD branch circuit.

D. Provide the following topologies:

1. 6-pulse rectifier topology with tuned passive filter with controls such that the filter is not energized when VFD is off or starting. 12-pulse rectifier topology for each VFDs with input current ratings in excess of 11 A.

2. 18-pulse rectifier topology for each VFDs with input current ratings in excess of 34 A.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.

1. Values in excess of specified limits require correction by contractor and re-measurement.

2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.06 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

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C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.

1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:

a. Inverter duty motors: 1280 V.

b. Standard motors: 800 V.

c. Rise time shall be greater than or equal to 0.1 microsecond.

d. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors..

D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10 percent shorter than the manufacturers published literature for maximum lead length for the type of cable installed.

1. Values in excess of specified limits require correction by contractor and re-measurement.

2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.07 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:

1. Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.

a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.

b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.

2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.

3. Cooling fans, as required, shall be provided to run when drive is running.

4. Enclosures for separately mounted VFD's:

a. NEMA Type 1 for installation in Electrical Rooms.

b. NEMA Type 12 for installation in other unclassified areas.

c. NEMA Type 4, 4X stainless steel, or 4X non-metallic as indicated on the Drawings for installations in wet, damp or outdoor areas.

1) Provide enclosure cooling required to not exceed drive temperature ratings.

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B. Wiring:

1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
    a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
    b. Bases with a self-sticking back will not be allowed.
2. All plug-in contacts shall be gold-plated.
3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
    a. Provide terminals for shield continuity where required.
4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
    a. Non-brittle, interlocking, track-mounted type.
    b. Screw terminals will not be allowed.
    c. A terminal for each conductor of external circuits plus one (1) ground for each shielded cable.
    d. For free-standing panels, 8 IN of clearance shall be provided between terminals and the panel base for conduit and wiring space.
    e. Not less than 25 percent spare terminals shall be provided.
    f. Terminals shall be labeled to agree with identification indicated on the supplier's submittal drawings.
    g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
    a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
    a. Markings or color code shall match the manufacturer's drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:

1. All devices mounted on the face of the drive shall be provided with a suitable nameplate as specified in Specification Section 26 05 00, paragraph 3.01.Q.
2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.

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3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.08 COMPONENTS AND ACCESSORIES

A. Reactors:

1. Impedance: As required.
2. Continuous current: Not less than drive rating.
3. Current overload: 150 percent for 1 minute.
4. Insulation temperature rating: 180 DegC.
5. Copper windings.
6. Saturation current rating: 3.5 to 5 times rated current.
7. Hi-potential rating: 2500 Vac line to ground and line to line, for 1 minute.
8. Noise reduction features:
   a. Epoxy over cast coil.
   b. Extra dips and bakes of varnish over continuous wound coil.

2.09 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.
2. Prior to final assembly:
   a. Inspect incoming components.
   b. Test and inspect power devices.
   c. Circuit cards:
      1) Component and functional tests:
      2) Burn-in chamber or temperature cycling test.
      3) System test after burn-in or temperature cycling.
3. After final assembly:
   a. Continuity and insulation test of 480 power control circuits.
   b. Drive tests:
      1) Burn-in complete drive at full load for 24 HRS.
      2) Verify all auxiliary circuits operation.
      3) Monitor output variables.

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c. Systems test:

1) Provide inputs to field connections and simulate on-site operation.

2) Test all auxiliary equipment.

2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

C. Provide services of manufacturer's representative to perform start-up services.

D. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.

1. The space available on the Drawings shall not be exceeded.

3.02 START UP

A. Pre-start-up Services:

1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period.

2. Shall consist of:

a. Physical and electrical installation check.

b. Final adjustments and calibration of drive parameters.

c. VFD operation from simulated input signals.

3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:

1. Perform field measurement of harmonics at each point of common coupling (PCC) per the Harmonic Protection Requirements.

a. For each individual VFD.

b. For the maximum number of VFDs that will be operational at the same time.

c. When all loads are at 75 percent load minimum.

d. Duration: 1 HR minimum.

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2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per the Motor Protection Requirements.
    a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
        1) Time shall be measured in microseconds.
    b. Tests shall be performed at full:
        1) Full voltage and speed.
        2) Loaded to 75 percent minimum.
        3) Duration: 1 HR minimum.
3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
    a. Perform all work in the presence of the Owner's designated representatives.
2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
    a. Ensure compatibility of VFD with associated control and instrumentation signals.
4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Instruct Owner's designated personnel:
1. Minimum of 8 HRS at the jobsite.
2. Include both field and classroom instruction.
3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
    a. Lubrication.
    b. Troubleshooting.
    c. Repair and replacement.
    d. Parts inventory.
    e. Maintenance records.

END OF SECTION

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SECTION 26 32 14 - ENGINE GENERATOR DIESEL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Engine generator set and accessories.
2. Generator fuel tank filling equipment and accessories.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions.

B. Section 26 05 00 - Electrical Basic Requirements.

C. Section 26 13 13 – Medium Voltage Circuit Breaker Switchgear Metal-Clad Paralleling Switchgear.

D. Section 26 36 23 – Automatic Transfer Switches.

E. Section 40 05 03 - Piping Materials and Methods.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI):

1. B11.19, Performance Requirements for Safeguarding.
2. C57.16, Requirements, Terminology, And Test Code For Dry-Type Air-Core Series-Connected Reactors.
3. C62.11, Metal-Oxide Surge Arresters For AC Power Circuits (> 1 kV).
4. S1.4, Specification for Sound Level Meters.

B. Environmental Protection Agency (EPA):

1. 40 CFR Part 60, Subpart IIII, Protection of Environment, Standards of Performance for New Stationary Sources, Standards for Performance for Stationary Compression Ignition Internal Combustion Engines.

C. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. LA-1, Surge Arresters.
3. MG 1, Motors and Generators.

D. National Fire Protection association (NFPA):

1. 70, National Electrical Code (NEC):
   a. Article 445, Generators.
   b. Article 700, Emergency Systems.
   c. Article 701, Legally Required Standby Systems.

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d. Article 702, Optional Standby Systems.

e. Article 705, Interconnected Electric Power Production Sources.

2. 110, Standard for Emergency and Standby Power Systems.

E. Underwriters Laboratories, Inc. (UL):

1. 2200, Standard for Stationary Engine Generator Assemblies.

1.04 SYSTEM DESCRIPTION

A. The engine generators will be used and rated for:

1. Optional standby power during a utility power outage, NFPA 70, Article 702.

B. The generator fuel tank fueling system will include fill box, controls, automatic overfill protection, and automatic fill shutoff for multiple tanks.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

c. Engine/generator performance curves.

3. Fabrication and/or layout drawings.

a. Dimensional plan and elevation drawings.

b. Wire interconnection drawings.

4. Complete outline and installation drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished and the operation and maintenance manuals, shall be submitted in accordance with the submittals section.

5. Test reports:

a. Factory test reports.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

C. Informational Submittals:

1. Unit installation, startup and operational statement.

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2. Field Quality Control test reports.
3. Test reports: Sound attenuating enclosure test measurements.

1.06 QUALITY ASSURANCE

A. The engine generator set manufacturer or authorized supplier is designated to have single source responsibility for the supply of all components and delivery and setting of the unit.

1.07 SITE CONDITIONS

A. Ambient air temperature:
1. Minimum: refer to Special Conditions.
2. Maximum: refer to Special Conditions.
3. Altitude: refer to Special Conditions.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Engine generator unit:
a. Caterpillar.
b. Cummins Onan.
c. Generac.
2. Silencers:
a. Maxim.
b. GT Exhaust Systems.
c. Nelson.
d. Cowl.
e. Hapco.
3. Battery charger:
a. Manufacturer's standard.
4. Governor:
a. Manufacturer's standard.
5. Radiator:
a. Manufacturer's standard.
6. Vibration isolators:
a. Caldyne.

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b. Mason Inds.

c. Ace.

d. Korfund Dynamics.

7. Day tank:

a. Pryco.

b. Simplex Access Controls.

c. Tramont.

8. Fuel Tank Fill Box Station:

a. Simplex.

b. Pryco, Inc.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 EQUIPMENT

A. Emissions Requirements:

1. A single unit's emissions shall meet all Federal, State and Local government requirements, including but not limited to:

a. Environmental Protection Agencies (EPA) New Source Performance Standards (NSPS), 40 CFR Part 60, Subpart IIII.

2.03 COMPONENTS

A. Engine Generator Unit General:

1. Diesel engine direct-connected to alternating current generator mounted on suitable rigid steel skid supports.

2. Mount unit on skid suitable for installation on concrete foundation.

3. Base rating on operation at rated RPM when equipped with all operating accessories.

4. Standards: UL 2200.

B. Engine:

1. Four-cycle, full compression ignition, single acting, solid-injection unit, either vertical or V-type pistons naturally aspirated or turbo charged with inner and after cooling.

2. Fuel supply: Low Sulfur Diesel.

3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.

4. Capable of operating at idle or light loads for extended periods of time.

C. Injection Pumps and Valves:

1. Type not requiring adjustment in service, which may be individually removed and replaced.

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2. Individual injection pump and valve for each cylinder.
3. Fuel injection pumps: Positive action, constant-stroke, actuated by cam driven by gears from engine crankshaft.
4. Fuel lines between injection pumps and valves: Heavy seamless steel tubing.
5. Flexible fuel line connectors for supply and return connections at pump.

D. Oil Pump:

1. Gear-type lubricating oil pump to supply oil under pressure to main bearings, crank pin bearings, pistons, timing gears, camshaft bearings and valve rocker mechanism.
2. Spray cool and lubricate pistons.
3. Oil filters so located that lubricating oil is continuously filtered, except during periods when oil is automatically by-passed to protect vital parts when filters are clogged.
4. Filter elements accessible and easily removable.
5. Filter elements: Effective full flow, replaceable resin-impregnated cellulose type.
6. Equip filter system with spring-loaded by-pass valve.
7. Oil cooler: Water-cooled, engine-mounted.

E. Fuel System:

1. Fuel pump: Built-in gear-type, engine-driven fuel transfer pump.
2. Equip fuel system with replaceable fuel filter elements arranged for easy removal without breaking any fuel line connections or disturbing fuel pumps or any other part of engine.
3. Locate all fuel filters in an accessible housing, ahead of injection pumps to thoroughly filter fuel before it reaches the pump.
4. Use no screens or filters requiring cleaning or replacement of injection pumps or valve assemblies.

F. Governor: Fully enclosed electronic type governor with actuator capable of providing accurate speed control within 1 percent of rated speed, complete with panel-mounted electronic assembly with ramp generator and speed-sensing modules.

G. Air Cleaners: Engine-mounted, dry type air cleaners of sufficient capacity.

H. Electric Starting System:

1. Sufficient capacity to crank at speed which will start engine under normal operating conditions.
2. Controls to provide automatic cranking of engine when generator is called to start.
3. Prevent excessive cranking which could damage cranking motor.
4. Automatic stop controls.
5. Starter motors with positive-engagement feature.

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I. Cooling System:

1. Capacity for cooling engine at the specified operating conditions.
2. Engine driven, centrifugal type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level.
3. Unit mounted radiator.
    a. Core guard flexible duct adapter.
    b. Site glass at top of unit.
    c. Engine driven blower fan.
    d. Low water level cutoff switch.
    e. Radiator shall be rated minimum 49 DegC/120 DegF ambient.
4. Provide fan guards.

J. Heater:

1. Thermostatically controlled jacket water heater(s) to maintain cooling jacket at the manufacturer's recommended temperature at the specified low ambient temperature.
2. Voltage as noted on the Drawings.

K. Silencer:

1. Suitable type for industrial silencing.
2. Seamless, stainless steel, flexible, exhaust adapter for exhaust outlet to silencer.
3. Silencer is to be the pancake or hockey puck type of construction on order to mount silencer inside of the enclosure.

L. Exhaust pipe enclosure-roof thimble:

1. Type 304 stainless steel.
2. Carrier pipe of the same diameter and wall thickness as the interconnecting engine exhaust pipe.
    a. Thimble to be self ventilating by means of holes drilled in metal plates at either end of the roof thimble.
3. Mounting plate to completely support the thimble from the roof curb and support the carrier pipe.
4. Exhaust pipe fitted with a hinged stainless steel rain cap.

M. Exhaust system insulation:

1. Rigid insulation: High temperature 3 IN calcium silicate type with aluminum jacket fastened with aluminum or stainless steel hardware.
2. Flexible insulation: High temperature fiberglass, 9 LB per cubic FT.

N. Engine Instruments and Controls (Meters and gauges are to be digital type to provide highest level of accuracy):

1. Engine-mounted instruments:

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a. Oil pressure gage.

b. Oil temperature gage.

c. Water temperature gage.

d. Run time meter.

e. Battery voltage meter.

2. Automatic cycle cranking and over-crank protection.

3. Safety controls: Equip engine with automatic safety controls to shut down engine in event of low lubricating oil pressure, high jacket water temperature, overspeed or overcrank.

4. Auxiliary control devices: Either integral with specified engine instruments, control, and safety devices or as separate devices as required to operate various signal circuits specified for remote annunciator panel.

5. Three (3) NO auxiliary contacts for interface with louvers, fans or other miscellaneous equipment.

a. Contacts shall close when generator is started.

O. Sub-Base Fuel Tank:

1. Double wall sub-base day tank mounted underneath engine generator unit.

2. Steel construction, top and bottom baffles, steel channel side supports, weatherproof secondary containment, rust preventive interior coating, rust proofed and finish painted exterior.

3. Tank connections: Fuel level gauge, fuel lines to generator, fill, vent, drain and pressure relief.

4. Manual overfill protection.

5. Low level warning with contacts for remote alarm.

a. Set to alarm at 50 percent of capacity.

6. Critical low level shutoff with contacts for remote alarm.

7. Analog signal for fuel tank level.

a. Level sensor transducer and transmitter.

8. Leak detection alarm with contacts for remote alarm.

9. Capacity: 24 HRS at full load minimum, unless otherwise noted on the project drawings or special conditions.

10. Provide stairs and platforms in order to provide full access to the inside of the enclosure for servicing techs when noted on the project drawings. Platforms must meet OHSA requirements for protection in front of every door.

P. Batteries:

1. Nickel cadmium type.

2. Furnish electrolyte separately for use when installation is complete and unit is ready for testing.

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3. Charging alternator is to be a minimum of 65 amps and battery charger to be a minimum of 20 amps.

Q. Battery Charger:

1. Output current rating of at least 1/20th of ampere hour capacity of battery and capable of automatically switching between low rate (float) mode and high rate (equalize) mode.
2. Solid state rectifiers, DC voltmeter and ammeter, fuse input and output, and 115 Vac input.
3. Malfunction alarm contacts (minimum): low and high battery voltage, weak battery and charger failure.

R. Generator:

1. Brushless, 4-pole drip-proof revolving field type with permanent magnet, 2/3 pitch stator, direct-coupled rotor, Class H insulation.
2. Minimum continuous standby ratings:
   a. 0.8 PF, substantiated by manufacturer's standard published curves and conforms to NEMA MG 1 specification.
   b. Special ratings or maximum ratings are not acceptable.
3. Rated to serve up to 50 percent non-linear load without exceeding rated temperature rise.
4. Minimum efficiency: 92 percent at 50 to 110 percent of nominal standby rating, less than 30 percent instantaneous voltage dip at full load and rated power factor and suitable for simultaneous operation with other future units connected in parallel.
5. Stator and rotor: 125 DegC temperature rise with minimum Class F insulated with 100 percent epoxy impregnation and overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration.
6. Directly connect stator to engine flywheel housing.
7. Drive rotor through semiflexible driving flange to ensure permanent alignment.
8. Self ventilating with suitable blower, air inlet and outlet openings.
9. Provide terminal box of adequate size for entrance of conduit and termination of conductors.
10. Generator drive free from critical torsional vibration within operating range.
11. Over current protection is by providing differential CTs at the generator set and at the parallel switchgear so that the paralleling gear circuit breaker connected to the generator set will trip upon over current or short circuit detected. A relay in the parallel gear shall also be provided and wired back to the generator set to shut the engine down.

S. Voltage Regulator:

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1. SCR type, to maintain 2 percent voltage regulation from 0 to full load with steady state modulation not exceeding plus 1/2 percent including cross-current compensation to provide maximum of 5 percent unbalance in kVA load sharing between this unit and possible future generators.
2. Automatic protection against short circuits on system.
3. Permit unit to operate at no load below rated frequency for engine start up and shut down procedures.
4. Provide voltage level and gain controls for normal operating adjustments.
5. Provide voltage level control with minimum range of plus or minus 5 percent from rated voltage.
6. Mount regulator, volts per hertz type, in generator housing on suitable vibration isolators.

T. Generator Instruments and Controls:

1. General:
   a. Generator instruments and controls shall be coordinated with the Master Controls as specified in Specification Section 26 13 13.
   b. Include the items listed below as a minimum for each generator plus all other items and components required for specified performance and function.
   c. Provide generator start/stop control, safety shutdown, alarm and status indication and operator controls.
2. Paralleling:
   a. Generators are to be run in parallel when indicated on the project drawings:
      1) Primary: Under control from Master Controller
      2) Secondary: (In the event the Master Control fails) Provisions shall be provided for generators to automatically synchronize.
         a) Provide microcontrollers and wiring as required to perform operations.
3. Generator mounted NEMA 1 type, illuminated vibration isolated instrument and control panel(s). All meters and gauges to be digital for maximum accuracy.
4. AC voltmeter and phase selector switch.
5. AC ammeter and phase selector switch.
6. Frequency meter.
7. Kilowatt load meter.
8. Run-off-auto engine, start-stop control switch.
9. Emergency stop.
10. Run time meter.
11. Governor control rheostat.
12. Voltage level adjustment rheostat.

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13. Cool down time delay 0-15 minute adjustable.
14. Cycle cranking control.
15. Minimum red shut down indicating lights as follows:
    a. Overcrank.
    b. Overspeed.
    c. Low lubricating oil pressure.
    d. High engine water temperature.
16. Minimum amber alarm indicator lights as follows:
    a. Control switch not in auto position.
    b. Low engine water temperature (less than 70 DegF).
    c. Low fuel in day tank.
    d. Day tank leak.
    e. Battery charger malfunctioning.
    f. Low battery voltage.
17. Minimum amber prealarm indicator lights as follows:
    a. High engine water temperature.
    b. Low lubricating oil pressure.
18. Common dry contact and audible alarm to indicate when one (1) or more alarm or prealarm conditions exist.
19. Exterior mount white strobe light to indicate when one (1) or more alarm or prealarm conditions exist when the unit is not ready to operate in automatic start mode.

U. Seismic Vibration Isolators: Vibration system shall consist of engine and generator mount isolators with or without additional mechanical spring isolators rubber pads to control both high and low frequency vibrations between major components, sub-base and structural foundation and to provide required vibration isolation for the size and configuration of gen-set provided.

V. Generator Neutral Grounding Equipment:
    1. Provide neutral grounding resistor in screened, ventilated enclosure for roof mounted installation above the individual generators:
        a. Resistance value selected to make maximum generator phase-ground short circuit current equal to the three phase value per NEMA MG-1, calculated from generator reactances. Size to standard rating from calculated value not exceeding three phase value.
        b. Comply with ANSI C57.16.
        c. Self-cooled, Class AA.
        d. Rated phase to ground voltage of generator.
        e. 10 second thermal rating.

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f. 60 kV BIL.

W. Transient Protection Equipment:

1. Provide surge arrestors, surge capacitor, connected to generator terminals.
2. Surge Arrestors:
   a. Comply with NEMA LA-1 and ANSI C62.11.
   b. Designed for rotating machinery protection.
   c. Gapless metal oxide type.
   d. Porcelain or polymer housing with metal base.
   e. Intermediate class.
   f. MCOV Rating: refer to Special Conditions

X. Fuel Tank Fill Equipment:

1. Tank Fill Box:
   a. Provide for freestanding installation at delivery truck curbside, a Simplex Compact Automatic Fuelport for Filling Multiple Tanks grade level fill box or equal with spill containment, overfill prevention and automatic fill shutoff in the filling of multiple above ground storage tanks.
   b. The tank fill box shall be installed outdoors anchored on a concrete pad.
   c. The tank fill box shall include the following fittings and features:
      1) Steel, weatherproof, lockable box with hinged door finished in white industrial enamel.
      2) External stainless steel ground stud for attachment of delivery truck ground cable.
      3) 3 IN quick detachable coupling for attachment of delivery hose
      4) Inlet angle check valve
      5) Twenty (20) gallon spill containment sump with drain hand pump. To remove spill contents to AST via fill pipe. Include check valve and shutoff valve.
      6) 3 IN threaded outlet fitting for attachment of fill pipe to each AST.
   d. The tank fill box shall include a control system for multiple tanks with tank gauging, alarm, overfill alarm, and automatic shutoff system as described below.
      1) Electrical; 115 VAC, 1-ph, 15-amp circuit.
   e. An electronic tank monitor and fill control system shall be provided and shall include:
      1) NEMA 3R rainproof, lockable enclosure with hinged door.
      2) Level transmitter for installation in each AST.
      3) Digital level gauge for each tank, reading in percent level.

4) High visibility red alarm light: 90% level.

5) High visibility red alarm light: 95% level.

6) 90 dB audible alarm horn activated at 90%, 95% and on AST leak.

7) Control power ON/OFF switch.

8) Fill valve OPEN/CLOSE switch.

9) Valve restriction at 90% level.

10) Automatic valve closure at 95% level.

11) Tank selection / electric valve control.

a) System shall allow operator selection of tank to be filled.

b) Automatic lock out of all off-line tanks.

12) Leak sensor alarm circuit input for each tank which activates automatic valve closure

f. Indicators for:

1) Power available.

2) Fill valve disarm.

3) Fill valve open.

4) Tank leak.

2. Electric Operated Ball Valve:

a. 3 IN inlet motorized ball valves for closure on each AST; offline, high level, and leak conditions.

b. Motorized ball valve shall open based on operator selection.

c. Valve shall be compatible with diesel fuel.

d. Features:

1) Full port lead free brass ball valve.

2) LED light for continuous status indication.

3) Weatherproof enclosure (IP67 rating).

4) Anti-condensation heater.

5) Manual override with visual valve position indicator.

6) Two auxiliary limit switches to confirm valve position.

e. Powered from Fill Box Control Panel.

f. Valworx, Series 5680 (568018) or equal.

3. Thermal Expansion Pressure Relief Valve:

a. Provide one (1) pressure relief valve in main header, relief outlet plumbed into generator fuel tank.

b. Materials:

1) Seat: Brass/FKM.

2) Spring: Stainless Steel Type 302.

3) Body: Bronze.

4) Cap: Brass.

c. Apollo, 16100 Series, FKM Seat or equal.

2.04 ACCESSORIES

A. Provide terminals, relays and gateway as required for interfacing with the Generator Controls and Master Controls. Coordinate with Systems Integrator.

B. Generator remote annunciator panel (for remote indication):

1. Surface mounted NEMA 1 or NEMA 4 enclosure as noted on the Drawings. Surface mounted enclosure with Human Machine Interface (HMI).

2. Circuits:

a. 120 Vac powered from local 20A circuit.

1) Provide ac/dc converter if necessary.

3. Provide red and green signal lamps, buzzer, silencing switch, lamp test switch, relays, solid-state components, and engraved function identifications.

4. Annunciator functions:

a. Green light "ON" to indicate generator is operating to supply power to load.

b. Separate red light for each shutdown or alarm condition and amber light for each pre-alarm condition and common buzzer with silence/ acknowledge switch.

c. Shut down indicating lights as follows:

1) Overcrank.

2) Overspeed.

3) Low lubricating oil pressure.

4) High engine water temperature.

d. Alarm indicator lights as follows:

1) Control switch not in auto position.

2) Low engine water temperature (less than 70 DegF).

3) Low fuel in main storage tank.

4) Low fuel in day tank.

5) Fuel in day tank rupture basin.

6) Battery charger malfunctioning.

7) Low battery voltage.

e. Pre-alarm indicator lights as follows:

1) High engine water temperature.

2) Low lubricating oil pressure.

3) Excessive ground fault has been detected on the generator main breaker.

f. Analog indication:

1) Fuel level in day tank.

C. Manual stop break glass stations:

1. Shuts down generator/s from remote location.
2. Verify locations prior to installation.

D. Generator set walk-in sound attenuating, weatherproof, self-contained, freestanding generator containment.

1. Attenuate engine-generator produced sound to an A-weighted sound level of 75 dB(A) at 23 FT from enclosure.
2. Construction:
   a. Galvanized steel or Aluminum frame and exterior panels.
   b. Structurally stable in 100 mph wind.
   c. Support roof load of 40 PSF.
   d. Fiberglass or mineral wool insulation to provide minimum R11 insulation in side walls and roof for thermal transmission, sound attenuation material can be in addition to or include the thermal insulation.
   e. Enclosure shall be approved for installation in local seismic zone.
3. Exterior shall be mill prepainted in color selected by Owner
4. Resist intake of blown sand or rain through intake air assembly.
5. Two (2) 36 IN wide man door in one (1) side and two (2) 36 IN wide doors in other side and removable air intake and louver assembly for removal of large assemblies.
6. Space for routine maintenance and service shall be provided on all four (4) sides of generator.
7. Anchor bolts for casting into concrete base for attaching enclosure to pad.
8. Provision for exit of exhaust stack in roof, flashed and sealed to prevent entry of moisture.
   a. Support for critical silencer on roof.
9. Lighting fixtures to provide 30 foot-candle lighting for servicing.
10. Motorized dampers for control of air intake and discharge openings.
11. Electric unit heaters to maintain internal temperature at 50 DegF and interlock so unit heaters shut off when generators are running.
12. Coordinate the enclosure with the engine generator furnished to assure physical clearances, sound attenuation, airflow and pressure drop through the system.

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13. Space for mounting electrical panel for serving loads inside enclosure to include but not be limited to lights, unit heaters, engine block heaters, battery chargers, ventilation fans. Loads inside the enclosure shall be pre-wired at the factory.

14. Ventilation fan with gravity damper, thermostatically controlled to operate continuously at internal temperatures adjustable from 60 to 90 DegF and interlocked to prevent them from running when the engine generators are running.

    a. Interlock ventilation fan with motorized inlet dampers.

    b. Enclosure shall accommodate an interior pancake style exhaust silencer mounted to the inside roof of the enclosure and the enclosure and walls shall be constructed to support the weight of the exhaust system to prevent weight transferal to the engine.

E. Alarm Annunciator Panel:

1. Furnish a NEMA 4X stainless steel alarm annunciator panel to be installed as noted on the Drawings. The annunciator panel shall display critical generator and paralleling switchgear alarms to alert the operator to take action.

2. Annunciator shall be manufactured by Panalarm (Ametek) Series 90B. Annunciator shall be mounted flush on the front of the NEMA 4X panel. Annunciator shall be capable of receiving at least 10 hardwired normally open inputs for alarm or status display. Vendor shall coordinate with the Owner to obtain alarm and status text which shall be engraved on the annunciator alarm windows (tiles).

3. Install a RuggedCom model RS910 Ethernet switch in the NEMA 4X panel along with two (2) Advantech model ADAM-6050-CE 18 channel Modbus TCP modules. The alarms and statuses to be displayed on the annunciator shall be transmitted via Modbus TCP from the PLC in the Paralleling Switchgear. The Modbus TCP modules shall provide digital outputs wired to the annunciator. All 12 outputs from the Modbus TCP modules shall be wired to the annunciator.

4. The alarm annunciator panel shall be powered by a 120VAC circuit obtained from the nearest lighting panel.

5. It shall be the responsibility of the generator and paralleling switchgear vendor to establish Modbus TCP communication to the annunciator panel from the PLC in the paralleling switchgear to successfully display the alarms and statuses. This communication shall be tested in the Factory Acceptance Test (FAT) and site test described in Specification 26 13 13.

2.05 SOURCE QUALITY CONTROL

A. Individually test each prime mover.

1. Apply derating factors for the proposed site to test data.

2. Continuously test for a period no less than 2 HRS.

3. Test procedure shall be as follows:

    a. Start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating at rated power factor in one (1) step.

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b. Observe and record the cranking time(s) required to start and run for each prime mover.

c. Observe and record the time required to come up to operating speed for each prime mover.

d. Record voltage and frequency overshoot for each prime mover.

e. Record voltage, frequency and amperes.

f. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

2.06 MAINTENANCE MATERIALS

A. Spare Parts:

1. Provide manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all components as indicated and in accordance with manufacturer's recommendations and instructions and with NFPA 110.

B. Fill cooling system with solution of 50-50 water and ethylene glycol anti-freeze to prevent freezing at temperatures as low as minus 30 DegF.

C. Contractor shall provide fuel for gen-set fuel tanks and oil for unit.

D. Contractor shall top off fuel and all fluids to normal operating levels after testing is complete.

E. Install all wiring to engine in conduit.

1. Control wiring on engine may be factory installed in high temperature loom.

F. Provide control wiring in conduit between generator control panel described under generator instrument and controls paragraph as specified and indicated in the contract documents.

G. Mount on concrete pad utilizing vibration/seismic isolators, see drawings for pad detail.

H. Sound attenuating engine generator enclosure:

1. Field test installation under load.

2. Use a precision sound measuring instrument meeting ANSI S1.4 Type 1.

3. Provide measurements to Engineer.

3.02 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.

2. Supervise pre-startup adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks.
4. Provide Owner written statement that manufacturer's equipment has been installed properly, started up, tested, and is ready for operation by Owner's personnel.
5. Provide 4 HRS of the manufacturer's technical representative's time for on-site training of Owner's personnel.

B. Provide two (2) load tests and one (1) cycle crank test.
1. Tests one (1) and two (2) shall be for continuous period of no less than 2 HRS each.
2. Engineer and Owner shall be notified seven (7) days prior to testing.
3. Test number one:
   a. With prime mover(s) in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to facility.
   b. Observe and record the time delay on engine start.
   c. Observe and record the cranking time(s) required to start and run for each prime mover.
   d. Observe and record the time required to come up to operating speed for each prime mover.
   e. Record voltage and frequency overshoot for each prime mover.
   f. Observe and record time required to achieve steady-state condition with all switches transferred to emergency position.
   g. Record voltage, frequency and amperes.
   h. Record oil pressure, water temperature where applicable and battery charge rate at 5-minute intervals for the first 15 minutes and at 15 minute intervals thereafter for each prime mover.
   i. Return normal power to facility, record time delay on retransfer to normal for each switch and cooldown time delay for each prime mover.
4. Test number two:
   a. Immediately after completion of test number one, start prime mover and upon reaching rated RPM, pick up 100 percent of nameplate KW rating in one (1) step.
      1) Unity power factor is acceptable for on-site testing
   b. Observe and record the cranking time(s) required to start and run for each prime mover.
   c. Observe and record the time required to come up to operating speed for each prime mover.
   d. Record voltage and frequency overshoot for each prime mover.

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e. Observe and record time required to achieve steady-state condition.

f. Record voltage, frequency and amperes.

g. Record oil pressure, water temperature where applicable and battery charge rate at first load acceptance and at 15 minute intervals thereafter for each prime mover.

5. Cycle crank test:

   a. Perform test for each prime mover.

      1) Utilize any method recommended by manufacturer to prevent prime mover(s) from running.

      2) Put control switch into "run" position to cause prime mover to crank.

   b. A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration.

      1) Upon starting and running of the prime mover, further cranking shall cease.

      2) Two (2) means of cranking termination shall be utilized so that one (1) will act as a backup to the other to prevent inadvertent starter engagement.

      3) Cranking limiter time shall be 75 seconds for cycle crank.

6. Furnish load banks of required ratings necessary for tests.

7. Record engine fuel consumption by means of test equipment.

8. Test all safeties specified for generator instruments and controls and generator remote annunciator panel as recommended by manufacturer and as required to verify proper operation.

9. Contractor shall be responsible for fuel and all consumables use during the test.

END OF SECTION

SECTION 26 33 00 -BATTERY AND BATTERY CHARGING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Batteries.

b. Battery charging system.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions

B. Section 01 65 50 - Delivery, Storage and Handling

C. Section 26 05 00 - Electrical: Basic Requirements.

D. Section 26 05 98 - Power Distribution Center – Gear Houses.

E. Section 26 13 13 - Medium Voltage Metal-Clad Paralleling Switchgear.

1.03 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

2. 485, Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.

3. 1106, Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.

4. 1115, Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications.

C. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

2. PE 5, Utility Type Battery Chargers.

D. Underwriters Laboratories, Inc. (UL):

1. 94, Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

2. 1012, Power Units Other Than Class 2.

E. Building code:

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1. International Code Council (ICC):
    a. International Building Code and associated standards, 2012 Edition including all amendments, referred to herein as Building Code.

1.04 SYSTEM DESCRIPTION

A. The battery system will be 125Vdc nominal. It will serve MEDIUM VOLTAGE METAL-CLAD PARALLELING SWITCHGEAR. (26 13 13)

1.05 SUBMITTALS

A. Shop Drawings:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Product technical data including:
        a. Provide submittal data for all products specified in PART 2 of this Specification:
        b. Calculations used to size the batteries and chargers in accordance with the specified duty and criteria.
        c. See Section 26 05 00 for additional requirements.
    3. Fabrication and/or layout drawings:
        a. General arrangement drawing.
        b. Cross sections, elevations and details.
        c. Battery cell layout drawing to facilitate the installation process.
        d. Location in the Power Distribution Center – Gear House.
    4. Certifications:
        a. Guarantee of performance.
B. Operation and Maintenance Manuals:
    1. See Specification Section 01 33 00 for requirements for:
        a. The mechanics and administration of the submittal process.
        b. The content of Operation and Maintenance Manuals.
    2. See Specification Section 26 05 00 for additional requirements.
C. Informational Submittals:
    1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
    2. Qualifications of system designer.
    3. Record of test results, inspections and procedures witnessed or performed by factory service representative.

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1.06 QUALITY ASSURANCE

A. Qualifications:

1. Battery system design shall be by personnel skilled in the design and construction of the system.

a. Experienced in design projects of similar size and character as required for this work.

b. Battery system furnished shall use standard components assembled in a general configuration having acceptable history of service in similar applications for more than three (3) uninterrupted years.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Section 01 65 50.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:

1. Altitude: refer to Special Conditions

2. Specifier: Consult the appropriate building code and include seismic design requirements as necessary.

3. Normal operating conditions: Indoor, air-conditioned environment; nominal +15 to +26 DegC.

4. Maximum temperature: 40 DegC (contingency situation).

5. Minimum temperature: 0 DegC (contingency situation).

B. Incorporate Batteries and Battery System Chargers into the Power Distribution System - Gear House. Include all required clearances, racks and fastening hardware.

1. Paralleling Gear Manufacturer shall provide the Batteries and Battery System Chargers as a complete package.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Alcad.

2. C&D.

3. Enersys.

4. GNB.

5. Hoppecke.

6. Stored Energy Systems.

B. Submit request for substitution in accordance with Specification Section 26 05 00.

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2.02 MANUFACTURED UNITS

A. Valve-Regulated Type Lead Acid Battery (VRLA):

1. General:
   a. AGM (absorbed glass mat) type.
   b. Lead-calcium or lead-antimony.
   c. Flat plate type construction.
   d. Electrolyte: Within the plates and separators.
   e. Cells: No residual free or bulk liquid electrolyte.
2. Battery ratings:
   a. Minimum voltage: 110 Vdc.
   b. Nominal voltage: 125 Vdc.
   c. Maximum voltage: 140 Vdc.
   d. Minimum voltage per cell: 1.75 Vdc.
   e. Float voltage: 2.25 +/-0.01 V per cell.
   f. Battery life: 10 years minimum.
3. Minimum initial specific gravity: 1.30 at 25 DegC.
4. Each cell shipped completely assembled:
   a. Filled with electrolyte.
   b. Fully charged within one (1) week of shipment to at least 90 percent capacity and ready for service.
5. Battery housing:
   a. Heat resistant and flame retardant.
   b. Shock absorbing PVC or ABS conforming to UL 94 V-0 flame retardency.
   c. Cover and case cemented together for permanent leak proof bond with adequate space for sediment below the plates.
   d. Mark each container with month/year of manufacturer.
6. The cell cover is to incorporate a low-pressure valve with flame arrester element and a vent to avoid flashback explosions into the cell and to provide a release of gas pressures.
7. Cell terminal posts;
   a. Sealed against any seepage of electrolyte.
   b. Inserted and suitable for bolted connections.
   c. Equipped with connector bolts and nuts.
   d. High capacity cells: Designed with a solid copper core.
8. Intercell and interstep connectors:

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a. Capable of carrying the 1 minute current rating of the battery.

b. Constructed to reduce mechanical stress and tensions caused by thermal expansion.

B. Battery Charger:

1. Controller:

a. Microprocessor controlled:

1) Programmable customized alarms.

2) Display both volts and current simultaneously.

2. Rating:

a. Input voltage: 120 Vac.

1) Voltage deviation: +10 percent.

b. Input phase: 1 PH.

c. Output voltage: 125 Vdc.

d. Output current: Adjustable from 60 percent to 110 percent of nominal rating.

e. Maximum RMS ripple voltage: 30mV when connected to battery.

f. Used in a DC system consisting of lead-acid batteries and used to maintain the battery in fully charged condition by float charge and to supply DC power to continuous load.

g. Service:

1) Used to supply "equalizing charge" to the battery while simultaneously supplying DC power to the continuous loads.

a) The equalizing charge rate is to be sufficient to fully charge the battery.

b) Sized to meet the requirements of the specification, from its fully discharged condition in 16 HRS while also energizing the continuous load.

c) For any setting of the output voltage within the "equalizing charge voltage setting range", the output voltage shall not vary beyond +0.5 percent under full load condition and input supply voltage and frequency variations.

2) The transfer from "floating charging" to "equalizing charging" service is to be automatic.

a) The float charge rate is to be sufficient to maintain the battery in its fully charged condition while serving the continuous load.

b) For any setting of the output voltage within the "float charge voltage setting range" specified, the output voltage shall not vary beyond +0.5 percent for any load variation from 0 percent to 100 percent and input supply voltage and frequency variations indicated.

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3) The return to float charge service is to be automatic after the time set on an adjustable timer.

h. Current limiting circuitry:

1) Limit the output current to a value which will not cause any damage or blow the fuses.

2) The charger voltage is to automatically return to normal value when the overload or short circuit is removed.

i. The charger shall be self-protecting against all AC and DC transients.

1) The charger shall be designed with or without the option of a blocking diode to prevent power feedback from the batteries during input AC supply failure or a charger internal failure.

2) Upon restoration of AC supply, the pre-set charging rate shall be resumed automatically.

3. Charger enclosure:

a. NEMA 1 cabinet.

b. Hinged door on which controls and instruments are mounted.

c. Provisions for either floor mounting on stand or wall mounting.

4. Protective devices:

a. Input circuit breaker with thermal magnetic trip element, operable for the front.

b. Two-pole output DC circuit breaker with thermal magnetic trip element, operable from the front.

5. Provide with the following:

a. Alarm light for each alarm relay.

b. Input AC circuit breaker.

c. Output DC circuit breaker.

d. Output DC voltmeter and ammeter.

e. Input AC failure alarm.

f. Ground fault detector.

g. Output DC failure alarm.

h. High charge volt alarm.

i. High DC voltage shutdown.

j. Low charge volt alarm.

k. Load current display.

l. Adjustable timer.

m. Input voltage lightning arrestors.

C. Battery Rack and Accessories:

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1. Rack:
    a. Tiered configuration.
    b. Constructed of phosphatized steel, coated with powder epoxy acid resistant ASA #61 gray coating or epoxy powder-coated and polyethylene power coated, acid and alkali resistant.
2. Accessories:
    a. No-oxide grease in sufficient quantity to coat all posts and connectors.
    b. Anti-corrosion compound for battery connections.
    c. Inter-cell connectors (including interstep connectors).
    d. Individual cell number labels.
    e. Two (2) solderless lugs for customer use.

D. Miscellaneous:
1. Battery safety switch: Fused, two-pole NEMA 1 enclosure, heavy duty class and rated as required.
2. DC Panelboard:
    a. 100Amp.
    b. 18 Circuit with 20A breakers.
    c. 10 kaic.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Battery amp-hour and battery charger ratings to be sufficient for the following emergency duty cycle (calculations to be performed by supplier and presented to engineer for review) (See Figure 1):
1. Continuous non-emergency amperes before the emergency duty cycle begins:
2. Length of emergency duty cycle (Time "W"): 8 HRS.
3. Load "A" during first minute (Time "X") of duty cycle:
4. Load "B" during next time period (Time "Y"):
5. Duration of time period "Y": Time "W" minus Time "X" minus Time "Z".
6. Load "C" during next time period (Time "Z"):
7. Duration of time period "Z": 6 minutes.
8. Design factors:
    a. Aging factor: 1.25.
    b. Design factor: 1.15.
9. Battery sized with the capability of supplying the specified emergency duty cycle throughout its life with the initial discharge capacity of the battery at 100 percent of rated discharge capacity.
10. Battery capacity includes the voltage drop across the connectors.

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11. Battery sized to support the above duty cycle with a minimum electrolyte temperature of 0 DegC.

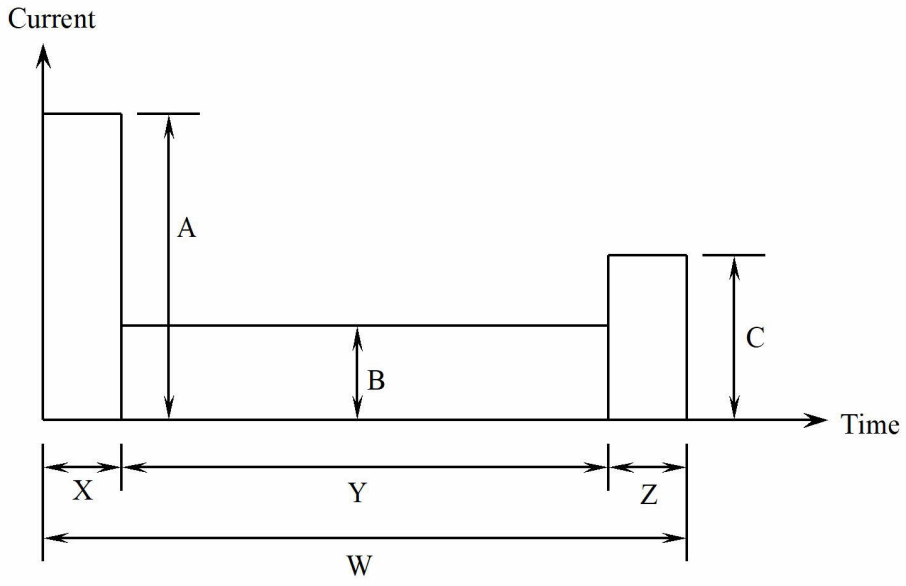


Figure 1 – Emergency Duty

2.04 SOURCE QUALITY CONTROL

A. The battery and charger are to be inspected and tested for conformance with the specifications prior to shipment.

1. An Owner may be present for all witness testing and inspections.

2. The representative shall notify Owner of all tests and inspections at least three (3) weeks prior to conducting said test or inspection.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a complete installation.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. Inspect the general assembly of the equipment to insure that the battery and charger conform to the Contract Drawings, procedures, and specifications.

2. Provide inspection and test procedures for the battery and charger in accordance with the manufacturer's instructions.

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3. The battery and charger performance test are to be conducted in accordance with the manufacturer's instructions.

B. Provide field services to handle correction of errors, discrepancies or omissions in the equipment and materials furnished.

END OF SECTION

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SECTION 26 36 13 - MANUAL TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Manual transfer switches.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 28 00 – Overcurrent and Short Circuit Protective Devices.

C. Section 26 32 14 Engine Generator Diesel.

1.03 REFERENCED STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE):

1. 446, Recommended Practice of Emergency and Standby Power Systems for Commercial and Industrial Applications.

B. National Electrical Manufacturers Association (NEMA):

1. ICS 10, Guide to Application of Low-voltage Automatic transfer switch Equipment.

C. National Fire Protection Agency (NFPA):

1. 70, National Electrical Code (NEC).
2. 101, Life Safety Code.
3. 110, Standard for Standby Power Systems.

D. Underwriters Laboratories, Inc. (UL):

1. 1008, Standard for Safety Transfer Switch Equipment.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   b. Provide a table that associates safety switch model number with connected equipment tag number.
   c. See Specification Section 26 05 00 for additional requirements.

B. Operation and Maintenance Manuals:

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1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.
2. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following automatic transfer switch manufacturers are acceptable:
    1. Square D.
    2. Automatic Switch Company.
    3. Eaton.
    4. Russelectric, Inc.
    5. Zenith Controls, Inc.

2.02 GENERAL

A. General:
    1. Switches shall form a complete grounded, continuous duty, integral assembly which is metal enclosed, dead front.
    2. Switches shall be UL listed per applicable UL standards as a recognized component for emergency systems and rated for all classes of loads.
    3. Suitable for environment where installed.
    4. Shall be fully rated for all types of load, inductive and resistive, without over sizing.

B. Construction:
    1. Switches shall be manually operated by permanently attached manual operator.
    2. Transfer switch shall be mechanically interlocked to prevent cross connection of sources when operated.
    3. Switches shall be capable of being operated manually under full rated load conditions. Removable manual operating handles are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.
    4. The neutral, where present, shall not be switched. A solid neutral block shall be provided for termination on neutral conductors.
    5. Power connection lugs and wiring shall be screw type or compression type, suitable for 75 degrees C (minimum) rated copper conductors.
    6. LED indicating lights shall be provided; one to indicate when switch is connected to the normal source (green) and one to indicate when switch is connected to the emergency source (red).

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7. Switch position shall be padlockable in normal or emergency source position.

C. Ratings:

1. Rated for 100% connected load for continuous duty.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
   a. Non-fused: 10,000A.
   b. Fused: 200,000A.

D. Auxiliary contacts:

1. Two auxiliary contacts that close when automatic transfer switch is connected to normal source, rated 10 amps, 480 volts, 60 hertz. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.
2. Two auxiliary contacts that close when automatic transfer switch is connected to emergency source, rated 10 amps, 480 volts, 60 hertz. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.

E. Enclosures:

1. NEMA 1 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. With or without knockouts, hinged and lockable door.
2. NEMA 3R rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. With or without knockouts, hinged and lockable door.
3. NEMA 4 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
4. NEMA 4X rated (metallic):
   a. Body and cover: Type 304 or 316 stainless steel.
   b. No knockouts, external mounting flanges, hinged and gasketed door.
5. NEMA 4X rated (nonmetallic):
   a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
   b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

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6. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Torque bus connections and tighten mechanical fasteners.

D. Inspect all wiring to be certain wiring does not interfere with switch operation, is not damaged as door opens and closes, does cont contact sharp or abrasive surfaces, and is not left loose or unconnected.

E. Adjust operating mechanisms for free mechanical movement.

F. Clean the interior of switch enclosure of debris.

G. Double check the phase rotation on three phase units. The normal side phase rotation must match the emergency side phase rotation.

H. Verify that remote start connections are correct.

I. Install floor mounted transfer switches on a reinforced concrete pad at least 3 IN beyond the switch enclosure, unless noted otherwise. Bolt switch to housekeeping pad using 3/8 IN minimum galvanized bolts and anchors on 30 in maximum centers. Refer to Section 26 05 00 for additional requirements.

J. Permitted uses of NEMA 1 enclosure:
    1. Surface in areas designated dry in architecturally finished areas.

K. Permitted uses of NEMA 3R enclosure:
    1. Surface mounted in exterior location.

L. Permitted uses of NEMA 4 enclosure:
    1. Surface mounted in areas designated as wet.

M. Permitted uses of NEMA 4X metallic enclosure:
    1. Surface mounted in areas designated as wet and/or corrosive.

N. Permitted uses of NEMA 4X nonmetallic enclosure:
    1. Surface mounted in areas designated as corrosive.
    2. Surface mounted in areas designated as highly corrosive.

O. Permitted uses of NEMA 12 enclosure:
    1. Surface mounted in areas designated as dry in non-architecturally finished areas.

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P. Touch up scratched or marred surfaces to match original finish.

Q. Provide identification nameplate as indicated on the drawings per Specification Section 26 05 00, 3.01.Q.

R. Install arc flash hazard labels in accordance with requirements of Section 26 99 00.

END OF SECTION

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SECTION 26 36 23 - AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Automatic transfer switches.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 - Electrical: Basic Requirements.

B. Section 26 28 00 – Overcurrent and Short Circuit Protective Devices.

C. Section 26 32 14 – Engine Generator Diesel.

1.03 REFERENCED STANDARDS

A. American National Standards Institute/ Institute of Electrical and Electronic Engineers (ANSI/IEEE):

1. C37.90a, Surge Voltage Withstand.

B. Institute of Electrical and Electronic Engineers (IEEE):

1. 446, Recommended Practice of Emergency and Standby Power Systems for Commercial and Industrial Applications.

C. National Electrical Manufacturers Association (NEMA):

1. ICS 10, Guide to Application of Low-voltage Automatic transfer switch Equipment.
2. ICS-109.21, Impulse Withstand Voltage Test.

D. National Fire Protection Agency (NFPA):

1. 70, National Electrical Code (NEC).
2. 101, Life Safety Code.
3. 110, Standard for Standby Power Systems.

E. Underwriters Laboratories, Inc. (UL):

1. 1008, Standard for Safety Transfer Switch Equipment.

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.

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b. Provide a table that associates safety switch model number with connected equipment tag number.

c. See Specification Section 26 05 00 for additional requirements.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following automatic transfer switch manufacturers are acceptable:

1. Cummins.
2. ASCO.
3. Automatic Switch Company.
4. Kohler.
5. Onan.
6. Russelectric, Inc.
7. Zenith Controls, Inc.

2.02 GENERAL

A. General:

1. Switches shall form a complete grounded, continuous duty, integral assembly which is metal enclosed, dead front.
2. Switches shall be UL listed per applicable UL standards as a recognized component for emergency systems and rated for all classes of loads.
3. Suitable for service entrance when required.
4. Suitable for environment where installed.
5. The neutral, where present, shall not be switched. A solid Neutral block shall be provided for termination on neutral conductors.
6. Sizes rated below 400 amperes shall also be rated for 100% tungsten lamp loads.

B. Ratings:

1. Rated of connected load.
2. Voltage and amperage: As indicated on the Drawings.

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3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Operation:
1. Switch shall be capable of automatic operation without intervention, perform the basic function of transferring the load to the available power source. A controller shall monitor each source for allowable voltage and frequency. The unit shall perform the following functions:
    a. Sense the interruption of utility power.
    b. Send a start signal to the generator when utility power is unavailable.
    c. Transfer the load to the generator.
    d. Retransfer the return to utility power when it becomes available.
    e. Send a stop signal to the generator.
2. Three phase automatic transfer switches shall monitor all line-to –line phases of the normal and emergency source with close differential voltage sensing.
3. The pickup voltage shall be adjustable from 85% to 95% nominal.
4. The dropout voltage shall be adjustable from 70% to 90% of nominal.
5. The starting of the emergency source will be initiated upon normal source failure or upon reduction of the normal source voltage to 90% of normal voltage.
6. The pickup frequency shall be adjustable from 90% of nominal frequency.

D. Time Delay:
1. A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. The time delay shall be field adjustable from 0.5 to 10 seconds.
2. A time delay to transfer to emergency shall be field adjustable from 0 to 60 seconds.
3. A time delay on transfer to normal source shall be automatically bypassed if the emergency source fails and normal source is available. The time delay shall be field adjustable from o to 30 minutes.
4. A time delay to shutdown of the generator set to provide unloaded running of the engine cool-down. The time delay shall be field adjustable from 0 to 30 minutes.
5. All time delays shall have an indicator to show the time delay setting including the units of measure used in the setting.

E. Auxiliary contacts:
1. Two auxiliary contacts that close when automatic transfer switch is connected to normal source, rated 10 amps, 480 volts, 60 hertz. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.

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2. Two auxiliary contacts that close when automatic transfer switch is connected to emergency source, rated 10 amps, 480 volts, 60 hertz. These contacts shall be in addition to those required for ATS indicators, monitoring and control interlock functions.
3. Additional contacts as required for external alarms and controls.

F. Accessories:
1. Exercise Timer
   a. A clock exerciser shall be furnished to automatically start the generator set at regular intervals and allow it to run for a preset time period. A selector switch shall permit selection of with load or without load operation. Without load the generator set runs unloaded and with load the transfer switch transfers the load to the generator after appropriate time delays in the same manner as for normal source interruption.
2. Communication Ports
   a. A RS-422 serial communications port and interface board to allow remote annunciation and control of the transfer switch from a remote annunciator or source.
3. Battery Charger
   a. A float-charge battery charger which regulates its charge voltage to continuously charge without damage to the battery.
   b. Unit shall have a 20 amp DC output breaker on the front of the battery charger and two 10 amp AC fuse to protect the charger circuit.
   c. Used to charge the generator starting and control batteries.
   d. Under normal operating conditions, low battery and AC failure relays are energized and the high battery relay is de-energized.

G. Enclosures:
1. NEMA 1 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. With or without knockouts, hinged and lockable door.
2. NEMA 3R rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. With or without knockouts, hinged and lockable door.
3. NEMA 4 rated:
   a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

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4. NEMA 4X rated (metallic):
    a. Body and cover: Type 304 or 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
5. NEMA 4X rated (nonmetallic):
    a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
6. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Operating handle padlockable in the On and OFF position.
7. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Torque bus connections and tighten mechanical fasteners.

D. Inspect all wiring to be certain wiring does not interfere with switch operation, is not damaged as door opens and closes, does cont contact sharp or abrasive surfaces, and is not left loose or unconnected.

E. Adjust operating mechanisms for free mechanical movement.

F. Clean the interior of switch enclosure of debris.

G. Double check the phase rotation on three phase units. The normal side phase rotation must match the emergency side phase rotation.

H. Verify that remote start connections are correct.

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I. Install floor mounted transfer switches on a reinforced concrete pad at least 3 IN beyond the switch enclosure, unless noted otherwise. Bolt switch to housekeeping pad using 3/8 IN minimum galvanized bolts and anchors on 30 in maximum centers. Refer to Specification Section 26 05 00 for additional requirements.

J. Permitted uses of NEMA 1 enclosure:

1. Surface in areas designated dry in architecturally finished areas.

K. Permitted uses of NEMA 3R enclosure:

1. Surface mounted in exterior location.

L. Permitted uses of NEMA 4 enclosure:

1. Surface mounted in areas designated as wet.

M. Permitted uses of NEMA 4X metallic enclosure:

1. Surface mounted in areas designated as wet and/or corrosive.

N. Permitted uses of NEMA 4X nonmetallic enclosure:

1. Surface mounted in areas designated as corrosive.
2. Surface mounted in areas designated as highly corrosive.

O. Permitted uses of NEMA 7 enclosure:

1. Surface mounted in areas designated as Class I hazardous.
2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

P. Permitted uses of NEMA 9 enclosure:

1. Surface mounted in areas designated as Class II hazardous.
2. Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.

Q. Permitted uses of NEMA 12 enclosure:

1. Surface mounted in areas designated as dry in non-architecturally finished areas.

R. Touch up scratched or marred surfaces to match original finish.

S. Provide identification nameplate as indicating on the drawings.

T. Install arc flash hazard labels in accordance with requirements of Section 29 99 00.

END OF SECTION

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SECTION 26 43 13 - LOW VOLTAGE SURGE PROTECTION DEVICES (SPD)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Type 1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), externally mounted.
2. Type 3 SPD - Medium exposure locations (switchboard, panelboard and motor control center), externally mounted.
3. Type 5 SPD - Medium or low exposure locations at individual equipment locations, external, parallel connection.

1.02 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
2. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
3. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
4. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.

B. Military Standard:

1. MIL-STD-220B, Method of Insertion-Loss Measurement.

C. National Electrical Manufacturers Association (NEMA):

1. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. LS 1, Low Voltage Surge Protective Devices.

D. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

E. Underwriters Laboratories, Inc. (UL):

1. 1283, Standard for Electromagnetic Interference Filters.
2. 1449, Standard for Safety for Surge Protection Devices.

1.03 DEFINITIONS

A. Clamping Voltage:

1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.

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2. The voltage measured at the end of the 6 IN output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:

1. The applied surge shall be induced at the 90 degree phase angle of the applied system frequency voltage.

2. The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:

1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10 percent deviation of clamping voltage at a specified surge current.

2. Listed by mode, since number and type of components in any SPD may very by mode.

E. MCC: Motor Control Center.

F. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

G. Surge Current per Phase:

1. The per phase rating is the total surge current capacity connected to a given phase conductor.

a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.

b. The N-G mode is not included in the per phase calculation.

H. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

a. Manufacturer's qualifications.

b. Standard catalog cut sheet.

c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.

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d. Testing procedures and testing equipment data.

e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).

1) Data in the Product Data Sheet heading:

a) SPD Type Number per PART 2 of the Specification.

b) Manufacturer's Name.

c) Product model number.

2) Data in the Product Data Sheet body:

a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.

b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.

c) Name of the nationally recognized testing laboratory that preformed the tests.

d) Warranty information.

3) Data in the Product Data Sheet closing:

a) Signature of the manufacturer's official (printed and signed).

b) Title of the official.

4) Date of signature.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

b. The content of Operation and Maintenance Manuals.

2. See Specification Section 26 05 00 for additional requirements.

3. Warranty.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.

a. Upon request, suppliers or manufacturers shall provide a list of not less than three (3) customer references showing satisfactory operation.

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1.06 WARRANTY

A. Minimum of a five (5) year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.01 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, NEMA LS 1, MIL-STD 220B, UL 1283, UL 1449.

2.02 MANUFACTURERS

A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:

1. Eaton.

2.03 TYPE 1 SPD

A. Product:

1. Externally mounted adjacent to switchgear, switchboards or MCCs.
2. Hybrid solid-state high performance suppression system.
    a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
3. Do not connect multiple SPD modules in series to achieve the specified performance.
4. Designed for parallel connection.
5. Enclosure:
    a. Metallic NEMA 4 or 12 for interior locations.
    b. Metallic NEMA 4 or 4X for exterior locations.
6. Field connection:
    a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors.
    b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 2 FT.
7. Device monitor:
    a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
    b. A fuse status only monitor system is not acceptable.

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B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.

1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10 percent deviation of the clamping voltage.

I. SPD Protection:

1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

		IEEE C62.41		
System Voltage	**Test Mode**	**C High V & I Wave**	**B Combination Wave**	**UL 1449**
L-L < 250 V	L-L	1470 V	1000 V	800 V
L-N < 150 V	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V	L-L	2700 V	2000 V	1800 V
L-N > 150 V	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.04 TYPE 3 SPD

A. Product:

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1. Externally mounted adjacent to switchboard, panelboards or motor control centers.
2. Hybrid solid state high performance suppression system.
    a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
3. Do not connect multiple SPD modules in series to achieve the specified performance.
4. Designed for parallel connection.
5. Enclosure:
    a. Metallic NEMA 4 or 12 for interior locations.
    b. Metallic NEMA 4 or 4X for exterior locations.
6. Field connection:
    a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors.
    b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 2 FT.
7. Device monitor:
    a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
    b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: Refer to Drawings for per phase maximum and per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

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I. SPD Protection:

1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

	Test	IEEE C62.41		
System Voltage	**Mode**	**B Comb. Wave**	**B3 Ring Wave**	**UL 1449**
L-L < 250 V	L-L	1000 V	700 V	800 V
L-N < 150 V	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V	L-L	2000 V	1400 V	1800 V
L-N > 150 V	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.05 TYPE 5 SPD

A. Product:

1. Externally mounted next to equipment or internally to control panel for point-of-use loads.
2. Hybrid solid state high performance suppression system.
   a. Do not use gas tubes, spark gaps or other suppression system components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
3. Designed for parallel connection.
4. Enclosure:
   a. Metallic NEMA 4 or 12 for interior locations.
   b. Metallic NEMA 4 or 4X for exterior locations.
5. Field connection:
   a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors.
   b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 2 FT.

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6. Device monitor:
    a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
    b. A fuse status only monitor system is not acceptable.
7. Accessories (when specifically specified): Unit mounted disconnect switch.

B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130 percent of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 120,000 A per phase, 60,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10 percent deviation of the clamping voltage.

I. SPD Protection:
1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 IN lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41 B Comb. Wave	IEEE C62.41 B Ring Wave	UL 1449
L-L < 250 V	L-L	1000 V	700 V	800 V
L-N < 150 V	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V	L-L	2000 V	1400 V	1800 V
L-N > 150 V	L-N	1150 V	8000 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

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K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.06 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:

1. Integral unit level and/or component level fusing.
2. Neutral and ground shall not be bonded during testing.
3. 6 IN lead lengths.
4. Integral disconnect switch when provided.

C. The "as installed" SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:

1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
2. Single pulse surge current capacity test.
3. Repetitive surge current capacity testing.
4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Type 1 and 3 SPD:

1. Mounting options:
   a. Nipple connection directly to the equipment to be protected.
2. Install leads as short and straight as possible.
3. Maximum lead length: 36 IN.
4. Minimum lead size: #2 stranded AWG or bus bar.
5. Connect leads to the equipment to be protected by one (1) of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
   b. Use manufacturer recommended circuit breaker size.
   c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

C. Type 5 SPD:

1. Mounting options:

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a. Nipple connection directly to the equipment to be protected.

2. Install leads as short and straight as possible.
3. Maximum lead length: 36 IN.
4. Minimum lead size:
   a. Type 5: #10 stranded AWG.
5. When conduit connection is used, provide a minimum of four (4) twists per foot in the lead conductors and install in NFPA 70 sized conduit.
6. Connect leads to the equipment to be protected by one (1) of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
      1) Use manufacturer recommended circuit breaker size.
   b. Directly to the protected equipment bus, when SPD has integral disconnect switch.
   c. To the load side of field mounted equipment's local disconnect switch.
      1) Provide taps or lugs as required to provide a UL and NFPA 70 compliant connection.

END OF SECTION

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SECTION 26 50 00 - INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Interior building and exterior building mounted luminaires.

b. Exterior and site luminaires.

c. Lamps and light-emitting diodes (LEDs).

d. Ballasts and drivers.

e. Light poles.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Division 03 - Concrete.

B. Section 26 05 00 - Electrical: Basic Requirements.

C. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

D. Section 26 09 16 - Control Panels.

1.03 REFERENCED STANDARDS:

A. American Association of State Highway and Transportation Officials (AASHTO):

B. Technical Bulletin No. 270 - A Guide to Standardized Highway Lighting Pole Hardware (LPH-1).

C. American Concrete Institute (ACI):

1. 301, Specifications for Structural Concrete.

D. American National Standards Institute (ANSI):

1. C78.377, Specification for the Chromaticity of Solid State Lighting Products.

E. American Society of Mechanical Engineers (ASME):

1. B18.2.2, Square and Hex Nuts (Inch Series).

2. B18.5, Round Head Bolts (Inch Series).

F. ASTM International (ASTM):

1. A36, Standard Specification for Carbon Structural Steel.

2. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

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4. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
5. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
6. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
7. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
8. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
9. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
10. A635, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

G. Alliance for Telecommunications Industry Solution (ATIS):
   1. O5.1, Wood Poles - Specifications and Dimensions.

H. American Wood Protection Association (AWPA) Book of Standards

I. Certified Ballast Manufacturers (CBM).

J. Federal Communications Commission (FCC):
   1. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.

K. International Electrotechnical Commission (IEC).

L. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

M. Illuminating Engineering Society of North America (IESNA):
   1. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
   2. LM-80, Measuring Lumen Maintenance of LED Light Sources.

N. National Electrical Manufacturers Association (NEMA):
   1. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
   2. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts.
   3. LE 4, Recessed Luminaires, Ceiling Compatibility.

O. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
   1. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.

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2. C82.4, Ballasts for High-Intensity Discharge (HID) and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
3. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.
4. SSL 1, Electronic Drivers for LED Devices, Arrays and Systems.

P. National Fire Protection Association (NFPA):
1. 70, National Electrical Code (NEC).
2. 101, Life Safety Code.

Q. Society of Automotive Engineering (SAE):
1. J429, Mechanical and Material Requirements for Externally Threaded Fasteners.

R. Underwriters Laboratories, Inc. (UL):
1. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
2. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
3. 924, Standard for Emergency Lighting and Power Equipment.
4. 935, Standard for Fluorescent-Lamp Ballasts.
5. 1012, Power Units Other Than Class 2.
6. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
7. 1310, Class 2 Power Units.
8. 1598, Luminaires.
9. 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.

S. United States Department of Energy (USDOE):
1. EPAct, the National Energy Policy Act.

1.04 DEFINITIONS

A. Average Rated Life for HID and fluorescent luminaire light sources:
1. The time after which 50 percent of a large group of light sources will have failed and 50 percent will have survived under normal operating conditions.

B. Useful Life for LED luminaire light sources:
1. The operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
2. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

1.05 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:

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a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. Identify luminaire by Luminaire Schedule designation.

c. Luminaire data sheet:

1) Name of manufacturer.

2) Complete order information (catalog number).

3) Description of construction and optics.

4) Total input wattage.

5) Luminous efficacy (lumens/Watt).

6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.

7) Dimensional size.

8) Weight.

9) UL nameplate data for luminaires used in Class I, Division 1 and 2 areas.

10) Effective Projected Areas (EPA) for pole mounted luminaires.

d. Solid state Luminaire additional data:

1) Voltage.

2) Initial and IES L70 lumens.

3) Luminous efficacy (lumens/Watt).

4) Correlated Color Temperature (CCT).

5) Color Rendering Index (CRI).

6) Total Harmonic Distortion (THD).

7) Lamp life.

8) Driver manufacturer and model number.

9) Driver life.

10) Emergency battery driver:

a) Compatibility with lighting module.

b) Lumen output of lighting module in emergency operation.

c) Battery life.

d) Description of testing.

e) Ambient operating temperature.

11) Toxicity Characteristic Leaching Procedure (TCLP) compliance.

12) Warranty information.

e. Luminaire lamp data sheet:

1) Name of manufacturer.

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2) Complete order information (catalog number).
3) Wattage.
4) Initial and mean lumens.
5) Luminous efficacy (lumens/Watt).
6) Correlated Color Temperature (CCT).
7) Color Rendering Index (CRI).
8) Lamp life.
9) Base configuration.
10) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
11) Warranty information.

f. Luminaire ballast data sheet:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Type and quantity of lamps it operates.
4) Ballast factor.
5) Input Wattage.
6) Inrush current.
7) Voltage.
8) End-of-life sensing shut off.
9) Total Harmonic Distortion (THD).
10) T8 linear lamps: NEMA Premium mark.
11) Emergency battery ballast:
a) Lumen output of lamp in emergency operation.
b) Battery life.
c) Description of testing.
12) Warranty information.

g. Luminaire halogen low voltage transformer:
1) Name of manufacturer.
2) Complete order information (catalog number).
3) Type and quantity of lamps it operates.
4) Power rating.
5) Voltage.
6) Overload protection.
7) Remote mounting distance.

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8) Dimming operation:
   a) Dimming range.
   b) Compatible dimming control devices.

h. Pole data sheet:
   1) Name of manufacturer.
   2) Complete order information (catalog number).
   3) Description of construction.
   4) Length, shaft size and thickness.
   5) Wind loading (available luminaire EPA per wind speed).
   6) Anchor bolt template.
   7) Bolt size and material.
   8) Luminaire

i. See Specification Section 26 05 00 for additional requirements.

3. Test Reports:
   a. IES LM-79 Test Report for Solid-State Luminaire.
   b. IES LM-80 Test Report Solid-State Light Source.
4. Certifications: Solid-state Luminaire Useful Life Certificate.

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
   2. The content of Operation and Maintenance Manuals.
      a. Submittal data for each component covered by warranty.
      b. Warranty.

1.06 WARRANTY

A. Minimum of a two (2) year Warranty from date of manufacture against failure for electromagnetic HID ballasts.

B. Minimum of a five (5) year Warranty from date of manufacture against failure for electronic HID ballasts.

C. Minimum of a five (5) year Warranty from date of manufacture against failure for electronic fluorescent ballasts.

D. Minimum of a five (5) year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15 percent of the individual light emitting diodes fail to illuminate.

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PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Luminaires: Per Luminaire Schedule.
2. Lamps:
    a. Philips Lighting Company.
3. Solid State Light Sources:
    a. Cree.
    b. Xicato.
    c. Luminaire manufacturer's proprietary system.
4. Ballasts:
    a. Luminaire manufacturer's standard.
5. LED Driver: Luminaire manufacturer's standard.
6. Emergency ballasts:
    a. Philips Bodine.
7. High bay luminaire lowering device.
    a. Lighting and Lowering System by North Star Lighting.
8. Poles: Luminaire manufacturer's standard.
9. Power installed pole foundation anchors:
    a. AB Chance.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

2.02 GENERAL REQUIREMENTS

A. All Luminaires and Electrical Components:

1. UL labeled.
2. Luminaires complete with lamps and ballasts or LED modules and drivers.
3. Rated for area classification as indicated on the Drawings.
    a. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and lamp or LED combination shall not exceed the auto-ignition temperature of the atmosphere in which the Luminaire is used.

B. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.

1. Provide recessed luminaires with trim gaskets cemented in proper position.

C. Provide standard plaster frame for all recessed luminaires installed in plaster walls or ceilings.

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1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

D. Coordinate luminaire mounting where recessed into building canopies prior to Submitting Shop Drawings. Confirm clearances and luminaire flange compatibility with construction.

E. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.

F. No live parts normally exposed to contact.

G. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

H. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

2.03 LUMINAIRES

A. Standards:

1. UL 1598.
2. UL 844 for hazardous locations.
3. NEMA LE 4 for recessed locations.

B. Housings:

1. As indicated in the Luminaire Schedule.

C. Trim (Recessed Mounted):

1. As indicated in the Luminaire Schedule.

D. Castings:

1. As indicated in the Luminaire Schedule.

E. Fasteners:

1. As indicated in the Luminaire Schedule.

F. Finishes:

1. As indicated in the Luminaire Schedule.

G. Lens/Louver Frames:

1. As indicated in the Luminaire Schedule.

H. Lenses:

1. As Indicated in the Luminaire Schedule.

I. Reflectors:

1. As Indicated in the Luminaire Schedule.

J. Gaskets:

1. As Indicated in the Luminaire Schedule.

K. Ventilation:

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1. Ventilation openings of adequate size and quantity to permit operation of lamps and ballast without affecting rated output or life expectancy. Include wire mesh screens.

L. Lamp Holders:

1. Position sockets so that lamps are in optically correct relation to luminaire components.
2. Secure sockets by screws to luminaire enclosure or husk. Spring mounted sockets are not approved. Do not use plastic or sheet metal sockets unless specified otherwise.
3. Sockets with open circuit voltage over 300 volts: Safety type, designed to open supply circuit upon lamp removal.
4. Mount lamp holders such that fluorescent lamps on rapid-start circuits are within 1 IN of grounded metal, a minimum of 1IN wide for full length of lamp.
5. Fluorescent: White urea plastic body; silver plated phosphor bronze or beryllium copper contacts.
6. High Intensity Discharge: Porcelain body; nickel plated brass socket, pre-lubricated with silicone compound. Lamp supplied must be compatible with socket orientation (horizontal, base up or base down).

M. Wiring:

1. Factory-wired to be compatible with the project electrical and controls systems.
2. Long tube fluorescent luminaires shall comply with NEC requirements and be supplied with a quick disconnect accessible to qualified persons before servicing or maintaining the ballast.
3. Thermally protect halogen and HID luminaires.

N. Mounting Accessories:

1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during relamping or cleaning.
3. Recessed Luminaires:
    a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
    b. Baffles and Gaskets: As required to prevent light leakage.
    c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
4. Luminaire Suspension Material:
    a. Unfinished Spaces:
        1) 1/2 IN minimum diameter swivel stem, unless otherwise noted.
        2) Safety chain on high bay type.

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b. Finished Spaces: Unless otherwise noted.

1) Manufactured cable or stem and outlet box canopy.

a) Contemporary design with swivel self-aligning features.

b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.

c) Finish to match luminaire.

2) Coordinate pendant location with ceiling tiles/ceiling grid.

a) Submit coordinated mounting accessories as part of Shop Drawing submission.

3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.

4) For high intensity discharge lamps:

a) Use stems suspended from swivel shock-absorbing fittings.

2.04 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:

1. IES LM-79, LM-80.
2. NEMA SSL 1.
3. UL 1012, 1310, and 8750.
4. UL 844 for hazardous locations.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:

1. Maximum uniform color temperature of 4,500K.
2. Minimum color rendering index (CRI) of 80.
3. LED module light output and efficacy: Measured in accordance with IES LM-79 standards.
4. LED useful life and lumen maintenance: Measured in accordance with IES LM-80 standards.
5. Driver and LED module: Minimum useful life of 50,000 HRS.
6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:

1. Compatible with solid-state modules and control devices specified.
2. Operate from 60 Hz input source of 120V through 480V with sustained variations of +/- 10 percent (voltage and frequency).

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3. Input current Total Harmonic Distortion (THD): Less than 20 percent when operated at nominal line voltage.
4. Power Factor: Greater than 0.90.
5. Avoid interference with infrared devices and eliminate visible flicker.
6. Comply with ANSI C62.41 Category A for Transient protection.
7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
8. Dimmable drivers capable of continuous dimming over a range of 100 percent to 1 percent of rated lumen output. Dimming controlled by a 0-10VDC signal, unless otherwise specified in Luminaire Schedule.
9. Control device must be compatible with type of driver, and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.
10. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:
1. Standard: UL 924.
2. Confirm compatibility with LED modules utilized.
3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger and electronic circuitry.
4. A solid state charging indicator light to monitor the charger and battery.
5. Single-pole test switch.
6. The following product family shall be selected based on coordination with LED lamp type:
a. Philips Bodine "BSL23C": can operate up to 4.5W at 410mA.
b. Philips Bodine "BSL26C": can operate up to 5.1W at 265mA.
c. Philips Bodine "BSL722": can operate up to 23W at 770mA.
d. Philips Bodine "BSL23C": can operate up to 23W at 770mA in operating conditions ranging from -20 DegC (-4 DegF) to 60 DegC (140 DegF).
e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
1. Provide ambient operating temperature range for which product is warrantied.

2.05 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:
1. UL 924.

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2. NFPA 101.
3. Local State or City requirements.

B. Exit Signs:
1. Housing and finish: As indicated in the Luminaire Schedule.
2. LED illuminated with integral driver.
3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
4. Battery powered units:
a. Battery type: As indicated in the Luminaire Schedule.
b. Self-testing/self-diagnostic.
1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
c. Consist of batter, charger and electronic circuitry.
d. Solid state charging indicator light to monitor the charger and battery.
e. Single-pole test switch.

C. Emergency Lighting Units:
1. Housing: As indicated in the Luminaire Schedule.
2. Lamps: As indicated in the Luminaire Schedule.
3. Battery type: As indicated in the Luminaire Schedule.
4. Self-testing/self-diagnostic.
a. Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
5. Consist of battery, charger and electronic circuitry.
6. Solid state charging indicator light to monitor the charger and battery.
7. Single-pole test switch.

2.06 LAMPS

A. Medium Screw Base Fluorescent and Solid State:
1. Type and initial lumens as indicated in the Luminaire Schedule.
2. Size and shape coordinated with luminaire.
3. Fluorescent:
a. Self-ballasted.
b. Types: Spiral, reflector.
4. Solid state:
a. Integral driver.
b. Types: A and PAR.

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B. Fluorescent:

1. T8 (265 mA) programmed start linear medium bi-pin lamps (G13):
   a. Correlated color temperature of 3500 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 80.
   c. Minimum initial lumen ratings for each lamp type shall be as indicated on drawings.
   d. Average rated life:
      1) 30,000 HRS at 3 HRS per start.
      2) 36,000 HRS at 12 HRS per start.
   e. Low-mercury, green-tipped type manufactured to be in compliance with the EPA's Toxicity Characteristic Leaching Procedure (TCLP).
2. T4 twin-tube, quad-tube, and/or triple twin-tube compact fluorescent lamps:
   a. Correlated color temperature of 3500 degrees Kelvin.
   b. Minimum color rendering index (CRI) of 80.
   c. Minimum initial lumen ratings for preheat 2-pin twin-tube lamps with a G23 or GX23 base shall be:
      1) 600 lumens for 6.5 IN, 9 watt CFT9W lamp.
      2) 825 lumens for 7.1 IN, 13 watt CFT13W lamp.
   d. Minimum initial lumen ratings for rapid-start 4-pin quad-tube lamps with a G24q-1, G24q-2 or G24q-3 base shall be:
      1) 900 lumens for 5.2 IN, 13 watt CFQ13W lamp.
      2) 1200 lumens for 5.8 IN, 18 watt CFQ18W lamp.
      3) 1710 lumens for 6.5 IN, 26 watt CFQ26W lamp.
   e. Minimum initial lumen ratings for rapid-start 4-pin triple twin-tube lamps with a GX24q-2 or GX24q-3 base shall be:
      1) 1200 lumens for 4.6 IN, 18 watt CFTR18W lamp.
      2) 1710 lumens for 5.2 IN, 26 watt CFTR26W lamp.
      3) 2200 lumens for 5.8 IN, 32 watt CFTW32W lamp.
      4) 3200 lumens for 6.3 IN, 42 watt CFTR42W lamp.
   f. Average rated life:
      1) 12,000 HRS at 3 HRS per start.
   g. Low-mercury, green-tipped type manufactured to be in compliance with the EPA's Toxicity Characteristic Leaching Procedure (TCLP).

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C. High Intensity Discharge (HID) Lamps:

1. Metal halide lamps:
   a. In an open luminaire, the lamp shall be rated for use in an open luminaire and incorporate a protective arc tube shroud design.
   b. Medium base pulse-start (pulse-strike) lamps.
      1) Coated lamps shall have a correlated color temperature of 3000 degrees Kelvin.
      2) Minimum color rendering index (CRI) for coated lamps is 85.
      3) Minimum initial lumen ratings for metal halide lamps with a medium base shall be as indicated on drawings.
      4) Average rated life:
         a) 10,000 HRS for 50 watt lamps.
         b) 15,000 HRS for all other lamps.
      5) Designated on the Luminaire Schedule by a 'MH' prefix.
         a) Coated lamps are designated by a '/C' suffix.
         b) Protected lamps are designated by a '/P' suffix.
   c. Mogul base pulse-start lamps:
      1) Clear lamps shall have a correlated color temperature of between 3600 and 4100 degrees Kelvin.
      2) Minimum color rendering index (CRI) for clear lamps is 62.
      3) Minimum initial lumen ratings for metal halide lamps with a mogul base in a universal position shall be:
         a) 23,000 lumens for 250 watt, ED-28 (ANSI M153/M138/E) clear lamp.
         b) 30,600 lumens for 320 watt, ED-28 (ANSI M154/M132/E) clear lamp.
         c) 42,000 lumens for 400 watt, ED-28 (ANSI M155/M135/M128/E) clear lamp.
      4) Average rated life:
         a) 15,000 HRS for 250 watt lamps.
         b) 20,000 HRS for all other clear lamps.
      5) Designated on the Luminaire Schedule by a 'MS' prefix.
2. Uncoated (clear) unless identified as coated in the luminaire schedule.
3. The specified luminaire in the Luminaire Schedule shall dictate the required lamp operating position and base type.
4. Provide lamps that have the correct bulb shape for the luminaire specified.

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2.07 BALLASTS

A. Fluorescent High-Frequency Electronic Ballasts:

1. General characteristics:

a. High frequency electronic type and operate lamp(s) at a frequency above 31 kHz to avoid interference with infrared devices and eliminate visible flicker.

1) Avoid frequency ranges of 27-31 kHz, 34-41 kHz, and 55-61 kHz.

b. Lamp Current Crest Factor of 1.7 or less.

c. Power Factor greater than 0.98.

d. Input current shall have Total Harmonic Distortion (THD) of less than 20 percent when operated at nominal line voltage with primary lamp.

e. Operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).

f. Contain auto restart circuitry in order to restart lamps without resetting power.

g. Class A sound rating or quieter.

h. Provided with integral leads or poke-in wire trap connectors color coded per ANSI C82.11.

i. Tolerate sustained open circuit and short circuit output conditions.

j. UL listed, Class P.

k. Standards:

1) UL 935.

2) ANSI C62.41 Category A for Transient protection.

3) ANSI C82.11 where applicable.

4) Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

5) NEMA 410 for in-rush current limits.

6) Manufactured in a factory certified to ISO 9001 Quality System Standards.

2. Fluorescent high-frequency electronic ballasts T8 linear lamps:

a. Programmed Start.

b. For T8 linear lamps: NEMA Premium.

c. Parallel operation providing independent lamp operation allowing remaining lamp(s) to maintain full light output when one or more lamps fail.

d. One circuit-interrupting socket per lamp.

e. Minimum Ballast Factor, unless otherwise noted in the Luminaire Schedule:

1) T8 lamps: 0.85.

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f. Minimum starting temperature:

1) Standard T8 and T5 lamps: 0 DegF.

2) Energy-saving T8 lamps: 60 DegF.

g. Tolerate operation at 158 DegF case temperature without damage.

h. Suitable to operate in:

1) Indoor conditioned spaces: 50 – 104 DegF ambient temperature.

2) Outdoor and unconditioned indoor spaces: 0 – 104 DegF ambient temperature.

i. Utilize multi-lamp ballasts in luminaires with multiple lamps unless otherwise noted in Luminaire Schedule.

j. Five year warranty from date of manufacture for operation at a maximum case temperature of 158 DegF.

3. Fluorescent high-frequency electronic ballasts T4 compact fluorescent lamps:

a. Rapid Start.

b. Contain integral end-of-life auto resetting protection.

c. Minimum Ballast Factor unless otherwise noted in Luminaire Schedule:

1) T4 lamps: 1.00.

d. Minimum starting temperature: 0 DegF.

e. Five year warranty from date of manufacture for operation at a maximum case temperature of 167 DegF.

B. Fluorescent Emergency Ballasts:

1. General characteristics.

a. UL924 listed for installation inside, on top of, or remote from the luminaire. Mount inside ballast channel of luminaire wherever possible.

b. Self-testing/self-diagnostic fluorescent emergency ballast.

1) Electronic circuitry shall be self-testing in design and automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.

c. Consist of a high temperature, maintenance-free nickel-cadmium battery, charger and electronic circuitry.

d. Solid state charging indicator light to monitor the charger and battery.

e. Single-pole test switch.

f. Mount components (battery, charger, inverter) in a common enclosure constructed of 20 gage (minimum) steel housing.

g. Provide a remote indicator light when luminaire construction prevents visible mounting within luminaire.

h. Emergency ballast shall delay AC ballast operation for approximately 3 seconds to prevent false tripping of AC ballast end-of-life shutdown circuits.

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i. Ambient temperature rating: 32 DegF to 122 DegF.

j. Five year warranty from date of manufacture.

2. Fluorescent emergency ballasts for one T8 fluorescent lamps:

a. Capable of operating fluorescent lamps at the following lumen levels initial light output in the emergency mode for a minimum of 90 minutes:

1) One (1) F32T8 lamp: 1100 lumens.

b. Suitable for indoor and damp locations and for sealed and gasketed luminaires, including luminaires rated for wet locations.

C. High Intensity Discharge (HID) Ballasts:

1. General characteristics:

a. Standards:

1) NEMA/ANSI C82.4.

2) UL 1029.

b. Produced in a factory certified to ISO 9001 Quality System Standards.

c. Contain no Polychlorinated Biphenyl (PCB's).

2. Electronic HID (Metal Halide):

a. Voltage sensing and operate from a nominal line voltage range of 120-480 volts, +/-10 percent, 50/60 Hz.

b. Furnished with integral, color-coded leads.

c. Total Harmonic Distortion (THD): Less than 15 percent.

d. Power Factor: Greater than 90 percent.

e. Lamp end-of-life detection and shutdown circuit.

f. Sound Rated A.

g. Output frequency to the lamps shall be less than 200 Hz to prevent acoustic resonance inside the lamp arc tube and to minimize visible flicker.

h. Lamp Current Crest Factor: Less than 1.5.

i. Thermally protected to shut off when operating temperatures reach unacceptable levels.

j. Meet Federal Communications Commission rules and regulations, Title 47 CFR Part 18, for Non-Consumer equipment.

k. Three-year warranty from the date of manufacture for operation at a case temperature of 122 DegF or less.

2.08 POLES

A. As Indicated in the Luminaire Schedule and the Following:

1. Designed for attached luminaire EPA with a 100 mph maximum wind velocity at the base with a 1.3 wind gust factor.

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2. Additional features:
    a. Handhole near base of pole.
    b. Grounding lug accessible at handhole.
    c. Galvanized anchor bolts.
    d. Anchor bolt covers.
    e. Vibration dampers shall be installed

B. Metal Poles:
1. Material: as indicated on drawings.
2. Shaft shape: as indicated on drawings.
3. Pole cross section: as indicated on drawings
4. Pole height: as indicated on drawings
5. Designed for attached luminaire EPA with a maximum wind velocity rating, per the Special Conditions, at the base.
6. Additional features:
    a. Luminaire mounting provisions.
    b. Handhole near base of pole.
    c. Grounding lug accessible at handhole.
    d. Galvanized anchor bolts.
    e. Anchor bolt covers.
    f. Vibration dampers, if indicated on drawings
7. Aluminum pole finish: as indicated on drawings.
8. Steel pole finish: as indicated on drawings.

C. Wood Poles:
1. Stamped and certified by AWPA and Edison Electric Institute (EEI).
2. Class 3 (minimum) conforming to ATIS O5.1.
3. Douglas Fir or Southern Yellow Pine
4. Pressure treated with Pentachlorophenol (Penta), Copper Naphthenate, Dichloro-octyl-isothiazolinone (DCOI), or Chromated Copper Arsenate (CCA) per standards of the AWPA and EEI specifications.
5. Overall pole length: As Indicated.

D. Fiberglass poles:
1. Material: Continuous fiberglass filament with thermosetting epoxy resin.
2. Direct bury installation, as indicated on drawings
3. Base plate: as indicated on drawings and factory bonded to fiberglass shaft.
4. Shaft shape: as indicated on drawings.

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5. Pole cross section: Round.
6. Pole height above grade: as indicated on drawings.
7. Designed for attached luminaire EPA with a maximum wind velocity rating, per the Special Conditions, at the base.
8. Additional features:
    a. Luminaire mounting provisions.
    b. Handhole near base of pole.
    c. Galvanized anchor bolts, if indicated on drawings
    d. Anchor bolt covers, if indicated on drawings.
    e. Vibration dampers, if indicated on drawings.
9. Finish: as indicated on drawings. Shall be UV resistant catalyzed urethane.

E. Concrete Poles:

1. Direct bury installation.
2. Steel reinforced, with 5/8 IN minimum concrete cover.
3. Concrete: Fiber reinforced, air-entrained.
4. Shaft shape: as indicated on drawings.
5. Pole cross section: as indicated on drawings.
6. Pole height above ground: as indicated on drawings.
7. Designed for attached luminaire EPA with a maximum wind velocity rating, per the Special Conditions, at the base.
8. Additional features:
    a. Luminaire mounting provisions.
    b. Handhole near base of pole.
9. Color: as indicated on drawings.
10. Finish: as indicated on drawings.
11. Sealer: as indicated on drawings.

2.09 MAINTENANCE MATERIALS

A. Furnish a minimum of 2 or 10 percent of total of each type and wattage of lamps, whichever is greater.

B. Furnish a minimum of 10 percent of total of each type and amperage of fuses for fixtures indicated to be fused.

C. Spare parts are to be stored in a box clearly labeled as to its contents.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:

1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.

1. Do not support luminaire from conduit system.

2. When luminaire is supported from outlet boxes, install per NFPA 70.

3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.

1. Luminaires up to 4 FT wide and 4 FT long: A minimum of four supporting points, one at each corner.

2. Luminaires 8 FT long: A minimum of five support points, one at center of luminaire and one at each corner.

3. Luminaires smaller than 2 FT in length: A minimum of two supporting points.

E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.

1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.

2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.

3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.

a. Chain or cable to prevent luminaire from falling more than 3 IN before the luminaire is caught by the chain or cable.

F. Pendant Mounted, Open, Industrial Fluorescent Luminaire:

1. Not in continuous rows:

a. Supported by conduit or by approved chains or cable:

b. Hardwired to ceiling mounted junction box.

2. In continuous rows:

a. Supported rigidly with conduit and fasten luminaire to each other or mount on continuous metal channel per Specification Section 26 05 00.

b. Hardwired to ceiling mounted junction box.

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c. Provide reflector alignment clips.

G. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.

1. Locate luminaires in accordance with reflected ceiling plans.

H. Locate luminaire in exact center of ceiling tile unless otherwise indicated.

1. Relocate misinstalled luminaire and replace damaged ceiling materials.

I. Mount luminaire at heights indicated in Specification Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

J. Install exterior luminaires so that water cannot enter or accumulate in the wiring compartment.

K. Where indicated, provide two-level control of three (3) and/or four (4) lamp fluorescent luminaires.

1. Provide two (2) ballasts per luminaire and control inside lamp(s) in each luminaire by one (1) switch or set of switches and the outside two (2) lamps by a second switch or group of switches.

L. Emergency Battery Ballasts:

1. Where emergency battery ballasts are shown controlled via switching device, wire ballast so lamps will not operate when normal power is available and switching device turns lights off. Lamps will operate in emergency mode regardless of switch position.

2. Luminaire manufacturer to supply the emergency battery ballasts with luminaire.

M. Ground luminaire and ballasts.

3.02 POLE INSTALLATION

A. Drawings indicate the intended location of Light Pole:

1. Field conditions may affect actual location.

2. Coordinate location with all existing or new utilities and pavement.

B. Anchor Base Plated Poles:

1. Mounted on cast-in-place foundations, as detailed on the Drawings.

a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.

2. Protect pole finish during installation.

a. Repair damage to pole finish with manufacturer approved repair kit.

C. Set wood poles straight and firm.

1. Dig holes large enough to permit proper use of tampers to the full depth of the hole.

2. Place earth into the hole in 6 IN maximum layers, then thoroughly tamped before the next layer is placed.

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3. Place surplus earth around each pole in a conical shape and packed tightly to drain water away from poles.
4. Pole setting depth: In good soil, per the "Minimum Dimensions and Setting Depths for Poles" detail in the UPRR Electrical Construction Manual. In poor soil, coordinate depth with UPRR Manager of Electrical Design.

D. Ground poles as indicated on the Drawings or Schedules.

E. Conductors:
1. See Specification Section 26 05 19 for required underground conductors.
2. Use interior building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #10 AWG minimum.

F. Overcurrent and Short Circuit Protection:
1. Protect each phase with a UL Class CC fuse:
a. Size: Three (3) times load current.
b. Standard: UL 248-4.
2. Fuseholder:
a. Watertight, in-line and break-a-way style.
b. Accept up to a 30 A, 600 V fuse.
c. Neutral conductor shall utilize a fuseholder with a solid copper rod.
d. Conductor terminal: Adequate size for the installed conductors.

3.03 LIGHTING CONTROL

A. See Specification Section 26 09 16 for lighting control equipment.

B. Exterior wall mounted and pole mounted fixtures controlled as detailed on the Drawings.

3.04 ADJUST AND CLEAN

A. See Specification Section 01 77 10.

B. Replace all inoperable lamps with new lamps prior to final acceptance.

C. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION

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SECTION 26 51 00 – HIGH MAST GENERAL AREA LIGHTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Design, material and installation requirements for:

a. High mast lighting systems including:

1) Fixtures and Fixture Components.

2) Steel Towers.

3) Foundations.

B. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.

C. The purpose of these specifications is to define the performance and design standards for High Mast Lighting equipment. The contractor shall supply lighting equipment to meet or exceed the criteria set forth in these specifications.

D. Lighting will be for the following area:

1. Railyards.

2. Intermodal Facility Lots.

3. Automotive Facility Lots.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Division 03 – Concrete.

B. Section 26 05 00 – Electrical Basic Requirements.

C. Section 26 05 19 – Wire and Cable - 600 Volt and Below.

D. Section 26 09 16 – Control Panels.

E. Section 26 50 00 – Interior and Exterior Lighting.

1.03 REFERENCED STANDARDS:

A. Union Pacific Railroad (UPRR) – Electrical Design Manual.

B. American Association of State Highway and Transportation Officials (AASHTO):

C. Technical Bulletin No. 270 - A Guide to Standardized Highway Lighting Pole Hardware (LPH-1).

D. American Concrete Institute (ACI):

1. 301, Specifications for Structural Concrete.

E. American National Standards Institute (ANSI):

1. C78.377, Specification for the Chromaticity of Solid State Lighting Products.

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F. American Society of Mechanical Engineers (ASME):

1. B18.2.2, Square and Hex Nuts (Inch Series).
2. B18.5, Round Head Bolts (Inch Series).

G. ASTM International (ASTM):

1. A36, Standard Specification for Carbon Structural Steel.
2. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. A123/A152M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel products.
4. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.
6. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.
7. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
8. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
9. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
10. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
11. A635, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.

H. Alliance for Telecommunications Industry Solution (ATIS):

1. O5.1, Wood Poles - Specifications and Dimensions.

I. American Wood Protection Association (AWPA) Book of Standards

J. Certified Ballast Manufacturers (CBM).

K. Design Lights Consortium (DLC)

L. Federal Communications Commission (FCC):

1. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.

M. International Electrotechnical Commission (IEC).

N. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.

O. Illuminating Engineering Society of North America (IESNA):

1. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
2. LM-80, Measuring Lumen Maintenance of LED Light Sources.

P. National Electrical Manufacturers Association (NEMA):
1. 250, Enclosures for Electrical Equipment (1000Volts Maximum).
2. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Fluorescent Ballasts.
3. LE 4, Recessed Luminaires, Ceiling Compatibility.

Q. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
1. C82.1, Lamp Ballasts - Line Frequency Fluorescent Lamp Ballast.
2. C82.4, Ballasts for High-Intensity Discharge (HID) and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).
3. C82.11, High-Frequency Fluorescent Lamp Ballasts - Supplements.
4. SSL 1, Electronic Drivers for LED Devices, Arrays and Systems.

R. National Fire Protection Association (NFPA):
1. 70, National Electrical Code (NEC).
2. 101, Life Safety Code.

S. Society of Automotive Engineering (SAE):
1. J429, Mechanical and Material Requirements for Externally Threaded Fasteners.

T. Underwriters Laboratories, Inc. (UL):
1. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
2. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
3. 924, Standard for Emergency Lighting and Power Equipment.
4. 935, Standard for Fluorescent-Lamp Ballasts.
5. 1012, Power Units Other Than Class 2.
6. 1029, Standard for High-Intensity-Discharge Lamp Ballasts.
7. 1310, Class 2 Power Units.
8. 1598, Luminaires.
9. 8750, Light Emitting Diode (LED) Equipment for Use in Lighting Products.

U. United States Department of Energy (USDOE):
1. EPAct, the National Energy Policy Act.

V. American Association of State Highway and Transportation Officials (AASHTO):
1. LTS 4, Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

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1.04 DEFINITIONS

A. Useful Life for LED luminaire light sources:

1. The operating hours before reaching 70 percent of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.

2. This is also known as 70 percent "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

B. Contractor: As defined in section 00 07 00 of this specification.

C. Manufacturer: Company that produces materials or equipment. In some cases, the supplier and manufacturer may be the same company.

D. Supplier/Distributor: Company providing materials to the Contractor. UPRR has purchasing agreements in place for some suppliers. See section 26 05 00 of specifications for additional information.

E. AFG: Above Finished Grade.

F. DLC: DesignLights Consortium, a non-profit organization.

G. EMI: Electromagnetic Interference.

H. EPA: Effective Projected Areas.

I. fc: Foot-candle

J. K: Kelvin, color temperature

K. kW: kilowatts.

L. LED: Light Emitting Diode.

M. PE: Professional Engineer, licensed in the State of the project location.

N. RFI: Radio Frequency Interference.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Bid Submittal – Contractor shall provide with Bid (attach in SourceHub).

a. Lighting design:

1) Photometric reports showing foot-candle levels.

a) Foot-candles levels at 25 FT calculation grid.

(1) Scale such that 25 FT foot-candle grid is legible when printed on 11x17 (ANSI B) sheet.

b) Average fc over whole area.

c) Average/Minimum (Average/Min) and Maximum/Minimum (Max/Min) calculations.

d) Pole Height, Fixtures on each pole, fixture info including wattage, lumens, optics, other options.

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2) Overall plan showing entire project area and spill light.

3) Separate plan for each area as described in paragraph 1.06 Lighting Solution Design/Verification Requirements.

4) Separate plans that Extends Calculation points outside of UP property lines until footcandle level drops below 0.1fc.

5) Luminaire aiming plan if applicable.

b. Tower Foundation design:

c. Proposed Changes to tower locations or loads from what is shown on plans shall be clearly indicated.

1) Instances where the electrical load exceeds the design load shown on the prints shall be clearly indicated.

a) Required revisions to the electrical design that support revisions to the lighting design as shown shall be the responsibility of the contractor.

(1) Updated electrical design if required shall be stamped by a professional engineer licensed in the state of install.

(2) Cost changes resulting from Changes to the electrical design shall be included in the bid.

(3) All changes shall be made in accordance with these general conditions and specs, specifically Division 26.

(4) Potential Changes include but are not limited to:

(a) Ampacity increases - Upgrade cable and conduit size accordingly.

(b) Voltage Drop increases - Upgrade cable and conduit size accordingly.

(c) Tower Location Changes - Verify Cable and Conduit sizes are appropriate.

3. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

1) Luminaires:

a) Identify luminaire by Luminaire Schedule designation.

b) Luminaire data sheet:

(1) Name of manufacturer.

(2) Complete order information (catalog number).

(3) Description of construction and optics.

(4) Total input wattage.

(5) Luminous efficacy (lumens/Watt).

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(6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.

(7) Dimensional size.

(8) Weight.

(9) UL nameplate data for luminaires used in Class I, Division 1 and 2 areas.

(10) Effective Projected Areas (EPA) for pole mounted luminaires.

(11) DLC certification

c) Solid state Luminaire additional data:

(1) Voltage.

(2) Initial and IES L70 lumens.

(3) Luminous efficacy (lumens/Watt).

(4) Correlated Color Temperature (CCT).

(5) Color Rendering Index (CRI).

(6) Total Harmonic Distortion (THD).

(7) Driver manufacturer and model number.

(8) Driver life.

(9) Emergency battery driver:

(a) Compatibility with lighting module.

(b) Lumen output of lighting module in emergency operation.

(c) Battery life.

(d) Description of testing.

(e) Ambient operating temperature.

(10) Toxicity Characteristic Leaching Procedure (TCLP) compliance.

(11) Warranty information.

2) Steel Towers:

a) Name of manufacturer.

b) Complete order information (catalog number).

c) Description of construction.

d) Length, shaft size and thickness.

e) Wind loading (available luminaire EPA per wind speed).

f) Anchor bolt template if required.

g) Bolt size and material if required.

h) Luminaire.

3) Concrete Foundation Design:

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a) Stamped by professional engineer licensed in state of install.

b) Type.

c) Dimensions.

d) Reinforcement requirements.

e) Installation Instructions.

b. See Specification Section 26 05 00 for additional requirements.

4. Test Reports:

a. IES LM-79 Test Report for Solid-State Luminaire.

b. IES LM-80 Test Report Solid-State Light Source.

5. Certifications: Solid-state Luminaire Useful Life Certificate.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 33 00 for requirements for:

a. The mechanics and administration of the submittal process.

2. The content of Operation and Maintenance Manuals.

a. Submittal data for each component covered by warranty.

b. Warranty.

3. Field Quality Control: Test Reports:

a. Provide a record of light meter readings taken in the field to confirm design footcandle levels are being met or exceeded. See also section 26 51 00, paragraph 3.04.

1.06 LIGHTING SOLUTION DESIGN/VERIFICATION REQUIREMENTS

A. Lighting design shall be provided for each area shown on drawings.

B. Lighting design shall ensure footcandle levels and uniformity ratios meet or exceed requirements set for in the Union Pacific Electrical Design Guide.

C. Light Loss Factors (LLF) – High mast LED Applications shall utilize a 0.8 LLF.

D. Light Levels shall be guaranteed to meet or exceed design levels for 10 years.

E. Energy Consumption:

1. Photometric report shall show total kW of combined lighting solution.

F. Glare/Spill Control:

1. Luminaires shall be aimed and/or oriented to minimize light trespass over UP property lines.

2. Photometric report shall include vertical footcandle calculations along entire perimeter of property lines every 25 FT.

3. Direct glare shall be minimized by providing integral or add-on shields on any fixtures aimed more than 10 degrees from nadir.

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1.07 WARRANTY

A. 10 year performance, parts, and labor warranty:

1. Fixture manufacturer shall supply written warranty covering lighting system covering fixtures and other electrical components provided with tower for a period of 10 years.

2. Warranty shall cover all parts, labor, and any other costs required to replace a failed system component within 30 days of notification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. LED Luminaires:

a. Musco.

b. Holophane.

2. Poles: Luminaire manufacturer's standard.

B. No Substitutions will be allowed.

2.02 GENERAL REQUIREMENTS

A. All components shall be designed as a system. All luminaires, wiring, drivers, and enclosures shall be factory assembled, aimed, wired, and tested.

B. All Luminaires and Electrical Components:

1. UL labeled.

2. DLC Certified.

3. Luminaires complete with LED modules and drivers.

C. Tower height shall be 100 FT except where required to be lower due to environmental/FAA requirements.

1. Supplier shall determine requirements if within 5 miles of any airport runway.

D. Fixture mounting assembly shall be fixed at top of pole. No lowering mechanisms shall be utilized.

1. Top of tower mounting arm/ring shall be replaced during retrofit projects.

E. No live parts normally exposed to contact.

F. Tower shall be installed on site within 12 weeks of notice to proceed.

2.03 LUMINAIRES

A. LED Characteristics

1. LED Color temp $\leq$ 4000K.

2. Minimum color rendering index (CRI) of 80.

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3. LED module light output and efficacy: Measured in accordance with IES LM-79 standards.
4. LED useful life and lumen maintenance: Measured in accordance with IES LM-80 standards.
5. LED module: Minimum useful life of 100,000 HRS.
6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

B. Drivers
1. Compatible with solid-state modules and control devices specified.
2. Operate from 60 Hz input source of 120V through 480V with sustained variations of +/- 10 percent (voltage and frequency).
3. Input current Total Harmonic Distortion (THD): Less than 20 percent when operated at nominal line voltage.
4. Power Factor: Greater than 0.90.
5. Avoid interference with infrared devices and eliminate visible flicker.
6. Comply with ANSI C62.41 Category A for Transient protection.
7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
8. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

C. Housings:
1. Die Cast Aluminum Housing or provide Hail shroud to protect reflector system.
2. All exposed aluminum shall be powder coated with high performance polyester or anodized.

D. Wiring:
1. Factory-wired to be compatible with the project electrical and controls systems.

E. Mounting Accessories:
1. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during relamping or cleaning.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
1. Provide ambient operating temperature range for which product is warrantied.

2.04 POLES

A. As Indicated in the Luminaire Schedule and the Following:
1. Additional features:
a. Handhole near base of pole.

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b. Grounding lug accessible at handhole.

c. Galvanized anchor bolts.

d. Anchor bolt covers.

e. Vibration dampers shall be installed.

f. Lightning Protection per NFPA 780.

g. Equipment mounting brackets (8 total).

1) Four brackets spaced evenly around pole at 5 FT AFG.

2) Two brackets on opposite sides of pole at 45 FT AFG.

3) Two brackets on opposite sides of pole at 55 FT AFG.

B. Metal Poles and pole top mounting arm/ring:

1. Stress analysis and safety factor of the poles shall conform to AASHTO 2001 (LTS-4).

2. Galvanized Steel:

a. All exposed components shall be construction of corrosion resistant material and/or coated to prevent corrosion.

b. All exposed carbon steel shall be hot dip galvanized per ASTM A123.

c. All exposed hardware and fasteners shall be stainless steel of 18-8 grade or better, passivated and coated for protection against corrosion and stress corrosion cracking.

3. Pole height: as indicated on drawings.

4. Designed for attached luminaire EPA with a maximum wind velocity rating, per the Special Conditions, at the base.

5. Poles and foundation system shall be confirmed to be appropriate for location to be installed by a registered PE licensed in the state of install.

6. Additional features:

a. Luminaire mounting provisions.

b. Ring or arm shall be fixed at top of pole. No lowering rings shall be allowed

c. Handholes near base of pole and at 10 FT AFG.

d. 2 IN nipple for cord penetration at 45 FT and 55 FT AFG.

e. Grounding lug accessible at handhole.

f. Galvanized anchor bolts.

g. Anchor bolt covers.

h. Vibration dampers, if indicated on drawings.

i. Equipment mounting brackets (8 total).

1) Four brackets spaced evenly around pole at 5 FT AFG.

2) Two brackets on opposite sides of pole at 45 FT AFG.

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3) Two brackets on opposite sides of pole at 55 FT AFG.

2.05 WIRING

A. Tower shall be installed on site with appropriate wiring installed within abrasion resistant sleeve, from luminaires down to accessible location on pole within 15 FT of grade to allow electrical connection without man lift.

B. Accessible location shall be a bracket mounted box or covered and gasketed handhole of adequate size to fit conductor splices through it.

C. All wiring shall be enclosed within the pole, mounting hardware or electrical components enclosure.

2.06 FOUNDATION

A. Contractor shall include Foundation design, stamped by PE licensed in the state the project is in.

1. When geotechnical information is available, foundation design shall be done according to site specific soil info.

2. When no geotechnical information is available, foundation design shall be done based on standard soils unless otherwise noted.

B. Foundation design requirements:

1. Shear (horizontal) force at ground level.

2. Axial (vertical) force at ground level.

C. Foundations shall be designed to match pole type design.

D. Foundation dimensions shall be limited when towers will be placed between railroad tracks.

1. Maximum Diameter of foundation and/or poles.

a. Towers may not be located in these areas with track spacing less than 21.5 FT.

b. Maximum diameter shall be equal to actual track spacing – 20 FT.

1) When a road or drive path is present between tracks, track spacing required to install towers is 28 FT.

2.07 IDENTIFICATION

A. Label high mast light towers “LT##” per project drawings and per Specification Section 26 05 00, paragraph 3.01.Q.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Luminaires shall be attached to tower per manufacturer’s recommendations.

1. Manufacturer shall provide written installation instructions for lighting system.

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2. Manufacturer shall provide a representative to provide guidance on installation requirements if required.

B. Luminaires shall be aimed or oriented as specified on photometric report.

C. Lighting equipment shall be handled in an appropriate manner to ensure safe installation and prevent damage to the equipment. Repair or replacement of damaged components shall be the responsibility of the supplier.

D. Rigging operations shall utilize appropriately rated web fabric slings to lift components into position. Chains or cables shall not be used.

3.02 FOUNDATION INSTALLATION

A. Concrete cure time shall be determined by foundation designer.

B. Reinforced Pre-Cast Foundations.

1. Per foundation design.

2. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.

C. Cast in Place foundations:

1. Per foundation design.

2. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.

3.03 POLE INSTALLATION

A. Drawings indicate the intended location of Light Pole:

1. Field conditions may affect actual location.

2. Coordinate location with all existing or new utilities and pavement.

B. Pre-Cast Foundations shall be installed per manufacturers recommendation.

C. Anchor Base Plated Poles:

1. Mounted on cast-in-place foundations.

a. Concrete and reinforcing steel, in accordance with Division 03 Specification Sections.

2. Protect pole finish during installation.

a. Repair damage to pole finish with manufacturer approved repair kit.

D. Conductors:

1. Use THWN-2/XHHW-2 building wire, as specified in Specification Section 26 05 19, from pole base to luminaire, #10 AWG minimum.

3.04 FIELD QUALITY CONTROL

A. Upon completion of the project, and in the presence of the manager of electrical design or assigned representative, field illumination measurements shall be taken in accordance with IESNA RP-6-01, Appendix B.

1. Contractor shall at their expense provide and install any additional fixtures to meet the requirements of this specification section.
    a. Structural analysis of tower and foundation shall be performed to ensure structural system is adequate to support additional loads.

END OF SECTION

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SECTION 26 99 00 - POWER SYSTEM ANALYSIS

PART 1 - GENERAL

1.01 SUMMARY

A. Contractor is responsible to provide a complete Power System Analysis including; short circuit analysis, equipment evaluation, protective device coordination, and arc flash risk assessment. This Analysis shall be performed by an approved vendor and completed under the direct supervision of a registered Professional Electrical Engineer licensed to practice in the State where the project is located.

B. The electrical distribution system to be evaluated is shown in the project drawings. The intent of the Analysis is to evaluate all electrical equipment shown for proper design and to determine hazards that exist at each piece of electrical equipment.

C. Union Pacific shall determine whether to have a pre-analysis meeting or phone conference and the location if it is a meeting. The discussion shall include:

1. Schedule.
2. Equations for 3 phase and single phase use.
3. Philosophy for conducting site investigations, doing the calculations and analysis, presentation of results and installation of labels.

D. Site Access:

1. Contractor and any onsite personnel shall comply with Union Pacific e-Railsafe including but not limited to background information and personnel credentials. Go to e-Railsafe.com for information.

E. Safety:

1. As part of Union Pacific Railroad's focus on safety, we want to make certain that our vendors establish and maintain safe work practices, including the proper training of their employees. Union Pacific will not allow vendors to perform work on our property unless they have been properly trained for the work they are performing.
2. Training for Engineering Department vendors falls into two primary categories:
    a. Regulatory Training – training that is required by federal, state or local workplace safety regulations. This training includes, but is not limited to:
        1) FRA Roadway Worker Protection (for those working within 25 FT of any track). This training is available from several sources, including other railroads, railroad industry training professionals and computer based training. Several internet web sites now offer RWP training for a modest fee, including:
            a) www.railroadeducation.com
            b) www.nrcma.org

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c) UPRR does not endorse any specific RWP training program nor does it require vendors employees to be trained specifically on UP's On-Track Safety Program. However, UPRR does require that vendors properly train their employees on RWP as required by 49CFR214.343.

d) OSHA Fall Protection (for those working on elevated structures 6 FT or higher).

e) OSHA Confined Space Entry (for those working in confined spaces).

2) Please note that Union Pacific Railroad does not provide regulatory training for vendors' employees but will assist vendors in locating training resources. The frequency of training is mandated in each regulation.

3) Union Pacific Railroad insists on 100 percent compliance with all governmental regulations by it vendors and their employees.

b. UPRR safety training – training that is required for Engineering Department vendors employees to perform work on UP property. This training is in addition to the regulatory training described above and is available in several different formats:

1) Video and pamphlet entitled "Minimum Safety Requirements for Engineering Department Contractors". One copy of the pamphlet is included with each video. You can order the video (catalog number E-153-99) and additional pamphlets (PB-20834) by calling Staples at 402-898-6448. Please have a credit card ready when ordering.

2) Online Training program via www.contractororientation.com. The information presented is the same as the video and pamphlet; however, this web site also provides record keeping and testing services. Once a person completes the course, they are sent a wallet-size card showing successful completion.

3) UPRR Safety Training must be completed every calendar year. Please note that this training does not meet the requirements for Roadway Worker Protection Training.

4) Vendors must furnish employees with documentation that they have completed the required regulatory and UPRR safety training. This can be accomplished by issuing cards denoting the employee's training, issuing list of employees who have completed specific training or by having available, at the job site, other forms of documentation.

5) Under government workplace safety regulation, each employer is responsible for the training of their employees. Union Pacific Railroad provides the necessary resources to train our employees and we expect the same from our vendors.

6) Vendors to UP also have oversight responsibilities for monitoring the training and compliance of employees of sub-contractors. Make sure that the sub-contractors you hire are familiar with and comply with the training requirements outlined above.

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7) Onsite Personnel shall comply with UPRR electrical safety rules and all local facility safety rules.

8) Field data collection personnel shall wear personal protective equipment (PPE) in accordance with Table 130.7(C)(9)(a) of the NFPA 70E at all times when exposed to energized electrical equipment not previously labeled with available incident energy.

9) Onsite Personnel shall have up-to-date training in electrical safety and shall supply and utilize their own PPE for electrical shock hazards and arc flash hazards. Union Pacific Railroad personnel shall not be responsible for reviewing or evaluating Vendors' safety program(s) for suitability. Attach information describing your safety training and program in your proposal.

10) Vendor providing Onsite Personnel shall have an internal safety program and up-to-date electrical safety training that includes arc flash hazards. Onsite Personnel shall comply with all internal safety program requirements and the UPRR safety regulations during field data collection. Union Pacific Railroad shall not be responsible for development of vendor safety program or safety procedures utilized during the data gathering process.

1.02 REFERENCED STANDARDS

A. Institute of Electrical and Electronics Engineers (IEEE):

1. 141, "Red Book", Recommended Practice for Electric Power Distribution for Industrial Plants.
2. 241, "Gray Book", Recommended practice for Electric Power Systems in Commercial Buildings.
3. 242, "Buff Book", Recommended Practice for Protection and Coordination of Industrial Power Systems.
4. 399, "Brown Book", Recommended Practice for Industrial and Commercial Power Systems.
5. 551, "Violet Book", Recommended Practice for Calculating Short-Circuit Currents in Industrial and Commercial Power Systems.
6. 1015, "Blue Book", Recommended Practice for Applying Low Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
7. 1584, Guide for Arc Flash Hazard Calculations.

B. American National Standards Institute (ANSI):

1. C37.010, Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
2. C37.13, Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
3. C37.41, Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single Pole Air Switches, Fuse Disconnecting Switches and Accessories.

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4. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.

C. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC), latest edition.
2. 70E, Standard for Electrical Safety in the Workplace, latest edition.
3. 79, Electrical Standard for Industrial Machinery.

D. To ensure compliance with all standards, no exceptions, or substitutions to this standard are allowed without written approval of the Union Pacific Manager of Electrical Design. Any discrepancies between these documents and this standard shall be brought to the attention of the Union Pacific Manager of Electrical Design.

1.03 DEFINITIONS

A. Contractor: Vendor holding contract directly with UP to either install electrical equipment/distribution or to perform a power system analysis.

B. Consultant: Vendor performing the Power System Analysis as described herein.

C. Onsite Personnel: Individuals who will be on site performing data collection, field adjustments and/or label application. These individuals may be employees of the contractor, consultant or third party vendor hired by the contractor or consultant.

D. VCB: Vertical conductors/electrodes in a metal box/enclosure. With the original vertical electrode configuration, when an arc flash occurs in an enclosure, the arc is driven away from the source, down the electrodes, toward the bottom of the enclosure and out of the front.

E. VCBB: Vertical conductors/electrodes terminated in a metal box/enclosure's insulating barrier. If vertical electrodes are terminated into an insulating barrier, research has demonstrated the arc hits the barrier, and the plasma cloud is directed more toward the enclosure opening.

F. HCB: Horizontal conductors/electrodes in a metal box/enclosure. When the electrodes are placed horizontally, the arc plasma is directed from the electrode ends outward.

G. VOA: Vertical conductors/electrodes in open air. Tests were conducted in open air using the original vertical configuration in open air.

H. HOA: Horizontal conductors/electrodes in open air. Tests were conducted in open air using a new configuration with horizontal electrodes in open air.

1.04 SUBMITTALS

A. Submittal For Review:

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1. The contractor shall submit the following products to the Union Pacific Railroad Electrical Design Group for review within sixty (60) days of contract award. The submittal for review shall be based upon an infinite utility contribution unless utility company available fault current data is readily available. The submittal for review may be based upon design drawings and submittal data. All Soft Copies shall be in Adobe .pdf format and shall be emailed or transmitted via an authorized UPRR File Transfer website to the Union Pacific Railroad Electrical Design Group.

    a. One (1) Soft Copy of the One Line Diagram.

    b. One (1) Soft Copy of the Equipment Evaluation Table.

    c. One (1) Soft Copy of the Protective Device Coordination Study table, including both default and recommended device settings.

B. Submittals For Approval:

1. The contractor shall submit the following products to the Union Pacific Railroad Electrical Design Group for approval prior to the final submittals and before any arc flash labels are produced. Submittals for approval shall utilize input data produced from on-site data collection to ensure the model reflects the system as installed. Submittal data and design drawings shall not be substituted for on-site data collection. All Soft Copies shall be emailed or transmitted via an authorized UPRR File Transfer website to the Union Pacific Railroad Electrical Design Group.

    a. One (1) Soft Copy of the interim report.

    b. One (1) Soft Copy of the SKM files.

    c. One (1) Soft Copy of a sample arc flash warning label.

C. Final Submittals:

1. The contractor shall submit the following products to the Union Pacific Railroad Electrical Design Group upon acceptance of submittal for approval. All Hard Copies shall be mailed to the Union Pacific Railroad Electrical Design Group. One Soft Copy shall be stored on a USB flash drive or CD-ROM and shall be mailed with the hard copies to the Union Pacific Railroad Electrical Design Group. The second Soft Copy shall be emailed or transmitted via an authorized UPRR File Transfer website to the Union Pacific Railroad Electrical Design Group.

    a. Three (3) Hard Copies and one (2) Soft Copies of the final report.

    b. One (2) Soft Copies of the SKM files.

    c. One (2) Soft Copies of the Arc Flash Labels.

1.05 REPORT

A. The report shall be stamped by a registered professional electrical engineer licensed to practice in the State where the project is located.

B. The report shall include the following sections in the following order:

1. Executive Summary:

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a. The executive summary shall be a brief 1 - 2 pages maximum and cover at an executive level the findings of the study, recommendations, and requirements for maintaining NFPA-70E compliance.

b. A synopsis of the overall findings, including but not limited to equipment locations with highest incident energy levels and total number of overcurrent devices with inadequate short circuit current interrupting ratings.

2. Introduction:

   a. A brief section to explain the necessity of performing an arc flash risk assessment and the criteria used during the project, as well as the following:

      1) The scope of the study. It shall provide details of what actions were performed for each aspect of the study, including short circuit analysis, equipment evaluation, protective device coordination study, and arc flash risk assessment.

      2) Description of system and explanation of bus and branch numbering system.

      3) Modes of operation studied: Each scenario operating condition shall be thoroughly documented.

3. Methodology:

   a. A brief explanation of the basis for each analysis performed for this project.

4. Assumptions:

   a. A list of all valid engineering assumptions made and why they were made during the course of the project.

5. Input Data:

   a. Input data shall include, but not be limited to the following:

      1) Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).

      2) Transformer input data, including winding connections, secondary neutral ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.

      3) Reactor data, including voltage rating and inductance.

      4) Generation contribution data, (synchronous generators and Utility), including short circuit reactance (X"d), rated MVA, rated voltage, three-phase and single-line-ground contributions (for utility sources) and X/R ratio.

      5) Motor contribution data (induction motors and synchronous motors), including short circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

6. Electrical One-Line:

   a. Electrical one-line in SKM format. Show all electrical distribution. Include at a minimum:

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1) All cables including sizes,

2) All Transformers with ratings, impedances and voltages.

3) All Overcurrent Protective Devices and Disconnects with ratings.

4) All Panelboards, Switchboards, Motor Control Centers and other distribution equipment.

5) All Motors, Lumped Motor Groups and Generators.

b. Separate one-line for each building's internal distribution is acceptable.

c. Sheet shall be sized either 8-1/2 IN x 11 IN, 11 IN x 17 IN, or 24 IN x 36 IN. Only multiple sheets of 24 IN x 36 IN for a single one-line will be allowed.

7. Short Circuit Current Analysis:

a. Short Circuit Output Data shall include, but not be limited to the following reports:

1) Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a) Voltage.

b) Calculated fault current magnitude and angle.

c) Fault point X/R ratio.

d) Equivalent impedance.

2) Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a) Voltage.

b) Calculated symmetrical fault current magnitude and angle.

c) Fault point X/R ratio.

d) Calculated asymmetrical fault currents.

(1) Based on fault point X/R ratio.

(2) Based on calculated symmetrical value multiplied by 1.6.

(3) Based on calculated symmetrical value multiplied by 2.7.

e) Equivalent impedance.

3) Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a) Voltage.

b) Calculated symmetrical fault current magnitude and angle.

c) Fault point X/R ratio.

d) No AC Decrement (NACD) ratio.

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e) Equivalent impedance.

f) Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis.

g) Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis.

8. Equipment Evaluation:

   a. The results of the equipment duty verification tabular format report shall provide the following data:

      1) Equipment name and kV.

      2) Manufacture, type, style, and ratings of the device.

      3) Short circuit currents through the device and percent over/under duty.

      4) Flag for the device showing VIOLATION or WARNING level for visual identification.

   b. A report of all problem areas shall be provided. A recommended action list shall be provided for all deficient equipment in the system.

9. Protective Device Coordination Study:

   a. The results of the Protective Device Coordination Study shall include, but is not limited to the following:

      1) Summary of the findings of the Protective Device Coordination Study.

      2) Table of Contents and descriptions for all TCCs included directly before TCC curves in the report.

      3) All TCCs needed to illustrate the system.

      4) A setting table shall be developed to summarize the selected settings, default or recommended, for the protective devices. The table shall include the following:

         a) Device identification.

         b) For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.

         c) Fuse manufacturer, type, style, and rating.

         d) Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

10. Arc Flash Risk Assessment:

    a. The results of the Arc Flash Risk Assessment shall include, but is not limited to the following:

       1) Summary of the findings of the arc flash risk assessment.

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2) Table indicating worst case scenario of all buses evaluated. At the top of the table, a reference to table 130.5(G) of NFPA 70E for PPE required shall be included. Table shall include but is not limited to the following:
    a) Arcing fault magnitude.
    b) Protective device clearing time.
    c) Duration of arc.
    d) Arc flash boundary.
    e) Working distance.
    f) Incident energy.
3) Table detailing all busses evaluated and all scenarios with the corresponding incident energies. The worst case scenario shall be highlighted for each bus.
4) Table for each scenario's results of all busses evaluated. At the top of the table, a reference to table 130.5(G) of NFPA 70E for PPE required shall be included. Table shall include but is not limited to the following:
    a) Arcing fault magnitude.
    b) Protective device clearing time.
    c) Duration of arc.
    d) Arc flash boundary.
    e) Working distance.

11. Incident Energy Deficiencies and Code Violations:
    a. Section shall include detailed accounts of all deficiencies and code violations noted while performing the study.
12. Recommendations:
    a. Section shall include detailed accounts of all recommendations Consultant suggests to improve the system, including recommendations for incident energy reduction.
13. Report Appendix A – Data Collection Forms:
    a. All data collection forms used in the study shall be affixed in Appendix A of the report.
14. Report Appendix B – Photographs:
    a. Photographs of all equipment as detailed in Data Collection paragraph shall be affixed in Appendix B of the report.

1.06 SKM FILES

A. The software database and library used to model the power system shall be submitted in native file format including all updates to the library necessary to complete the model. The database files submitted shall be compatible with the version of SKM software owned by UPRR.

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1.07 QUALITY ASSURANCE

A. The studies shall be in conformance with the NFPA and ANSI Standards, and IEEE recommended practices detailed in this specification.

B. The Consultant is responsible for compliance with all performance specifications in this standard. Any deviations must be explained in detail and documentation provided. Consultant shall list assumptions used in completing the analysis.

1.08 SEQUENCING AND SCHEDULING

A. Contractor shall provide a proposed timeline listing all submittal dates with proposal based on starting 30 days after proposal date.

PART 2 - PRODUCT

2.01 CONSULTANT QUALIFICATIONS

A. The short circuit, equipment evaluation, protective device coordination and arc flash risk assessment studies shall be conducted by one of the following firms:

1. CBS Field Services: Ryan Downey, email: rdowney@groupCBS.com.
2. Electric Power Systems: Howard Campbell, email: H.Campbell@epsii.com.
3. Patrick Engineering Inc: David Swoch, email: dswoch@patrickco.com.
4. Wilson and Company: Travis Gambrell, email: travis.gambrell@wilsonco.com.
5. Zachry Engineering Corporation: Chad Wieseler, email: WieselerC@zachrygroup.com.
6. TKDA: Wesley Wegner, email: wesley.wegner@tkda.com.
7. Quanta Utility Engineering Services: Clint Thayer, email: CThayer@QUES.com.

2.02 COMPUTER ANALYSIS SOFTWARE

A. The studies shall be completed using the latest version of the SKM System Analysis PowerTools for Windows (PTW) software program.

2.03 ARC FLASH LABELS

A. Consultant shall provide a thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on the implemented overcurrent device settings and will be provided after the results of the analysis have been approved by the Union Pacific Manager of Electrical Design.

C. The label shall include the following information, at a minimum:

1. Equipment Name (per Drawings).
2. Protective Device Location.
3. Protective Device Size and Type.
4. System Nominal voltage.

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5. Limited Approach Boundary.
6. Restricted Approach Boundary.
7. Arc Flash Boundary.
8. Available Incident energy.
9. Working distance.
10. List of specific PPE required (per table 130.5(G) of NFPA 70E).
11. Label expiration date (5 years from issue date).
12. UPRR Engineering Project Code, revision number and issue date.

D. Labels shall be machine printed, with no field markings. The labels shall be printable directly from the power system software utilized for the study with a Brady i3300 printer, PowerMark, BBP85, or GlobalMark printer to ensure that Union Pacific Railroad personnel have the option of printing the labels.

E. Arc flash labels shall be provided in the following manner.

1. For applicable panelboard, safety switch, or control panel, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one arc flash label shall be provided.
5. For medium voltage equipment, one arc flash label shall be provided.
6. For pad mounted transformers, both dry type and oil filled, one arc flash label shall be provided. The side of the transformer with the highest incident energy shall be utilized to create the label.

F. See Appendix D of this specification section for examples of arc flash labels.

1. All arc flash labels shall be field installed by Onsite Personnel once written approval has been received from the Union Pacific Manager of Electrical Design.

PART 3 - EXECUTION

3.01 DATA COLLECTION

A. Onsite Personnel shall be responsible to verify all supplied information.

B. Contractor shall ensure that all field data collection is performed by a qualified (as defined by NFPA 70E) person to ensure accurate equipment modeling.

C. Copies of any available drawings shall be provided electronically by Union Pacific Railroad. Consultant shall create new electronic one-line diagrams.

D. Equipment shall be visually inspected to collect the necessary nameplate data used in the analysis. Onsite Personnel shall be responsible for the visual verification of all nameplate data required for the analysis.

E. UPRR shall provide personnel to escort Onsite Personnel to equipment locations and to open all equipment rooms, locks, etc. necessary to collect nameplate data.

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F. Onsite Personnel shall research and record existing equipment interrupting capacities.

G. Onsite Personnel shall record all NEC and NESC violations observed during normal activities of the study.

H. Onsite Personnel shall document all equipment whose physical condition requires attention.

I. Onsite Personnel shall provide all the data collection necessary for the electrical system shown on the project drawings. The power system analysis shall include the utility service (including primary relaying, fusing, and/or other overcurrent protection) down through each and every overcurrent protective device, disconnect and transformer in excess of 50 volts for all systems. Equipment between 200V and 50V is to be included in the Short Circuit Analysis, Equipment Evaluation, and Protective Device Coordination Study portions of the final report but may be excluded from the Arc Flash Risk Assessment.

   1. When the project involves electrical equipment installed in existing UP electrical systems or services, the scope of the study shall include all equipment defined above as well as all upstream equipment back to the existing utility service(s). This includes UP primary systems between project location and utility service point, any other UP service drops from UP primary system may be excluded.

J. Consultant shall obtain from the utility the normal operating service voltage levels, three-phase and single phase short circuit MVA and X/R ratio at each service point and utility overcurrent device settings.

K. Onsite Personnel shall use data collection forms in Appendix A of this specification section. If a form is needed that is not part of Appendix A, contact the Union Pacific Electrical Design Group.

L. Onsite Personnel shall provide digital pictures of all electrical equipment being evaluated. Pictures shall be taken after arc flash labels have been applied.

   1. All pictures shall have a minimum 8 megapixel resolution.

M. Vendor providing Onsite Personnel shall be responsible for any qualified escorting, supervision, or equipment necessary to complete all associated on-site work (i.e. data collection, label installation, etc.) for all equipment including overhead equipment and wiring.

3.02 SYSTEM MODELING

A. Provide a list of all assumptions to the Union Pacific Manager of Electrical Design. The Union Pacific Railroad Electrical Design Group shall review, discuss and request any changes to assumptions before the system model is run.

B. Equipment names used in the modeling software shall be identical to the naming convention shown in the project drawings.

C. Consultant shall refer to Appendix B of this specification section for SKM symbol selection. If a symbol is needed that isn't included, contact UPRR Electrical Design Group.

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D. The Union Pacific Railroad yard or project location may have multiple operating conditions, including, but not limited to, generation on/off, shutdown, bus-ties, start-up, emergency operation, etc. Consultant shall discuss facility operation with designated Union Pacific Railroad personnel to determine the possible operating modes of the system. Each of the operating modes shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment.

E. The software shall model each operating mode in a manner such that each mode is a scenario or change case from the base case. Modifications to the base case model shall automatically update all scenarios to eliminate the necessity to store complete databases for each condition, providing for a manageable file.

F. Project files shall be self-contained and have all necessary information to describe the one-line, system data, settings, and analysis information. Files shall be easily transferable to any site via email or disk and operable with no setting changes to the database file. Output files shall be as required to be run on Union Pacific Railroad SKM software.

G. Lumped motor groups for MCC's shall be modeled per IEEE standards. Where motor list data is not available, single lumped groups may be modeled per IEEE-141 "Red Book".

H. Each motor greater than 40 HP shall be modeled individually.

I. All analysis of the system shall be run utilizing the normal system voltage, as well as the minimum and maximum voltage for the given nominal voltage per IEEE-141 "Red Book" Chapter 3 Table 3-1 Range A. Each of the voltage level scenarios shall be documented and modeled in the software in order to determine the worst-case arc flash hazard and associated parameters for the electrical equipment.

J. If exact conductor length is not known, utilize the best engineering judgment length.

K. All protective device equipment shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

L. All relay data shall be modeled based on the actual nameplate data including manufacturer, type, style, trip device, and actual settings. Generic substitutions or assumptions shall not be allowed unless data cannot be field verified. All assumptions shall be documented in the report.

M. All overcurrent relay types for the distribution system shall be modeled on the one-line diagram (and database) including phase and ground overcurrent, differential, residual, ground neutral, etc. to establish a complete and detailed system model where protective device data can be easily modified and updated by the facility and all data is available for a comprehensive protective device coordination study if required in the future.

N. Relay models shall depict the actual connection requirements.

O. Multi-function relays shall have all their overcurrent devices modeled in a single device and shall be able to accept multiple CT's.

P. All equipment modeled must have a corresponding one-line diagram symbol. The symbol shall be linked to easily see all equipment, its associated data, to be able to link documents to the equipment as a data repository, etc. and to see problems clearly on the one-line drawing.

Q. All system modeling shall conform to accepted modeling practices as outlined in IEEE-399 "Brown Book". Consultant may provide more advanced modeling techniques where compliance with the specification is maintained.

3.03 SHORT CIRCUIT ANALYSIS

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.

B. Actual Transformer impedances shall be used. Transformer design impedances shall only be used where actual impedance is illegible.

C. Provide the following:

1. Calculation methods and assumptions.
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated.
4. Source impedance data, including electric utility system and motor fault contribution characteristics.
5. Tabulations of calculated quantities.
6. Results, conclusions, and recommendations.

D. Calculate short circuit momentary and interrupting duties for three-phase and unbalanced faults at each:

1. Electric utility's supply termination point.
2. Incoming switchgear.
3. Unit substation primary and secondary terminals.
4. Low voltage switchgear.
5. Motor control centers.
6. Standby generators and automatic transfer switches.
7. Branch circuit panelboards.
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short circuit study.

3.04 EQUIPMENT EVALUATION

A. Evaluate equipment and protective devices and compare short circuit ratings. Equipment shall be evaluated using actual transformer impedances.

B. Determine adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short circuit stresses.

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C. Notify Union Pacific Manager of Electrical Design, in writing, of existing circuit protective devices improperly rated for the actual calculated available fault current.

3.05 PROTECTIVE DEVICE COORDINATION STUDY

A. Protective device coordination time current curves (TCC) shall be displayed on log-log scale graphs. The TCC shall be printed in color on 8 ½" x 11 IN sized paper – full size portrait mode.

B. Include on each TCC graph a complete title.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. For low voltage systems, TCCs shall be developed for both phase and ground protective devices. The TCC shall show the largest feeder/motor protective device in the MCC or panel up through the switchgear/switchboard feeder breaker, transformer secondary main, primary fuse, and medium voltage feeder breaker. For secondary switchboards serving large loads or a wide variety of loads that may affect upstream coordination, additional TCCs may be required.

E. For medium voltage systems, TCCs shall be developed for both phase and ground protective devices. The TCC should show the largest feeder/motor protective device in the lineup up through the switchgear/transformer secondary main, unit substation primary fuse, and medium voltage feeder breaker.

F. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

G. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility's overcurrent protective device.
2. Medium voltage equipment overcurrent relays.
3. Medium voltage recloser trip coil settings and clearing curves.
4. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
5. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands.
6. Transformer full-load current, magnetizing inrush current and ANSI through-fault protection curves.
7. Conductor damage curves.
8. Ground fault protective devices, as applicable.
9. Pertinent motor starting characteristics and motor damage points, where applicable.
10. Pertinent generator short circuit decrement curve and generator damage curve.
11. The largest feeder circuit breaker in each motor control center and applicable panelboard.

H. Provide adequate time margins between device characteristics such that the selective operation is provided, while providing proper protection.

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I. Provide a protective device coordination study per the Submittals Section for the Existing/Default Configuration. If the Existing/Default configuration does not provide adequate selective coordination, a recommended configuration shall be developed based on the fusing criteria shown in Appendix C of this specification section to provide the best selective coordination and protection.

1. During the review, Union Pacific Railroad will decide whether the final report will be based on the existing configuration, the recommended configuration, or a combination of both.
2. Contractor shall implement the recommended settings if the Union Pacific chooses to utilize any or all recommended settings.
3. The arc flash risk assessment shall be based upon the determined configuration above.

J. A settings table shall be developed to summarize the settings selected/existing for the protective devices. The table shall include the following:

1. Device identification.
2. For low voltage breakers, the circuit breaker manufacturer, type, and style, sensor rating, long-time, short-time, instantaneous settings, and time bands. For breakers with ground fault capability, the pickup and time delay.
3. Fuse manufacturer, type, style, and rating.
4. Protective relay manufacturer, type, style, function (51, 50, 67, etc.) pickup, current multiplier, time dial, and delay. For multi-function units, list all devices being used. Include the CT and/or PT ratios for each function.

3.06 ARC FLASH RISK ASSESSMENT

A. The arc flash risk assessment shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2015, Annex D.4, under the following conditions:

1. Voltages in the range of 208 V - 15 kV, 3 phase.
2. Power system operating frequencies of 50 or 60 Hz.
3. 3 phase bolted fault current in the range of 700A - 106kA.
4. Grounding of all types and ungrounded.
5. Equipment enclosures of commonly available sizes.
6. Gaps between electrical conductors in the range of 13 mm - 152 mm.
7. Electrode configuration is either VCB, VCBB, HCB, VOA, or HOA.
8. Fault involving 3 phases.

B. All three phase arc flash hazard calculations, within the conditions stated in the Arc Flash Risk Assessment paragraph shall be performed with the arc flash study module in the SKM PowerTools for Windows software under the IEEE std. 1584-2002 heading.

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C. Arc flash risk assessments of systems encountered outside the conditions listed, shall be performed per the following procedures to derive the incident energy, utilizing the bolted fault current output from the unbalanced/Single-Phase Study Module:

1. Single phase systems with voltages <1000V shall utilize equations specified by IEEE 1584.
2. Single phase systems with voltages >1000V, shall utilize the following equation.

$$E=2.142 \times 10^{6} V I_{bf} (t/D^{2})$$

(IEEE std. 1584-2002 recognizes this model for calculating incident energy of single phase systems. This model will provide conservative results.)
(For voltages over 15kV, arcing fault and bolted fault current are considered equal. NFPA 70E-2015 Edition)

D. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (i.e. switchboards, switchgear, motor control centers, panelboards, busways, and splitters) where work could be performed on energized parts.

E. The arc flash risk assessment shall include all significant locations rated 200 volts and above, including single phase equipment, where work could be performed on energized parts.

F. Safe working distances shall be based upon the calculated arc flash boundary considering incident energy of 1.2 cal/cm^2.

G. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short circuit and coordination study model. Ground fault protection should not be taken into consideration when determining the clearing time when performing incident energy calculations.

H. The short circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and with a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors (above 40hp) to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

I. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.

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2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

J. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

K. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

L. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location. The calculation should utilize the fastest device to compute the incident energy for that corresponding location, including utility overcurrent protective devices.

M. Arc Flash calculations shall be based on the assumption that all circuit breakers will have a clearing time of 2 seconds.

1. Exception #1: If a fuse upstream of a circuit breaker will trip prior to 2 seconds at the arcing current of the bus the circuit breaker is protecting, set the clearing time of the circuit breaker to the fuse clearing time. Include a list of all circuit breakers that have had their clearing times adjusted within the report.

2. Exception #2: Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, the maximum clearing time based on the specific location shall be utilized.

N. Maximum clearing time for all other protective devices shall be capped at 2 seconds based on IEEE 1584-2002 section B.1.2.

1. Exception #1: Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, the maximum clearing time based on the specific location shall be utilized.

3.07 FIELD QUALITY CONTROL

A. The contractor shall ensure that all changes to device settings determined per Protective Device Coordination Study are implemented prior to final approval of power system analysis report.

END OF SECTION

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APPENDIX A - DATA COLLECTION FORMS

UP-Pirate-0005942

UTILITY DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____
(Utility company name or UPRR)

_____
(Address)

_____
(City, state, zip)

_____
(Telephone number)

Operating Service Voltage (normal: _____ kV

3Ø short circuit (MVA & x/r ratio): _____

1Ø short circuit (MVA & x/r ratio): _____

3Ø fault current (maximum / available): _____ kA

Single line-to-ground fault current (maximum / available): _____ kA

Available system impedance: _____

NOTES:

_____
(Collected by) (Date)

_____
(Company name)

_____
(Address)

_____
(City, state, zip)

UP-Pirate-0005943

TRANSFORMER DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____

(Utility company name or UPRR)

Transformer manufacturer / type: _____

Transformer voltage (primary / secondary): _____

Transformer rating: _____ kVA

Transformer load ratings (primary / secondary): _____ amps

Transformer impedance rating: _____

Transformer x/r ratio: _____

Transformer phase connection(s): _____

Grounding type: _____

Working distance / clearances: _____

Obstructions that will prevent exiting the flash protection boundary in 2 seconds (Y/N): _____

Transformer location: _____

NOTES:

_____

(Collected by) (Date)

_____

(Company name)

_____

(Address)

_____

(City, state, zip)

UP-Pirate-0005944

GENERATOR DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____

(Utility company name or UPRR)

Generator manufacturer / type: _____

Generator voltage (primary / secondary): _____

Generator rating: _____ kW

Generator impedance rating: _____

Generator x/r ratio: _____

Generator grounding type: _____

Working distance / clearances: _____

Obstructions that will prevent exiting the flash protection boundary in 2 seconds (Y/N): _____

Generator location: _____

NOTES:

_____

(Collected by) (Date)

_____

(Company name)

_____

(Address)

_____

(City, state, zip)

UP-Pirate-0005945

CABLE DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____

(Utility company name or UPRR)

Cable manufacturer / insulation type: _____

Cable voltage: _____

Cable size: _____

Cable length: _____ FT

Age of cable (approximate): _____ YRS

Source End Equipment ID: _____

Load End Equipment ID: _____

NOTES:

_____

(Collected by) (Date)

_____

(Company name)

_____

(Address)

_____

(City, state, zip)

UP-Pirate-0005946

PROTECTIVE DEVICE DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____

(Utility company name or UPRR)

Device manufacturer / type: _____

Device voltage: _____

Device amperage rating: _____ amps

Device Electrode Configuration: _____ Options are VCB, VCBB, HCB, VOA or HOA.

Device delay curves: _____ (attach if applicable)

Device delay settings: _____ (attach if applicable)

Device minimum melt: _____ (attach if applicable)

Device maximum clear: _____ (attach if applicable)

Device fault clearing time: _____

Device peak let thru current: _____ amps

Device pickup (tap) setting: _____

Device Interrupting Rating: _____ amps

Protective device location: _____

Obstructions that will prevent exiting the flash protection boundary in 2 seconds (Y/N): _____

NOTES:

_____

(Collected by) (Date)

_____

(Company name)

_____

(Address, City, state, zip)

EQUIPMENT DATA COLLECTION

Equipment Name/ID:

(The consultant shall fill in the appropriate areas with information collected during field studies.)

Source of Electrical Power

(In the space provided, indicate if the local utility company is providing the electrical service, or if the facility is being served from Union Pacific Railroad power lines.)

_____

(Utility company name or UPRR)

Equipment manufacturer / type: _____

Equipment voltage: _____

Equipment rating: _____

Equipment impedance rating: _____

Equipment x/r ratio: _____

Equipment phase / connections: _____

Type of enclosure: _____

Equipment grounding type: _____

Working distance / clearances: _____

Obstructions that will prevent exiting the flash protection boundary in 2 seconds (Y/N): _____

Equipment location: _____

NOTES:

_____

(Collected by) (Date)

_____

(Company name)

_____

(Address)

_____

(City, state, zip)

UP-Pirate-0005948

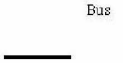
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UP-Pirate-0005949

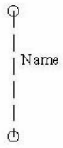
APPENDIX B - SYMBOLOGY

When the system is modeled in SKM Power Tools for Windows the following symbols shall be used as specified below. If deviations or other symbols required shall not be used without written approval from the Union Pacific Railroad Manager of Electrical Design.

BUS



CABLES



Primary Distribution



Overhead Secondary Distribution



Below Grade Conductors

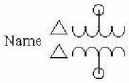


Above Grade In Conduit Secondary Conductors

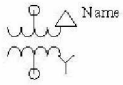
TRANSFORMERS



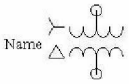
Single Phase Transformer



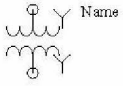
Delta-Delta 3 Phase Transformer



Delta-Wye 3 Phase Transformer



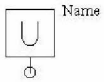
Wye-Delta 3 Phase Transformer



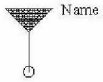
Wye-Wye 3 Phase Transformer

UP-Pirate-0005950

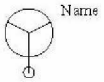
SOURCES



Feed from Utility



Feed from Yard Distribution

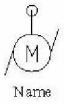


Generator Feed

LOAD



Synchronous Motor



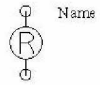
Induction Motor



Non-Motor Load

UP-Pirate-0005951

PROTECTIVE DEVICE



Recloser



Non-Fused Switch



Medium Voltage Fuse



Medium Voltage Circuit Breaker



Low Voltage Fuse



Low Voltage Fused Switch

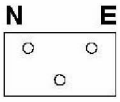


Low Voltage Circuit Breaker

MISCELLANEOUS EQUIPMENT



UPS



Transfer Switch

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APPENDIX C – FUSE INFORMATION

All fusing shall be based on the information found in this Appendix, any deviation from this appendix must be approved by the UPRR Manager Electrical Design

A. Fuses 600V and less:
   1. See Specification Section 26 28 00 for additional information.
   2. All fuses over 600A shall be Low-Peak, Time-Delay, Current-Limiting Class L fuses.
   3. All service disconnect fuses under 600A shall be Low-Peak, Dual-Element, Time-Delay Current-Limiting Class RK1 fuses.
   4. All non-service disconnect fuses under 600A shall be Dual-Element, Time-Delay, Current-Limiting Class RK5.
   5. Approved Manufacturers:
      a. Cooper Bussmann.
      b. Littelfuse.
      c. Ferraz Shawmut.

B. Overhead Equipment Medium Voltage Fuses:
   1. See Specification Section 26 10 00 for additional information.
   2. All overhead medium voltage equipment shall use "T" Speed Fuse links.
   3. All transformer primary fuses shall be based on the selection sheets in this Appendix.
   4. Approved Manufacturers:
      a. Cooper Power Systems.
      b. S&C.
      c. Hubbell Chance.

C. Pad Mount Equipment Medium Voltage Fuses:
   1. See Specification Section 26 12 19 for additional information.
   2. All pad mount medium voltage equipment shall use Dual Element and/or Dual Sensing Bay-O-Net fuses.
   3. All transformer primary fuses shall be based on the selection sheets in this Appendix.
   4. Approved Manufacturers:
      a. Cooper Power Systems.
      b. Hubbell Chance.

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TYPE K, T, 200, & QA FUSE LINKS

Fuse link ratings recommended in these tables will carry the full load of the transformer continuously and will open in five minutes when the transformer load is approximately three times full load. Smaller or larger fuse link ratings may be used to give the desired correlation of protection and continuity of service, These tables are to be used as a guide until a more detailed study can be made.

SINGLE-PHASE

Single-Phase Table is used for all single-phase, three-phase "WYE" and outside legs of open delta connected transformers. Do not fuse neutral.

THREE-PHASE

Three-Phase Table is used for closed Delta and common legs of open Delta connected transformers. Use fuse size recommended for largest transformer connected to lead under consideration.

Refer to single-phase table for "WYE" and open Delta connected transformers.

™

UP-Pirate-0005955

Kearney™ Type K or T Fuse Link Ratings for Single-Phase Transformer Installations Three-Phase "WYE" and Outside Legs of Open Delta

KVA RATING	RATED LINE VOLTAGE (kV)								
	2.4	4.16	4.8	7.2	7.62	12	13.2	14.4	22.9
3	2	1	1	1	1	1	1	1	1
5	3	2	2	1	1	1	1	1	1
7.5	6	3	2	2	1	1	1	1	1
10	6	3	3	2	2	1	1	1	1
15	8	6	6	3	3	2	2	2	1
25	15	8	8	6	6	3	3	3	2
37.5	25	12	10	8	8	6	3	3	3
50	30	15	15	10	10	6	6	6	3
75	50	25	25	15	15	8	8	8	6
100	65	30	30	20	20	12	10	10	6
150	100	50	50	30	30	20	15	15	10
167	100	65	50	30	30	20	20	15	10
200	140	65	65	40	40	25	20	20	12
250	140	80	80	50	50	30	25	25	15
333	140	100	100	65	65	40	40	30	20
500	200	140	140	100	100	65	50	50	30

Kearney™ Type K or T Fuse Link Ratings for Three-Phase Individual Transformer Sizes In Closed Delta and Common Legs of Open Delta

KVA RATING	RATED LINE VOLTAGE (kV)									
	2.4	4.16	4.8	7.2	8.32	12	12.47	13.2	14.4	22.9
3	3	2	2	1	1	1	1	1	1	1
5	6	3	3	2	2	1	1	1	1	1
7.5	8	6	3	3	2	2	2	1	1	1
10	10	6	6	3	3	2	2	2	2	1
15	15	8	8	6	6	3	3	3	3	2
25	25	15	12	8	6	6	6	6	3	3
37.5	40	25	20	12	10	18	10	6	6	3
50	50	30	25	15	15	10	10	10	8	6
75	80	50	40	25	25	15	15	15	12	8
100	100	65	50	30	30	20	20	20	15	10
150	140	100	80	50	50	30	30	30	25	15
167	140	100	80	65	50	30	30	30	30	20
200	200	100	100	65	65	40	40	40	30	20
250	200	140	100	80	80	50	50	50	40	25
333	200	140	140	100	100	65	65	65	65	40
500	–	200	200	140	140	100	100	100	80	50

Cooper Dual Sensing Bay-O-Net

Single-Phase Transformer (Phase-to-Ground) Applications

Transformer kVA	Transformer Primary Voltage (kV)										
	2.4	4.16	4.8	7.2	7.62	8.32	12.0	12.47	13.2	13.8	14.4
5	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03
10	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03	C03
15	C08	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03
25	C10	C08	C08	C05	C05	C05	C03	C03	C03	C03	C03
37.5	C12	C10	C08	C08	C08	C08	C05	C05	C05	C05	C05
50	C12	C10	C10	C08	C08	C08	C05	C05	C05	C05	C05
75	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
100	C14	C12	C12	C10	C10	C10	C08	C08	C08	C08	C08
167	C18	C14	C14	C12	C12	C12	C10	C10	C10	C10	C10
250	–	C16	C18	C14	C14	C14	C12	C12	C12	C12	C12
333	–	C18[a]	C18	C14[a]	C14	C14	C12	C12	C12	C12	C12
500	–	–	–	C18	C18	C18	C14	C14	C14	C14	C14

Three-Phase Transformer (Phase-to-Phase) Applications

Transformer kVA	Transformer Primary Voltage (kV)									
	2.4	4.16	4.8	8.32	12.0, 12.47	13.2	13.8, 14.4	20.8b,d	22.9b,d	24.9b
45	C10	C08	C08	C05	C03	C03	C03	C03	C03	C03
75	C12	C10	C10	C08	C05	C05	C05	C03	C03	C03
112.5	C14	C12	C10	C08	C08	C08	C08	C05	C05	C05
150	C14	C12	C12	C10	C08	C08	C08	C05	C05	C05
225	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
300	C18	C14	C14	C12	C10	C10	C10	C08	C08	C08
500	–	C18	C18	C14	C12	C12	C12	C10	C10	C10
750	–	C18[a]	C18[a]	C18	C14	C14	C14	C12[a]	C12	C12
1000	–	–	–	C18	C14[a]	C14[a]	C14[a]	C12[a]	C12	C12
1500	–	–	–	–	C18[c]	C18[c]	C18[c]	C14	C14	C14

Cooper Dual Element Bay-O-Net

Single-Phase Transformer (Phase-to-Ground) Applications

Transformer kVA	Transformer Primary Voltage (kV)										
	2.4	4.16	4.8	7.2	7.62	8.32	12.0	12.47	13.2	13.8	14.4
5	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03	C03
10	C05	C04	C04	C03	C03	C03	C03	C03	C03	C03	C03
15	C07	C05	C05	C03	C03	C03	C03	C03	C03	C03	C03
25	C09	C06	C06	C04	C04	C04	C03	C03	C03	C03	C03
37.5	C11	C09	C08	C06	C06	C06	C05	C05	C04	C04	C04
50	C12	C09	C09	C07	C07	C07	C06	C06	C05	C05	C05
75	C14	C12	C11	C09	C09	C09	C07	C06	C06	C06	C06
100	–	C12	C12	C09	C09	C09	C09	C09	C07	C07	C07
167	–	–	–	C12	C12	C12	C11	C11	C09	C09	C09
250	–	–	–	C14	C14	C14	C12	C12	C11	C11	C11
333	–	–	–	–	–	–	C12	C12	C12	C12	C12

Three-Phase Transformer (Phase-to-Phase) Applications

Transformer kVA	Transformer Primary Voltage (kV)									
	2.4	4.16	4.8	8.32	12.0, 12.47	13.2	13.8, 14.4	20.8a,b	22.9a,b	24.9a
45	C09	C07	C07	C04	C03	C03	C03	C03	C03	C03
75	C12	C09	C09	C06	C04	C04	C04	C03	C03	C03
112.5	C14	C11	C09	C07	C06	C06	C06	C05	C04	C04
150	–	C12	C12	C09	C07	C07	C07	C06	C05	C05
225	–	C14	C14	C11	C09	C09	C09	C07	C06	C06
300	–	–	–	C12	C09	C09	C09	C09	C07	C07
500	–	–	–	C14	C12	C12	C12	C11	C09	C09
750	–	–	–	–	C14	C14	C14	C12	C11	C11
1000	–	–	–	–	–	–	–	C14	C12	C12

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APPENDIX D - SAMPLE ARC FLASH LABELS



WARNING

ARC FLASH & SHOCK HAZARD

APPROPRIATE PPE REQUIRED

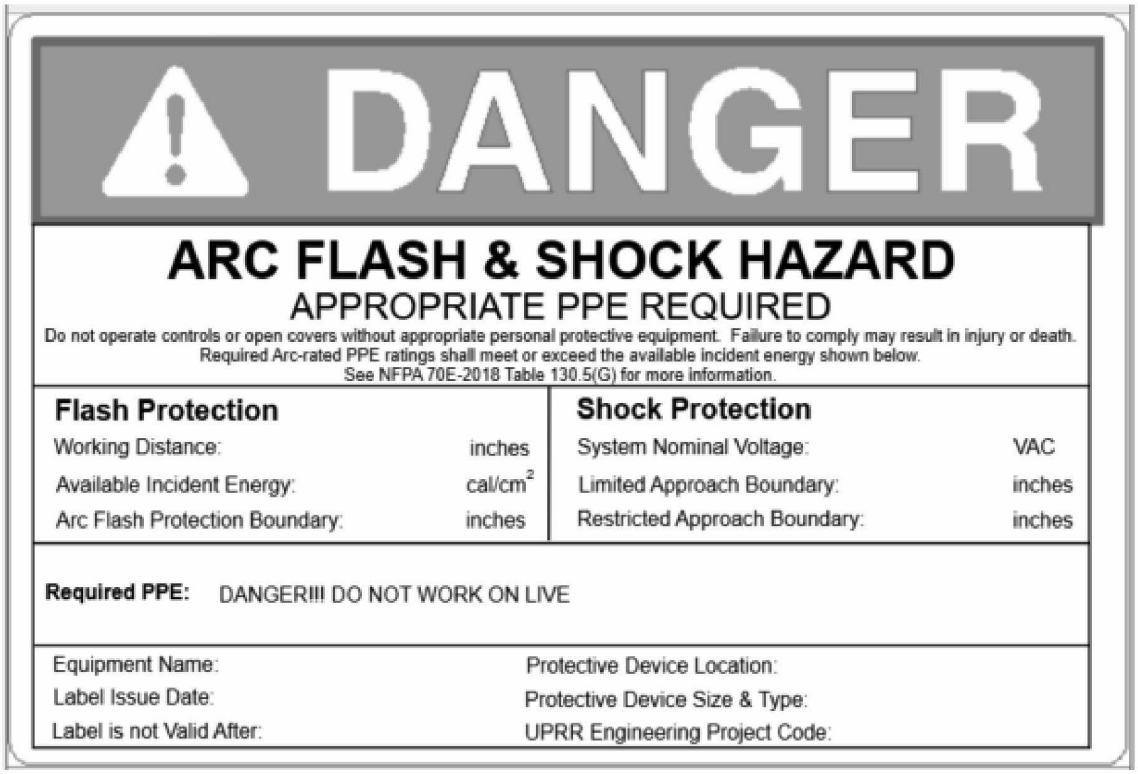
Do not operate controls or open covers without appropriate personal protective equipment. Failure to comply may result in injury or death.
Required Arc-rated PPE ratings shall meet or exceed the available incident energy shown below.
See NFPA 70E-2018 Table 130.5(G) for more information.

Flash Protection		Shock Protection	
Working Distance:	inches	System Nominal Voltage:	VAC
Available Incident Energy:	cal/cm^2	Limited Approach Boundary:	inches
Arc Flash Protection Boundary:	inches	Restricted Approach Boundary:	inches

Required PPE: Arc-rated long sleeve shirt and pants or coveralls, arc-rated flash suit hood, arc-rated gloves, arc-rated jacket, hard hat with arc-rated liner, safety glasses, hearing protection, heavy duty leather gloves, and leather footwear.

Equipment Name:	Protective Device Location:
Label Issue Date:	Protective Device Size & Type:
Label is not Valid After:	UPRR Engineering Project Code:

Sample Arc Flash Label for less than 40 cal/cm^2.
Required PPE list reflects incident energies between 12 cal/cm^2 and 40 cal/cm^2.
Provide incident energy level specific list per table 130.5 (G) for each label.



DANGER

ARC FLASH & SHOCK HAZARD

APPROPRIATE PPE REQUIRED

Do not operate controls or open covers without appropriate personal protective equipment. Failure to comply may result in injury or death.
Required Arc-rated PPE ratings shall meet or exceed the available incident energy shown below.
See NFPA 70E-2018 Table 130.5(G) for more information.

Flash Protection		**Shock Protection**	
Working Distance:	inches	System Nominal Voltage:	VAC
Available Incident Energy:	cal/cm^2	Limited Approach Boundary:	inches
Arc Flash Protection Boundary:	inches	Restricted Approach Boundary:	inches

Required PPE: DANGER!!! DO NOT WORK ON LIVE

Equipment Name:	Protective Device Location:
Label Issue Date:	Protective Device Size & Type:
Label is not Valid After:	UPRR Engineering Project Code:

Sample Arc Flash Label for greater than 40 cal/cm^2.

Arc Flash label samples are courtesy of Zachry Engineering Corporation.

SECTION 27 11 13 - COMMUNICATIONS ENTRANCE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Communications entrance.

1.02 REFERENCED STANDARDS

A. National Electrical Code (NEC).

B. National Electrical Safety Code (NESC).

C. UPRR Telecom Building Construction Best Practices (latest edition)

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 INSTALLATION

A. The service entrance facility shall be provided and installed according to the manufacturers recommended installation practices for hand holes and maintenance holes, whichever the owner specified.

B. Install two (2) 4 IN inside diameter PVC conduits extending from the Telecommunications Closet / Equipment Room to the Service Box.

1. Install two (2) 1-1/4 IN and one (1) 1 IN innerduct within these conduits. Innerduct material shall be as follows: Premier Corrugated HDPE manufactured from High Density Polyethylene (HDPE) and shall be placed inside of the conduit. This lightweight product offers maximum flexibility, and allows for installation in small or restricted areas. Corrugated duct is available in 1 IN and 1-1/4 IN and is orange in color.

2. For conduits identified as fiber trunk pathways, the innerducts shall be a MaxCell product. The 4 IN 3-Cell product is designed to hold larger backbone cables up to 1.34 IN diameter in each cell. Up to two packs can be placed in a 4 IN conduit.

a. Only one 3-cell pack is required.

1) Standard color is green.

2) Color-coded pull tapes are pre-installed.

3) Factory lubricated.

C. A tracer wire is required in all installations using non-conductive conduits.

D. The total number of bends in a conduit section run shall not exceed two (2) 90 bends or equivalent of sweeps and radius bends. Each bend shall have a minimum radius in accordance with existing standards.

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E. Encase conduit(s) in concrete (2,500 PSI) where, minimum 36 IN depth cannot be attained, conduits pass under roads, driveways, or bend points are subject to movement. When crossing under UPRR tracks follow instructions in UPRR web site under Real Estate and crossings. When terminating at a pole, clamp the conduit(s) rigidly to the field side of the pole at a 90-degree separation from power.

F. Conduits terminating inside of a building shall be installed so that the conduit extends 10 cm (4 IN) (Above Finished Floor [AFF]) beyond the surface from which it emanates. Conduits shall be plugged with mechanical-type seals to ensure that foreign matter does not enter the building.

G. The ends of metallic conduit shall be reamed, bushed, and grounded according to NEC and NESC.

H. All conduits shall have a non-corrosive pull rope installed.

I. Installation shall include a detectable orange warning tape placed 18 IN above the conduit. The warning tape shall be located at a minimum of 12 IN below grade.

J. Additional details and instructions are available in item C of the Referenced Standards for this section.

END OF SECTION

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SECTION 31 11 00 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Removal and disposal of all trees, stumps, undergrowth, brush, trash, grass, weeds, roots, concrete, debris, or other objectionable materials within the limits of the excavation, embankment, borrow, and other areas as shown on the plans and Contract Documents.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 31 24 13 – Excavation, Embankments and Other Fills

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 GENERAL

A. The designated areas shall be cleared except certain areas as directed by the Engineer for preservation. Areas designated for preservation shall be carefully protected from abuse, marring or damage during construction operations.

B. All holes remaining after clearing and grubbing shall be backfilled and compacted as directed by the Engineer and the entire area bladed to provide drainage, except, in areas to be immediately excavated, the Engineer may direct that the holes not be backfilled.

3.02 EXCAVATIONS

A. Areas that are to be excavated and hauled into embankments shall be cleared and grubbed of all objectionable material to the full depth and width of the completed excavation. Areas that are to be excavated and wasted shall not be cleared unless specifically requested by the Engineer. Roots or other vegetation existing below the finished surface of excavated sections shall be removed to a depth of 2 FT below the finished surface. There will be no allowance for any grubbing required below such finished surface. All such grubbing below the finished surface shall be considered incidental to clearing and grubbing, and shall be included in the bid item cost for clearing and grubbing.

3.03 BORROW PITS

A. Areas required for borrow sites and material sources must be cleared and grubbed, except for designated trees and shrubs, to prevent such objectionable material being used in construction.

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3.04 EMBANKMENTS

A. All areas that will be beneath embankments shall be free from all vegetation and roots to a minimum depth of 2 FT below the ground surface.

B. All rubbish shall be removed in embankment areas.

3.05 OTHER DESIGNATED AREAS (SUCH AS STAGING AND STORAGE AREAS)

A. Designated portions of the right-of-way other than excavations, borrow areas, and embankments shall be cleared off level with ground surface by cutting and removal of all trees (standing or fallen), stumps, undergrowth, brush, vines, roots, and other vegetation, trash, or objectionable materials so that no obstruction will interfere with close machine or hand mowing of cleared areas. Cleared areas shall be left smooth and free of obstructions that will impound water.

3.06 TOPSOIL

A. Topsoil shall be stockpiled as necessary for capping of slopes and ditch bottoms. See Section 31 14 14.

3.07 DISPOSAL

A. All cleared and grubbed material shall be disposed of off property unless otherwise directed by Engineer, and shall comply with Federal, State and Local regulations. Pieces of rail, broken ties, and rubble within the grading limits are to be removed off of railroad property in a legal proper manner. This shall be incidental to the clearing and grubbing bid item.

B. Material being disposed of shall not be burned either on or off Railroad property.

C. No material will be disposed of in the grading footprint.

D. Large trees and shrubs may be shredded into mulch and used for capping slopes and ditch bottoms, as approved and directed by the Engineer.

E. Unless otherwise stated in the special provisions, all merchantable timber will be the property of the Contractor.

3.08 LIMITS OF WORK

A. Trees or other growth outside the limits for clearing and grubbing shall be preserved and protected from damage during construction operations. If rare or endangered plants or artifacts are encountered during construction, work shall stop in the vicinity of the find, and the Contractor shall notify the Engineer of said find.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. "Clearing and Grubbing" will be measured by the acre or bid as a lump sum.

B. If a bid item for “Clearing and Grubbing” is not included, payment for this work will be considered as incidental to the unit price for grading.

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4.02 PAYMENT

A. Clearing and grubbing shall be paid for at the contract unit price per acre cleared and grubbed within the grading limits. This price shall be full compensation for furnishing all labor, materials, tools, equipment, supplies, supervision, and incidentals necessary for clearing, grubbing, and disposal of the resulting materials.

B. Areas outside the grading limit, such as borrow areas, staging areas, and material storage areas are not included. Clearing and grubbing for these areas are incidental to their respective bid items.

C. Pieces of rail, broken ties, and rubble within the grading limits are to be removed off of railroad property in a legal proper manner. This shall be incidental to the clearing and grubbing bid item.

END OF SECTION

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SECTION 31 14 14 - TOPSOIL - STOCKPILE AND PLACING

PART 1 - GENERAL

1.01 SUMMARY

A. Roadbed slopes, both in excavation and embankment sections, and any disturbed soils that will not support plant life and/or will cause or allow soil erosion shall be covered with 6 IN of top soil at the completion of the grading operation or the project.

B. Areas which have soils which are suitable for use as topsoil, at the completion of the project, shall be cleared of all vegetation, brush, rocks that are larger than 2 IN, and any other debris on the surface, which is part of the Clearing and Grubbing Section 31 11 00.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 43 26 – Testing Laboratory Services

B. Section 31 11 00 – Clearing and Grubbing

C. Section 31 24 13 – Excavation, Embankments and Other Fills

D. Section 31 25 10 – Slope Protection and Erosion Control

E. Section 32 92 19 – Seeding

PART 2 - PRODUCT

2.01 MATERIAL

A. Topsoil:

1. Topsoil consisting of friable, fertile soil of loamy character, containing an amount of organic matter normal to the region, capable of sustaining healthy plant life, and reasonably free from subsoil, roots, heavy or stiff clay, stones larger than 2 IN in greatest dimension, noxious weeds, sticks, brush, litter and other deleterious matter.

2. Obtain topsoil from sources within the project limits, or provide imported topsoil obtained from sources outside the project limits, or both.

PART 3 - EXECUTION

3.01 REMOVAL AND STOCKPILING OF TOPSOIL.

A. The top 6 IN of suitable topsoil, or the soil that complies with the requirements for topsoil to any depth within the template for the excavation area will be removed and stockpiled during construction.

B. Stockpiles shall be shaped or graded to maintain drainage and protect the topsoil material from being over wetted which will require time to disk, roll and dry back to moisture requirements for compaction of embankment.

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C. After construction, the topsoil will be placed on slopes, trouble areas and ditches as specified by the Engineer.

D. See Section 32 92 19 or the Schedule of rates and prices for seeding, should it be required.

E. Care shall be taken not to damage any area in the process of moving the topsoil from the stockpile to the final location.

F. The stockpile shall be wetted to control dust.

G. The Contractor shall check with the Engineer, the drawing, and the Specifications for the origin, the stockpile location, and the areas which will require topsoil.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Removing from the excavation areas, the hauling and stockpiling, the protecting of the stockpile from the elements, and the hauling and placing of the topsoil, with compaction as required in Section 31 24 13, and the redressing of slopes and areas involved.

4.02 PAYMENT

A. Stockpiling of Topsoil is to be paid for at the unit of Cubic Yard. This price includes the following:

1. The removal from the excavation area.
2. The hauling to and placing in the stockpile.
3. The maintaining of the stockpile.
4. The hauling and placing of the topsoil in areas requiring topsoil, as designated by the Engineer.
5. The care and repair of areas disturbed while moving, placing, and compacting the topsoil.

B. If there is no Stockpiling of Topsoil bid item, Stockpiling of Topsoil shall be incidental to the embankment or excavation bid item.

END OF SECTION

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SECTION 31 22 19 - FINISH GRADING

PART 1 - GENERAL

1.01 SUMMARY

A. The Roadbed shall be finished to the lines and grades shown on the Drawings and as staked. Finished Roadbeds shall be protected from damage from all causes by the Contractor until accepted by the Railroad.

1.02 ALIGNMENT AND GRADE

A. The finished Grading and Borrow Areas shall conform to the alignment and grade set forth in the Drawings. The Engineer shall furnish control for line and grade and sufficient information for the Contractor to set the required construction stakes.

1.03 SLOPE STAKES

A. Slope stakes will be set by the Contractor in accordance with the typical sections and cross sections on the Drawings. The Engineer shall use his judgment or soil tests to determine the stability of the materials encountered, and if the physical properties of the materials encountered necessitates changing the slopes after an excavation has been completed. The Engineer may require the Contractor to reset the slope stakes and to steepen, flatten, or bench the slopes. The reasonable costs of re-setting stakes in this case shall be borne by the Railroad. The Contractor shall maintain and preserve all stakes and other marks established until authorized by the Engineer to remove them. If the Contractor removes or destroys such stakes or marks before receiving authorization from the Engineer the replacing of such stakes or marks shall be the Contractor's responsibility.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. All finish grading labor, material and equipment used shall be incidental to the grading service item.

B. If Proposal & Bid Form contains a finish grading service item, all labor, material and equipment used for finished grading shall be incidental to that service item.

END OF SECTION

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SECTION 31 23 10 - EXCAVATION AND FILL FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavation for building foundations.
2. Excavation for slabs-on-grade and paving.
3. Excavation for site structures.
4. Site Filling: Placement of structural fill to raise site elevations and stabilize foundations.

B. This section does not apply to the construction of mainline and/or yard track projects. Refer to Section 31 24 13 – Excavation, Embankments and Other Fills for excavation and fill - to construct railroad track projects.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 45 00 - Quality Control.

C. Section 01 43 26 - Laboratory And Field Testing Services.

D. Section 31 23 24 – Backfill for Buildings.

E. Section 31 23 17 – Trenching for Buildings.

1.03 REFERENCED STANDARDS

A. ANSI/ASTM D698 (Standard Proctor) - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 5.5 LB Rammer and 12 IN drop.

B. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth).

C. Code of Federal Regulations Occupational Safety and Health Administration (OSHA) Title 29-Labor, Part 1926.

1.04 FIELD MEASUREMENTS

A. Verify that survey benchmark and intended elevations for the work are as indicated.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Section 31 23 24 – Backfill for Buildings.

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PART 3 - EXECUTION

3.01 PREPARATION

A. Identify known underground, above ground, and aerial utilities. Stake and flag locations.

B. Protect above and below grade utilities that are to remain.

C. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

D. Prepare subgrade.

3.02 EXCAVATION

A. Take special precautions as required preserving condition and integrity of existing structures. Special precautions would include sheeting, shoring, bracing, etc.

B. Excavate subsoil required to accommodate building foundations, slabs-on grade, and paving.

C. Scarify the exposed soil to an additional depth of 6 IN; adjust the soil moisture by adding water or dryer so the soil moisture content is within 3 percent of the optimum moisture content.

D. Compact the subgrade soils to at least 98 percent Standard Proctor maximum dry density (ASTM D698 as in Reference A).

E. Grade top perimeter of excavation to prevent surface water from draining into excavation.

F. Use precaution during final excavation to subgrade level to prevent disturbance and remolding of subgrade material. Hand trim excavation as required. Remove loose material.

G. Remove lumped subsoil, boulders, and rock up to 1/3 CU YD measured by volume.

H. Notify the Engineer's Field Representative of unexpected subsurface conditions or hazardous materials encountered. Discontinue affected work in area until notified to resume work.

I. Correct unauthorized excavation. Unauthorized excavation performed by the Contractor will be corrected at the Contractor’s expense. If a party other than the Contractor directed the unauthorized excavation then the expense to correct the unauthorized excavation will be covered by that party.

J. Correct areas over-excavated by error in accordance with Section 31 23 24 - Backfill. Any over-excavation performed by the Contractor will be corrected at the Contractor’s expense. If the Owner directed the over-excavation then the expense to correct the overexcavation will be covered by the Owner.

K. It is the Contractor's responsibility to comply with applicable State and Federal regulations on excavation, shoring, and trenching.

3.03 FILL COURSE PLACEMENT

A. Fill areas to contours and elevations with unfrozen materials.

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B. Place the material in 8 IN loose lifts and compact to 98 percent Standard Proctor density (ASTM D698) using a vibratory roller.

C. Inaccessible areas should be compacted using hand equipment in 4 IN loose lifts.

D. Maintain optimum moisture content (±3 percent) of all fill materials to attain required compaction density.

E. If subgrade material or previously placed subsoil fill has deteriorated due to weather exposure, scarify the top 2 IN of material to establish an acceptable interface prior to placing any additional fill.

F. Slope grades away from buildings a minimum of 2 IN in 10 FT, unless noted otherwise. Grade site to promote drainage for surfaces that are to remain exposed for an extended period of time to prevent water accumulation and subsequent softening.

G. Make grade changes gradual. Blend slope into level areas and match existing paving that will remain.

H. Remove surplus fill materials from site or dispose of in designated disposal areas.

3.04 FIELD QUALITY CONTROL

A. Field inspection will be performed under provisions of Section 01 43 26.

B. The final surface should be smooth and uniform and should conform to the required cross section and established grade. Tolerance for the finished surface: ±1/10 FT. Tolerance for the finished surface under paved areas: ±1/2 IN.

C. Compaction testing will be performed in accordance with ASTM D2922 and Section 01 43 26.

D. Provide for visual inspection of bearing surfaces.

3.05 PROTECTION

A. Protect excavations by methods required, preventing cave-in or loose soil from falling into excavation.

B. Remove water which enters excavations.

C. Protect soil adjacent to and beneath existing foundation from freezing.

D. It is the Contractor's responsibility to comply with applicable State and Federal regulations in protecting open excavations.

END OF SECTION

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SECTION 31 23 17 - TRENCHING FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Excavated trenches for utilities.
2. Compacted bedding under fills over utilities to subgrade elevations.
3. Backfilling and compaction.

B. This section does not apply to the construction of mainline and/or yard track projects.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 45 00 - Quality Assurance and Control.

C. Section 01 43 26 - Laboratory And Field Testing Services.

D. Section 03 30 00 - Cast-In-Place Concrete.

E. Section 31 23 10 - Excavation and Fill For Buildings.

F. Section 31 23 24 – Backfill For Buildings.

1.03 REFERENCED STANDARDS

A. ANSI/ASTM D698 (Standard Proctor) -Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 5.5-pound Rammer and 12-inch drop.

B. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.

C. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth).

D. Code of Federal Regulations Occupational Safety and Health Administration Title 29- Labor, Part 1926, Subpart P - Excavations, Trenching, and Shoring.

1.04 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Certification that the Contractor's shoring methods conform to the requirements of OSHA and other applicable codes.

1.05 FIELD MEASUREMENTS

A. Verify that survey benchmark and intended elevations for the work are as shown on drawings.

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PART 2 - PRODUCTS

2.01 FILL MATERIALS

A. Types B, C, and flowable fill materials as specified in Section 31 23 24.

2.02 BED MATERIALS

A. Type B or C material as specified in Section 31 23 24. Bedding must be free of particle larger than 1 inch in diameter.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify fill materials to be reused are acceptable.

3.02 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

C. Protect above and below grade utilities which are to remain.

D. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with Type B fill and compact to density equal to or greater than requirements for subsequent backfill material.

3.03 EXCAVATION

A. Excavate subsoil required for connection to existing utilities.

B. Cut trenches sufficiently wide to enable installation of utilities and allow inspection.

C. Excavation shall not interfere with normal 45 degree bearing splay of foundations.

D. Remove rocks to a minimum clearance of 8 IN around the bottom and sides of pipe, conduit, and duct.

E. Hand trim excavation. Remove loose material.

F. Keep trenches dewatered.

G. Correct unauthorized excavation in accordance with Section 31 23 24 and as specified in Section 31 23 10.

H. Correct areas over-excavated by error in accordance with Section 31 23 24 and as specified in Section 31 23 10.

I. Stockpile excavated material in area designated on site.

3.04 BEDDING

A. Support pipe and conduit, if necessary, during placement and compaction of bedding fill, according to design drawings.

B. Bedding material shall provide continuous support for pipe between joints.

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3.05 BACKFILLING

A. Reference Section 31 23 24 for general backfilling materials and instructions.

B. Backfill trenches to proper contours and elevations with unfrozen materials.

C. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.

D. Sheeting and bracing may not be left in place unless written permission has been received from the Engineer.

E. Employ a placement method that does not disturb or damage conduit in trench. Place lifts equally on each side of conduit to maintain balanced loading on pipe wall.

F. Comply with ASTM D2321, Class II, for backfill around HDPE piping. Work fill material underneath haunches of pipe with a shovel and hand tamp under haunches to provide firm, uniform support of pipe. Place remaining backfill in continuous layers not exceeding 6 inches compacted depth and compact to the following schedule:

1. Under foundations or slabs-on-grade - 98 percent Standard Proctor.
2. Under paved areas, parking areas or sidewalks - 98 percent Standard Proctor.
3. All other areas - 85 percent Standard Proctor.

G. Backfill around sides and top of rigid pipe with Type B or Type C fill, tamped in place in 6 IN loose lifts and compacted to 95 percent Standard Proctor Density at (±3 percent) of optimum moisture content.

H. Allow 24 HRS minimum cure time for concrete encasements prior to backfilling.

3.06 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: ±1/2 IN from required elevations.

B. Top Surface of General Backfilling: ± 1 IN from required elevations.

3.07 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 01 45 00. Testing will be done at a rate of 1 test per 100 FT of trench length.

B. Tests and analysis of fill material will be performed in accordance with ANSI/ASTM D698 and with Section 01 43 26.

C. Compaction testing will be performed in accordance with ASTM D2922 and with Section 01 43 26.

D. If tests indicate work does not meet specified requirements, remove work, replace and retest.

3.08 PROTECTION OF FINISHED WORK

A. Protect finished work.

B. Recompact fill disturbed by vehicular traffic.

END OF SECTION

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SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.01 SUMMARY

A. If water is encountered during trenching and excavating operations, remove or lower by means of one of the following dewatering systems as required to permit preparation of a satisfactory pipe bed or structural subgrade, free from water.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 31 24 13 – Excavation, Embankment and Other Fills

B. Section 33 42 00 – Culverts

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

3.01 WELL POINTS AND PUMPS

A. This dewatering system requires the use of individually cased wells and pumps, connecting pipelines and continuous operation in order to permit preparation of a satisfactory pipe bed or structural subgrade.

3.02 CASED WELLS AND PUMPS

A. This dewatering system requires the use of individually cased wells and pumps, connecting pipelines and continuous operation in order to permit preparation of a satisfactory pipe bed or structural subgrade.

3.03 DISCHARGE

A. Water from dewatering operations shall be discharged to the existing drainage course and shall be approved by Owner, Engineer and appropriate regulatory agency.

3.04 PERMITS

A. Secure the necessary Water Rights permit from the Federal, State or Local or other appropriate regulatory agency prior to dewatering activity.

3.05 DURATION

A. Continue dewatering until there is no danger of structure displacement due to buoyancy

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PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. All dewatering labor, material and equipment used shall be incidental to the corresponding earthwork service item.

B. If Proposal & Bid Form contains a dewatering service item, all labor, material and equipment used for dewatering shall be incidental to that service item.

END OF SECTION

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SECTION 31 23 24 - BACKFILL FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Building perimeter backfilling to subgrade elevations.
2. Backfilling.
3. Fill under paving.
4. Consolidation and compaction.
5. Fill for over-excavation and unauthorized excavation.
6. Section does not include excavation and preparation for foundation construction.

B. This section does not apply to the construction of mainline and/or yard track projects.

1.02 RELATED REQUIREMENTS (SECTIONS):

A. Section 01 33 00 - Submittals.

B. Section 01 45 00 - Quality Assurance and Control.

C. Section 01 43 26 - Laboratory And Field Testing Services.

D. Section 03 30 00 - Cast-In-Place Concrete.

E. Section 31 23 10 - Excavation and Fill For Buildings.

F. Section 31 23 17 - Trenching For Buildings.

1.03 REFERENCED STANDARDS

A. ASTM C127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate.

B. ANSI/ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.

C. ASTM C618 - Fly Ash and Raw or Calcinated Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

D. ANSI/ASTM D698 (Standard Proctor) - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, using 5.5 LB Rammer and 12 IN drop.

E. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (shallow depth).

F. ASTM D2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.

G. ASTM D2487 - Classification of Soils for Engineering Purposes.

H. ASTM D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

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1.04 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures.

B. Samples: Submit a 10 LB sample of each type of fill, in airtight containers, to testing laboratory. For each type of fill to be used, one moisture-density curve (ASTM D698), sieve analysis, and Atterberg limit tests (liquid limit, plastic limit, and plasticity index according to ASTM D4318) shall be performed. The results of the tests shall be submitted to the Engineer for approval prior to starting any fill operations.

C. Submit flowable fill mix design with laboratory tests verifying compliance with these specifications.

PART 2 - PRODUCTS

2.01 FILL MATERIALS

A. Type A - Coarse aggregate road base.

B. Type B - Sand: Natural river or bank sand; washed: free of silt, clay, loam, friable or soluble materials, or organic matter; graded in accordance with ANSI/ASTM C136, within the following limits:

Sieve Size	Percent Passing
No. 4	100
No. 40	30 to 50

C. Type C - Excavated subsoils: Properly sampled, tested, and approved for reuse. Material is to be homogeneous and free of organic material or lumps and stones larger than 1 IN DIA.

D. Type D - Stabilized Soil: Homogeneous mixture of ASTM C618 Class C fly ash, soil, and water.

E. Flowable Fill: Blend of ASTM C618 Class C fly ash, cement, and water. Sand may be added as a filler. Flowable fill mixtures shall be proportioned to meet the following requirements:

1. Twenty-eight day compressive strength of the fill material shall be greater than 75 LBS/SQ IN, but less than 175 LBS/SQ IN, when cured and tested as standard concrete cylinders.

2. Workability shall be such that the mixture flows easily into all voids and crevices of an excavation with minimal mechanical agitation or dispersion. Flowability shall be such that the wet mixture is self-leveling. The mixture should have a slump of approximately 10 IN.

3. Shrinkage of the fill material shall be no more than 1/8 IN/FT of fill depth.

F. Coarse Aggregate Fill: Washed stone; free of shale, clay friable material, and debris; graded in accordance with ASTM D2487 Group Symbol Coarse "GP".

G. Fly Ash: ASTM C618 Class C Fly Ash.

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H. Final fill course in unpaved or unsurfaced areas shall be topsoil capable of establishing vegetative ground cover.

I. Concrete: Lean Concrete conforming to Section 03 30 00.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify fill materials to be reused are acceptable to Engineer, and test materials to establish compaction requirements.

3.02 PREPARATION

A. Generally, compact subgrade to density requirements for subsequent backfill materials.

B. Cut out soft areas of subgrade not capable of in situ compaction. Backfill with Type A fill or Type C fill, as appropriate, and compact to 98 percent Standard Proctor density.

C. Prior to placement of aggregate base course material at paved areas, compact subsoil to 98 percent of its maximum dry density (Standard Proctor) within ±3 percent of optimum moisture content determined in accordance with ANSI/ASTM D698.

3.03 FILLING AND BACKFILLING

A. Backfill areas to contours and elevations with unfrozen materials. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

B. Granular Fill: Place and compact materials in continuous layers not exceeding 8 IN loose depth.

C. Soil Fill: Unless otherwise noted, place and compact material in continuous layers not exceeding 8 IN loose depth for structural backfill. All backfill shall be compacted to 98 percent Standard Proctor density.

D. Install and compact a 6 IN thickness of well-graded crushed stone with maximum 6 percent fines beneath building slabs.

E. Comply with ASTM D2321 for backfill around HDPE and other flexible piping in trenches.

F. Employ a placement and compaction method that does not disturb or damage utilities in trenches.

G. Maintain optimum moisture content (±3 percent) of backfill materials to attain required compaction density.

H. Slope grades away from building, minimum 2 IN in 10 FT, unless noted otherwise.

I. Make grade changes gradual. Blend slope into level areas.

J. Remove surplus backfill materials from site and dispose of in designated disposal areas.

K. Fill for overexcavation or unauthorized excavation shall be compacted engineered fill, as specified in Section 31 23 10.

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3.04 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: ±1/2 IN from required elevations.

3.05 FIELD QUALITY CONTROL

A. Grading/Embankment:

1. In at-grade and fill areas, after clearing and grubbing, and prior to fill placement, exposed subgrade shall be moisture conditioned to within the range of 2 percent below to 3 percent above the optimum moisture content, and compacted inplace to a dense and unyielding condition and to a minimum of 95 percent of the modified proctor (ASTM D1557) maximum dry density for the exposed subgrade material.
2. All materials testing shall be paid for by the Contractor and is part of Grading/Embankment.
3. The compacted subgrade surface shall then be proofrolled with a fullyloaded, tandemaxle, 10 CU YD dump truck or equivalent proposed by the Contractor and will be incidental to Grading/Embankment.
4. In areas to be excavated, the exposed excavated surface shall be proofrolled as described above for at grade and fill areas, after finished subgrade elevation is achieved.
5. Any subgrade area identified as being loose, soft, or yielding during proofrolling shall either be further compacted or subexcavated and replaced with properly compacted native soils or imported fill. Care shall be taken during proofrolling and subgrade preparation to minimize disturbance to subgrade soils and adjacent supporting soils which will remain in place. The final prepared subgrade surface shall be sloped to promote positive drainage.
6. Subgrade within a distance of 20 FT from the outside edge of and along the length of culverts shall be compacted to a minimum of 100 percent of the modified Proctor (ASTM D1557) maximum dry density.

B. Tests and analysis of fill material will be performed in accordance with ANSI/ASTM D698, and Section 01 43 26.

C. Compaction testing will be performed in accordance with ASTM D2922 and Section 01 43 26.

D. Frequency of Tests: Perform at least 1 test per 1,000 SQ FT per lift, unless otherwise noted by the Engineer. Minimum 2 tests per lift.

E. If tests indicate work does not meet specified requirements, remove work, replace, and retest.

F. Proof roll compacted fill surfaces under slabs-on-grade and site paving with smooth drum roller (5-ton minimum weight) to expose soft or weak areas of soil. Rework loose or soft areas to attain firm, uniform surface.

G. Final density of reworked areas must equal or exceed density of adjacent material.

3.06 PROTECTION OF FINISHED WORK

A. Protect finished work under provisions of Sections 01 18 13.

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B. Scarify and recompact fills subjected to vehicular traffic.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of borrow material is to be made at the source by topographical surveying methods and equipment as approved by the Owner. The contractor shall coordinate measurement method operations, so as to leave the excavated areas in a condition that will permit the taking of original and final surveying as necessary for accurate determination of quantities. The frequency and intervals of surveying operations by Contractor shall be agreed upon amongst Owner and Contractor. Owner will conduct verification surveys alongside Contractor forces for comparison of quantities at the Owner's convenience. Owner will determine the quantities by excavated volume (EV) of the excavation material in its original position. The limits for quantity determinations will not extend beyond the authorized grading sections set forth by the Owner.

4.02 PAYMENT

A. Partial payment for Borrow shall be determined by Owner estimates of borrow material excavated and placed or wasted via methods of load counts, approximate percent complete, Contractor survey, and/or Owner verification survey. Final payment for Borrow shall be made from final Contractor survey of all borrow areas utilized on the project and verified with a final Owner survey. Borrow shall be paid on a unit price basis for CY (EV) of Borrow Material excavated and placed into the work, or excavated to waste. Payment for borrow shall be compensation in full for furnishing, hauling, and placing the material as specified, including final compacting and finishing operations and any wasting operations.

END OF SECTION

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SECTION 31 23 26 - COMPACTION CONTROL AND TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. How compacted fill shall be constructed and tested for determination of degree of compaction and moisture content. The Contractor shall acquire and pay for all testing. This shall include but is not limited to subgrade, subballast, and concrete.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. 01 43 26 Laboratory and Field Testing Services

B. 31 24 13 Excavation, Embankments and Other Fills

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 PLACEMENT AND COMPACTION OF EMBANKMENT

A. Lift Thickness:

1. The Contractor shall provide sufficient compaction equipment to properly place and compact the material being used to construct the Embankment. Equipment used for towing shall not be considered as compaction equipment. The material used to construct the Embankment shall be placed in successive horizontal lifts. Each lift shall extend the full width of the Embankment before another lift is started. Each layer shall be adjusted for moisture content, if required, and shall be thoroughly mixed by disking or other means approved by the Engineer. Each lift shall be leveled before compacting and shall be compacted by distributing the travel of the compaction equipment uniformly over the entire length and width of the Embankment.

B. Compaction Equipment:

1. Only equipment that is appropriate for the material being constructed shall be used for compaction. During Embankment construction, continuous use of approved compaction equipment is mandatory. If at any time, the Contractor has not furnished sufficient compaction equipment to compact the materials being used to construct the Embankment, then placement of such Embankment materials shall be reduced accordingly. Since the number of pieces of equipment required for compaction depends on the type and quantity of embankment material being placed, the Contractor shall carefully estimate the rate at which embankment material is placed for the construction equipment available to achieve uniform fill compaction.

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C. Frozen Materials:

1. Embankment material requiring water for density control shall be placed only when temperature is above freezing. No frozen material shall be placed in Embankments. Sustained periods of freezing that induce frost into the previously placed embankment material or embankment material being placed shall be cause for the suspension of construction of the Embankment.

D. Operating Heavy Equipment Over Embankment:

1. When moving over previously compacted Embankments, the Contractor's heavy earth moving equipment shall be operated over the entire area of such Embankment in order to avoid uneven compaction of such Embankment.

E. Definitions and Terms:

1. Compaction - The process of mechanically stabilizing a material by increasing its density within a range of acceptable moisture contents. "Degree of Compaction" is expressed as a percent of maximum density obtained by the test procedure described in ASTM D1557, Test Method for Determining Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT^3 (2,700 Kn-m/m^3)).

2. Density in place- Field testing to determine the density and degree of compaction of fill in place shall be determined in accordance with ASTM D2922, Density of Soils and Soil-Aggregate in Place by Nuclear Methods; or other methods approved by the Engineer and/or Soils Engineer.

3.02 DENSITY REQUIREMENTS

A. Excavation:

1. Scarifying Subgrade:

a. In cut sections, the Contractor shall scarify the top 6 IN of material below the top of existing ground, after cut has been completed, adjust moisture content, and compact such scarified material to not less than 95 percent of maximum density.

2. Excavation in Rock Cut Areas:

a. In cut sections where the material to be excavated is in rock or solid rock the Contractor shall excavate 12 IN below the finished subgrade elevation as shown on the Drawings and shall replace such excavation with embankment material approved by the Engineer. Finished subgrade level is defined as the bottom-of-subballast level. This 12 IN shall be compacted to not less than 95 percent of the maximum dry density (ASTM D1557).

B. Embankment:

1. Scarifying, Adjusting Moisture Content and Compaction:

a. After the required clearing, the resultant subgrade for embankments shall be prepared by scarifying the top 6 IN layer of existing ground, adjusting the moisture content of the scarified materials if required to comply with the project moisture content specifications, and compacting the scarified materials to not less than 95 percent of maximum density (ASTM D1557).

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b. Less Than 3 FT of Fill:

1) The embankments which are to be 3 FT or less in height shall be compacted for their full depth to a density not less than that equal to 95 percent of the soils maximum dry density.

c. More Than 3 FT of Fill:

1) Fills having heights greater than 3 FT shall have the upper 3 FT compacted as stated immediately above with the fill constructed at depths more than 3 FT below finished grade uniformly compacted to a density equal to not less than 90 percent of the soils maximum dry density, or as otherwise specified by the Engineer or Soils Engineer for the project.

d. Soil compaction and moisture content shall be "determined" with a nuclear density meter in accordance with ASTM D2922, or other method approved by the Soils Engineer. Soil compaction shall be computed using ASTM D1557, or another method approved by the Soils Engineer.

C. Bridges and Culverts:

1. When back-filling at the culverts, the Contractor shall be required to attain 100 percent of maximum density, by modified proctor (ASTM D1557), within 20 FT of the culvert.

2. When back-filling at bridges, the Contractor shall be required to attain 100 percent of maximum density, by modified proctor (ASTM D1557), within 100 FT of the bridge abutment.

3.03 MOISTURE AND DENSITY CONTROL

A. Unless otherwise shown on the Drawings, or designated by the Engineer, embankment and those portions of cut sections which are not in rock or solid rock shall be constructed with moisture and density control. Unless otherwise directed by the Engineer, the moisture content of the soil at the time of compaction shall be at the optimum moisture content or within zero and six (6) percentage points above the soils optimum moisture content as determined by ASTM D1557. Locations and the frequency of tests will be determined by the Engineer. Moisture content for sand and gravel materials should be near the optimum moisture content to facilitate compaction of these cohesionless materials.

B. The application of water to embankment or borrow materials shall be done with sprinkling equipment consisting of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities and at variable widths. Mobile sprinkling equipment shall have adequate tractive power and shall be equipped with controls operated from the driver's seat to control the rate of water flow. The Contractor shall be required to furnish sufficient water equipment to ensure proper moisture content of all materials. Watering of embankments shall be done in such a manner that pools of water will not develop. Watering and fill placement operations shall be performed in such a manner that the compacted materials have a uniform moisture content that complies with the Engineer and Soils Engineers moisture requirements for the project.

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3.04 MINIMUM FREQUENCY OF TESTING

A. For density control of embankment, culvert and bridge backfill, subballast, road base, and hot mix asphalt pavements, a sufficient number of tests should be taken to ensure that the specified results are obtained. The frequency of testing will vary with the project, the placement operation, and the material being used. For a project where compaction is relatively easy to obtain, the material is reasonably uniform and the compacting methods are consistent, a minimum number of tests are needed for acceptance. The minimum frequency of test needed under the relatively ideal conditions follow. Most operations will require more tests for proper control. Each lift must meet compaction requirement prior to placing a succeeding lift of material.

Material	**Test Type**	**Frequency**
Embankment	Moisture and Density	1 test per 2000 SY on each lift but no greater than 1000' spacing on each lift for narrow grading operations
Culvert, Bridge and Other Structural Backfill	Moisture and Density	1 test per 200 CY of material
Road Base	Moisture and Density	1 test per 1000 SY on each lift but no greater than 500' spacing on each lift for narrow grading operations

END OF SECTION

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SECTION 31 24 13 – EXCAVATION, EMBANKMENTS AND OTHER FILLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Removal of excavation, the placement of embankment and other fills, and the classification of soils to meet the requirements of construction shown on the drawings, described in the contract documents, and stated in the Specifications.
2. The work shall be conducted so that the terrain outside the grading limits will not be disturbed except where approved by the Engineer.

B. This section does not apply to excavation and fill for buildings. Refer to Section 31 23 10 – Excavation and Fill for Buildings for excavation and fill near buildings

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions

B. Section 01 45 00 - Quality Control

C. Section 01 43 26 – Laboratory and Field Testing Services

D. Section 31 23 26 – Compaction Control and Testing

E. Section 31 78 00 – Blasting

1.03 QUALITY ASSURANCE

A. Requirements:

1. Comply with government agencies having jurisdiction.
2. Comply with the directions of the Railroad Engineer, Geotechnical Engineer, and independent testing laboratory.

1.04 DEFINITIONS

A. The following terms shall be interpreted as follows:

1. Borrow Area - The source, other than required roadbed excavation, where material(s) has been dug for use as fill for embankment and construction at other locations on the project.
2. Embankment (Fill) - A raised structure of soil, soil aggregate, sand, gravel, or rock; or any mixture thereof that is to be (1) used as the subgrade or foundation materials for track or other roadbeds, building(s), or other facilities; and (2) constructed to perform safely and satisfactorily under proposed train, vehicle, embankment, building and/or other proposed loading conditions.
3. Excavation (Cut) - Soil or material to be removed and used as fill for construction of a roadbed embankment or foundation for other structures or facilities; or to be disposed of properly.

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4. Subexcavation -Excavation required below finished subgrade level as part of correcting unsuitable subsurface conditions.
5. Grading Area - The limits (surface) within a designated set of boundaries which includes where both excavations (cuts), embankments (fills), and fills for facilities other than track will be performed.
6. Lift - A layer (or course) of uncompacted embankment material placed on top of suitable natural subgrade or previously prepared embankment fill.
7. Nominal Maximum Size - The maximum U.S. sieve size upon which material is retained.
8. Roadbed - The bed or foundation that supports road surfacing or a track section (i.e., subballast, ballast, ties and rails).
9. Subgrade - The upper roadbed materials that underlie and support subballast; ballast; track structure (i.e., ties and rails); road surfacing (i.e., aggregate or pavement) materials, and the floor within the lowest level of a structure.
10. Unsuitable Material - Earthen and rock subgrade, foundation, borrow, or manufactured materials that do not possess the required strength, stability, and/or consolidation properties to safely and satisfactorily support proposed train or other facility loading conditions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. EXCAVATED MATERIALS

1. Excavatability - The ease or difficulty, and means of excavating materials that are to be obtained from cut sections or borrow areas for a project will not be established for the Contractor. The Contractor shall be responsible for determining the methods necessary for excavation and handling of materials based on his interpretation of site conditions, geotechnical reports (if available), or other information sources.
2. Unsuitable Soil Materials:
    a. The contractor shall remove and dispose of unsuitable and/or contaminated materials at a defined location on the property, at other locations shown on the plans, or as directed by the Engineer.
    b. When project site restrictions mandate, the Contractor shall dispose of excess waste materials off the project site. These waste materials shall be legally disposed of at acceptable waste sites. Contaminated waste materials shall be disposed of at landfills approved to handle and store such materials without causing harm to the environment.
    c. Topsoil shall be excavated during the performance of the clearing and grubbing operations for the project. The excavated topsoil materials shall either be stockpiled for later use as top dressing in grassed areas, wasted at locations directed by the Engineer, or used as part of the construction of the outer portions of embankments outside the track, road or other facilities load-bearing area(s). See Section 31 14 14 for Topsoil – Stockpile and Placing.

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3. Suitable Materials:

   a. Suitable materials shall be used for embankment or other fill construction.

   b. Excess suitable materials, not used for embankment construction, are to be disposed of in a legal manner as follows: (1) at a designated location(s) within the project limits, (2) at other locations shown on the plans, (3) at a location(s) approved by the Engineer, or (4) at an approved landfill location(s).

4. Rock Materials:

   a. Rock is considered to be material requiring blasting or the use of heavy construction breakage equipment (such as a D-8 or larger bulldozer and/or 6,000 FT LBS or greater breakage equipment) as part of excavation. Rock shall include all materials in ledges, bedded deposits, and cemented and conglomerated deposits exhibiting the physical characteristics and difficulty of removal that requires removal using systematic drilling and blasting or as determined by the project engineer or geotechnical engineer. The fact that blasting may be resorted to by the Contrator shall not, of itself, entitle the material to be classified as "rock". Material that the Contractor encounters during excavation shall be uncovered and the Engineer notified so that the Engineer can classify the material. Materials from rock excavation which are to be used for embankment and fill construction shall be processed so as to produce a well-graded material which has a nominal maximum size as defined by the project Engineer or Geotechnical Engineer.

B. EMBANKMENT AND FILL MATERIALS

1. Embankment material (fill) is suitable earthen and/or rock that are excavated from on-site and/or off-site borrow areas, and considered suitable for use during construction based on their strength and consolidation properties, and approval by the Railroad's Engineer, Geotechnical Engineer, and/or an independent soils testing laboratory.

2. Embankment material shall be relatively free of organic materials, and not contain environmentally harmful or noxious substances.

3. Import fill or off site borrow material supplied by the Contractor shall meet specifications for: 1) granular fill, 2)random fill, 3)an inorganic lean clay having a maximum liquid limit of 45 and a maximum plasticity index of 15, 4)a clayey sand, or 5)pit run sand. Imported borrow materials, other than listed above, that are proposed for use as compacted fill on a project will require approval of the UPRR's Geotechnical Engineer prior to being used on the project.

4. Embankment and fill materials shall be identified and "classified" as follows:

   a. Fine Grained Materials:

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1) Clayey Soils - Clay soils shall consist of soils having 50 percent or more by dry weight passing the No. 200 U.S. Standard sieve, that can be made to exhibit plasticity (cohesive/putty-like properties) within a range of water contents, and that exhibit considerable strength when air dry. For classification purposes, a clay is the fine-grained portion of a soil which exhibits a plasticity index equal to or greater than 4, and for which a plot of plasticity index verses liquid limit for the soil falls on or above the "A" line on the Unified Soil Classification chart. Clays with Liquid Limits above 50 are considered suitable for use as embankment materials when approved for selective placement by the Geotechnical Engineer and/or when chemically treated to reduce undesireable plasticity characteristics and associated soil properties.

2) Silty Soils – Silty soils shall consist of soils having 50% or more by dry weight passing the No. 200 U.S. Standard sieve, that can not be made to exhibit plasticity (cohesive/putty-like properties) within a range of water contents – and that are nonplastic or very slightly plastic and exhibits little or no strength when air dry. For classification purposes, a silt is the fine-grained portion of a soil which exhibits a plasticity index less than 4, and for which a plot of plasticity index verses liquid limit for the soil falls below the "A" line of the Unified Soil Classification chart. Silty soils can become unstable when saturated. As a result, silty soils are only considered suitable for use as embankment and general compacted fill construction when approved for selective placement by the Geotechnical Engineer. Silty materials are predominantly extremely fine sand particles that are best compacted using vibratory construction equipment.

b. Coarse Grained Materials:

1) Sands – Sandy materials consist of granular materials having 50 percent or more by dry weight retained between the No. 200 and No. 4 U.S. Standard sieves. Sandy materials are generally visible to the human eye.

2) Granular Materials – Coarse grained soil material with more than 50 percent dry weight retained on the No. 200 U.S. Standard sieve, and which exhibit no characteristics of cohesiveness or plasticity.

3) Gravels – Gravelly materials consist of granular materials having 50 percent or more by dry weight retained between the No. 4 and 3 IN U.S. Standard sieve.

4) Cobbles – Cobbles consist of rock materials having 50 percent or more by dry unit weight retained between the 3 IN and 10 IN U.S. Standard sieves.

5) Boulders – Boulders consist of rock materials having 50 percent or more by dry unit weight having a diameter greater than 10 IN.

6) Cinders – Cinders consist of a porous by product that routinely is the residual of partially burnt coal. Cinders have the potential for degradation (reduction in volume) when subject to freeze-thaw action and heavy loadings.

c. Stone:

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1) Material. "B" Stone shall comprise of naturally-occurring limestone, dolomite, quartzite, or granite. Stone must be hard, durable, angular in shape, resistant to weathering and shall be free of cracks, seams, expansive materials or other defects that would cause accumulated deterioration from exposure to climatic conditions.

2) The material shall meet, in addition to the Specifications, the following quality requirements:

   a) The approval of some "B" Stone from a particular source shall not be construed as constituting the approval of all riprap taken from that source.

   b) The Engineer shall be the sole judge of "B" Stone quality and sources of material.

   c) "B" Stone may be rejected on the basis of visual examination, regardless of laboratory tests and/or service records.

   d) Tests to which the materials may be subjected include specific gravity, abrasion, absorption, soundness, freezing and thawing and such other tests as may be considered necessary.

	TEST	REQUIREMENT
Specific Gravity	(ASTM C127)	2.65 Min.
Absorption	(ASTM C127)	2.0% Min. – 8.0% Max.
Soundness, 5 cycles Mg S04	ASTM C88)	2.0% Min. – 15.0% Max.
Abrasion	(AASHTO)	50% Max.

3) Gradation. All "B" Stone to be loaded and quarried shall conform to the following gradation unless otherwise specified or as shown on the plans:

   a) Nominal 8 IN size:

      (1) 100 percent passing the 10 IN screen.

      (2) 100 percent retained on the 6 IN screen.

   b) Gradation compliance is determined by visual inspection, monitored by the Engineer. The Engineer may designate the material as too fine or too coarse.

d. Rock:

   1) Rock shall include all material in ledges, bedding deposits, cemented and conglomerate deposits which exhibit physical characteristics and difficulty of removal without systematic drilling and blasting, or as determined by the Engineer. The fact that blasting may be resorted to by the Contractor shall not, in itself, entitle the material to be classified as rock.

5. "Types" of embankment (fill) materials shall be identified as follows:

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a. Select Fill Material – The plasticity index of select fill material (as determined in accordance with ASTM D4318) shall not exceed 15. Select materials shall be limited to sand and gravel materials that possess minimal expansive properties and that meet the following criteria:

Liquid Limit Passing the No. 200 Sieve (Test Method ASTM D 4318)	Maximum Allowable Percent (Test Method ASTM D 1140)
Greater than 50	30%
Between 30 and 50	40%
Less than 30	50%

b. Random Fill Materials – Random fill materials are defined as those non-organic cohesive soils, cohesionless soils, combined cohesive and cohesionless soils, and rock materials that possess the minimal required physical strength, consolidation and other characteristics, after placement and compaction, that are required to provide a stable and safe embankment and foundation for the project. Depending upon the physical properties required to provide a stable embankment and fill, routine materials consisting of, but not limited to, clayey silts (CL-ML), lean clays (CL), sandy lean clays (CL), clayey sands (SC), silty sands (SM), sands and gravely sands (SP & SW), sandy gravels and gravels (GP and GW), rock, and combinations of these materials may prove satisfactory embankment materials. Highly plastic clayey (CH) soils may possess the physical properties required to perform satisfactorily as part of embankment and foundation construction but are routinely either buried within the fill or chemically stabilized prior to placement and compaction to reduce undesireable physical characteristics associated with encountering water. Random fill materials shall be defined by the Railroad and/or Geotechnical Engineers for the project.

c. Rock Fill – Rock fill shall consist only of sound, durable rock from solid rock excavation containing not more than 20 percent by weight which passes through a 1/2 IN sieve. Mixtures of boulders and silt will not be considered as rockfill. The maximum nominal size of rock shall be 24 IN or as specified by the Engineer or Geotechnical Engineer for the project.

d. Cinder Fills - Cinder fills are subject to degradation when subject to forces such as frost action, heavy loading, etc. Such degradation can result in a reduction in the mass of the material resulting in settlement of the overlying fill and facilities. Cinder fills shall not be constructed within the load bearing zone under tracks and other structural facilities. Materials containing more than 25 percent cinders should be either wasted or uniformly blended with cohesive soil such that the blended material contains no more than 25 percent cinders. The soil/cinder blended material can be used to construct those portions of either the embankment or fill sections located within either the track or structure loading areas when approved by the Railroad and/or Geotechnical Engineers on the project.

C. SOURCES OF EMBANKMENT

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1. If the quantity of materials required for construction of Embankments and fills exceeds the quantity of materials removed from excavation necessary to complete the project, additional Embankment material will first be obtained by widening cuts. If widening cuts does not provide the necessary embankment, then borrow areas, either on-site or off-site, will be used.

    a. WIDENING CUTS – The Contractor shall widen cuts in the Grading Area or widen cuts in the vicinity of the project. The Contractor shall consult with the Engineer to determine the location of cuts in the vicinity of Grading Area and to determine the volume of such cuts which are to be widened. Cuts shall be widened in such a manner as to be at least as stable as the original cut, provide adequate drainage for the Roadbed, and retain the same slope lines as the original cut.

    b. BORROW AREAS - Borrow Areas within the Right-of-Way, if available, or from Borrow Areas outside of the Right-of-Way, provided by the Contractor, shall be required to complete the embankment. All borrow areas shall be cleared and grubbed (see Section 31 11 00, Clearing and Grubbing). Materials must be tested by an independent testing laboratory and/or approved by the Engineer prior to placement.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. The contractor shall examine the areas and conditions under which work of this section will be performed, and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

B. Access - The contractor shall maintain access to adjacent areas and facilities at all times, unless approved or directed by the Engineer.

C. Drainage - All grading shall be performed in a manner and sequence that will provide proper drainage at all times.

D. Signs – All signs, with the exception of safety related signs (whistle posts, stop signs, etc.) located in the construction area shall be removed, protected, and replaced in the proper locations, as directed by the Engineer. Safety related signs shall be maintained in their original location until such time they are to be relocated as directed by the Engineer. This shall be incidental to the grading.

E. Signal foundations, or other concrete, will be removed to an elevation of 2 FT below finished subgrade. Signal foundations will not be removed until new signals have been turned over to operations.

F. Haul – Transporting excavated or embankment material, whether on-site or off-site, shall be considered incidental to the grading work. Vehicles and equipment used for hauling shall be sufficient in number and capacity to meet the project schedule. The contractor shall route the hauling equipment over the grade in such a manner as to maintain uniform compaction across the grade and minimize damage to completed work.

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PART 3 - EXECUTION

3.01 GENERAL

A. Before grading begins, the area shall be cleared and grubbed. See Section 31 11 00 - Clearing and Grubbing. The Contractor shall perform all grading as shown on the Drawings, as specified herein, or as otherwise staked in the field. This Work shall consist of excavating the material from roadbed areas or the Borrow Areas, and placing the material as embankment, shaping and sloping as necessary for the construction, preparation and completion of roadbeds, facilities, and other earthwork.

3.02 EXCAVATION

A. Perform excavation of every type of material encountered within the limits of the work to the lines, grades, and elevations indicated on the plans and specified herein.

B. Excavation as Embankment - The Contractor shall excavate all materials, including rock and common materials, which must be removed to accomplish the excavation as shown on the Drawings. All excavated materials will be used in the formation of Embankments, Roadbeds, and other earthwork so long as such excavation material is satisfactory for such use.

C. Disposition of Excavated Materials - The Contractor shall utilize all satisfactory excavated materials in the formation of embankment. Where excess excavation materials or unsatisfactory material exists, such materials will be disposed of in areas on the right of way approved by the Engineer or off the right of way in a legal and proper manner. If the contractor disposes material off of the right of way, it shall be at the Contractor's expense and liability.

D. Scarifying Subgrade - In cut sections, the Contractor shall scarify the top 6 IN of material below the Subgrade, adjust the moisture content, and recompact such scarified material.

E. Proofrolling - After the site has been stripped, and/or excavated to the rough subgrade elevation, the exposed subgrade should be proofrolled prior to placement of any structural fill to identify any soft, disturbed, or unstable areas. Unstable or otherwise unsuitable soils, which are revealed by proofrolling and which cannot be adequately densified in-place, should be remediated under the direction of the Engineer. If required, the methods of stabilization typically include over-excavation and replacement, a lift of crushed stone materials, a geosynthetic over the soft soils, or chemical stabilization with lime. Appropriate remediation methods shall be determined in consultation with the Engineer.

F. Excavation in Solid Rock Areas - In cut sections where the material to be excavated is solid rock, the Contractor shall excavate 12 IN below finished track subgrade elevations as shown on the Drawings and shall replace such excavated 12 IN of solid rock with embankment material approved by the Engineer.

G. Blasting - No blasting will be allowed without sufficient advanced notice given to the Engineer. This time will permit the safe and continuous operation of the Railroad. See section 31 78 00 Blasting.

H. Ditches and Slopes - The Contractor shall construct intercepting "V" ditches on the uphill side of cut slopes as directed by the Engineer. The ditches are to be 2 FT deep with 3:1 side slope.

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I. Over Excavation – The Contractor shall not excavate below the design finished grade elevation without the Engineer's prior approval. Materials that are excavated below design finished grade elevation, prior to obtaining prior approval of the Engineer, shall be reconstructed to design grade with materials designated by the Engineer and at the Contractor's expense.

J. Subexcavation - The Contractor shall inform the Engineer when unsuitable subgrade and foundation materials are encountered. Unsuitable subgrade and foundation materials shall be removed and replaced with compacted fill placed in accordance with recommendations provided by the Soils Engineer. Subexcavation that is unplanned should be quantified and the information provided to the Engineer. Subexcavation shall include suitable material for backfill, unless otherwise specified. Other considerations in lieu of subexcavation may include surcharging, or the use of geosynthetic fabric and/or geogrid in combination with a granular materials, both of which must be specified and approved by the project Engineer and/or Geotechnical Engineer prior to their installation. Geotextile/filter fabric shall be extra heavy nonwoven geotextile meeting the requirements found in Table 1-10-2 of the AREMA Manual. Geogrid shall be Tensar BX 1100 or an approved equivalent. Quantites are estimated to establish a unit price. Payment will be for square yards as installed and approved.

K. Soil Treatment or Modification – The treatment of soils using lime, fly ash, or other additives may be used when specified, or as directed by the project Engineer and/or Soils Engineer. See section 31 32 14 - Lime Stabilization.

L. Borrow Areas - Except as otherwise permitted, borrow pits and other excavation areas shall be excavated in such a manner as will afford adequate drainage. After borrowing operations are completed, areas shall be left in a neat, orderly condition with uniformly shaped slopes not steeper than 2 FT horizontal on 1 FT vertical. Borrow areas of fine grained material subject to wind erosion and blowing shall be stabilized or seeded. The Contractor shall ensure that the excavation of material from any source results in minimum detrimental effects on natural environmental conditions.

3.03 EMBANKMENT AND FILL CONSTRUCTION

A. Earth Fill:

1. Embankments and fills shall be constructed and compacted as shown on the plans, in these specifications, in the special provisions, or as directed by the Engineer. Embankments shall be constructed in lifts containing only that amount of material that can be compacted uniformly throughout its entire depth when utilizing the compaction construction equipment available on the project. Compaction shall be accomplished by sheeps foot rollers, pneumatic-tired rollers, steel-wheeled rollers, vibratory compactors, or other approved equipment. Earth fills shall be uniformly compacted to the densities specified by the project Engineer or Soils Engineer for the project using methods and equipment best suited for the materials.

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2. Each successive lift or layer shall be carefully leveled and completely and uniformly compacted over the full width of the embankment before a succeeding layer is placed. Embankments built of soil material or material consisting of gravel or small pieces of rock 6 IN or less in maximum dimension shall be placed and compacted until the required degree of compaction is obtained thoroughly and uniformly throughout the layer. No stones larger than 3 IN in diameter will be permitted within the top 12 IN of the finished grade elevation.

B. Rock Fill:

1. Embankments built of materials comprised predominantly of rock larger than 6 IN in maximum nominal size dimension shall be constructed by placing the material in layers not exceeding the maximum size of the rock present, but in no case shall the thickness of layers exceed 24 IN, unless approved by the Engineer.

2. Rock fill shall be placed using procedures that form a dense, well-graded mass of stone with a minimum of voids. The rock fill lifts shall extend the full width of the roadbed or fill area. When directed by the project Engineer or Geotechnical Engineer (1) the bottom, sides and top of the rock fill shall be covered with geosynthetic fabric or (2) the voids shall be in filled with finer cohesive or coarse grained materials to prevent migration of finer materials located around the rock fill into the voids, thereby avoiding settlement and/or loss of the finished subgrade profile.

C. Preparation of Foundations for Embankments:

1. General – Following required clearing and grubbing, the foundation and subgrade for the proposed embankments and fills shall be prepared by scarifying the top 6 IN layer of existing ground, adjusting the moisture content of the scarified material and compacting the scarified soils in accordance with the project specifications.

2. Benching Of Fill Into Existing Slopes – Slopes that are steeper than four horizontal to one vertical (4.0H:1.0V) and to receive embankment and fill materials shall be benched (stepped) to tie the existing and constructed materials. The base of each step shall be cut as nearly horizontal as possible and the face of each step cut no steeper than 1.0H:1.0V to allow fill placed adjacent to the vertical cut to be compacted in its entirety to the degree specified for the project. Benching operations should be performed so as to avoid undermining of any adjacent existing tracks or structures. Steps cut into the slope shall not be allowed to remain unsupported overnight.

D. Grading During Freezing Conditions - With the approval of the Engineer, the Contractor may construct embankment and fill materials during freezing weather. The Contractor shall not place any embankment or fill materials on frozen ground, or use frozen materials for embankment or fill construction. Fill materials that are placed must be completely compacted before freezing. The placing of fill shall stop if the materials freeze before the required compaction is obtained. Frozen materials must be removed at the Contractor's expense before filling operations resume.

E. Topsoil - Topsoil placed shall be compacted with at least two complete coverages over the area with a multiple wheel, pneumatic-tired roller designed for use in the compaction of earth fills.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Cross sections provided shall be considered Pay Quantities for grading. The quantities are calculated to neat line of the cross sections with no allowance for shrinkage, clearing and grubbing, or topsoil stripping and placement. Adjustments to pay quantities will not be considered after commencement of grading. If the Contractor disputes the accuracy of the plan quantities, the Contractor shall pay for the cost to perform measurements and calculations of the quantities.

B. Subexcavation quantities, which are estimated, shall be measured and approved by the Engineer. Backfill is to be included unless there is a separate bid item.

END OF SECTION

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SECTION 31 32 14 - SOIL STABILIZATION - LIME

PART 1 - GENERAL

1.01 SUMMARY

A. Requirements:

1. The Primary requirement of this Specification is to secure a completed course of treated subgrade material containing a uniform lime mixture, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent embankment. It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.

1.02 QUALITY ASSURANCE

A. Certification and verification:

1. If lime is furnished in trucks, the Contractor shall be required to furnish to the Railroad weight tickets on each truck load for verification of the actual tonnage installed on the roadbed.
2. When Type A Hydrated lime is furnished in bags, each bag shall bear the manufacturer's certified weight and the Contractor shall verify, to the Railroad, the number of bags along with the weight of each bag actually used on the project.
3. Type B Commercial Lime Slurry, the distributor truck shall be equipped with a sampling device.
4. Type C Quicklime to be used only when conditions require it and approved by the Engineer. Placement shall be in accordance with the State Highway specifications for the state in which the work is being performed.

1.03 DELIVERY AND STORAGE

A. Hydrated lime in bags shall be stored and handled in closed weatherproof containers until immediately before distribution on the roadbed.

B. Hydrated lime in bags shall be stored in weatherproof building with adequate protection from ground dampness.

1.04 PREPARATION OF SUBGRADE

A. The roadbed shall be constructed and shaped to conform to the typical sections, lines and grades as shown on the plans or as established by the Engineer.

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B. If the Contractor elects to use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time, he will not be required to expose the secondary grade nor windrow the material. However, the Contractor shall be required to roll the subgrade, as directed by the Engineer, before using the pulverizing machine and correct any soft areas that this rolling may reveal. This method will be permitted only where a machine is provided which is capable of cutting to the full depth of the stabilized layer in one pass. It must also ensure that the material is cut uniformly to the proper grade to a smooth surface over the entire width of the cut. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.

C. In lieu of using the cutting and pulverizing machine, the Contractor shall excavate and windrow the material to expose the secondary grade. Any wet or unstable materials below the secondary grade shall be corrected, as directed by the Engineer, by scarifying, adding lime, compacting, or by other methods until satisfactory stability is obtained. When this method is used the mixing and compaction shall be done in maximum 6 IN lifts.

1.05 PULVERIZATION

A. The existing pavement or base material shall be pulverized or scarified so that 100 percent passes the 2 IN sieve.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The lime and lime slurry being furnished under the terms of this specification shall, in addition to all other requirements, also meet the following chemical and physical requirements.

1. Type A Hydrated Lime, dry powdered material consisting essentially of calcium hydroxide.
2. Type B Commercial Lime Slurry, a liquid mixture of essentially hydrated lime solids and water in slurry form.
3. Lime shall conform to following requirements:

CHEMICAL COMPOSITION	TYPE A	TYPE B
Active lime content, % by weight $Ca(OH)_2$+CaO	90.0 min[1]	87.0 min[2]
Unhydrated lime content, % by weight CaO	5.0 max	
Free water content, % by weight H_2O :	5.0 max	
SIZING		
Wet Sieve, as % by weight residue retained:		
No. 6	0.2 max	0.2 max[2]
No. 30	4.0 max	4.0 max[2]

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Notes:
1. Maximum 5.0% by weight CaO shall be allowed in determining total active lime content.

2. MAXIMUM SOLIDS CONTENT OF SLURRY.

PART 3 - EXECUTION

3.01 SAFETY

A. Precautions should be taken, including but not limited to, dust masks; eye protection; and protective clothing. Lime will not be spread on windy days. The Contractor will comply with all Federal, State and local regulations governing this type of work.

3.02 APPLICATION

A. Restrictions and requirements:

1. Lime shall be spread only on that area where the first mixing operations can be completed during the same day.

2. Hydrated lime shall be added, at the percentage specified on the plans, as a percentage of the dry weight of the soil.

B. Dry placing method:

1. The lime shall be spread by an approved spreader or by bag distribution or as directed by the Engineer.

2. Lime shall be distributed at a uniform rate and in such a manner as to reduce the scattering of lime by the wind to a minimum. Lime shall not be applied when wind conditions, in the opinion of the Engineer, are such that blowing lime becomes objectionable to traffic or adjacent property owners. A motor grader shall not be used to spread the lime.

3. The material shall be sprinkled as directed by the Engineer.

C. Slurry Placing:

1. Where Type A Hydrated Lime is specified and slurry placement is to be used, the Type "A" Hydrate shall be mixed with water to form a slurry of the solids content designated by the Engineer. The distribution truck shall be equipped with an agitator that will keep the lime and water in a uniform mixture.

2. Type B Commercial Lime Slurry shall be delivered to project in slurry form at or above the minimum dry solids content approved by the Engineer. The distribution of lime at the rates shown on the plans or approved by the Engineer shall be attained by successive passes over a measured section of roadway until the proper lime content has been secured.

3.03 MIXING

A. This process will be the same for both methods.

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B. The material and lime shall be thoroughly mixed by approved road mixers or other approved equipment, and the mixing continued until, in the opinion of the Engineer, a homogenous friable mixture of material and lime is obtained, such that when all nonslaking aggregates retained on the 3/4 IN sieve are removed, the remainder of the material shall meet the following requirements when tested from the roadbed in the roadbed condition by the laboratory sieves:

Minimum passing 1 - 3/4 IN sieve	100 percent
Minimum passing 0 - 3/4 IN sieve	85 percent

C. The soil-lime mixture shall be sprinkled during the mixing operation to obtain a moisture content at least 5 percent above optimum.

D. During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6 HRS or more, or has had excessive loss due to washing or blowing will not be accepted for payment.

E. Hydrated lime mixing and pulverizing shall not be started until the temperature is greater than 40 DegF in the shade, and rising.

F. After initial mixing, the lime-treated layer should be shaped to the approximate section and compacted lightly prior to curing in order to minimize evaporation loss. The mixture may be left to cure for one to four days or the mixing continued until the above sieve requirements are met.

G. When shown on the plans or approved by the Engineer, the pulverization requirement may waived when the material contains a substantial quantity of aggregate.

3.04 COMPACTION

A. Definitions:

1. Ordinary Compaction - The Soils shall be sprinkled and rolled as directed by the Engineer. All irregularities, depressions or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and reshaping and recompacting by sprinkling and rolling. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

2. Density Control - The course shall be sprinkled as required and compacted to the extent necessary to provide the density specified in the Railroad's Earthwork Specification 31 24 13 and Compaction Control and Testing Specification 31 23 26. In addition to the above, the full depth of material shown on the plans shall be compacted to the extent necessary to remain firm and stable under construction equipment. After such section is completed, tests as necessary will be made by the testing laboratory, see section 01 43 26. If the material fails to meet the testing requirements, it shall be reworked as necessary to meet these requirements. Should the material, due to any reason or cause, lose the required stability, density and finish before the next course is placed or the work is accepted, it shall be reprocessed and refinished at the cost of the Contractor.

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3.05 FINISHING, CURING AND PREPARING FOR SURFACING

A. After the final layer, course, or lift of the lime treated subgrade, subbase, or base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed sections shall then be finished by rolling as directed by the Engineer, with a pneumatic tire or other suitable roller sufficiently light to prevent hair line cracking.

B. The Completed section shall be moist-cured for a minimum of 7 days before further lifts are added or any traffic is permitted, unless otherwise directed by the Engineer. In cases where subgrade treatment sets up sufficiently to prevent objectionable damage from traffic, such lifts may be opened to construction and/or access traffic, and may be covered by other courses the day following compaction, unless otherwise directed by the Engineer. If the plans provide for the treated material to be sealed or covered by additional courses of material, such seal or courses shall be applied after final mixing and compaction is completed, unless otherwise directed by the Engineer.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Lime will be paid for at the unit price bid per ton (of 2000 LBS) for Type "A" Hydrated Lime.

B. Lime treated Subgrade (Ordinary Compaction), or Lime treated subgrade (Density Control), of the depth specified will be paid for at the unit price bid per square yard. The unit price bid shall be full compensation for all correction of secondary subgrade, for loosening, mixing, pulverizing, spreading, sprinkling, rolling, drying, furnishing and application of lime, shaping, and maintaining, for all manipulations required, for all hauling, and freight involved, for all tools, equipment, materials, labor, and for all incidentals necessary to complete the work.

END OF SECTION

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SECTION 31 35 20 - SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General information required in connection with slopes and dust control.
2. Installing silt fence and ditch checks for controlling stormwater erosion during construction as shown on the plans or designated by the Engineer.
3. This work shall consist of furnishing, placing, and removal of silt fence and ditch checks in accordance with these Specifications at locations shown in the plans or designated by the Engineer.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

2.01 GENERAL

A. Only products on the respective State Department of Transportation's Approved Products List will be allowed for use on this project, unless specified elsewhere in these specifications or on the Plans.

B. Material for hold down stakes shall be wood or other degradable material. Metallic stakes will not be allowed.

PART 3 - EXECUTION

3.01 FILTER FABRIC

A. Height of silt fence shall not exceed 36 IN.

B. Posts shall be spaced a maximum of 10 FT apart when using standard strength filter fabric with wire fence backing and spaced a maximum of 6 FT apart when using extra strength filter fabric. Posts shall be driven a minimum of 12 IN into the ground.

C. A trench shall be excavated approximately 4 IN deep x 4 IN wide along the line of posts and upslope from the barrier.

D. When standard strength filter fabric is used, a wire mesh support fence shall be fastened securely to the upslope side of the posts using heavy duty wire staples at least 1 IN long, tie wires or hog rings. The wire shall extend into the trench a minimum of 2 IN and shall not extend more than 36 IN above the original ground surface.

E. The standard strength filter fabric shall be stapled or wired to the fence and 8 IN of the fabric shall be extended into the trench. The fabric shall not extend more than 36 IN above the original ground surface.

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F. When extra strength filter fabric and closer post spacing are used, the wire mesh support fence may be eliminated. In such a case, the filter fabric shall be stapled or wired directly to the posts and 8 IN of the fabric shall be extended into the trench. The fabric shall not extend more than 36 IN above the original ground surface.

G. The trench shall be backfilled and the soil compacted over the filter fabric.

H. Inspection shall be frequent and repair or replacement shall be made promptly as needed or as directed by Engineer. Silt fences shall be replaced every 6 months and removed when the seeding has been established or as directed by the Engineer.

I. Sediment deposits shall be removed periodically as directed by Engineer or when depth reaches 1/3 height of silt fence.

3.02 STRAW BALE DITCH CHECKS

A. Straw bales shall be placed in a single row, lengthwise, oriented perpendicular to the contour, with ends of adjacent bales tightly abutting one another.

B. All straw bales shall be either wire-bound or plastic tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales.

C. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a straw bale and the length of the proposed barrier to a minimum depth of 4 IN. After the straw bales are staked and chinked, the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 IN against the uphill side of the barrier.

D. Each bale shall be securely anchored by at least two stakes driven through the bale. The first stake in each bale shall be driven toward the previously laid bale to force the bales together. Stakes shall be driven deep enough into the ground to securely anchor the bales.

E. The gaps between straw bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales.

F. The barrier shall be extended to such a length that the bottoms of the end straw bales are higher in elevation than the top of the lowest middle bale to assure that sediment-laden runoff will flow either through or over the barrier but not around it.

G. Sediment deposits shall be removed after each storm event or when depth reaches 1/3 height of straw bales to prevent sediments from reaching further downstream via a channel.

H. Inspection shall be frequent and repair or replacement shall be made promptly as needed or as directed by Engineer. Straw bales should be replaced every 3 months and removed when the seeding has been established or as directed by the Engineer.

3.03 SLOPES AND PROTECTION OF FINISHED WORK

A. Construction and Protection:

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1. The Contractor shall be responsible for developing, implementing and maintaining a Storm Water Pollution Prevention Plan. If permits are included, the Contractor must adhere to all of the conditions set forth in the permit, and the Contractor must keep a copy of the permit and SWPPP onsite at all times. UPRR has provided silt fence and stabilized construction exit details. The Contractor shall use best management practices to ensure that a proper plan is developed and followed. The Contractor shall submit a SWPPP to the Engineer for review and approval 14 days prior to the start of activities impacted by the plan. This plan shall be approved and implemented prior to the start of any grading, and cost shall be incidental to grading unless there are separate bid items. The Contractor shall submit the Notice of Intent for the NPDES permit, as well as the Notice of Termination, unless it is provided by the Railroad. If the permit is provided by the Railroad, a Transfer of Ownership form, if available, shall be completed by the Contractor and the permit shall be transferred to the Contractor. The Contractor shall be responsible for maintaining the SWPPP for the duration of the project. This shall include, but not limited to, re-staking loose hay bales, adjusting and re-staking silt fence, mucking out accumulated silt and other items as necessary to maintain the system.
2. Silt fence is normally the first item constructed, especially on import fill projects. Silt fence may be offset from toe of slopes as directed by the Engineer.
3. All reasonable precautions shall be taken to preserve the character of the material outside of the theoretical slope lines. The slope shall be finished to the lines and grades furnished by the Engineer. All loose materials shall be removed from the slopes and all materials, whether solid or loose, projecting more than one foot outside of the theoretical slope line as staked, shall be removed by the Contractor.
4. The Contractor shall not widen cuts or benches without the prior approval of the Engineer. Widened cut slopes or benches, if approved, must be constructed as follows:
    a. In such a manner as to be at least as stable as the original cut slopes or benches.
    b. To provide adequate drainage for the Roadbed.
    c. In accordance with these Specifications and in the same manner as if such widened cut slopes or benches had been originally contemplated by these Specifications and the Drawings.
5. Care shall be taken to ensure drainage is diverted along or away from the toe of the slope during construction to eliminate water pockets and toe saturation. All operations shall be conducted such that proper drainage shall be provided at all times, especially at the close of work shift or before anticipated rain.

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3.04 DUST AND WIND EROSION CONTROL

A. As the Work progresses, all finished grades and finished slopes both in excavation and Embankments must be protected from damage by application of water as necessary until the Work has been completed. The Contractor will be required to maintain all excavations, embankments, stockpiles of material sources, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas inside or outside of the physical boundaries of the work, free from dust or other materials which would violate federal, state or local air pollution standards or which would cause a hazard or nuisance to people in the vicinity of the Work. Approved temporary methods of dust control, including sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted. Sprinkling must be repeated at such intervals as to keep all potential sources of dust wet at all times, and the Contractor must provide sufficient sprinkling equipment to comply with this requirement at no expense to the Railroad.

B. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the surface, reshape, and compact to the required density prior to further construction.

PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. The Storm Water Pollution Prevention Plan will be paid for as a lump sum. Approved installations will be paid for at the contract unit price per 50 percent initial installation, percentage payments each month determined by length of contract and a final payment of 10 percent for bid item “SWPPP”.

B. Straw bales and silt fence, if provided as separate bid items, shall be paid for at the Contract Unit Price. Silt fence and straw bales are estimated quantities in order to establish a unit price. The Contractor will be paid for the actual amount used.

END OF SECTION

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SECTION 31 35 26 - SECONDARY CONTAINMENT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Secondary containment membrane, geotextile fabric, and accessories required for leak-proof liners under tracks, tanks, and other structures and above grade containment.

B. Furnish all labor materials, tools, equipment and services for all Secondary Containment System as indicated in accordance with the provisions of the Contract Documents. This includes coordination with all trades and all associated work not specifically indicated.

C. Although such work may not be specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure, and complete installation.

1.02 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. D751, Standard Test Methods for Coated Fabrics.
2. D1117, Standard Guide for Evaluating Nonwoven Fabrics.
3. D5641, Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
4. E96, Standard Test Methods for Water Vapor Transmission of Materials.
5. E515, Standard Test Method for Leaks Using Bubble Emission Techniques.

1.03 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Submittal data shall include, but not be limited by, the following:

1. Product samples of all materials to be used in project, including liners and fabrics. Each sample shall be approximately 8 IN x 10 IN in size with clear designation of product.
2. Specification sheet giving full details of minimum physical properties and test methods used, site seaming methods and a list of similar projects completed in which the manufactured materials have been successfully used.
3. Shop drawings of the proposed panel layout and the location and direction of seams. Seams shall be labeled either field or factory. Details shall be included to show the termination of the panels at the perimeter of lined areas, the methods of sealing around penetrations, and methods of anchoring.
4. Sub-grade certification as required in Paragraph 3.01.

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5. All field test results.
6. Records of all repairs and resultls of repair testing.
7. Warranty

C. The manufacturer shall provide the Contractor with complete written instructions for the storage, handling, installation, and seaming of the liner in compliance with this specification. Contractor shall forward a copy of this information the Engineer.

D. In order to qualify as an approved synthetic liner, the Contractor shall submit lining material samples and a specification sheet to the Engineer for approval prior to construction.

1.04 QUALITY ASSURANCE

A. A manufacturers authorized installation contractor shall install the geomembrane liner per the written instructions of the manufacturer.

PART 2 - PRODUCTS

2.01 GEOMEMBRANE LINER

A. Above grade liners shall be Petrogard VI – No Substitutions Accepted.

B. Below grade liners shall be Petrogard X – No Substitutions Accepted.

2.02 GEOTEXTILE FABRIC

A. Geotextile fabric shall be provided as cover for all buried geomembrane liners, and indicated on drawings.

B. Geotextile fabric shall be nonwoven fabric consisting of only continuous chains of polymetric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals, and hydrocarbons; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have a minimum fabric weight of 16 OZ/SQ YD per ASTM D1117.

C. The filter fabric shall be provided in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris.

D. For abovegrade applications, the geotextile fabric will be placed in between the liner and the surface.

E. For belowgrade applications, the geotextile fabric will be placed in between the liner and the subgrade and a second layer on top of the liner.

2.03 NON-SKID WALKWAYS

A. Provided non-skid walkways as noted on drawings that are compatible with respective Petrogard liner product or other installed liner system if existing.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION

A. Area Subgrade Preparation:

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1. Surfaces to be lined should provide firm, unyielding foundation for the membrane with no sudden, sharp or abrupt changes or breaks in grades and shall be sloped as specified in the contract drawings. Usually no object larger than USCS sand and (SP) should remain on subgrade in order to protect against puncture. The subgrade should be uniformly compacted to ensure against settlement.
2. Contractor shall certify in writing that the surface on which the membrane is to be installed is acceptable before commencing work.

B. Geotextile fabric shall be used under the liner to compensate for irregular subgrades or where added protection of liner necessary. Fabric is required on top of the liner for below grade applications.

3.02 INSTALLATION

A. Field fabrication of liner will not be allowed. On-site modification of liner material shall be laid out and overlapped by a minimum of 4 IN prior to welding if applicable. Extreme care shall be taken by the installer in the preparation of the area to be welded. The area to be welded shall be cleaned and prepared according to procedures identified by material fabricator. All seams will be electronically welded in factory or heat-fused on the jobsite.

B. No "fish mouths" shall be allowed within the seam area. Where "fish mouths" occur, the material shall be cut, overlapped, and an overlap heat weld shall be applied. All welds on completion of the work shall be tightly bonded. Any membrane area showing injury due to excessive scuffing, puncture or distress from any cause, shall be replaced or repaired with an additional section of liner material.

C. The liner shall be installed per the written instructions of the manufacturer.

D. In areas where wind is prevalent, lining should be started from upwind side of containment and proceed downwind. The leading edge of the liner should be secured at all times with sandbags or other methods sufficient to hold liner down during high winds. Sandbags or tires may be used as required to hold down liner during and after installation.

E. Equipment or other items shall not be dragged across surface of liner. All installers walking on the liner must have soft-soled shoes.

F. Lining material should fit as closely as possible around inlets, outlets, and other penetrations. Any penetration must be sealed with approved sealing methods. Any lining attached to concrete should be made with a mechanical anchor. Manufacturer of liner shall submit anchorage details for approval.

G. All seams to be vacuum box tested and results recorded and given to the engineer for review. All defects found are to be repaired and vacuum box tested after repairs. Installer shall retain all records of all repairs and the results of repair testing and submit to the engineer for review.

3.03 GUARANTEE

A. The liner shall be warranted to maintain its integrity in this installation for twelve (12) years. A copy of the warrantee shall be submitted to the owner upon acceptance of installation.

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END OF SECTION

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SECTION 31 37 00 - RIP RAP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Riprap furnished, hauled, and placed by the Contractor to the locations and of the types shown on the drawings and as directed by the Engineer.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Standard Drawing 680000 - Round Steel Pipe Culverts

B. Section 31 24 13 – Excavation, Embankments and Other Fills

C. Section 33 42 00 - Culverts

D. Section 40 05 39 – Reinforced Concrete Pipe

1.03 QUALITY ASSURANCE

A. Sections covering Responsibilities and Duties include, but are not necessarily limited to, General Requirement Specification, Section 00 07 00.

PART 2 - PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. Material:

1. Riprap shall be hard, durable, angular in shape, resistant to weathering and shall be free of cracks, seams, expansive materials or other defects that would cause accumulated deterioration from exposure to climatic conditions.

B. The material shall meet, in addition to the Specifications, the following quality requirements:

1. The approval of some riprap from a particular source shall not be construed as constituting the approval of all riprap taken from that source.

2. The Engineer shall be the sole judge of riprap quality and sources of material.

3. Rip rap may be rejected on the basis of visual examination, regardless of laboratory tests and/or service records.

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4. Tests to which the materials may be subjected include specific gravity, abrasion, absorption, soundness, freezing and thawing and such other tests as may be considered necessary.

TEST	REQUIREMENT
Specific Gravity (ASTM Designation C127)	2.65 Minimum
Absorption (ASTM Designation C127)	8.0% Maximum
Soundness, 5 cycles Mg S04 (ASTM Designation C88)	2.0% Minimum 15% Maximum

C. Requirements:

1. All riprap to be loaded and quarried shall conform to the following limitations unless otherwise specified or as shown on the plans:

RIP RAP CLASS	AVERAGE PER STONE (LBS)	DIMENSION (IN)	TYPICAL VELOCITIES (FT/S)
I	50 to 200	9 to 14	6-8
II	200 to 1,000	14 to 24	8-12
III	1,000 to 4,000	24 to 38	≥12
IV	> 4,000	> 38	Special cases

D. Requirements, Limitations, and Allowances:

1. The riprap class(es) required shall be well distributed and the entire mass of stone shall conform to the limitations specified. However, the following allowances shall be acceptable to produce the required riprap protection:

   a. Riprap Class I - No allowances are permitted.

   b. Riprap Class II - 15 percent of Riprap Class I.

   c. Riprap Class III - 15 percent of Riprap Class I and 15 percent of Riprap Class II.

   d. Riprap Class IV - 15 percent of Riprap Class I, 15 percent of Riprap Class II and 15 percent of Riprap Class III.

E. The above allowances may be adjusted in the field where at the discretion of the engineer a greater or lesser percentage would be required. Individual pieces, larger than the maximum specified size may be toed in at the bottom of the riprap toe.

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PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

A. Riprap shall be placed in such a manner as:

1. To produce a compact mass of rock which shall provide adequate embankment protection and erosion control.
2. To avoid segregation of the various sizes of rock.

B. Placement of Stones:

1. Individual stones shall be tightly in contact with other stones in order to produce the least possible amount of void spaces.
2. All material going into riprap protection shall be so placed and distributed that there will be no large accumulations of either the larger or smaller sizes of stone.
3. Installation of riprap along ditch bottoms shall be performed in a manner that preserves the sections and profile grades as depicted in the drawings. Additional grading, excavation, removal, and/or haul away of subgrade material not shown on cross sections may be needed to have the top of riprap meet proposed grade lines.
4. Rearranging of individual stones by mechanical equipment or by hand may be required to the extent necessary to obtain a reasonably well graded distribution of stone sizes.
5. The Contractor shall maintain the riprap protection until accepted. Material displaced by any cause shall be replaced at no additional cost to the Railroad.

C. Sources:

1. The sources proposed for use by the Contractor shall be selected in advance, and approval of a source by the Engineer may depend upon laboratory test data, visual examination and service records.
2. If such records are not available, such as in the case of newly opened quarries, the materials shall be subject to tests considered necessary by the Engineer.
3. Riprap removed as part of this project may be used for placement at other locations if the riprap meets the material requirements in Part 2.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of acceptable riprap, complete in place, will be made on the basis of the area actually covered, and the volume will be computed on the basis of the measured area and the thickness specified on the plans.

4.02 PAYMENT

A. The Riprap quantities measured as provided above, will be paid for at the unit prices bid per cubic yard.

B. The Riprap of the various classifications shown above will each be bid separately.

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C. All grading, excavation, removal, and/or haul away of subgrade material needed to have the top of riprap meet proposed grade lines shall be considered incidental to riprap installation.

D. Riprap shall be included with culvert installation unless specified separately with a bid item. The cost of Riprap material and installation at the end of culverts shall be included in the unit price per foot cost of installing of the culvert.

E. Hauling and stockpiling of removed existing riprap for reuse shall be incidental.

F. The unit price bid will include full compensation for furnishing, hauling, placing of all materials and furnishing of all labor, tools, equipment, incidental and necessary to the completion of the work.

END OF SECTION

SECTION 31 63 16 - AUGERED PRESSURE GROUTED PILING

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor shall furnish all labor, tools, equipment and services for the complete and correct installation of all pilings as shown in the Drawings, and Construction Documents.

1.02 QUALITY ASSURANCE

A. The Piling Contractor shall inspect the site and related conditions prior to commencing his portion of the work.

B. All piles shall be installed by an experienced Piling Contractor who is able to submit evidence of having a minimum of three (3) years of similar experience.

C. The Piling Contractor shall submit to the Architect and the Engineer in writing, all applicable information as listed in Section 8, records for review and approval, in addition to the above experience record.

1.03 LOCATION TOLERANCE

A. All finished piles shall be in the location as shown on the drawings within 3 IN from the plan center of the pile when installed from the pile cut off elevation. Deviation shall not be more than 2 percent or ±2 IN, whichever dimension is more strict, from the plan cut off elevation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement – Per ASTM C150, Standard Specification for Portland Cement, Type I or Type II.

B. Special Pozzolan – The special pozzolan, when available, shall be an approved flyash or equal: A finely powdered siliceous material which possesses the property of combining with the lime liberated during the hydration of portland cement. The special pozzolan shall contribute markedly to the later-age strength of the cement base mortar.

C. Grouting Agent – The grouting agent shall affect the base mortar to reduce mixing water and eliminating setting shrinkage.

D. Water – Water for cement base mortar shall be fresh, clean, and free from deleterious amounts of sewage, oil, acid, alkali, or organic matter.

E. Fine Aggregate – Sand shall meet the requirement of the current ASTM C33, Standard Specification for Concrete Aggregates, except that the gradation shall be as herein specified. The sand shall be well graded from fine to coarse with a fineness modulus of two and three tenths to three and 4 tenths (2.30-3.40).

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2.02 MIXING AND PUMPING MORTAR

A. Only approved mixed and pumping equipment shall be used in preparing and handling the mortar. All materials shall be measured by volume or weight as they are fed into the mixer. The time of mixing shall be such as to produce a homogeneous mortar, whether mixed on the site, or obtained form a Ready-Mix plant.

B. The cement base non-shrinkage mortar shall consist of portland cement, when available, a special pozzolan, a grouting agent, sand and water so proportioned and mixed as to produce a mortar capable of maintaining the solids in suspension without applicable water gain; which may be pumped without difficulty and which will penetrate and fill open voids in the adjacent solids. These materials shall be proportioned to produce a hardened mortar, which will achieve the design strength within twenty-eight (28 days), or if it contains a special pozzolan, within 90 days. The grout strength shall be specified to meet applicable codes for the specified pile size and capacity.

C. A pressure gauge in good operating condition shall be located on the grout pump so that the grouting pressure may be checked by the operator, and the Engineer's representative.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The piling shall be in the diameter and length shown on the drawings and shall be constructed in accordance with the methods specified below. Only experienced Piling Contractors will be accepted to perform the work.

B. A continuous flight hollow shaft (minimum inside diameter of 2-1/2 IN auger shall be rotated into the underlying soil to the pre-determined tip elevation or refusal, whichever comes first. Leaving the auger in the hole, and maintaining a slow positive rotation, being injecting the specified mortar through the hollow shaft. Inject a sufficient quantity of grout to completely fill the augered hole, carefully coordinating the rate of injection as the auger is withdrawn.

C. Protection of piles – Provide a sequence of pile installation within pile groups such that the adjacent piles are not disturbed. Do not place piles within 3 FT of adjacent piles or as soil conditions permit until set as occurred. Initial set is that time period when the grouted pile changes from being a fluid. A physical check of the adjacent pile is the most accurate way of determining when initial set has occurred.

D. In the event non-augerable material is encountered, the obstruction shall be removed by the General Contractor, and the pile completed. An additional pile may be required at the Engineer's direction, and shall be paid for in accordance with the unit price for additional piles.

E. APG Piles shall be poured to top of ground and the mortar may be removed to the cut-off elevation prior to initial set. If the hole will not stand open, the pile must be cut off after final set or mortar and the excavation for the pile cap has been made.

F. Auger refusal shall be defined as an auger penetration rate of 1 FT/min or less.

G. Upon filling of the hole, the pipe pile shall be immediately placed into the wet hole with the pipe protruding to the cut off elevation as shown on the plans.

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3.02 FIELD QUALITY CONTROL

A. During the progress of the job, standard 2 IN compression test cubes shall be tested in accordance with ASTM C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 IN or 50 mm Cube Specimens), by a qualified commercial testing laboratory, approved by the Engineer. A minimum of one (1) set of six (6) cubes shall be made for each days work. From each set of six (6) cubes, two (2) shall be tested at three (3) days, two(2) at seven (7) days and two (2) at twenty-eight (28) days unless specified strength has already been obtained. If a special pozzolan is used, make a break two (2) additional cubes at ninety (90) days, if necessary.

B. RECORDS

1. Before commencing the work, the Piling Contractor shall submit to the Architect or the Engineer for approval of the following:

   a. Sketch and/or description of pile drilling equipment to be utilized.

   b. Complete description of method of installation.

2. Mortar design mix.

   a. During the course of the work, the Owner's Project Testing Agency or Piling Contractor shall submit:

   b. Load test reports, if applicable, including all test data, and a graph of load verses settlement.

   c. A daily pile report showing the pile number and location, date placed, length of pile, and final tip elevation.

C. LOAD TESTS

1. Pile load tests, if required, shall be performed by the Piling Contractor and witnessed by an independent testing laboratory, paid for by the Owner. The cost of the test pile, anchor piles and all equipment necessary to perform the pile load test shall be included in the base bid. All load testing shall be performed in accordance with the method outlined in ASTM D1143, Standard Test Methods for Deep Foundations Under Static Axial Compressive Load, unless otherwise changed or revised by the Soils Engineer and / or Architect.

2. The test pile lengths shall be established either before or during the test pile installation.

3. The Engineer shall make a thorough analysis of the drilling characteristics and test results to determine the optimum production pile length.

4. The Piling Contractor shall coordinate the performance of the load tests with the testing laboratory and General Contractor. The tests may be performed, with the Engineer's approval, prior to the general excavation.

D. REMOVAL OF WASTE

1. Augered soil and waste grout accumulated from piling operation shall be removed continuously from the pile location.

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PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT

A. The base bid shall include the lump sum amount for installing the piling as shown on the structural plans, and if required, the amount of the pile load tests.

4.02 UNIT PRICES

A. A unit price, per lineal foot, for greater lineal footage than shown on the base quantity.

B. A unit price, per lineal foot, for lesser lineal footage than shown on the base quantity.

C. A unit price, per pile of the estimated length, for additional piles than shown on the base quantity.

D. A unit price, per pile of estimated length, for fewer piles than shown on the base quantity.

E. A unit price for each additional pile load test.

END OF SECTION

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SECTION 31 66 14 - AGGREGATE PIERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Vibrated or rammed aggregate piers.

1.02 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. D1194, Spread Footing Load Testing (individual column, or column groups).
2. D1143, Standard Test Method for Piles Under Static Axial Compressive Load.
3. D3689, Standard Test Method for Individual Piles Under Static Axial Tensile Load.
4. D1241, Standard Specification for Materials for Soil Aggregate Subbase, Base, and Surface.
5. D422, Standard Test Method for Particle Size Analysis.
6. C33, Standard Specification for Concrete Aggregates.

1.03 DEFINITIONS

A. Aggregate Piers - Columns of compacted aggregate used to reinforce the ground: to increase bearing capacity; reduce settlement of a structure; or increase slope stability. The piers can be constructed with a down-hole vibrator or down-hole tamper.

B. Down-Hole Vibrator - High-energy vibrators used to produce horizontal vibrations to consolidate aggregate and surrounding soils.

C. Bottom Feed Vibrators - Down-hole vibrators equipped with a tremie pipe to feed aggregate to the tip of the vibrator. Used in soft or cohesionless soils where hole walls are susceptible to collapse.

D. Down-Hole Tampers - Proprietary high-energy impact apparatus to provide vertical tamping energy through a hammer connected to a beveled tamper head.

1.04 SCOPE OF WORK

A. The work shall consist of installation, monitoring and testing of the aggregate piers within the limits indicated on the project documents.

B. The aggregate pier contractor shall provide all labor, materials, and equipment to accomplish the work, to include:

1. Pre-drilling of holes as necessary and disposal or stockpiling of all spoil.
2. Construction of the aggregate piers to the requirements of the construction documents.

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C. It shall be the aggregate pier contractor's responsibility to determine and implement the systems and criteria to ensure that the specified performance is achieved.

1.05 SUBMITTALS

A. A list of at least five previously completed projects of similar scope and purpose, to include a description of the project, relative size, and contact person with phone number.

B. Ground improvement design based on information contained in the project geotechnical report, prepared by an engineer licensed in the state of the work to be performed.

C. Ground improvement QA plan, as detailed in Section 3.04 of these Specifications, including work procedures and control criteria; shop drawings for review, indicating the spacing, location, and depth of the aggregate piers to achieve the required criteria; modulus test detail and setup to confirm that the installation procedure produces the pier modulus used in the design.

D. Daily records that include: The type and size of compaction equipment; predrill auger diameter used; the identification number and depth of the pier tip for each pier; any change in subsurface conditions observed during the work; modulus test data, analysis of the data, and the concluding recommended design parameters, prepared by an engineer licensed in the state of the work.

E. A final report documenting the observations and results of the tests. This report will certify that the bearing pressure has been achieved within settlement tolerances.

F. A warranty document good for one year.

1.06 QUALITY ASSURANCE

A. The aggregate pier contractor shall have at least five continuous years of documented experience in aggregate piers.

B. The aggregate pier contractor shall provide experienced management, supervisory and key personnel to implement the aggregate pier program.

C. The Owner's third party QA representative will ensure that procedures and documentation conform to these specifications.

D. Third party QA observation and initial testing costs shall be the responsibility of the Owner. The installing contractor shall be responsible for testing and observation costs associated with failed tests or rejected piers.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. Down-Hole Vibrator –Piers installed by vibration shall utilize a down-hole vibrator capable of providing at least 80 HP of rated energy and a centrifugal force of 15 tons. The equipment shall include a metering device to monitor amperage usage and fluctuations during the operation of the equipment. Complete equipment specifications should be submitted to the Engineer prior to commencement of the fieldwork.

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B. Down-Hole Tamper – Piers installed by tamping shall utilize a down-hole tamper with a diameter at least 90 percent of the pre-drilled hole diameter, have beveled sides, and be long enough to reach the full depth of the pre-drilled hole. The tamper shall have a minimum rating of 1,225 FT-LB and shall apply direct downward impact energy to each lift of aggregate. A minimum tamper energy level of 490,000 FT-LBS of force per minute shall be applied by the energy source.

2.02 BACKFILL MATERIALS

A. Down-Hole Vibrator Method: The backfill aggregate should consist of hard, angular to sub-angular durable rock fragments, with the majority of particles in the range of 1/8th IN to 1-1/2 IN such as ASTM C33 size No. 57, or shall be other graded aggregate selected by the installer, successfully used in the modulus test, and approved by the Project Engineer.

B. Down-Hole Tamper Method:

1. Aggregate used for piers constructed above the water table shall be Type I, Grade B in accordance with ASTM D1241, or shall be other graded aggregate selected by the installer, successfully used in the modulus test, and approved by the Project Engineer.

2. For aggregate used for piers constructed below the water table, the gradation shall be the same as Type I Grade B, except that particles passing the number 40 sieve shall be eliminated. Alternately, No. 57 stone or other stone selected by the installer, and approved by the Engineer may be used.

3. When type I Grade B material is used, potable water or other suitable source shall be used to increase the aggregate moisture content when required.

PART 3 - EXECUTION

3.01 SITE INSPECTION

A. Adjacent structures within 15 FT of work area shall be examined prior to initiating work to document preexisting cracks/damage, and monitored for movement during any work within 15FT of the structure. The work shall be stopped and the engineer notified if any building settlement is observed.

3.02 AGGREGATE PIER CONSTRUCTION

A. The general procedures are as follows:

1. Stable Ground Conditions: The following general procedures shall be followed when the pre-drilled hole remains open during construction.

a. Pre-drilling to the design depth will be performed with an auger diameter equal to the finished column diameter.

b. Down-Hole Vibrator Method: The quantity of aggregate initially added shall be such that the vibrator tip is able to penetrate to within 12 IN of the design depth. The vibrator will be raised and lowered repeatedly, such that on each re-penetration, the tip of the vibrator advances to within 12 IN of the previous penetration depth.

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c. Down-Hole Tamper Method: Following placement of the first 12 IN lift of aggregate, the tamper is to be lowered to the top of the aggregate and activated. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 IN in thickness.

d. The aggregate shall be removed and replaced with fresh aggregate if cave-ins occur during the aggregate placement such that the volume of caved-in soil is greater than 10 percent of the aggregate being compacted.

2. Unstable Ground Conditions: The following general procedures will be followed when a pre-drilled hole will not remain open before or during pier construction.

a. Down-Hole Vibrator Method: If the hole will remain temporarily stable, the hole may be filled with aggregate to a level above the instability as long as the vibrator is still able to penetrate to within 1 FT of the pre-drilled depth. If the hole will not remain temporarily stable, a Bottom Feed Down-Hole vibrator may be used.

b. Down-Hole Tamper Method: A casing with a minimum outside diameter equal to 100 percent of the pier diameter is advanced to the full treatment depth. The first 12 IN lift of aggregate will be placed, and the tamper lowered to the top of the aggregate. The full energy of the impactor and weight of the excavator shall be used for at least 30 seconds per lift, and subsequent lifts shall not exceed 12 IN in thickness. The casing is extracted after each lift is compacted with the bottom of the casing always maintained below the top of the aggregate.

3. Obstructions: Aggregate piers shall be constructed within 6 IN of the design location. Obstructions encountered during excavation or drilling that will prevent installation of the aggregate piers to design depth, or cause the aggregate pier to stray from its specified location during installation shall be removed. To the extent the obstructions are shown in the geotechnical report, removal of obstructions shall be performed at no additional cost to the owner.

a. Obstructions include, but are not limited to, boulders, timbers, concrete, bricks, utility lines, etc., that prevent installing the aggregate piers to the required depth, or cause the aggregate pier to drift from the required locations. Dense natural rock or weathered rock shall not be deemed obstructions, and piers may be terminated short of design lengths on such materials. The aggregate pier design engineer shall be notified within 24 HRS to verify that the short piers are acceptable.

3.03 PERFORMANCE CRITERIA

A. Construct appropriate aggregate piers with granular backfill material beneath all column foundations and load-bearing wall foundations to provide the following criteria upon completion:

1. An allowable soil bearing capacity of 2000 psf with a maximum total settlement of 0.5 IN and a maximum differential settlement of 0.003 times the distance between adjacent columns.

UP-Pirate-0006029

B. Aggregate piers should be constructed to a depth sufficient to satisfy the settlement criteria above. A modulus test shall be performed to verify the parameter values selected for the pier aggregate.

3.04 FIELD QUALITY ASSURANCE

A. Inspections:

1. All aggregate pier operations for test and production work including: Installation; monitoring; and logging shall be performed under the observation and documentation of the third party QA representative.

2. The QA representive will provide site observation and documentation to ensure performance of the aggregate pier work to include: pier identification; recording of pre-drill hole depth, or initial vibrator tip depth; observance of the aggregate pier installation procedures; and recording of compaction energy information.

3. A sample of the aggregate pier material should be submitted to the Engineer or third party QA firm for a grain size distribution analysis to establish suitability and conformance to this specification. The cost of which will be borne by the contractor. Certification of grain size distribution provided by the quarry may be submitted in lieu of a sample. The aggregate material shall be randomly tested throughout installation for conformance at least once per week of installation, or any time the material source changes. If the aggregate material is not produced by an established rock crushing operation with an approved QC program, then the testing frequency shall be daily. Aggregate material not conforming to the specification shall be rejected and not installed. Any piers installed using rejected material shall be at the risk of the installing contractor and undergo performance testing at the discretion of the Owner and Engineer. Piers failing the performance test shall be rejected, and costs associated with failing piers shall be the responsibility of the installing contractor.

4. The foundation bearing surface shall be compacted and firm prior to the construction of the foundation.

B. Modulus Test:

1. Testing to determine specification compliance will be provided by the aggregate pier contractor, and will consist of at least one modulus test of an aggregate pier. The results of the Modulus Test shall meet the following criteria to pass:

a. The geotechnical engineer shall approve of the location of the Modulus Test.

b. Deflections of the top of the test pier shall be measured by a suitable method.

c. Deflections at the bottom of the test pier shall be measured by means of a telltale installed at the bottom of the test aggregate pier. Performance will be deemed acceptable when, at the specified design stress, deflection at the bottom of the pier does not exceed 20 percent of the deflection at the top of the pier.

d. Load increments, decrements, and duration, shall be determined using ASTM D1143 as general guidelines.

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e. Surficial disturbance shall be compensated for by applying a seating load equal to 5 percent of the total load to the loaded steel plate before applying load increments.

f. The modulus testing shall be performed as described in the Design Submittal.

3.05 UPLIFT TEST

A. In addition to specifications within this section, ASTM D3689 shall be the general guide in establishing uplift load test procedures. The uplift load test will be performed as described in the Design Submittal.

B. The Geotechnical Engineer shall approve the site location of the uplift load test.

C. Verification that the design of the aggregate pier system is in accordance with the performance observed during the uplift load test shall be attained through information acquired during the uplift load test.

3.06 REJECTION OF AGGREGATE PIERS

A. If an aggregate pier is installed in an incorrect location or exceeds the specified tolerances, the aggregate pier contractor shall replace the pier. Pier replacement may be avoided if alternate remedial procedures are approved by the Designer. Unless the rejection is caused by obstruction, refusal in rock or dense soil or errors in the project drawings, the cost of all labor, material, and testing required for the replacement shall be the responsibility of the installer.

END OF SECTION

UP-Pirate-0006031

SECTION 31 78 00 - BLASTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Blasting shall be used in cut sections only as necessary to loosen rock or cemented material and to reduce such rock or cemented material to sizes that can be handled by mechanical earth moving equipment.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 31 24 13 – Excavation, Embankments and Other Fills

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 PREFERRED METHOD OF REMOVING ROCK

A. Ripping shall be the preferred method of removing rock and cemented material from cut sections and ripping shall be used whenever possible to remove rock and cemented materials from cut sections.

3.02 BLASTING

A. Qualifications:

1. The blasting shall be performed by an experienced and properly licensed explosive engineer familiar with Railroad work and operations.

B. Blasting shall be conducted in a manner that follows:

1. Rock or other material outside of the cut section will not be disturbed.
2. The Shape of the cut section after blasting has been completed will conform as nearly as possible to the lines and grades for the cut section shown on the Drawings or established by the Engineer.
3. Excessive blasting will not be permitted. The Contractor shall stop any method of blasting which leads to overshooting or which is dangerous to public or destructive to property or natural features. Blasting shall not be used as a method of moving rock, cemented material or earth cut in a cut section.

C. Removal of Overburden Prior to Blasting:

1. Prior to blasting, the Contractor shall, in accordance with the excavation procedures set forth in Section 31 24 13 of these Specifications, remove from the cut section as much overburden as possible.
2. The Contractor shall stabilize slopes that require stabilization before proceeding with the blasting.

UP-Pirate-0006032

3.03 PREPARATION TO BLAST

A. Operations Outages:

1. Prior to blasting, the Engineer shall arrange a suitable track outage or work window to ensure there is no danger to passing trains.
2. The contractor shall ensure that the blasting can be performed in the allotted time in the track outage. This shall include any cleanup work that may be necessary prior to train movement.
3. The contractor shall ensure that any communications, electrical equipment, or weather will not interfere with the blasting operation.

B. Inspection:

1. The railroad track and track bed, property, and facilities shall be inspected prior to blasting

3.04 LIMITATIONS

A. The following limitations are mandatory for all blasting operations except in quarries:

1. Benches - When drilling and blasting rock cut sections, benches shall be created at intervals not to exceed 20 FT in height. This limitation does not apply to relief holes.
2. Quantity of Explosives - Explosives shall be of such quantity and shall be used in such a manner as will neither open seams nor otherwise damage rock outside the cut section.
3. Repair Damage - Should seams be opened or rock outside the cut section be otherwise damaged, the Contractor shall perform all work which, in the opinion of the Engineer, is necessary to remedy such damage.
4. Time Of Placement and Detonation - Placement and detonation of explosives shall, to the extent reasonably possible, take place during the same work shift. Explosives shall never be placed one day and left overnight for detonation on a subsequent day.
5. Blasting Along Rock Cliffs - In blasting along rock cliffs where preservation of bed rock at and below the subgrade is necessary to provide support for the full width of the subgrade, the Contractor shall reduce depths of all drill holes, reduce quantities of explosives, modify drill patterns and take other measures necessary to prevent breaking down, loosening, or otherwise damaging the supporting bed rock below the subgrade.

3.05 BLASTING PLANS

A. Prior to each blast, the Contractor shall furnish the Engineer with a plan showing:

1. The pattern and depth of all blast holes including relief holes.
2. The type of explosive used.
3. The loading pattern.
4. The sequence of the firing.
5. The plan shall show the position of all holes and relative charges.

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6. The location of charges relating to engineering stations and distances from the centerline of track.
7. The plans shall show grades, lines and slopes of the cut section or as designated by the Engineer.
8. The blasting plan is for record purposes only and will not absolve the Contractor of his responsibility for using proper drilling and blasting procedures and protecting the Railroad's property.

3.06 DAMAGES

A. The railroad track and track bed, property, and facilities shall be inspected after the blasting operation.

B. Any damages to the Railroad or other outside parties, property and facilities, are the responsibility of the blasting contractor or general contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Blasting shall not be measured directly for payment but shall be considered incidental to the work for which it is performed, with all costs being incorporated in the appropriate bid items for the work being performed.

END OF SECTION

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SECTION 32 01 13 - ASPHALT CONCRETE PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Provide asphaltic concrete paving, wheel stops, speed bumps, and curbs where shown on the drawing or as stated in the bid items, and as needed for complete and proper installation.

B. The extent of each type and thickness of Asphalt Paving is shown on the drawings or identified in the bid items.

C. In addition to the asphalt paving courses, the items in this section include, but are not limited to:

1. Sub-grade.
2. Soil treatment.
3. Base-Aggregate.
4. Prime, tack and seal coats.
5. Asphalt pavement.

D. Patching, repairing, surface preparation - new, and repair to existing asphalt is included in this Section.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Excavating, grading and compaction required in the preparation of subgrades are specified in Section 31 24 13 and 31 23 26.

B. Paint Striping and Marking specified in Section 32 17 23.

1.03 REFERENCE STANDARDS:

A. ASTM: ASTM International.

B. State Department of Transportation Standards and Specifications latest edition of the state in which the work is being done.

C. AASHTO: American Society of State Highway Transportation Officials.

1.04 SUBMITTALS

A. Materials Certificates: Provide copies of materials certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

1.05 JOB CONDITIONS

A. Apply prime and tack coats when ambient temperature is above 50 DegF, and when temperature has not been below 35 DegF for 12 HRS immediately prior to application. Do not apply when base is wet or contains an excess of moisture.

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B. Construct asphalt concrete surface course when atmospherical temperature is above 40 DegF and rising and when sub-base is dry. Sub-base shall be placed when air temperature is above 30 DegF and rising and no frost in the existing sub-base or soil.

C. Grade Control: Establish and maintain required line and elevations.

D. The Contractor shall provide, erect, remove, relocate, clean, replace and maintain, if required, suitable signs, barricades, fences or other necessary traffic control devices as may be required or directed by the Engineer. Requirements of local, city, state or federal agencies shall be complied with, including all necessary permits. The Contractor will be required to coordinate his activities with the activities of the Railroad as well as others not party to the Contract.

PART 2 - PRODUCTS

2.01 SUBGRADE

A. Shall be compacted in accordance with Section 31 00 00.

B. See the special instructions for subgrade stabilization, if required.

2.02 AGGREGATE BASE

A. Unless otherwise specified, aggregate base material shall conform to sub-ballast Specifications Section 34 11 27.

2.03 PRIME COAT

A. Prior to the application of the asphaltic concrete, apply a bituminous prime coat of liquid asphalt on the prepared compacted base at a rate of 0.25 GAL/SQ YD or at a rate approved by the Engineer.

B. Apply liquid asphalt by pressure distributors.

C. Allow sufficient time before placing the asphaltic concrete to permit the prime coat to penetrate the prepared compacted base.

2.04 TACK COAT

A. Tack coat is used to promote a bond between new and existing courses.

B. Tack coat, if required, shall be applied immediately in advance of the new surfacing.

C. Tack coat, if required, shall be applied at very low orders of coverage to preclude the development of a slip plane between courses.

2.05 PRODUCT HANDLING

A. Protect asphalt paving materials before, during and after installation, and prevent damage to the installed work of other trades. In the event of damage, immediately make repairs or replacements necessary for approval of the Engineer and at no additional cost to the Railroad.

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2.06 ASPHALT MIX

A. Asphalt mix shall conform to the most current State Department of Transportation Specifications in which the work is being performed. All mix designs shall be approved by the Engineer prior to placement.

PART 3 - EXECUTION

3.01 INSTALLATION OF ASPHALT

A. Asphalt installation shall conform to the most current State Department of Transportation Specifications of the State in which the work is to be performed. Installation shall be approved by the Engineer prior to installation.

B. Surface Preparation:

1. The subgrade shall conform to the design grade and cross section, be free from irregularities and compacted to specified densities.
2. Remove loose material from compacted Aggregate surface immediately before applying herbicide treatment and prime coat.
3. Proof-roll prepared subgrade surface to check for unstable areas and areas requiring additional compaction.
4. Notify Engineer of unsatisfactory conditions. Do not begin paving work until deficient subgrade areas have been corrected and are ready to receive aggregate and paving.
5. It shall be the Contractor's sole responsibility to maintain the subgrade and aggregate as prepared, and any deterioration which may develop shall be corrected at the Contractor's expense.
6. When the surface is constructed on an existing bituminous surface, it shall be cleaned of all foreign material and broomed free of dust before tack coat is applied.
7. When the surface is constructed on an existing concrete or brick surface, it shall be cleaned of all foreign material and broomed free of dust before tack coat is applied, with special care taken in cleaning cracks.
8. Joints or wide longitudinal or diagonal cracks shall be filled with surface course material and compacted as designated by the Engineer. Filling of joints or cracks shall be considered incidental and included in the price of the paving.
9. All waste material as a result of Contractor's operations and site preparation shall be disposed of by the Contractor in an approved manner.

3.02 TACK COAT

A. Tack coat is the application of a very light film of asphalt to an existing paved surface prior to placing new asphalt surfacing.

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3.03 APPLICATION OF PRIME COAT

A. Apply prime coat at a rate of 0.25 GAL/SQ YD over the compacted aggregate base after weed killer has been applied. Apply material to penetrate and seal, but not flood, the surface and/or reduce the adhesion between the aggregate and the surfacing material. Cure and dry as long as necessary to attain penetration and evaporation of volatiles.

3.04 PATCHWORK ON EXISTING SURFACE

A. If the existing surface requires patching, the defective area will be saw cut around its limits and the defective material removed. The remaining hole shall be filled with aggregate base rock material and the asphalt patch should be applied at least as thick as the surrounding asphalt. Both base and asphalt shall be compacted to a minimum density of 96 percent.

3.05 PLACING MIX

A. The mix shall be placed by means of a mechanical spreader and shall spread the mix without tearing the surface. The spreader shall strike a finish that is smooth, true to cross section, uniform in density and texture and free from hollows, transverse corrugation and other irregularities. The mix may be spread and finished by hand methods only where machine methods are impractical as determined by the Engineer.

B. The paving operations shall be maintained as continuously as possible. The speed of the spreader should be adjusted to the capacity of the plant and hauling operations. If the spreader stops for any considerable time and the mix cools below optimum viscosity of the asphalt for proper spreading and compaction and causes roughness in the finish surface and poor densification of the finish mix, the Contractor shall remove and repair that portion of the work at his own expense.

C. Asphalt mixture shall be spread at a minimum temperature of 225 DegF. When conditions warrant, the mixture in hauling equipment shall be protected to maintain the minimum mix temperature.

D. Place in strips not less than 10 FT wide, unless otherwise approved by the Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.

E. Make joints between old and new pavements or between successive days' work to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

3.06 ROLLING

A. Begin rolling when mixture will bear roller weight without excessive displacement.

B. Compact mixture with hot hand-tampers or vibrating plate compactors, in areas inaccessible to rollers.

C. Breakdown rolling: Accomplish breakdown or initial rolling immediately following rolling of joint and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling required, with hot material.

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D. Second rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

F. Patching: Remove and replace areas with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness. Patch areas remaining after thickness test.

3.07 QUALITY CONTROL

A. In addition to the specified testing of subgrade base material, test asphalt courses for thickness, smoothness and compaction.

B. Thickness: In-place compacted thickness will not be acceptable if exceeding 1/2 IN greater, nor 3/8 IN less than the designated course thickness. Any areas found to be deficient in thickness will be overlaid with a minimum of 1 IN thickness, or totally removed and replaced, as determined by the Engineer, at no additional cost to the Railroad. Furnish core tests at locations designated by the Engineer, a minimum rate of one (1) test per 40,000 SQ FT of paved areas, or as directed by the Engineer.

C. Surface Smoothness: Test finished surface of each asphalt concrete course for smoothness using a 10 FT straightedge. Surfaces will not be acceptable if the tolerances for smoothness exceed 3/8 IN in 10 FT-0 IN.

D. Compaction: Rolling shall be continued until all roller marks are eliminated and a minimum density of 96 percent has been obtained.

E. Prior to the seal coat, perform a flood test, if required by, and in the presence of the Engineer.

1. Flood the entire paved area with water.
2. If a depression is found where water ponds to a depth of 1/8 IN in 6 FT, fill and correct.
3. Feather and smooth the edges of fill so that the joint between fill and surface isn't visible.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Asphalt Paving will be paid for at the contract unit price per square yard, installed according to specifications, including grade control.

B. Asphalt prime will be paid for at the contract unit price per square yard, installed according to specifications, and includes cleaning of surfaces.

C. Tack will be paid for at the contract unit price per square yard, installed according to specifications.

D. Patchwork on existing surfaces will be paid for at contract unit price per square yard, installed according to specifications, which includes disposal of defective material.

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END OF SECTION

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SECTION 32 01 14 - ASPHALT - CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. General requirements pertaining to cutting (including excavating), and asphalt fitting and patching of the Work required to:

   a. Make the several parts fit properly.

   b. Uncover work to provide for installing, inspecting or both, of ill-timed work.

   c. Remove and replace work not conforming to requirements of the Contract Documents.

   d. Remove and replace defective work.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Documents affecting work of this Section include, but are not necessarily limited to, General conditions, Supplementary Conditions and Sections in Division 01 of these Specifications.

B. In addition to other requirements specified, upon the Engineer's request, uncover work to provide for inspection by the Engineer of covered work, and remove samples of installed materials for testing.

C. Do not cut or alter work performed under separate contracts without the Engineer's written permission.

1.03 SUBMITTALS

A. Request for Engineer's Consent:

1. Prior to cutting which effects structural safety, submit written request to the Engineer for permission to proceed with cutting.

2. Should conditions of the Work or schedule indicate a required change of materials or methods for cutting and patching, so notify the Engineer and secure his written permission and the required Change Order prior to proceeding.

B. Notice to the Engineer:

1. Prior to cutting and patching performed pursuant to the Engineer's instructions, submit cost estimate to the Engineer. Secure the Engineer's approval of cost estimates and type of reimbursement before proceeding with cutting and patching.

2. Submit written notice to the Engineer designating the time the Work will be uncovered to provide for the Engineer's observation.

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1.04 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. For replacement of items removed, use materials complying with pertinent Sections of these Specifications.

PART 3 - EXECUTION

3.01 SURFACE CONDITIONS

A. Inspection:

1. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, patching and backfilling.
2. After uncovering the work, inspect conditions affecting installation of new work.

B. Discrepancies:

1. If uncovered conditions are not as expected, immediately notify the Engineer and secure directions.
2. Do not proceed until unsatisfactory conditions are corrected.

3.02 PREPARATION PRIOR TO CUTTING

A. Provide required protection including, but not necessarily limited to, shoring, bracing, and support to maintain structural integrity of the Work.

3.03 PERFORMANCE

A. Perform required excavating and backfilling as required under pertinent other Sections of these Specifications.

1. Perform cutting and demolition by methods which will prevent damage to other portions of the Work and provide proper surfaces to receive installation of repair and new work.
2. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.

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PART 4 - MEASUREMENT AND PAYMENT

4.01 PAYMENT FOR COSTS

A. The Railroad will reimburse the Contractor for cutting and patching actually performed by the Contractor at the bid price quoted in the Proposal and Bid.

END OF SECTION

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SECTION 32 12 16 - HOT MIX ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Hot-mix asphalt paving.
2. Hot-mix asphalt patching.
3. Pavement-marking paint.
4. Wheel stops.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Drawings and general provisions of the contract, including General and Supplementary conditions and Division 01 Specification sections, apply to this section.

1.03 SYSTEM DESCRIPTION

A. Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the standard specifications.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Job-Mix Designs:

1. Contractor is to comply with local parking lot mix design standard.

C. Material Certificates:

1. Certificates signed by manufacturers certifying that each material complies with requirements.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Manufacturer Qualifications:

1. Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance. The firm shall be a registered and approved paving mix manufacturer with authorities having jurisdiction or with the DOT of the state in which the Project is located.

C. Asphalt Paving Publication:

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1. Comply with The Asphalt Institute's "The Asphalt Handbook," except where more stringent requirements are indicated.

1.06 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:

1. Prime and Tack Coats – Minimum surface temperature of fifty degrees Fahrenheit, or fifteen and one-half degrees Celsius (50 Deg. F / 10 Deg. C).

2. Asphalt Base Course – Minimum surface temperature of forty degrees Fahrenheit, or four degrees Celsius (40 Deg. F / 4 Deg. C) and rising at time of placement.

3. Asphalt Surface Course – Minimum surface temperature of sixty degrees Fahrenheit, or fifteen and one-half degrees Celsius (60 Deg. F / 15.5 Deg. C) at time of placement.

B. Pavement Marking Paint – Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 Deg. F / 4 Deg. C for oil-based materials, 50 Deg. F / 10 Deg. C for water-based materials, and not exceeding 95 Deg. F / 35 Deg. C.

PART 2 - PRODUCTS

2.01 AGGREGATES

A. Coarse Aggregate – Sound; angular crushed stone; crushed gravel; or properly cured, crushed blast-furnace slag; complying with ASTM D692, Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.

B. Fine Aggregate – Sharp-edged natural sand or sand prepared from stone; gravel, properly cured blast-furnace slag, or combinations thereof; comply with ASTM D1073, Standard Specification for Fine Aggregate for Bituminous Paving Mixtures. For hot-mix asphalt, limit natural sand to a maximum of 10 percent by weight of the total aggregate mass.

2.02 ASPHALT MATERIALS

A. Asphalt Cement – ASTM D3381, Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction, for viscosity-graded material.

B. Prime Coat – Asphalt emulsion prime conforming to state DOT requirements.

C. Tack Coat – ASTM D977, Standard Specification for Emulsified Asphalt, emulsified asphalt or ASTM D2397, Standard Specification for Cationic Emulsified Asphalt, cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.

D. Water – Potable.

2.03 RECYCLED ASPHALT MATERIAL

A. Due to certain environmental concerns, the usage of recycled asphalt materials is only to be used as follows:

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1. As a base beneath a new asphalt or concrete parking lot or road, or other below-grade bedding base.
2. As stock material for new asphalt.
3. As a patch material for damaged asphalt roads or lots, provided a tack material or bonding agent is used to hold millings together.

B. Areas where recycled asphalt is not acceptable:

1. As a loose ballast material where the granular material is exposed to weather or stormwater.
2. Placed as a road or lot patch filler without using a tack material or bonding agent to hold millings together.
3. Any other application where recycled asphalt granules would be exposed to weather or stormwater run-off.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.

B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction.

C. Notify the Engineer of Record in writing of any unsatisfactory conditions. Do not begin paving installation until these conditions have been satisfactorily corrected.

3.02 PATCHING AND REPAIRS

A. Patching – Saw cut perimeter of patch and excavate existing pavement section to sound base. Re-compact new subgrade. Excavate rectangular or trapezoidal patches, extending 12 IN / 300 mm into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically.

1. Tack coat faces of excavation and allow to cure before paving.
2. Partially fill excavation with dense-graded, hot-mix asphalt base mix and compact while still hot. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

B. Tack Coat – Apply uniformly to existing surfaces of previously constructed asphalt or portland cement concrete paving and to surfaces abutting or projecting into new, hot-mix asphalt pavement. Apply at a uniform rate of 0.05 to 0.15 GAL/SQ YD of surface.

1. Allow tack coat to cure undisturbed before paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

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3.03 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. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge aggregate embedded in compacted surface or base course.

B. 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.

C. Prime Coat – Apply uniformly over surface of compacted-aggregate base at a rate of 0.25 GAL/SQ YD. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coast to cure for 72 HRS minimum. Protect primed substrate from damage until ready to receive paving.

3.04 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to 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. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Place hot-mix asphalt surface course in single lift.

B. Refer to design documents for base course, surface course and total pavement thicknesses.

1. Spread mix at minimum temperature of 250 Deg. F / 121 Deg. C.
2. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.
3. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

C. Place paving in consecutive strips not less than 10 FT-0 IN / 3m wide, except where infill edge strips or a lesser width are required. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove any excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.05 JOINTS

A. Construct joints to ensure 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.

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2. Offset longitudinal joints in successive courses a minimum of 6 IN / 150 mm.
3. Offset transverse joint in successive courses a minimum of 24 IN / 600 mm.
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in the Asphalt Institute's, The Asphalt Handbook.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.06 COMPACTION

A. General Compaction – 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 vibratory-plate compactors in areas inaccessible to rollers. Complete compaction before mix temperature cools to 185 Deg. F / 85 Deg. C.

B. Breakdown Rolling – Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and re-rolling to required elevations.

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 has been uniformly compacted to the following density: Average Density: 96 percent of reference laboratory density according to ASTM D5581 Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 IN DIA Specimen), but not less than 94 percent nor greater than 100 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 still hot, with back of rake or smooth iron. Compact thoroughly using tamper or satisfactory method.

F. Repairs – Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection – After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

3.07 INSTALLATION TOLERANCES

A. Thickness – Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: ±1/2 IN / ±13 mm.
2. Surface Course: +1/4 IN / 6 mm, no minus.

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B. Surface Smoothness – Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10 FT- 0 IN / 3m straightedge applied transversely or longitudinally to paved areas.

1. Base Course: 1/4 IN / 6 mm.
2. Surface Course: 1/8 IN / 3 mm.

3.08 PAVING MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Engineer of Record.

B. Allow paving to cure for thirty (30) days before starting permanent pavement marking. In locations where the new pavement will be placed in service prior to (30) day cure, temporary pavement markings may be required.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of fifteen (15) mils or four tenths millimeter (0.4 mm).

1. Parking lot striping: 4 IN wide.
2. Color shall be white.

3.09 FIELD QUALITY CONTROL

A. Testing Agency – The Contractor will engage a qualified independent testing agency to perform field inspections and tests and to prepare test reports. The Testing agency will conduct and interpret tests and state in each report whether tested Work complies with or deviates from specified requirements.

B. Additional Testing – Additional testing, at Contractor's expense, will be performed to determine compliance of corrected Work with specified requirements.

C. Thickness – In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549, Standard Test Method for Thickness and Height of Compacted Bituminous Paving Mixture Specimens.

D. Surface Smoothness – Finished surface of hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density – Samples of un-compacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D979 Standard Practice for Sampling Bituminous Paving Mixtures.

1. Reference laboratory density will be determined by averaging results from 4 samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D5581 Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (6 IN DIA Specimen) and compacted according to job-mix specifications.

2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples or ASTM D2726 Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.

   a. One core sample will be taken for every one-thousand square yards or eight-hundred thirty-six square meters (1000 SQ YD / 836 sq. m.) or less of installed pavement, but in no case will fewer than three (3) cores be taken.

   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D2950 Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods and correlated with ASTM D1188, Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples or ASTM D2726 Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION

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SECTION 32 13 00 - RIGID PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing all plant, material, and equipment, and performing all labor for the manufacturing, transporting, placing, finishing, jointing, and curing of Portland Cement Concrete (PCC) pavement.

1.02 PRE-QUALIFICATIONS

A. Contractor shall submit, along with bid, qualifications and prior projects for review by UP. UP reserves the right to reject bids from contractors who in the opinion of UP lack satisfactory experience or fail to provide documentation.

B. Prior Project List:

1. Provide evidence of the successful installation of PCC pavement on three prior projects of comparable size and application. Include multiple lift construction if project being bid requires multiple lift construction. The project listing shall include a brief description for each project, the final contract amount, the owner's name and contact information and the design engineer's name and contact information.

C. Paving Personnel:

1. Submit resumes and references for the proposed PCC Project Manager, Project Superintendent, Foreman, and Paver Operator. All are expected to have experience with a similar level of responsibility on at least 3 similar projects. Should the proposed contractor become the successful contractor, the personnel proposed in this submission shall be assigned to the project. If for some reason the proposed personnel are not available for this project, replacement personnel shall be subject to qualification by UP.

1.03 REFERENCED STANDARDS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. American Association of State Highway And Transportation Officials (AASHTO):

a. M 182, (2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

b. T 26, (2008) Standard Method of Test for Quality of Water to Be Used in Concrete.

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2. American Concrete Institute International (ACI):
    a. 211.1, (1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
    b. 214R, (2011) Evaluation of Strength Test Results of Concrete.
    c. 305R, (2010) Guide to Hot Weather Concreting.
    d. 306R, (2010) Guide to Cold Weather Concreting.
    e. 309R, (2005) Guide for Consolidation of Concrete.
3. ASTM International (ASTM):
    a. A1064/A1064M, (2013) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
    b. A184/A184M, (2006; E2011) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
    c. A615/A615M, (2013) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    d. A775/A775M, (2007b) Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
    e. C1017/C1017M, (2007) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
    f. C1064/C1064M, (2011) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
    g. C1077, (2011c) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
    h. C1157/C1157M, (2011) Standard Specification for Hydraulic Cement.
    i. C117, (2004) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing.
    j. C123/C123M, (2012) Standard Test Method for Lightweight Particles in Aggregate.
    k. C1240, (2012) Standard Specification for Silica Fume Used in Cementitious Mixtures.
    l. C1260, (2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
    m. C127, (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
    n. C128, (2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
    o. C131, (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
    p. C136, (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

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q. C138/C138M, (2013a) Standard Test Method for Density ("Unit Weight"), Yield, and Air Content (Gravimetric) of Concrete.

r. C142/C142M, (2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates.

s. 143/C143M, (2012) Standard Test Method for Slump of Hydraulic-Cement Concrete.

t. C150/C150M, (2012) Standard Specification for Portland Cement.

u. C1567, (2011) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).

v. C1602/C1602M, (2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete.

w. C1646/C1646M, (2008a) Making and Curing Test Specimens for Evaluating Frost Resistance of Coarse Aggregate in Air-Entrained Concrete by Rapid Freezing and Thawing.

x. C171, (2007) Standard Specification for Sheet Materials for Curing Concrete.

y. C172/C172M, (2010) Standard Practice for Sampling Freshly Mixed Concrete.

z. C 174, (2012) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Cores.

aa. C192/C192M, (2013a) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

bb. C231/C231M, (2010) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

cc. C260/C260M, (2010a) Standard Specification for Air-Entraining Admixtures for Concrete.

dd. C29/C29M, (2009) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate.

ee. C294, (2012) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates.

ff. C295/C295M, (2012) Petrographic Examination of Aggregates for Concrete.

gg. C309, (2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

hh. C31/C31M, (2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field.

ii. C39/C39M, (2012) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

jj. C40/C40M, (2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

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kk. C42/C42M, (2012) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

ll. C494/C494M, (2012) Standard Specification for Chemical Admixtures for Concrete.

mm. C595/C595M, (2012; E 2012) Standard Specification for Blended Hydraulic Cements.

nn. C618, (2012) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

oo. C 642, (2013) Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.

pp. C666/C666M, (2003; R 2008) Resistance of Concrete to Rapid Freezing and Thawing.

qq. C78/C78M, (2010) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

rr. C88, (2013) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

ss. C856, (2011) Petrographic Examination of Hardened Concrete.

tt. C87/C87M, (2010) Effect of Organic Impurities in Fine Aggregate on Strength of Mortar.

uu. C881/C881M, (2013) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

vv. C94/C94M, (2014) Standard Specification for Ready-Mixed Concrete.

ww. C989/C989M, (2012a) Standard Specification for Slag Cement for Use in Concrete and Mortars.

xx. D1751, (2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

yy. D1752, (2004a; R 2013) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion.

zz. D2995, (1999; R 2009) Determining Application Rate of Bituminous Distributors.

aaa. D3665, (2012) Random Sampling of Construction Materials.

bbb. D4791, (2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

ccc. D75, (2009) Standard Practice for Sampling Aggregates.

ddd. E1274, (2003; R 2012) Standard Test Method for Measuring Pavement Roughness Using a Profilograph.

4. Concrete Plant Mixer Manufacturers Bureau (CPMB):

   a. 100, , (2007) Concrete Plant Standards.

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5. National Ready Mixed Concrete Association (NRMCA):
    a. QC 3, (2011) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities.

1.04 SUBMITTALS

A. The Contractor shall submit documentation to the UP that verifies the following:
    1. All the materials utilized in the PCC Paving meet the specified requirements.
    2. Aggregates:
        a. Source name and location.
        b. Soundness loss with calculations.
        c. Percent of Fractured Faces for the coarse aggregate.
        d. Gradations.
        e. Bulk saturated surface dry specific gravities.
        f. Los Angeles wear abrasion.
        g. Fineness modulus.
        h. Aggregate absorption.
        i. Aggregate correction factor.
        j. Sand equivalent of fine aggregate.
        k. Fine aggregate clay lumps content.
        l. Organic impurity content, including soft fragments, coal and lignite, flat or elongated pieces, and other deleterious substances.
        m. Whether or not the aggregate is prequalified by the State Department of Transportation.
    3. Cementitious Materials (Cement, Fly Ash, Blended Cement):
        a. Source name and location.
        b. Chemical and physical properties.
        c. Whether or not the cementitious materials are prequalified by the State Department of Transportation.
    4. Admixtures:
        a. Documentation of compliance with appropriate ASTM requirements.
    5. Concrete mixture proportions.
    6. Water/cementitious ratios.
    7. Type and amount of admixtures.
    8. Water source and location; include pH, available alkalis, and a full chemical analysis.
    9. ASR Testing.

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10. Plastic Concrete Properties:
    a. Air temperature.
    b. Concrete temperature.
    c. Slump; when using super-plasticizer, document the slump before and after addition of the super-plasticizer.
    d. Unit weight.
    e. Air content.
    f. When using super-plasticizer, document the measured air content before and after adding the super-plasticizer.
11. Hardened Concrete Properties:
    a. Compressive strength tests (the average of three cylinders tested at 3 Days, 7 Days, and 28 Days).
    b. Modulus of Rupture strength tests (the average of three beams tested at 3 Days, 7 Days, and 28 Days).
    c. Expansion data from AASHTO T 303.
12. Dowel and Tie Bars, and reinforcement:
    a. Material certifications.
13. Joint Sealant:
    a. Material certifications.
    b. Manufacturer's installation instructions.
14. Curing Compound:
    a. Material certification.

B. The Contractor shall submit the following:
    1. Quality Control Plan.
    2. Cold Weather Procedures.
    3. Hot Weather Procedures.
    4. Quality Control Staff.
    5. Laboratory Accreditation.

1.05 EQUIPMENT

A. Equipment necessary for handling materials and performing all parts of the work shall be approved by the engineer as to design, capacity, and mechanical conditions. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

B. Obtain National Ready Mixed Concrete Association (NRMCA) certification of the concrete plant. The concrete plant shall be inspected by an engineer approved by the NRMCA. A list of NRMCA approved engineers is available on the NRMCA website at http://www.nrmca.org. All fees and costs associated with this inspection shall be paid by the Contractor. Submit a copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist, NRMCA Certificate of Conformance, and Calibration documentation on all measuring and weighing devices prior to uniformity testing.

C. Locate the mixing plant within a proximity to the site to enable PCC placement within specified times.

D. The batch plant and equipment shall conform to the requirements of ASTM C94.

E. Mixers and Transportation Equipment

1. General: Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

2. Central plant mixer: Central plant mixers shall conform to the requirements of ASTM C94. The mixer shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 IN or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

3. Truck mixers and truck agitators. Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall conform to the requirements of ASTM C94.

4. Nonagitator trucks: Nonagitating hauling equipment shall conform to the requirements of ASTM C94.

F. Finishing Equipment:

1. The standard method of constructing concrete pavements on UP projects shall be with an approved slip-form paving equipment designed to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so a dense and homogeneous pavement is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2200 LBS/FT of paving lane width and powered by an engine having at least 6.0 HP/FT of lane width.

2. On projects requiring less than 500 SQ YD of PCC pavement or requiring individual placement areas of less than 500 SQ YD, or irregular areas at locations inaccessible to slip-form paving equipment, PCC pavement may be placed with approved placement and finishing equipment using stationary side forms. Hand screeding and float finishing may only be used on small irregular areas as allowed by the Engineer.

G. Vibrators:

1. Vibrator shall be the internal type. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025 - 0.05 IN.

2. The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of ACI 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer.

3. Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309, Guide for Consolidation of Concrete.

H. Concrete Saws:

1. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

I. Side Forms:

1. Straight side forms shall be made of steel and shall be furnished in sections not less than 10 FT in length. Forms shall have a depth equal to the pavement thickness at the edge, and a base width equal to or greater than the depth. Flexible or curved forms of proper radius shall be used for curves of 100 FT radius or less. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 IN in 10 FT, and the upstanding leg shall not vary more than 1/4 IN. The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Engineer.

J. Pavers:

1. The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver shall be equipped with electronic or hydraulic horizontal and vertical control devices.

K. Dowel Bar Inserters:

1. A mechanical device or dowel bar inserter may be used during placement of the concrete, subject to the following requirements:

   a. The pavement shall be placed and consolidated to full depth prior to insertion of the dowel bars.

   b. Dowel bars shall be inserted into the plastic concrete ahead of the finishing beam or screed.

   c. The installing device shall consolidate the concrete so that no voids exist around the dowel bars.

   d. Dowel bars shall be located within 1 IN of the planned transverse and depth locations.

   e. Dowel bars shall be placed within 2 IN of the planned longitudinal locations.

   f. Dowel bars shall be parallel to the pavement surface and centerline within a tolerance of 1/2 IN per bar length.

   g. Forward movement of the finishing beam or screed shall not be interrupted by insertion of the dowel bars.

   h. A positive method of marking transverse joint locations shall be provided Dowel bar location tolerances shall be randomly checked by the Engineer. Deviance from the tolerance shall result in suspension of paving operations until the problem is corrected. Significant and/or multiple deviances from dowel bar location tolerances may result in removal of the affected concrete section(s) at the Contractor's expense.

L. Curing Equipment:

1. Equipment for applying membrane-forming curing compound shall be mounted on a self-propelled frame that spans the paving lane. The reservoir for curing compound shall be constantly mechanically (not air) agitated during operation and shall contain means for completely draining the reservoir. The spraying system shall consist of a mechanically powered pump which will maintain constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to give uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame. All spray nozzles shall be protected with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph: Membrane Curing. Any hand-operated sprayers allowed by that paragraph shall be compressed air supplied by a mechanical air compressor. If the curing equipment fails to apply an even coating of compound at the specified rate, it shall immediately be replaced.

M. Straightedge:

1. Furnish one 12 FT straightedge for each paving spreader for testing the finished surface. Straightedges shall be made available for UP use upon request. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box- girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on the pavement.

PART 2 - PRODUCTS

2.01 MATERIAL SOURCES

A. All materials shall be obtained from the sources selected by contractor and approved by UP. Any change in materials requires resubmittal, testing and UP approval before being introduced to the project site.

B. Obtain samples of aggregates during paving at the point of batching. Additional tests and analyses of aggregates at various stages in the processing and handling operations may be made by UP at the discretion of UP.

2.02 CEMENTITIOUS MATERIALS

A. Portland Cement:

1. Portland cement shall conform to ASTM C150/C150M, Type I or II, including the false set requirement. Low alkali cement shall be used if the proposed aggregates are found to have greater than 0.10 percent expansion when tested in accordance with the Alkali-Silica Reactivity paragraph. Submit current production mill certifications. All portland cement for the project shall be from a single source.

B. Blended Cement:

1. Blended cement shall conform to ASTM C595/C595M, Type IP or IS, including the optional requirement for mortar expansion. The pozzolan added to the Type IP blend shall be ASTM C618 Class F or Class N and shall be interground with the cement clinker. The manufacturer shall state in writing that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. The percentage and type of mineral admixture used in the blend shall not change from that submitted for the aggregate evaluation and mixture proportioning. The requirements of Table 2 in paragraph SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCM) CONTENT do not apply to the SCM content of blended cement.

C. Fly Ash:

1. Fly ash shall conform to the requirements of ASTM C618, Class F, including the optional requirements for drying shrinkage, uniformity, and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 3 percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity shall have a Calcium Oxide (CaO) content of less than 13 percent and a total equivalent alkali content less than 3 percent.

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D. Ultra Fine Fly Ash and Ultra Fine Pozzolan:

1. Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) shall conform to ASTM C618, Class F or N, and the following additional requirements:

   a. The strength activity index at 28 days of age shall be at least 95 percent of the control specimens.

   b. The average particle size shall not exceed 6 microns.

E. Ground Granulated Blast Furnace Slag:

1. Ground granulated blast furnace slag shall conform to the requirements of ASTM C989/C989M, Grade 100 or 120. Submit current mill certification and chemical composition analyses. All GGBFS for the project shall be from a single source.

F. Supplementary Cementitious Materials (SCM) Content:

1. Contractor may elect to use one of the SCMs listed in Table 2, unless the SCM is required to mitigate ASR, in which case the effective SCM shall be utilized.

TABLE 2 – SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content	Maximum Content
Class N Pozzolan and Class F Fly Ash		
$SiO_2 + Al_2O_3 + Fe_2O_3 > 70\%$	25%	35%
$Si0_2 + A1_2O_3 + Fe_2O_3 > 80\%$	20%	35%
$Si0_2 + A1_2O_3 + Fe_2O_3 > 90\%$	15%	35%
UFFA and UFP	7%	16%
GGBF Slag	40%	50%

2.03 WATER

A. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product. Water will be tested in accordance with the requirements of AASHTO T 26. Water known to be of potable quality may be used without testing.

2.04 CURING MATERIALS

A. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class B, or Class A if wax base only.

B. White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

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C. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

D. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

E. Burlap and cotton mat used for curing shall conform to AASHTO M182.

2.05 AGGREGATES

A. Locate and test the sources from which the aggregates are to be obtained. All aggregate for each nominal size group of aggregates shall be from a single aggregate source and shall meet specified quality requirements. Complete aggregate quality testing prior to performing mixture proportion studies. Furnish, separately, fine, intermediate and coarse aggregates that meet requirements of these specifications.

B. Alkali-Silica Reactivity:

1. Aggregates shall be tested for deleterious reactivity with alkalis in the cement, which may cause excessive expansion of the concrete. Separate tests of coarse and fine aggregate shall be made in accordance with ASTM C1260. If the expansion of coarse or fine aggregate test specimens, tested in accordance with ASTM C1260, does not exceed 0.10 percent at 16 days from casting (14-days of alkali solution (1N NaOH) exposure), the coarse and fine aggregates shall be accepted.

2. If the expansion of any aggregate, coarse or fine, at 16 days is greater than 0.10 percent, tests of combined materials shall be made in accordance with ASTM C1567 using the aggregates, cementitious materials, and/or specific reactivity reducing chemicals in the proportions proposed for the mixture design. If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, does not exceed 0.10 percent at 30 days from casting, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10 percent at 30 days from casting, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10 percent at 30 days, or new aggregates shall be evaluated and tested.

C. Fine Aggregate:

1. Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two. Particles of the fine aggregate shall be generally spherical or cubical in shape.

2. Fine aggregate shall conform to the requirements of ASTM C33. Gradation shall meet the requirements of Table 1 when tested in accordance with ASTM C136, except as may otherwise be qualified under Section 6 of ASTM C33.

Table 1. Gradation for Fine Aggregate (ASTM C 33)

Sieve Designation (Square Openings)	Percentage by Weight Passing Sieves
3/8 in. (9.5 mm)	100
No. 4 (4.75 mm)	95-100
No. 8 (2.36 mm)	80-100
No. 16 (1.18 mm)	50-85
No. 30 (600 µm)	25-60
No. 50 (300 µm)	10-30
No. 100 (150 µm)	2-10

D. Coarse and Intermediate Aggregate

1. Coarse aggregate shall conform to the requirements of ASTM C33. Gradation, within the separated size groups, shall meet the requirements of Table 2 when tested in accordance with ASTM C136. When the nominal maximum size of the aggregate is greater than 1 in, the aggregates shall be furnished in two size groups.

Table 2 Gradation For Coarse Aggregate

(ASTM C 33)

Sieve Designations (square openings)		Percentage by Weight Passing Sieves	
in	**mm**		
2-1/2	63	---	---
2	50.8	100	---
1-1/2	38.1	90-100	---
1	25.0	20-55	100
3/4	19.0	0-15	90-100
1/2½	12.5	---	---
3/8	9.5	0-5	20-55
No. 4	4.75	---	0-10
No. 8	2.36	---	0-5

2. Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled blast furnace slag, crushed recycled concrete pavement, or a combination thereof. The aggregate shall be composed of clean, hard, uncoated particles and shall meet the requirements for deleterious substances contained in ASTM C33, Table 3, Class 4S, 4M, and 1N shall apply for the severe, moderate, and negligible weathering regions identified in Figure 1 of ASTM C33.

3. Dust and other coating shall be removed from the aggregates by washing. The aggregate in any size group shall not contain more than 8 percent by weight of flat or elongated pieces when tested in accordance with ASTM D4791. A flat or elongated particle is one having a ratio between the maximum and the minimum dimensions of a circumscribing rectangular prism exceeding 5 to 1.

4. The percentage of wear shall be no more than 40 percent when tested in accordance with ASTM C131 or ASTM C535.

5. Aggregates that have a history of D-cracking shall not be used. Prior to approval of mixture design and production of Portland cement concrete the Contractor shall submit written certification that the aggregate does not have a history of D-Cracking and that the aggregate meets the specified State requirements.

    a. Other sources of crushed stone aggregate shall be approved if the durability factor as determined by ASTM C666 is greater than or equal to 95 and all other quality test requirements within these specifications are fulfilled. The UP will consider and reserves final approval of other State classification procedures.

E. Aggregate Material Storage:

1. Aggregate shall be stored at the site of the mixing plant, avoiding breakage, segregation, or contamination by foreign materials. Each size of aggregate from each source shall be stored separately in free-draining stockpiles. Aggregate shall remain in free-draining storage for at least 24 HRS immediately prior to use. Stockpiles shall be built on a 12 IN thick sacrificial layer that extends beyond limits of stockpile using concrete production aggregates. Do not allow loader bucket to penetrate into sacrificial layer. Asphalt millings or other materials shall not be used for a sacrificial layer. Sufficient aggregate shall be maintained at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time PCC is being placed. Aggregate shall be handled to prevent segregation or degradation. The tires or tracks of vehicles used for stockpiling or moving aggregate shall be kept clean of foreign materials.

2. Aggregate Stockpiles:

    a. Aggregates as delivered to site shall be clean and free of debris and deleterious material. Stockpiles observed to contain clay balls, dirt, organic matter, material foreign to concrete, other contamination, or material considered objectionable to UP, shall be rejected and removed from the site. Protect stockpiles from contamination by runoff water, storm water, mud, other aggregates or materials and other contaminants. Ensure stockpile base is above any run off flow or localized ponding/flooding, and slopes away from all stockpiles.

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3. Stockpile Construction:

   a. Stockpiles shall be built to prevent segregation and degradation. Stockpiles built with end loaders shall not be higher than the maximum height of loader bucket. Conveyors shall continuously be adjusted so the maximum free-fall is 6 FT and aggregate does not roll down sides of pile. Telescoping radial stackers shall also be controlled the same as conveyors. Stockpiles built with conveyors or stackers shall build small individual cones of 6 FT height, and then build successive cones adjacent and on top. Tracked or wheeled equipment shall not operate on stockpiles.

2.06 ADMIXTURES

A. The use of any material added to the concrete mix shall be approved by the Engineer. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

   1. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

   2. Water-reducing, set retarding, and set-accelerating admixtures shall meet the requirements of ASTM C494, including the flexural strength test.

B. Calcium chloride and admixtures containing calcium chloride shall not be used.

2.07 EXPANSION JOINT MATERIALS

A. Premolded joint filler for expansion joints shall conform to the requirements of ASTM D1751 or ASTM D1752, Type II or III, as required to be compatible with the joint filler Expansion joints shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

B. Expansion joint filler shall be 3/4 IN thick, unless otherwise indicated, and shall be furnished in a single full depth piece.

2.08 JOINT SEALER

A. Dow Corning 888 (ASTM D5893, Type NS) (FAA P-605 for silicone joint selants).

B. Dow Corning 890SL (ASTM D5893, Type SL) (FAA P-605 for silicone joint selants).

C. ASTM D1854 - Jet-Fuel-Resistant Concrete Joint Sealer, Hot-Applied Elastic Type.

D. ASTM D3406 - Joint Sealants, Hot-Applied, Elastometric-Type, for Portland Cement Concrete Pavements.

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2.09 REINFORCING

A. All reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties shall not be used.

B. Reinforcing bars shall conform to ASTM A615/A615M, billet-steel or ASTM A996/A996M, rail and axle steel, Grade 60. Bar mats shall conform to ASTM A184/A184M. The bar members may be billet rail or axle steel.

C. Welded Wire Reinforcement shall be deformed or smooth, conforming to ASTM A1064/A1064M, and shall be furnished in flat sheets.

2.10 DOWELS

A. Dowels shall be single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 0.04 IN on the diameter of the dowel and does not extend more than 0.04 IN from the end of the dowel. Dowels shall be plain (non-deformed) steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Dowel bars shall be epoxy coated in conformance with ASTM A775/A775M. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

B. Dowel bar assemblies shall consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. The dowels shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from rising, sliding out, or becoming distorted during paving operations.

2.11 TIE BARS

A. Tie bars shall be deformed steel bars conforming to ASTM A615/A615M, or ASTM A996/A996M, Grade 60, and of the sizes and dimensions indicated. Deformed rail steel bars and high-strength billet or axle steel bars, Grade 50 or higher, shall not be used for bars that are bent and straightened during construction.

B. Tie bars shall be epoxy coated in conformance with ASTM A775/A775M.

2.12 EPOXY RESIN

A. Epoxy-resin used to anchor dowels and tie bars in pavements shall conform to the requirements of ASTM C881, Type I, Grade 3, Class C. Class A or B shall be used when the surface temperature of the hardened concrete is below 60 DegF.

2.13 MIX DESIGN

A. Proportions:

1. Concrete shall be designed to achieve a 28-day flexural strength that meets or exceeds the minimum design strength. The mix shall be designed using the procedures contained in Chapter 9 of the Portland Cement Association's manual, "Design and Control of Concrete Mixtures".
2. The Contractor shall note that to ensure that the concrete actually produced will meet or exceed the acceptance criteria for the specified strength. The mix design average strength must be higher than the specified strength. The amount of overdesign necessary to meet specification requirements depends on the producer's standard deviation of flexural test results and the accuracy that that value can be estimated from historic data for the same or similar materials.
3. The minimum cementitious material (cement plus flyash, or GGBFS) shall be 517 LBS/CU YD.
4. Prior to the start of paving operations and after approval of all material to be used in the concrete, the Contractor shall submit a mix design showing the proportions and flexural and compressive strengths obtained from the concrete at 7 and 28 days. The mix design shall include copies of test reports, including test dates, and a complete list of materials including type, brand, source, and amount of cement, flyash, ground slag, coarse aggregate, fine aggregate, water, and admixtures. The fineness modulus of the fine aggregate and the air content shall also be shown. The mix design shall be submitted to the Engineer at least 14 days prior to the start of operations. The submitted mix design shall not be more than 90 days old. Production shall not begin until the mix design is approved in writing by the Engineer.
5. Should a change in sources be made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval.
6. Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. Compressive strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C39. The mix determined shall be workable concrete having a slump for side-form concrete between 1 and 2 IN as determined by ASTM C143. For vibrated slip-form concrete, the slump shall be between 1/2 IN and 1-1/2 IN.
7. Before or during construction, if the source of any materials is changed, or if there is any variation in quality of materials furnished, conduct additional tests and adjust amount of cement as required to obtain the specified results.

B. Cementitious Materials:

1. Flyash may be used in the mix design. When flyash is used as a partial replacement for cement, the minimum cement content may be met by considering Portland cement plus flyash as the total cementitious material. The replacement rate shall be determined from laboratory trial mixes, but shall be between 20 and 30 percent by weight of the total cementitious material. If fly ash is used in conjunction with ground granular blast furnace slag the maximum replacement rate shall not exceed 10 percent by weight of total cementitious material.

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2. Ground blast-furnace slag may be used in a mix design containing Type I or Type II cement. The slag, or slag plus flyash if both are used, may constitute between 25 to 55 percent of the total cementitious material by weight. If the concrete is to be used for slipforming operations and the air temperature is expected to be lower than 55 DegF the percent slag shall not exceed 30 percent by weight.

C. Admixtures:

1. Air-entraining admixture shall be added in such a manner that will insure uniform distribution of the agent throughout the batch. The air content of freshly mix air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 5 - 7%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

D. Concrete Mix Design Laboratory:

1. The Contractor's laboratory used to develop the concrete mix design shall meet the requirements of ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix design must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

PART 3 - EXECUTION

3.01 PREPARATION OF SUBGRADE OR SUBBASE

A. Verify that substrate is in place, compacted as specified, finished to the specified tolerances, and free from debris, waste concrete or cement, frost, ice and standing or running water.

B. After the underlying surface has been placed and compacted to the required density, the areas that will support the paving machine and the area to be paved shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall be controlled by a positive grade control system using lasers, stringlines, or guide wires.

C. If the density of the underlying surface is disturbed by the trimming operations, it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor.

D. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete.

E. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete is placed.

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3.02 HANDLING, MEASURING, AND BATCHING MATERIAL

A. The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials.

B. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 HRS before being batched. Rail shipments requiring more than 12 HRS will be accepted as adequate binning only if the car bodies permit free drainage.

C. Batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device shall be arranged to provide positive assurance that the cement content specified is present in each batch.

3.03 MIXING CONCRETE

A. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94.

B. Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the Engineer.

3.04 LIMITATIONS ON MIXING AND PLACING

A. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

B. Cold Weather:

1. Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40 DegF and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35 DegF.

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2. The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50 DegF at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

3. When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150 DegF. The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

4. Concrete damaged by freezing shall be removed and replaced as directed.

C. Hot Weather:

1. During periods of hot weather when the maximum daily air temperature exceeds 85 DegF, the following precautions shall be taken.

   a. The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90 DegF. The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

   b. The finished surfaces of the newly laid pavement shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. If necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf per hour as determined in accordance with Figure 2.1.5 in ACI 305R, Hot Weather Concreting, which takes into consideration relative humidity, wind velocity, and air temperature.

   c. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

D. Temperature Management Program:

1. Prior to the start of paving operation for each day of paving, the contractor shall provide the engineer with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program shall address the following items:

   a. Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

   b. Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity.

   c. Anticipated timing of initial sawing of joint.

3.05 PLACING CONCRETE

A. The Contractor has the option of placing the concrete with either side (fixed) forms or slip-forms. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 FT. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used unless the contractor demonstrates that they can be used without contaminating the concrete and base course and it is approved by the Engineer.

B. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches 90% of its design strength or approved by engineer of record. Also, subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi.

C. Slip-Form Construction:

1. The concrete shall be distributed uniformly into final position by a self propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms.

2. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 IN. The spacing of internal units shall be uniform and shall not exceed 18 IN.

3. The term internal vibration means vibrating units located within the specified thickness of pavement section.

4. The rate of vibration of each vibrating unit shall be within 8000 to 12000 cycles per minute and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least 1 FT. The frequency of vibration or amplitude shall vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

5. The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible. And all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

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6. When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

D. Side-Form Construction:

1. Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.
2. Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up shall also be metal.
3. Width of the base of all forms shall be equal to at least 80 percent of the specified pavement thickness.
4. Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of the concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.
5. Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.
6. Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.
7. Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.
8. Side forms shall remain in place at least 12 HRS after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.
9. Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.
10. Concrete shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross section with a minimum of handwork.
11. The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

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12. Concrete for the full paving width shall be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators' rate of vibration shall be not less than 7,000 cycles per minute. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than 1 FT from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

13. Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

14. The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

E. Consolidation Testing:

1. The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete. If a lack of consolidation of the concrete is suspected by the Engineer, additional referee testing may be required. Referee testing of hardened concrete will be performed by cutting cores from the finished pavement after a minimum of 24 HRS curing. Density determinations will be made based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. Referee cores will be taken at the minimum rate of one for each 500 CU YDS of pavement, or fraction thereof.

2. The average density of the cores shall be at least 97 percent of the original mix design density, with no cores having a density of less than 96 percent of the original mix design density.

3. Failure to meet the above requirements will be considered as evidence that the minimum requirements for vibration are inadequate for the job conditions, and additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete as indicated by further referee testing shall conform to the above listed requirements.

3.06 STRIKE-OFF OF CONCRETE AND PLACEMENT OF REINFORCEMENT

A. Following the placing of the concrete, it shall be struck off to conform to the cross section shown on the plans and to an elevation such that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

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B. Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

3.07 JOINTS

A. Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2 in from their designated position and shall be true to line with not more than 1/4 IN (6 mm) variation in 10 FT (3 m). The surface across the joints shall be tested with a 10 FT (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 IN (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

B. Joint plan changes requested for construction.

C. Construction:

1. Longitudinal construction joints shall be slip-formed or formed against side forms with or without keyways, as shown in the plans.

2. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

D. Contraction:

1. Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 in wide and to the depth shown on the plans.

E. Expansion:

1. Expansion joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

F. Tie Bars:

1. Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. These bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed in the female side of the keyed joint provided the installation is made without distorting the keyed dimensions or causing edge slump. If a bent tie bar installation is used, the tie bars shall be inserted through the keyway liner only on the female side of the joint. In no case shall a bent tie bar installation for male keyways be permitted.

G. Dowel Bars:

1. Dowel bars or other load-transfer units of an approved type shall be placed across joints in the manner as shown on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A metal, or other type, dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on the plans. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. The portion of each dowel painted with rust preventative paint and shown on the plans to receive a debonding lubricant, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel. If free-sliding plastic-coated or epoxy-coated steel dowels are used, a lubrication bond breaker shall be used except when approved pullout tests indicate it is not necessary. Where butt-type joints with dowels are designated, the exposed end of the dowel shall be oiled.

2. Dowel bars at contraction joints may be placed in the full thickness of pavement by a mechanical device approved by the Engineer. The device shall be capable of installing dowel bars within the maximum permissible alignment tolerances. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

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H. Installation:

1. All devices used for the installation of expansion joints shall be approved by the Engineer.
2. The top of an assembled joint device shall be set at the proper distance below the pavement surface and the elevation shall be checked. Such devices shall be set to the required position and line and shall be securely held in place by stakes or other means to the maximum permissible tolerances during the pouring and finishing of the concrete. The premolded joint material shall be placed and held in a vertical position; if constructed in sections, there shall be no offsets between adjacent units.
3. Dowel bars and assemblies shall be checked for position and alignment. The maximum permissible tolerances on dowel bar alignment shall be in accordance with reinforcement design. During the concrete placement operation, it is advisable to place plastic concrete directly on dowel assemblies immediately prior to passage of the paver to help maintain dowel position and alignment within maximum permissible tolerances.
4. When concrete is placed using slip-form pavers, dowels and tie bars shall be placed in longitudinal construction joints by bonding the dowels or tie bars into holes drilled into the hardened concrete. Holes approximately 1/8 IN to 1/4 IN greater in diameter than the dowel or tie bar shall be drilled with rotary-type core drills that must be held securely in place to drill perpendicularly into the vertical face of the pavement slab. Rotary-type percussion drills may be used provided that spalling of concrete does not occur. Any damage of the concrete shall be repaired by the Contractor in a method approved by the Engineer. Dowels or tie bars shall be bonded in the drilled holes using an epoxy resin material. Installation procedures shall be adequate to insure that the area around dowels is completely filled with epoxy grout. Epoxy shall be injected into the back of the hole and displaced by the insertion of the dowel bar. Bars shall be completely inserted into the hole and shall not be withdrawn and reinserted creating air pockets in the epoxy around the bar. The Contractor shall furnish a template for checking the position and alignment of the dowels.
5. Dowels and/or tie bars in a longitudinal joint shall not be less than 10 IN from a transverse joint and shall not interfere with dowels in the transverse direction.

I. Sawing of Joints:

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1. Joints shall be cut as shown on the plans. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8 IN wide and to the depth shown on the plans. The top portion of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs. Sawing shall be carried on both during the day and night as required. The joints shall be sawed at the required spacing, consecutively in sequence of the concrete placement. Curing compound, if being used as the cure type, shall be reapplied in the initial sawcut and maintained for the remaining cure period. Curing compound shall not be applied, and used as the cure method, to any final concrete face that is to receive a sealant. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing.

3.08 FINAL STRIKE-OFF, CONSOLIDATION, AND FINISHING.

A. Sequence:

1. The sequence of operations shall be the strike-off, floating and removal of laitance, straightedging, and final surface finish. The addition of superficial water to the surface of the concrete to assist in finishing operations will not be permitted.

B. Finishing at Joints:

1. The concrete adjacent to joints shall be compacted or firmly placed without voids or segregation against the joint material; it shall be firmly placed without voids or segregation under and around all load-transfer devices, joint assembly units, and other features designed to extend into the pavement. After the concrete has been placed and vibrated adjacent to the joints, the finishing machine shall be operated in a manner to avoid damage or misalignment of joints. If uninterrupted operations of the finishing machine, to, over, and beyond the joints, cause segregation of concrete, damage to, or misalignment of the joints, the finishing machine shall be stopped when the screed is approximately 8 IN from the joint. Segregated concrete shall be removed from the front of and off the joint; and the forward motion of the finishing machine shall be resumed. Thereafter, the finishing machine may be run over the joint without lifting the screed, provided there is no segregated concrete immediately between the joint and the screed or on top of the joint.

C. Machine Finishing:

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1. The concrete shall be spread as soon as it is placed, and it shall be struck off and screeded by a finishing machine. The machine shall go over each area as many times and at such intervals as necessary to give to proper consolidation and to leave a surface of uniform texture. Excessive operation over a given area shall be avoided. When side forms are used, the tops of the forms shall be kept clean by an effective device attached to the machine, and the travel of the machine on the forms shall be maintained true without lift, wobbling, or other variation tending to affect the precision finish. During the first pass of the finishing machine, a uniform ridge of concrete shall be maintained ahead of the front screed for its entire length. When in operation, the screed shall be moved forward with a combined longitudinal and transverse shearing motion, always moving in the direction in which the work is progressing, and so manipulated that neither end is raised from the side forms during the striking-off process. If necessary, this shall be repeated until the surface is of uniform texture, true to grade and cross section, and free from porous areas.

D. Hand Finishing:

1. Hand finishing methods will not be permitted, except under the following conditions: in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade; in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Concrete, as soon as placed, shall be struck off and screeded. An approved portable screed shall be used. A second screed shall be provided for striking off the bottom layer of concrete when reinforcement is used.
2. The screed for the surface shall be a least 2 FT longer than the maximum width of the slab to be struck off. It shall be of approved design, sufficiently rigid to retain its shape, and shall be constructed either of metal or of other suitable material covered with metal. Consolidation shall be attained by the use of suitable vibrators.

E. Floating:

1. After the concrete has been struck off and consolidated, it shall be further smoothed and trued by means of a longitudinal float using one of the following methods:
    a. Hand Method. Long-handled floats shall not be less than 12 FT in length and 6 IN in width, stiffened to prevent flexibility and warping. The float shall be operated from foot bridges spanning but not touching the concrete or from the edge of the pavement. Floating shall pass gradually from one side of the pavement to the other. Forward movement along the centerline of the pavement shall be in successive advances of not more than one-half the length of the float. Any excess water or laitance in excess of 1/8 IN thick shall be removed and wasted.

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b. Mechanical method. The Contractor may use a machine composed of a cutting and smoothing floats, suspended from and guided by a rigid frame and constantly in contact with, the side forms or underlying surface. If necessary, long-handled floats having blades not less than 5 FT in length and 6 IN in width may be used to smooth and fill in open-textured areas in the pavement. When the crown of the pavement will not permit the use of the mechanical float, the surface shall be floated transversely by means of a long-handled float. Care shall be taken not to work the crown out of the pavement during the operation. After floating, any excess water and laitance in excess of 1/8 IN thick shall be removed and wasted. Successive drags shall be lapped one-half the length of the blade.

F. Straight-edge Testing and Surface Correction:

1. After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 16 FT straightedge swung from handles 3 FT longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 IN thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements as stated in the pavement design documents. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

3.09 SURFACE TEXTURE

A. The surface of the pavement shall be finished with either a brush or broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the Engineer.

B. Brush or Broom Finish:

1. If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 IN in depth.

C. Burlap Drag Finish:

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1. If a burlap drag is used to texture the pavement surface, it shall be at least 15 OZ/SQ YD To obtain a textured surface, the transverse threads of the burlap shall be removed approximately 1 FT from the trailing edge. A heavy buildup of grout on the burlap threads produces the desired wide sweeping longitudinal striations on the pavement surface. The corrugations shall be uniform in appearance and approximately 1/16 IN in depth.

D. Artificial Turf Finish:

1. If artificial turf is used to texture the surface, it shall be applied by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf. The leading transverse edge of the artificial turf drag will be securely fastened to a lightweight pole on a traveling bridge. At least 2 FT of the artificial turf shall be in contact with the concrete surface during dragging operations. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated by the Contractor to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85 IN long polyethylene turf blades per square foot. The corrugations shall be uniform in appearance and approximately 1/16 IN in depth.

3.10 CURING

A. Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 HR during the curing period.

B. When a two-sawcut method is used to construct the contraction joint, the curing compound shall be applied to the sawcut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

C. Impervious Membrane Method:

1. The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of 1 GAL to not more than 150 SQ FT. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the Engineer, a double application rate shall be used to insure coverage. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

D. Polyethylene Films:

1. The top surface and sides of the pavement shall be entirely covered with polyethylene sheeting. The units shall be lapped at least 18 IN (457 mm). The sheeting shall be placed and weighted to cause it to remain in contact with the surface and sides. The sheeting shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the pavement. Unless otherwise specified, the sheeting shall be maintained in place for 7 days after the concrete has been placed.

E. Waterproof Paper:

1. The top surface and sides of the pavement shall be entirely covered with waterproofed paper. The units shall be lapped at least 18 IN (457 mm). The paper shall be placed and weighted to cause it to remain in contact with the surface covered. The paper shall have dimensions that will extend at least twice the thickness of the pavement beyond the edges of the slab. The surface of the pavement shall be thoroughly saturated prior to placing of the paper. Unless otherwise specified, the paper shall be maintained in place for 7 days after the concrete has been placed.

F. White Burlap-Polyethylene Sheets:

1. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for 7 days after the concrete has been placed.

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2. Curing in Cold Weather. The concrete shall be maintained at a temperature of at least 50 DegF for a period of 72 HRS after placing and at a temperature above freezing for the remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather, and any concrete injured by frost action shall be removed and replaced at the Contractor's expense.

G. Water Method:

1. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for 7 days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

3.11 PROTECTION OF PAVEMENT

A. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense. The Contractor shall have available at all times, materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

3.12 OPENING TO TRAFFIC

A. The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 550 psi when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion. The pavement shall be cleaned before opening for normal operations.

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3.13 REPAIR, REMOVAL, REPLACEMENT OF SLABS

A. General:

1. New pavement slabs that are broken or contain cracks shall be removed and replaced or repaired, as specified hereinafter at no cost to the owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The engineer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be 4 IN (100 mm) DIA, shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the owner. All epoxy resin used in this work shall conform to ASTM C881, Type V.

B. Shrinkage Cracks:

1. Shrinkage cracks, which do not exceed 4 in in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the Engineer. Shrinkage cracks, which exceed 4 in in depth, shall be treated as full depth cracks.

C. Slabs with Cracks through Interior Areas:

1. Interior area is defined as that area more than 6 IN (600 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the owner, when there are any full depth cracks, or cracks greater than 4 IN in depth, that extend into the interior area.

D. Cracks Close To and Parallel To Joints:

1. All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 in either side of the joint shall be treated as specified hereinafter. Any crack extending more than 6 IN (600 mm) from the joint shall be treated as specified above in subparagraph "Slabs With Cracks Through Interior Area."

    a. Full Depth Cracks Present, Original Joint Not Opened:

        1) When the original uncracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4 IN (19 mm), ±1/16 IN (1.6 mm), and to a width of 5/8 IN (16 mm), ±1/8 IN (3.2 mm). Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

        2) If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

    b. Full Depth Cracks Present, Original Joint Also Cracked:

        1) At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced for the full lane width and length.

E. Removal and Replacement of Full Slabs:

1. Where it is necessary to remove full slabs, unless there are keys or dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 24 IN (150 mm) from the edge if only keys are present, or just beyond the end of the dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 1 IN (25 mm) of the depth of the dowel or key.

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2. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along keyed or doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 LB (14 kg) or less, or other approved similar equipment.

3. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. The joint face below keys or dowels shall be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 IN (12 mm) and no gradual offset greater than 1 IN (25 mm) when tested in a horizontal direction with a 12 FT (3.6 m) straightedge.

4. No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 IN (37 and 100 mm) deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

5. If underbreak over 4 IN (100 mm) deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All 4 edges of the new slab shall thus contain dowels or original keys or original tie bars.

6. Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) shall be re-compacted and shaped as specified in the appropriate SECTION of these specifications. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

F. Repairing Spalls Along Joints:

1. Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, shall be repaired by first making a vertical saw cut at least 1 IN (25 mm) outside the spalled area and to a depth of at least 2 IN (50 mm). Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2 IN (12 mm) of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin shall be avoided. The cavity shall be filled with low slump Portland cement concrete or mortar or with epoxy resin concrete or mortar. Concrete shall be used for larger spalls, generally those more than 1/2 CU FT (0.014 m3) in size, and mortar shall be used for the smaller ones. Any spall less than 0.1 CU FT (0.003 m3) shall be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved by the Engineer. The epoxy resin materials shall be placed in the cavity in layers not over 2 IN (50 mm) thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140 DegF (60 DegC) at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab shall be removed and replaced as previously specified.

3.14 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

A. All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface.

B. Removal of Existing Pavement Slab:

1. When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, the joint between the removal area and adjoining pavement to stay in place, shall first be cut full depth. The pavement to be removed shall be carefully broken up and removed using hand-held jackhammers, 30 LB (14 kg) or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place.

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C. Edge Repair:

1. The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas that are damaged during construction shall be repaired at no cost to the Owner.

2. Spall Repair. Spalls shall be repaired where indicated and where directed. Repair materials and procedures shall be as previously specified in subparagraph "Repairing Spalls Along Joints."

3. Underbreak Repair. All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely filled with paving concrete, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

4. Underlying Material. The underlying material adjacent to the edge or under the existing pavement, which is to remain in place, shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement that is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction shall be carefully removed and replaced with concrete per Engineer's recommendations. The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed.

3.15 CONTRACTOR QUALITY CONTROL

A. Quality Control Program:

1. When the proposed paving area is greater than 40,000 sf or a full length craneway, the Contractor shall develop a Quality Control Program in accordance with Section 01 45 00 Quality Assurance & Controls. The program shall address all elements that affect the quality of the pavement including but not limited to:

   a. Mix Design.

   b. Aggregate Gradation.

   c. Quality of Materials.

   d. Stockpile Management.

   e. Proportioning.

   f. Mixing and Transportation.

   g. Placing and Consolidation.

   h. Joints.

   i. Dowel Placement and Alignment.

   j. Flexural and Compressive Strength.

   k. Finishing and Curing.

l. Surface Smoothness.

3.16 QUALITY CONTROL TESTING

A. The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

B. A Quality Control Testing Plan shall be developed as part of the Quality Control Program, and shall include the following:

1. Fine Aggregate:

a. Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

b. Moisture Content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

2. Coarse Aggregate:

a. Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

b. Moisture Content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

3. Slump. Four slump tests shall be performed for each lot of material produced. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

4. Air Content. Four air content tests, shall be performed for each lot of material produced. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

5. Four unit weight and yield tests shall be made in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

C. Control Charts:

1. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content.
2. Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the Engineer may halt production or acceptance of the material.
3. The control charts shall include:
    a. Fine and Coarse Aggregate Gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits shall be superimposed on the Control Chart for job control.
    b. Slump and Air Content. The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

Control Chart Limits

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
Slip Form:			
Slump	+0 to -1 in (0-25 mm)	+0.5 to -1.5 in (13-38 mm)	+/- 1.5 in (38 mm)
Air Content	+/- 1.2%	+/- 1.8%	+/- 2.5%
Fixed Form:			
Slump	+ 0.5 to -1 in (13-25 mm)	+1 to -1.5 in (25-38 mm)	+/- 1.5 in (38 mm)
Air Content	+/- 1.2%	+/- 1.8%	+/- 2.5%

The individual measurement control charts shall use the mix design target values as indicators of central tendency.

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D. Corrective Action:

1. The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Contractor Quality Control Program shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

   a. Fine and Coarse Aggregate Gradation. When two consecutive averages of five tests are outside of specification limits, immediate steps, including a halt to production, shall be taken to correct the grading.

   b. Fine and Coarse Aggregate Moisture Content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5 percent, the scale settings for the aggregate batcher and water batcher shall be adjusted.

   c. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

      1) one point falls outside the Suspension Limit line for individual measurements or range.
      OR

      2) two points in a row fall outside the Action Limit line for individual measurements.

   d. Air Content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

      1) one point falls outside the Suspension Limit line for individual measurements or range.
      OR

      2) two points in a row fall outside the Action Limit line for individual measurements.

   e. Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility.

E. Contractor Quality Control Staff:

1. All Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) certified in the following grade (or shall have written evidence acceptable to UP of having completed similar qualification programs):

   a. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Inspector.

   b. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

   c. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

F. Laboratory Accreditation:

1. Laboratory and testing facilities shall be provided by and at the expense of the Contractor. The laboratories performing the tests shall be accredited in accordance with ASTM C1077, including ASTM C1260. The accreditation shall be current and shall include the required and optional test methods, as specified throughout this Specification.

G. Reports:

1. All results of tests conducted at the project site shall be reported on the same day tested and shall be delivered to UP. These requirements do not relieve the Contractor of the obligation to report failures immediately to UP. Such reports of failure and the action taken shall be confirmed in writing in the routine reports. UP has the right to examine all Contractor quality control records at any time.

3.17 QUALITY ASSURANCE

A. UP may sample and test aggregates and concrete during construction and inspect production and placement facilities and equipment to determine compliance with the specifications as specified herein and as otherwise considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing performed by UP will not relieve the Contractor from the quality control testing requirements specified.

END OF SECTION

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SECTION 32 13 13 - CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior cement concrete pavement for the following:

a. Driveways and roadways.

b. Parking aprons and Drop Slabs.

c. Curbs and gutters.

d. Walkways.

e. Equipment Pads.

1.02 RELATED REQUIREMENTS (SECTIONS)

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

B. Section 31 00 00 - "Earthwork" for subgrade preparation, grading, and subbase course.

C. Section 07 92 00 - "Joint Sealants" for joint sealants within concrete pavement and at isolation joints of concrete pavement with adjacent construction.

D. Section 03 30 00 - "Cast-in-Place Concrete" for general building applications of concrete.

E. 03 20 00 - “Concrete Reinforcement” for exterior cement pavement requiring reinforcement.

F. Soils Report: The Owner has provided a Soils Report for this project which contains specific recommendations for Concrete Pavement Design Sections. All portions of this report, including recommendations for subgrade stabilization, preparation, and Pavement Design are considered to be part of this specification.

1.03 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixes: For each concrete pavement mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed pavement work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

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B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.

C. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

D. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

E. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.05 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.01 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves of a radius 100 FT or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.02 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: ASTM A185, fabricated from as-drawn steel wire into flat sheets.

B. Deformed-Steel Welded Wire Fabric: ASTM A497, flat sheet.

C. Reinforcement Bars: ASTM A615/A615M, Grade 60, deformed.

D. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60, deformed bars; assembled with clips.

E. Plain Steel Wire: ASTM A82, as drawn.

F. Joint Dowel Bars: Plain steel bars, ASTM A615/A615M, Grade 60. Cut bars true to length with ends square and free of burrs.

G. Tie Bars: ASTM A615/A615M, Grade 60, deformed.

H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows:

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

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2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer coated wire bar supports.

2.03 CONCRETE MATERIALS

A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project.

B. Portland Cement: ASTM C150, Type I or II.

C. Aggregate: ASTM C33, uniformly graded, from a single source, with coarse aggregate as recommended for climate zone of project location.

D. Water: ASTM C94.

2.04 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.

B. Air-Entraining Admixture: ASTM C260.

C. Water-Reducing Admixture: ASTM C494, Type A.

D. High-Range, Water-Reducing Admixture: ASTM C494, Type F.

E. Water-Reducing and Accelerating Admixture: ASTM C494, Type E. Water-Reducing and Retarding Admixture: ASTM C494, Type D.

2.05 CURING MATERIALS

A. Absorptive Cover: AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 OZ/SQ YD dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

E. Clear Waterborne Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B.

F. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

1. Evaporation Retarder:

a. Spray-Film; ChemMasters.

b. Sure Film; Dayton Superior Corporation.

c. Eucobar; Euclid Chemical Co.

d. Lambco Skin; Lambert Corporation.

e. E-Con; L&M Construction Chemicals, Inc.

f. Confilm; Master Builders, Inc.

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g. Waterhold; Metalcrete Industries.

h. SikaFilm; Sika Corporation.

i. Finishing Aid; Symons Corporation.

2. Clear Waterborne Membrane-Forming Curing Compound:

a. Safe-Cure Clear; ChemMasters.

b. Day Chem Rez Cure (J-11-W); Dayton Superior Corporation.

c. Aqua Kure-Clear; Lambert Corporation.

d. L&M Cure R; L&M Construction Chemicals, Inc.

e. 1100 Clear; W. R. Meadows, Inc.

f. Resi-Chem Clear Cure; Symons Corporation.

2.06 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.

B. Pavement-Marking Paint: Alkyd-resin type; ready mixed; complying with FS TT-P-115, Type I, or AASHTO M248, Type N.

1. Color: Blue for handicapped requirements, red for fire lanes, yellow elsewhere.

C. Glass Beads: AASHTO M247.

2.07 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.

1. Do not use Owner's field quality-control testing agency as the independent testing agency.

C. Proportion mixes to provide concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.

2. Maximum Water-Cementitious Materials Ratio: 0.45.

3. Slump Limit: 4 IN, ±1 IN.

a. Slump Limit for Concrete Containing High-Range Water-Reducing Admixture: Not more than 8 IN after adding admixture to plant- or site-verified, 2 to 3 IN slump.

D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

E. Air Content: 6.0 percent, ±1.5 percent.

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2.08 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C94.

PART 3 - EXECUTION

3.01 PREPARATION

A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.02 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 HRS after concrete placement.

B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.03 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.

1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2 IN overlap to adjacent mats.

3.04 JOINTS

A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

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B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than 1/2 HR, unless pavement terminates at isolation joints. All expansion joints shown on the Drawings and as otherwise noted are considered to be a construction joint.

1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 IN into concrete.
2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
3. Provide tie bars at sides of pavement strips where indicated.
4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
5. Terminate Pour at all required expansion joint locations. Secure and support expansion joint material on one side by forms.
6. Follow requirements outlined for preparation and cutting of joint bed at all construction joints as outlined in Paragraph 3.04 E. below.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals as indicated on the drawings.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler less than 1/2 IN or more than 1 IN below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint- filler sections together.
6. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

E. Contraction / Control Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints as indicated on the Drawings.

1. Locate contraction joints and construct as indicated on the Drawings.
2. In areas where spacing of Control Joints is not specified, the following maximum spacing of control joints shall not be exceeded in either direction.

   a. 4 IN Thick Slabs: 6 FT-0 IN.

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b. 5 IN Thick Slabs: 8 FT-0 IN.

c. 6 IN Thick Slabs: 10 FT-0 IN.

d. 8 IN Thick Slabs: 12 FT-0 IN.

e. Greater than 8 IN: Depth (IN) x 1.5 = Max. Joint Spacing (FT).

3. Make initial cut equal to 1/4 slab depth as soon as slab can be cut without damage but in no case shall initial cut be made more that 24 HRS after initial pour.

4. Soft cut process may be used only with prior approval of the Architect and then only for the initial cut.

5. Allow concrete pavement to cure for 28 days or until 28 day design strength can be verified by independent test reports before making second cut.

6. Use wet cut process to cut joint for sealant bed as indicated on the Drawings.

F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

1. Radius: 3/8 IN.

3.05 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, roding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed pavement surfaces with mechanical screed. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry- shake surface treatments.

I. Curbs and Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not approved, remove and replace with formed concrete.

J. When adjoining pavement lanes are placed in separate pours, do not operate equipment on concrete until pavement has attained 85 percent of its 28-day compressive strength.

3.06 CONCRETE FINISHING

A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.

1. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 IN deep with a stiff-bristled broom, perpendicular to line of traffic.

3.07 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot- weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 LB/SQ FT x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 IN and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

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2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.08 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 IN.
2. Thickness: +3/8 IN, -1/4 IN.
3. Surface: Gap below 10 FT long, unleveled straightedge not to exceed 1/4 IN.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 IN.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 IN.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 IN.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 IN per 12 IN.
8. Joint Spacing: 3 IN.
9. Contraction Joint Depth: +1/4 IN, no minus.
10. Joint Width: +1/8 IN, no minus.

3.09 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. If drawings indicate reflective markings broadcast glass spheres uniformly into wet pavement markings at a rate of 6 LB/GAL.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement.

B. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed.

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3.11 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

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SECTION 32 17 23 - PAINT STRIPING AND MARKINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Installing traffic and parking lot markings, including lines, letters, numbers, and symbols, on pavements using paint or preformed thermoplastic materials.
2. Removal of existing markings.

1.02 REFERENCED STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO)

B. Manual on Uniform Traffic Control Devices (MUTCD)

C. Federal Aviation Administration (FAA)

D. Federal Highway Administration (FWHA)

1.03 SUBMITTALS

A. Action Submittals:

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

1.04 QUALITY ASSURANCE

A. The Contractor shall furnish manufacturer's certifications for each marking material to be supplied and to be used on the project. Certificates shall indicate compliance with the provisions of these Specifications.

B. The Contractor shall use a crew experienced in installing the type of pavement marking material designed and shall supply all the equipment necessary for pavement preparations and the placement of the pavement markings.

PART 2 - PRODUCT

2.01 PAINTED MARKING

A. Paint

1. Waterborne
   a. Paint shall meet the requirements of Federal Specification TT-P-1952F, Type III.
2. Epoxy
   a. Paint shall be a two component, minimum 99 percent solids type system conforming to the following:
      1) Pigments. Component A. Percent by weight.
         a) White:

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(1) Titanium Dioxide, ASTM D 476, type II shall be 18percent minimum (16.5 percent minimum at 100 percent purity).

b) Yellow and Colors:

(1) Titanium Dioxide, ASTM D 476, type II shall be 14 to 17 percent.

(2) Organic yellow, other colors, and tinting as required to meet color standard.

(3) Epoxy resin shall be 75 to 79 percent.

2) Epoxy Content. Component A. The weight per epoxy equivalent, when tested in accordance with ASTM D 1652 shall be the manufacturer's target plus or minus 50.

3) Amine Number. Component B. When tested in accordance with ASTM D 2074 shall be the manufacturer's target plus or minus 50.

4) Prohibited Materials. The manufacturer shall certify that the product does not contain mercury, lead, hexavalent chromium, halogenated solvents, nor any carcinogen as defined in 29 CFR 1910.1200 in amounts exceeding permissible limits as specified in relevant Federal Regulations.

3. Traffic paint will be furnished in the following Federal Standard 595 colors:

a. Yellow – 33538

b. Green – 34108

c. Black – 37038

d. Blue – 35180

e. Red – 31136

f. White – 37925

B. Glass Beads

1. Glass beads shall meet the requirements for Federal Specification TT-B-1325D, Type IV Gradation B. Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

2. Glass beads shall be coated with the necessary coating to provide both good embedment and adhesion into the traffic paint film.

3. The glass beads shall be transparent, clean, colorless, smooth and spherical shaped, free flowing, and free of pitting or excessive air bubbles.

4. When applied at the specified rate of glass beads per gallon of traffic paint, the glass beads shall show good adherence to the paint and provide good night visibility throughout the useful life of the reflectorized traffic paint.

5. The beads shall allow sufficient capillary action to form a firm embedment when dropped on a freshly applied wet paint film.

6. The following detailed requirements shall be met:

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a. A minimum of eighty-five percent (85%) of the beads of each sieve size shall be true spheres as determined by "Standard Test for Roundness of Glass Spheres" ASTM D 1155.

b. The glass beads shall have a refractive index of not less than 1.50 when tested according to the specification.

c. When tested according to the specification, the specific gravity of the glass beads shall be between 2.30 and 2.50.

d. The drop-on glass beads in a representative sample shall meet the following gradation requirements when tested in accordance with Standard Method of Tests for Sieve Analysis of Glass Spheres, ASTM Designation D 1214.

U.S. Standard Sieve No.	Amount Passing, %
12	100
16	95-100
20	35-70
30	0-5

e. The glass beads shall be resistant to acid, calcium chloride, sodium sulfide, and water when tested in accordance with the Federal Specification.

f. The glass beads shall flow freely through the dispensing equipment in any weather suitable for marking.

2.02 PREFORMED THERMOPLASTIC MARKING

A. General

1. Must be composed of an ester modified rosin resistant to degradation by motor fuels, lubricants etc. in conjunction with aggregates, pigments, binders and glass beads which have been factory produced as a finished product, and meets the requirements of the current edition of the Manual on Uniform Traffic Control Devices for Streets and Highways.

2. The thermoplastics material conforms to AASHTO designation M249, with the exception of the relevant differences due to the material being supplied in a preformed state.

3. The material must be resistant to deterioration due to exposure to sunlight, water, salt or adverse weather conditions and impervious to oil and gasoline.

B. Graded Glass Beads

1. The material must contain a minimum of thirty percent (30%) intermixed graded glass beads by weight. The intermixed beads shall be conforming to AASHTO designation M247, with minimum 80% true spheres and minimum refractive index of 1.50.

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2. The material must have factory applied coated surface beads in addition to the intermixed beads at a rate of 1 lb. (± 10%) per 10 sq. ft. The factory applied coated surface beads shall have a minimum of 90% true spheres, minimum refractive index of 1.50, and meet the following gradation.

U.S. Standard Sieve No.	Retained %	Passing %
12	0 – 2	98 – 100
14	0 – 3.5	96.5 – 100
16	2 – 25	75 – 98
18	28 – 63	37 – 72
20	63 – 72	28 – 37
30	67 – 77	23 – 33
50	89 – 95	5 – 11
80	97 – 100	0 – 3

C. Pigments

1. White: The material shall be manufactured with sufficient titanium dioxide pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected.
2. Red, Blue, and Yellow: The material shall be manufactured with sufficient pigment to meet FHWA Docket No. FHWA-99-6190 Table 5 and Table 6 as revised and corrected. The yellow pigments must be organic and must be heavy-metal free.
3. Other colors: The pigments must be heavy-metal free.

PART 3 - EXECUTION

3.01 PREPARATION OF SURFACE

A. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other foreign material that would reduce the bond between the paint and the pavement.

B. The area to be painted shall be cleaned by sweeping and blowing or by other methods as required to remove all dirt, laitance, and loose materials without damage to the pavement surface.

C. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the Engineer.

D. Markings shall not be applied to Portland cement concrete pavement until the areas to be painted are clean of curing material. Sandblasting or high-pressure water shall be used to remove curing materials.

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E. Existing Pavement Markings

1. Existing pavement markings which are in alignment with approximately the same location as proposed new pavement markings must be removed to the extent necessary to prepare the roadway surface for the installation of the new pavement marking material in accordance with these Specifications and the materials manufacturer's recommendations. This type of pavement marking removal is considered part of pavement marking preparation and is not a separate pay item.
2. Existing traffic pavement marking which is not in alignment with the proposed new pavement marking, normally because of a change in pavement marking design or layout, must be removed to avoid conflicting marking. This type of marking will not be removed by the preparation of the roadway surface at the location of the proposed new marking. The removal of this marking is a separate pay item
3. The removal method used should not significantly damage the pavement surface and should be determined after consideration of the type of marking material to be removed and type of pavement surface.
4. The pavement marking shall be removed to the satisfaction of the Engineer.
5. Any residue remaining after the removal of the marking shall be collected and removed from the project by the Contractor.

F. Longitudinal Marking

1. All longitudinal traffic pavement markings shall be placed in accordance with the pavement marking plan.
2. Longitudinal pavement markings shall generally be offset at least 2 inches from construction joints. Lines shall be visually straight and shall have overall widths as shown on the plan or UPRR Standard Plans. Markings shall essentially have a uniform cross section. The density and quality of markings shall be uniform throughout their thickness. The applied markings shall have no more than 5 percent, by area, of holes or voids and shall be free of blisters.
3. Existing markings are not to be used as guides for the layout of new markings, except when plans specify "Match Existing Markings".
4. The traffic lane width and other transverse dimensions on the marking plan indicate the nominal distance from existing pavement features to center of marking line, and between centers of marking lines.

G. Transverse Marking

1. Word and symbol marking, including letters, numbers, and arrows, are considered transverse marking. Transverse marking layout shall comply with the current MUTCD.

H. Cross Hatching

1. Cross hatching shall be 4 inches wide unless otherwise specified on plans.

I. Contrast Marking

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1. Contractor shall install black markings as a border around proposed markings where indicated on the plans per the details in the UPRR Standard Plans to provide contrast.

3.02 APPLICATION

A. General

1. Markings shall be applied at the locations and to the dimensions and spacing shown on the plans.
2. Markings shall not be applied until the layout and condition of the surface has been approved by the Engineer.
3. All markings shall be pre-marked by the Contractor. The pre-marking shall be reviewed and approved by the UPRR prior to application of any marking material. A UPRR on-site representative will review the pre-marking on any UPRR workday, if requested, twenty-four (24) hours in advance. The pavement markings shall be installed at the approved pre-marked alignment. Deviation from the approved alignment shall not exceed 2 inches, and the total of all deviations from the approved alignment shall not exceed 1 inch per 200 feet of length nor shall any deviation be abrupt.

B. Painted Markings

1. The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate(s) shown in Table 1. The addition of thinner will not be permitted.

TABLE 1 - APPLICATION RATES FOR PAINT AND GLASS BEADS

Paint Type	Paint Type Paint Square feet per gallon, ft2 /gal.	Glass Beads, Type IV Pounds per gallon of paint—lb./gal.
Waterborne	90 ft2 /gal. maximum	8 lb./gal. minimum
Epoxy	90 ft2 /gal. maximum	15 lb./gal. minimum

2. Paint markings shall not be installed at pavement, air, or paint temperatures less than 50°F. Waterborne paint may be heated to a maximum of 150°F.
3. Paint markings shall not be applied when wind prevents the Contractor from placing markings acceptable to the UPRR on-site representative.
4. The paint shall have a dry thickness of 12± 1 mils and shall be the width shown in the plans ±1/2", The UPRR on-site representative may take periodic samples to ensure the thickness and width of the stripe. Finished lines shall have well defined edges and lateral deviations shall not exceed 2 inches in 200 feet.
5. Equipment
   a. Longitudinal paint marking lines shall be applied with a self-propelled, riding-type line striper that shall:
      1) Be capable of applying three lines simultaneously on the left side and/or right side.

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2) Be capable of applying the traffic marking paint the width specified in the plans and to a dry thickness of 12± 1 mils that is uniform across the width and length of the stripe.

3) Have reservoirs that keep the paint mixture smooth and even.

4) Be equipped with an automated skip device that applies stripe and gap of a specified length with a tolerance of 3 inches per cycle of skip. This tolerance shall not be accumulated in subsequent cycles. The striper shall be able to adjust the cycle while striping to allow for matching the existing stripe.

5) Be capable of applying the traffic marking beads to the wet paint immediately after the application of the paint at a rate required in the plans and these Specifications. The bead applicator shall be equipped with an automatic shut off synchronized with the paint flow.

6. The UPRR on-site representative may allow the use of a walk-behind type of machine with a limited quantity of markings.

7. Glass Bead Application

a. Glass beads shall be distributed upon the marked areas immediately after application of the paint.

b. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads.

c. Glass beads shall be applied at the rate(s) shown in Table 1.

d. Glass beads shall not be applied to black paint.

e. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made

C. Preformed Thermoplastic Marking Application

1. Additional Pavement Preparations

a. Asphalt

1) The materials shall be applied using the propane torch method recommended by the manufacturer.

2) The material must be able to be applied without minimum requirements for ambient and road temperatures and without any preheating of the pavement to a specific temperature. The material must be able to be applied without the use of a thermometer.

3) The pavement shall be clean, dry and free of debris.

4) Supplier must enclose application instructions in English and Spanish with each box/package only pertaining to an application method that does not require preheating of the pavement to a specific temperature before application.

b. Portland Cement Concrete

1) The same application procedure shall be used as described for Asphalt.

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2) A compatible primer sealer shall be applied before application to assure proper adhesion.

c. Heating Indicators

1) The top surface of the material (same side as the factory applied surface beads) shall be regularly spaced indents.

2) The closing of these indents during application, shall act as a visual cue that the material has reached a molten state allowing for satisfactory adhesion and proper bead embedment, and as a post-application visual cue that the application procedures have been followed.

d. Skid Resistance

1) The surface, with properly applied and embedded surface beads, must provide a minimum resistance value of 45 BPN when tested according to ASTM E 303.

e. Thickness

1) The thermoplastic material along, not including topical glass beads, must be supplied at a minimum thickness of 125 mils (3.15 mm).

3.03 CLEAN-UP

A. All material used to clean or prepare the surface for application of markings shall be cleaned up and removed by the Contractor.

B. The Contractor will submit a location to dump waste for the Engineer's approval.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The removal of existing pavement markings to allow a change in pavement marking layout, or location and to remove conflicting marking will not be paid for separately, but shall be included in the cost of other items.

B. Such payment shall be considered full compensation for preparation of pavement surface, removing and disposing of all existing material, furnishing and installing marking materials including glass beads, and for all labor, equipment, tools, materials and incidentals necessary to complete in accordance with the Plans and Specifications and acceptable to the UPRR on-site representative.

C. Markings, including symbols, numbers or letters, will be paid for at the contract unit price per each marking applied according to Specifications.

D. Striping will be paid for at the contract unit price per linear foot applied according to Specifications.

END OF SECTION

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SECTION 32 31 10 - RIGHT OF WAY FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Standard Right Of Way Fence:

a. The extent of the Standard Right of Way fence and gates is as indicated on the drawings or as designated by the Engineer and in accordance with typical details shown on drawing 0075.

1.02 SUBMITTALS

A. Submit manufacturer's technical data and installation instructions for all fence material, a sufficient time in advance to permit review by the Engineer, before ordering material.

1.03 QUALITY ASSURANCE

A. Provide wire fences and gates as complete units, controlled by a single source, or approved by the Engineer, including necessary erection accessories, fittings and fastenings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Dimensions indicated for material are outside dimensions, exclusive of coating and shall consist of all new materials unless otherwise specified herein.

B. Hog Tight, Woven Wire, Steel Fabric:

1. A 26 IN woven wire galvanized steel fabric is to be used. With 7 horizontal bars of No. 9 galvanized wire and stays on 6 IN centers. Weight is approximately 266 LBS per 20 rod roll.

C. Posts:

1. Line Posts: Use painted studded tee steel fence posts 7 FT-0 IN long, with anchor plate, spaced as shown on drawing 0075.

2. Corner Post: Use 6 IN DIA by 9 FT-0 IN with 5 percent solution penta treated wood posts or 7 IN x 9 IN second hand wood ties.

3. Brace Panel Posts: Use 6 IN DIA by 9 FT-0 IN, with 5 percent solution penta treated wood posts or 7 IN x 9 IN second hand wood ties.

4. Horizontal Brace Posts: Brace posts shall be 4 IN DIA or 4 IN x 4 IN x 8 FT-0 IN wood with 5 percent solution penta treated horizontal braces.

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5. Gate Posts: Use 7 IN x 9 IN x 9 FT second hand ties. Each side of gate shall have a brace panel constructed to support gate.

D. Barbed Wire: Barbed wire shall be two-strand 12.5 galvanized wire, twisted, with 14-gauge 4-point barbs spaced not more than 5 IN center to center. Metal and finish to match fabric (galvanized).

E. Diagonal Tie Wire: Use double number 8 galvanized steel wire twisted.

F. Wire Clips: Use 12 gauge galvanized wire clips.

G. Wire Staples: Use 1.5 IN 9 gauge galvanized steel wire stapes.

H. Gates: Gate frames shall be constructed of 1.625 IN DIA steel tube with .066 IN wall. Rails shall be high strength 16 gauge s-bend shape. Stays shall be roll-formed 12 gauge welded in pairs. Latch shall be double pine 1/2 IN x 1 IN steel with lock and saddle horse type handle. Hinge shall be full wrap omega style 1/4 IN steel with bottom in fixed position and top will adjust vertically 5 IN between rails.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Do not begin fence construction until timely notice has been given to the Engineer. At locations where a new fence will replace an existing fence, the new fence shall be completely constructed prior to removing the existing fence, unless the Contractor receives consent from the Engineer and adjacent landowner that livestock containment, security, and other concerns have been addressed.

B. The area along the fence line shall be cleared enough to permit proper construction. Any clearing required for fence construction shall be incidental to the fence construction bid item.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Fencing shall be measured by the linear foot of fence constructed, excluding gates. Gates shall be measured as each gate, complete in place.

4.02 PAYMENT

A. Fence shall be paid for at the unit price bid per linear foot.

B. Gates shall be paid for at the lump sum price bid per each gate.

C. The price shall be full compensation for furnishing, fabricating and installing all materials, preparation, hauling, including all labor, tools, equipment and incidentals necessary to complete the work. Excavation, backfilling, disposal of surplus material and clean-up is also included.

END OF SECTION

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SECTION 32 31 13 - CHAIN LINK FENCING AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Description:

1. The extent of chain link fence and gates is indicated on the drawings, in the bid items, or as designated by the Engineer.

B. Quality Assurance:

1. Provide chain link fence and gates, including all erection accessories, fittings, and fastenings as complete units, which are called for in the specifications and approved by the Engineer.

C. Submittals:

1. Submit under provisions of Section 01 33 00.
2. Submit manufacturer's technical data and installation instructions for all fence material. Submit data early enough to permit review and approval by the Engineer before ordering material.

D. Comply with provisions of shop drawings as noted.

PART 2 - PRODUCTS

2.01 GENERAL

A. Dimensions indicated for posts, roll formed and H Section, are outside dimensions, exclusive of coatings.

2.02 MANUFACTURER

A. Subject to compliance with requirements, provide products of one of the following:

1. Allied Tube and Conduit Corp.
2. American Fence Corp.
3. Anchor Fence, Inc.
4. Cyclone Fence - A Div. of U.S. Diversified Group or other approved source
5. Stephens Pipe and Steel, LLC
6. Merchants Metal

2.03 STEEL FABRIC:

A. Fabric: No. 9-gauge or 0.148" coated steel wire size, 2" mesh fabric 60" and under knuckled both selvages, for fabric 72" or over, bottom selvage knuckled and the top selvage twisted and barbed.

B. Furnish one-piece fabric widths.

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C. Fabric Finish must be one of the following:

1. Galvanized, ASTM A 392, Class II, with not less than 2.0 oz. zinc per square foot of surface.

2. Aluminum-Coated Steel, ASTM A491 Aluminum-Coated Steel Chain Link Fabric, American Association of State Highway Transportation Officials M-181 Chain Link Fence, Type H

2.04 GENERAL FITTINGS AND POSTS.

A. Accessories:

1. Steel Framework, General:

a. Galvanized steel, ASTM A 120 or KA 123, with not less than 1.8 oz. zinc per square foot of surface.

2. Fittings and Accessories:

a. Galvanized, ASTM A 153, with zinc weights per Table I.

3. End, Corner, and Pull Posts:

a. Minimum sizes and weights as follows:

1) 2.875" O.D. steel pipe, 5.79 lbs. per lin. ft.

4. Line Posts:

a. Space 10' o.c. maximum, unless otherwise indicated, of following minimum size and weight:

1) 2.375" O.D. steel pipe, 3.65 lbs. per lin. ft.

2) 2.25" x 1.70" H Section line posts, 3.26 lbs. P.L.F.

5. Gate Posts:

a. Furnish posts for supporting 12'-6" nominal gate leaf, as follows:

1) 6.625" O.D. pipe post, 18.97 lbs. per lin. ft.

6. Tension Wire:

a. 7-gauge, coated coil spring wire, metal and finish to match fabric.

7. Wire Ties:

a. 11-gauge galvanized steel or 11 gauge aluminum wire, to match fabric core material.

8. Top and Brace Rails:

a. Use 1.626" O.D. pipe as top rail for brace, and truss to line post.

9. Truss Rod:

a. Use 0.375" diameter rod and adjustable tightener.

10. Stretcher Bars:

a. One-piece lengths equal to full height of fabric, with minimum cross section of 3/16" x 3/4".

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11. Stretcher Bar Bands:
    a. Space not over 15" o.c. to secure stretcher bars to end, corner, pull and gate posts.
12. Barbed Wire:
    a. Three-strand, 12-1/2 gauge wire, with 14 gauge 4 point barbs spaced not more than 5" o.c.; metal and finish to match fabric, if required.
13. Barbed Wire Supporting Arms:
    a. Capable of withstanding 250 lbs. of downward pull at the outermost end.
14. Fence Slats (If Required):
    a. Manufacturer: P.D.S. Division of AB Plastics, Inc.
    b. Type: Tubular shaped plastic, to fit fencing mesh size for vertical installation.
    c. Color of slats will be selected by the Engineer.

2.05 GATES:

A. Swing Gates:
    1. Manually Operated:
        a. Gate Hardware: Provide hardware and accessories for each gate, galvanized per ASTM A 153.
        b. Hinges: Size and material to suit gate size, non-lift-off type, offset to permit 180 degree gate opening. Provide 1-1/2 pair of hinges for each leaf.
        c. Latch: Forked type or plunger-bar type to permit operation from either side of gate, with padlock eye as integral part of latch.
        d. Keeper: Provide keeper which automatically engages gate leaf and holds it in open position until manually released.
        e. Make perimeter frames of min. 1.90" O.D. pipe.
    2. Double Swing gates.
        a. Provide gate stops for double gates, consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage center drop rod or plunger bar.
        b. Include locking device and padlock eyes as integral part of latch, permitting both gate leaves to be locked with single padlock.

B. Sliding Gates:
    1. Sliding Gates Manual:
        a. Provide manufacturer's standard heavy-duty inverted channel track, ball bearing hanger sheaves, supports, guides, stays, bracing, hardware, and accessories as required. Provide for locking with padlock.
    2. Sliding Gates Automatic:

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a. "Electrical gate opener" provide manufacturer's standard heavy-duty inverted channel track, ball bearing hanger, guides, sheaves, support, stays, bracing, hardware, and accessories as required and controlled by a single source.

b. NOTE: These gates may be single or double gates, which will be called out in the bid item.

C. Concrete:

1. Provide concrete consisting of Portland cement, ASTM C 150, aggregates ASTM C 33, and clean water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 3,000 psi, using a min. of 5 sack cement per C.Y. 1" maximum size aggregate, maximum 3" slump and 2% to 4% entrained air.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Do not begin installation and erection before asphalt paving under fence area is completed. If fence is not on asphalt, the area along the fence line shall be cleared to permit proper construction. Any clearing required for fence installation is incidental to fence construction bid item.

B. Excavation:

1. Drill or hand-excavate (using post-hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed, and/or compacted soil. Excavate holes for each post to minimum diameter of not less than four times largest cross-section of post.

C. Setting Posts:

1. Center and align post 3' above bottom of excavation. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment, and hold in position during placement and finishing operations. Unless otherwise indicated, extend concrete footings 2" above grade, and trowel to a crown to shed water.

D. Center Rails:

1. Provide center rails where indicated. Install in one piece between posts, and flush with post on fabric side, using special offset fittings where necessary.

E. Post Brace Assemblies:

1. Install braces so posts are plumb when diagonal rod is under tension. Manufacturer's standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric.

F. Tension Wire:

1. Install tension wires through post cap loops before stretching fabric, and tie each post cap with not less than 6 gauge galvanized wire. Fasten fabric to tension wire using 11 - gauge galvanized steel hog rings, spaced 24" o.c. Install tension wire at top and bottom of fence fabric.

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G. Fabric:

1. Leave approximately 1" above top of asphalt or ground and bottom selvage, unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Install plastic slats in areas shown on drawings, if required.

H. Stretcher Bars:

1. Thread through or clamp to fabric 4" o.c., and secure to posts with metal bands spaced 15" o.c. Provide one stretcher bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into post.

I. Barbed Wire:

1. Pull wire taut and install securely to extension arms, and secure to end post or terminal arms in accordance with manufacturer's instructions.

J. Barbed Wire Supporting Arms:

1. Manufacturer's standard barbed wire supporting arms, metal and finish to match fence framework, with provision for anchorage to posts and attaching three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap, and must be capable of withstanding 250 lbs. downward pull at outermost end. Single 45 degree arm; for three strands barbed wire, one for each post and vertical arm installation.

K. Tie Wires:

1. Use U-shaped wire, conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Bend ends of wire to minimize hazard to persons or clothing. Tie fabric to line posts, with wire tie spaced 12" o.c. Tie fabric to rails and braces, with wire ties spaced 24" o.c. Tie fabric to tension wires, with hog rings spaced 24" o.c.

L. Fasteners:

1. Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Pen ends of bolts or score threads to prevent removal of nuts.

3.02 GATES:

A. Installation and Fabrication:

1. Install gates plumb, level, and secure for full opening without interference. Install ground set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

2. Fabrication: Fabricate perimeter frames of gates from metal and finish to match fence framework. Assemble gate frames by welding or with special fittings and rivets for rigid connection, providing security against removal or breakage connections. When welding or damage occurs, repair finish so as to protect from rust. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members maximum of 8' apart, unless otherwise indicated.

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3. Provide same fabric as for fence. Install fabric with stretcher bars at vertical edges, and at top and bottom edges. Attach stretcher bars to gate frame at not more than 15" o.c.
4. Install diagonal cross-bracing, consisting of 3/8" diameter adjustable length truss rods on gates to ensure frame rigidity, without sag or twist.
5. Extend end members of gate frames 1'-0" above top member, and prepare to receive three strands of wire. Provide necessary clips for securing wire to extensions.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Chain Link or Cyclone Fencing shall be measured by the linear foot of fence which is a certain height constructed per specifications and excluding gates.

B. Gates for Chain Link or Cyclone fencing shall be measured as each type, a certain height and width of gate, complete in place as per specifications.

4.02 PAYMENT

A. Chain Link Fence shall be paid for at the contract unit price per linear foot.

B. Gates for Chain Link Fence shall be paid for at the contract lump sum price per each gate for a certain type, height and width.

4.03 GENERAL

A. Security fence systems will sometimes have noise detectors. These systems hang on the fence and also pick up noise from the fence. Care shall be taken to install the fence in a manner that caps, arms, braces, wire and posts do not set off a noise sensitive system.

B. Gates, Support arms for barbed wire, the barbed wire, razor wire, and fence slats will be included in the Bid Items if they are required and noted.

END OF SECTION

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SECTION 32 31 56 - WIRE FENCES (DEER PROOF)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The extent of the "Deer Proof" fence and gates is as indicated on the drawings or as designated by the Engineer.

1.02 SUBMITTALS:

A. Submit manufacturer's technical data and installation instructions for all fence material, a sufficient time in advance to permit review by the Engineer, before ordering material.

1.03 QUALITY ASSURANCE:

A. Provide wire fences and gates as complete units, controlled by a single source, or approved by the Engineer, including necessary erection accessories, fittings and fastenings.

1.04 MATERIALS

A. General:

1. Dimensions indicated for material are outside dimensions, exclusive of coatings.

B. Steel Fabric:

1. A woven wire galvanized steel fabric is to be used. Fabric may be furnished in two-piece widths with prior approval of the Engineer. The top and bottom wire widths to be of 10-gauge galvanized steel wire. Intermediate wires and stays to be of 12.5-gauge galvanized steel wire. The bottom fabric is to have horizontal wires with gradually increasing spacing, starting narrowest at the bottom, up to but not more than 6 - 8 IN. Vertical stays are to be spaced at 6 IN. Where two piece fabric widths are used, the fabrics shall be connected by use of 11 - gauge galvanized steel hog rings on 18 - 24 IN centers.

C. Posts:

1. Line Posts: Use painted studded tee steel fence posts 10 FT long, with anchor plate, spaced on 25 FT centers. Approximate weight of 1.33 LBS/FT. Splicing of posts will not be allowed.

2. Corner Posts: Use 8 IN DIA or 8 IN by 8 IN penta or CCA treated wood posts 12 FT long, set in concrete.

3. Brace Panel Posts: Use 6 IN DIA or 6 IN by 6 IN penta or CCA treated wood posts 12 FT long. Brace panels to be spaced not more than 650 FT apart.

4. Horizontal Brace Posts: Brace posts shall be 2.5 IN DIA galvanized steel posts. Approximate weight of 3.79 LBS/FT.

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5. Gate Posts: Gate posts shall be 4 IN DIA galvanized steel posts 12 FT long with top cap, set in concrete. Approximate weight of 9.36 LBS/FT.

D. Barbed Wire:

1. Barbed wire shall be two-strand 121.5 gauge wire, twisted, with 14 gauge 4-point barbs spaced not more than 5 IN center to center. METAL AND FINISH TO MATCH FABRIC (galvanized).

E. Top Wire:

1. Top wires shall be two-strand 12.5 gauge galvanized twisted barbless wire with metal and finish to match fabric.

F. Diagonal Tie Wire:

1. Use two strand 9 gauge galvanized steel wire.

G. Wire Clips:

1. Use 10 gauge galvanized wire clips on approximately 12 IN centers on the fabric and t each tension and barbed wire.

H. Wire Staples:

1. Use 1.5 IN 9 gauge galvanized steel wire staples.

I. Gates:

1. Gate frames shall be constructed of 1.875 IN DIA galvanized steel pipe with approximate weight of 1.89 LBS/FT, except the vertical hinge side which shall be constructed of 1.875 IN DIA galvanized steel pipe with approximate weight of 2.50 LBS/FT. Gate frame shall be covered with the same fabric and wires as the fence.

J. Miscellaneous Fittings and Accessories:

1. These shall be galvanized steel of good commercial quality and design and approved by the Engineer before ordering.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Do not begin installation and erection until timely notice has been given to the Engineer. The area along the fence line shall be cleared enough to permit proper construction. Any clearing required for fence construction shall be incidental to the fence construction bid item.

B. Excavation:

1. Drill or hand-excavate (using post hole digger) holes for posts to spacing indicated, in firm, undisturbed, or compacted soil. Excavate holes for each post to a minimum diameter of 16 - 24 IN.

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C. Setting Posts:

1. Fence posts shall be spaced at the intervals and set to the depth shown on the plans. Check each post for vertical and top alignment. Metal line posts may be driven in place providing such driving does not damage the posts. Posts must be set to the desired depth and tops of posts not cut off to height. 8 IN wood corner posts and 4 IN galvanized gate posts shall be set n concrete. Place concrete around posts and vibrate or tamp for consolidation. Extend concrete 2 IN above grade and trowel to a crown to shed water. Metal line posts that will not drive in and 6 IN wood brace posts shall be backfilled in 4 IN layers with each layer thoroughly tamped. Corner posts shall be braced in both directions and end and gate posts shall be braced in one direction. Brace panels will also be installed at all grade breaks as directed by the Engineer. At all grade depressions where stresses tend to pull the posts out of the ground, the fencing shall be snubbed or guyed at the critical point by means of a double 9 gauge galvanized wire connected to each horizontal line of barbed and top wire and to the top and bottom wire of the fabric. This shall be connected to a deadman of sufficient weight to hold the fence down.

D. Fabric:

1. Leave fabric approximately 2 IN above the top of ground level. Pull fabric taut and tie or staple to posts. Install and anchor so that fabric remains in tension after pulling force is released. Existing cross fences shall be connected, if required, to the new fence. Where this occurs, a braced corner post shall be installed.

E. Barbed and Top Wire:

1. Pull wire taut and tie or staple to the posts such that it remains tight. Install the barbed wire 1 IN above the top of ground level. Install one top wire 1 IN from the top of the post and the other midway between it and the top of the fabric.

F. Horizontal Brace Post:

1. The horizontal brace post shall be installed 6 FT above the ground on brace panels and fastened with a no. 60 spike on wood posts or the proper fitting n galvanized steel posts.

G. Diagonal Tie Wires:

1. Wires shall be securely fastened to posts and provide rigidity to brace panels.

H. Gates:

1. Fabricate perimeter frames of gates from metal as described above. Assemble gate and frames by welding or with special fittings and rivets for rigid connection and provide security against removal or breakage of connections. When welding or damage occurs, repair finish so as to protect from rust. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware and accessories. Provide same fabric for gate as the fence. Stretch fabric on frame and securely fasten. Install diagonal cross-bracing, consisting of 3/8 IN DIA adjustable length truss rods on gate to ensure frame rigidity without sag or twist. Extend end members of gate frame above and below the fabric a sufficient distance to attach barbed and top wires. Provide necessary clips for securing wire to extensions. Provide end caps on top of vertical members. Provide hinges to suit gate size, non lift-off type, and permit 180 degree gate opening. Latch shall be forked type or plunger bar type to permit operation from either side. Latch shall have padlock eye as integral part of latch. Provide keeper which automatically engages gate leaf and holds it in an open position until manually released. Where double gates are used, provide gate stops for double gates, consisting of mushroom-type flush plate with anchors, set in concrete, and designed to engage center drop rod as integral part of latch, permitting both gate leaves to be locked with a single padlock. Padlocks will be applied by the owner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Fencing shall be measured by the linear foot of fence constructed, excluding gates. Gates shall be measured as each gate, complete in place.

4.02 PAYMENT

A. Fence shall be paid for at the unit price bid per linear foot.

B. Gates shall be paid for at the lump sum price bid per each gate.

C. The price shall be full compensation for furnishing, fabricating and installing all materials, preparation, hauling, including all labor, tools, equipment and incidentals necessary to complete the work. Excavation, backfilling, disposal of surplus material and clean-up is also included.

END OF SECTION

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SECTION 32 32 23 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Single depth segmental retaining walls without soil reinforcement.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 31 00 00 - "Earthwork" for excavation for segmental retaining walls.

1.03 PERFORMANCE REQUIREMENTS

A. Structural Performance: Engineering design shall be based on vehicle loads, loads due to soil pressures resulting from grades indicated and determined according to “NCMA's "Design Manual for Segmental Retaining Walls."

B. Drainage: Provide drainage system capable of preventing accumulation of storm water behind segmental retaining wall.

1.04 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:

1. Test soil backfill materials for coefficient of friction according to ASTM D5321.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:

a. Indicate assembly dimensions, locations of structural members, connections, attachments, wall system dimensions, layout, general construction details, method of installation, sizes, and locations from datum, and design loads.

1) Provide drawings signed and sealed by a professional engineer licensed in the state where the work is to be built.

b. Standard manufacturer's installation drawings alone will not constitute a Shop Drawing submittal and will be disapproved.

c. Any deviation from the plans and specifications shall be noted with a "cloud" and state if it affects other trades or not. All deviations shall be subject to approval.

d. No product shall be delivered to the site prior to Shop Drawing approval.

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

3. Samples: For each color and texture of concrete unit required.

B. Informational Submittals:

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1. Preconstruction test reports.
2. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SEGMENTAL RETAINING WALL UNITS

A. Concrete Units: ASTM C1372, Normal Weight, except that units shall not differ in height more than ±1/16 IN from specified dimension.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Redi-Rock 6 FT-0 IN Standard Batter Wall, 41 IN Series Blocks or comparable product by a licensee of one of the following:

a. Allan Block Corporation.

b. Anchor Wall Systems, Inc.

c. GeoWestern, Inc.

d. ICD Corporation.

e. Keystone Retaining Wall Systems, Inc.; a Contech company.

f. Risi Stone Systems; a division of Rothbury International.

g. Rockwood Retaining Walls, Inc.

h. Tensar Earth Technologies, Inc.

i. Versa-Lok Retaining Wall Systems; a division of Kiltie Corporation.

2. Provide units that comply with requirements for freeze-thaw durability.

3. Provide units that interlock with courses above and below by means of integral lugs or lips.

B. Color: As indicated by manufacturer's designations.

C. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.

2.02 INSTALLATION MATERIALS

A. Pins and Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.

B. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.

C. Leveling Base: Comply with requirements in Section 31 00 00 - "Earthwork" for base material and drainage fill.

D. Soil Fill: Comply with requirements in Section 31 00 00 - "Earthwork" for satisfactory soils.

E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.

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1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D4751.
2. Minimum Grab Tensile Strength: 110 LB; ASTM D4632.

F. Subdrainage Pipe: Comply with requirements in Section 33 40 10 - "Storm Drainage."

PART 3 - EXECUTION

3.01 RETAINING WALL INSTALLATION

A. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
1. Lay units in running bond.
2. Form corners and ends by using special units.

B. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D698.

C. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
1. Tamp units into leveling base as necessary to bring tops of units into a level plane.

D. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.

E. Cap Units: Place cap units and secure with cap adhesive.

3.02 FILL PLACEMENT

A. General: Comply with requirements in Section 31 00 00 - "Earthwork," NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.

B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.

C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall and place and spread fills toward embankment. above bottom of wall, whichever is greater.
1. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D698.
a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D698.
2. Compact nonreinforced-soil fill to comply with Section 31 00 00 - "Earthwork."
3. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 IN wide behind drainage geotextile to within 12 IN of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.

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D. Place a layer of drainage fill at least 12 IN wide behind wall to within 12 IN of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.

E. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated sloped not less than 0.5 percent to drain.

F. Place impervious fill over top edge of drainage fill layer.

3.03 FIELD QUALITY CONTROL

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

B. Comply with requirements in Section 31 00 00 - "Earthwork" for field quality control.

1. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 30 FT or less of segmental retaining wall length.

END OF SECTION

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SECTION 32 90 10 - LANDSCAPING FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Trees.
2. Shrubs.
3. Ground covers.
4. Plants.
5. Lawns.
6. Topsoil and soil amendments.
7. Fertilizers and mulches.
8. Stakes and guys.
9. Landscape edgings.
10. This section does not apply to the construction of mainline and/or yard track projects.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Drawings and general provisions of the Contract, including General and Special Conditions apply to this Section.

B. Section 31 00 00 - "Earthwork" for excavation, filling, rough grading, and subsurface aggregate drainage and drainage backfill.

C. Section 31 11 00 - "Clearing and Grubbing" for protection of existing trees and planting, topsoil stripping and stockpiling, and site clearing.

1.03 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product certificates signed by manufacturers certifying that their products comply with specified requirements.

1. Manufacturer's certified analysis for standard products.
2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
3. Label data substantiating that plants, trees, shrubs, and planting materials comply with specified requirements.

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C. Certification of grass seed from seed vendor for each grass-seed mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for sod, identifying sod source, including name and telephone number of supplier.

D. Samples of each of the following:

1. Edging materials and accessories to verify color selected.

E. Maintenance instructions recommending procedures to be established by Owner for maintenance of landscaping during an entire year. Submit before expiration of required maintenance periods.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.

1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that landscaping is in progress.

B. Provide quality, size, genus, species, and variety of trees and shrubs indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock."

C. Measurements: Measure trees and shrubs according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 IN above ground for trees up to 4 IN caliper size, and 12 IN above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at site.

B. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

C. Sod: Harvest, deliver, store, and handle sod according to the requirements of the American Sod Producers Association's (ASPA) "Specifications for Turfgrass Sod Materials and Transplanting/Installing."

D. Trees and Shrubs: Deliver freshly dug trees and shrubs. Do not prune before delivery, except as approved by Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy natural shape. Provide protective covering during delivery. Do not drop trees and shrubs during delivery.

1. Immediately after digging bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

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2. Handle balled and burlapped stock by the root ball.

E. Deliver trees, shrubs, ground covers, and plants after preparations for planting have been completed and install immediately. If planting is delayed more than 6 hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots in water for 2 HRS if dried out.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of trees and shrubs stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.06 PROJECT CONDITIONS

A. Utilities: Determine location of above grade and underground utilities and perform work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.

B. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Architect before planting.

1.07 COORDINATION AND SCHEDULING

A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required.

1.08 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Warrant the following living planting materials for a period of one year after date of Substantial Completion, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, abnormal weather conditions unusual for warranty period, or incidents that are beyond Contractor's control.

1. Trees.
2. Shrubs.
3. Ground covers.
4. Plants.

C. Remove and replace dead planting materials immediately unless required to plant in the succeeding planting season.

D. Replace planting materials that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

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E. A limit of one replacement of each plant material will be required, except for losses or replacements due to failure to comply with requirements.

PART 2 - PRODUCTS

2.01 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs conforming to ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully-branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades conforming to ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

D. Label at least 1 tree and 1 shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

2.02 SHADE AND FLOWERING TREES

A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, conforming to ANSI Z60.1 for type of trees required.

1. Branching Height: 1/3 to 1/2 of tree height.
2. Branching Height: 1/2 of tree height.

B. Small Trees: Small upright or spreading type, branched or pruned naturally according to species and type, and with relationship of caliper, height, and branching recommended by ANSI Z60.1, and stem form as follows:

1. Form: Single stem.
2. Form: Multi-stem, clump, with 2 or more main stems.
3. Form: Multi-stem, shrub, with multiple stems.

C. Provide balled and burlapped trees.

D. Provide bare-root trees.

E. Provide balled and burlapped trees except where bare-root trees are indicated.

1. Container-grown trees will be acceptable in lieu of balled and burlapped trees subject to meeting ANSI Z60.1 limitations for container stock.

2.03 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

B. Provide balled and burlapped deciduous shrubs.

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C. Provide bare-root deciduous shrubs.

D. Provide balled and burlapped deciduous shrubs except where bare-root deciduous shrubs are indicated.

1. Container-grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to meeting ANSI Z60.1 limitations for container stock.

2.04 CONIFEROUS EVERGREENS

A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, conforming to ANSI Z60.1.

B. Provide balled and burlapped coniferous evergreens.

1. Container-grown coniferous evergreens will be acceptable in lieu of balled and burlapped coniferous evergreens subject to meeting ANSI Z60.1 limitations for container stock.

2.05 BROADLEAF EVERGREENS

A. Form and Size: Normal-quality, well-balanced, broadleaf evergreens, of type, height, spread, and shape required, conforming to ANSI Z60.1.

B. Provide balled and burlapped broadleaf evergreens.

1. Container-grown broadleaf evergreens will be acceptable in lieu of balled and burlapped broadleaf evergreens subject to meeting ANSI Z60.1 limitations for container stock.

2.06 GROUND COVERS AND PLANTS

A. Provide ground covers and plants established and well rooted in removable containers or integral peat pots and with not less than the minimum number and length of runners required by ANSI Z60.1 for the pot size indicated.

2.07 GRASS MATERIALS

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances.

1. Seed Mixture: Provide seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated on The Drawings.

B. Sod: Certified turfgrass sod complying with ASPA specifications for machine-cut thickness, size, strength, moisture content, and mowed height, and free of weeds and undesirable native grasses. Provide viable sod of uniform density, color, and texture of the following turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

1. Species: Provide sod of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated on Schedules at the end of this Section.

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2.08 TOPSOIL

A. Topsoil: ASTM D5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of stones 1 IN or larger in any dimension, and other extraneous materials harmful to plant growth.

1. Topsoil Source: Reuse surface soil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

2. Topsoil Source: Import topsoil from off-site sources. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 IN deep; do not obtain from bogs or marshes.

3. Topsoil Source: Amend existing surface soil to produce topsoil. Supplement with imported topsoil when required.

2.09 SOIL AMENDMENTS

A. Lime: ASTM C602, Class T, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent, with a minimum 99 percent passing a No. 8 sieve and a minimum 75 per-cent passing a No. 60 sieve.

1. Provide lime in the form of dolomitic limestone.

B. Aluminum Sulfate: Commercial grade, unadulterated.

C. Sand: Clean, washed, natural or manufactured sand, free of toxic materials.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Peat Humus: Finely divided or granular texture, with a pH range of 6 to 7.5, composed of partially decomposed moss peat (other than sphagnum), peat humus, or reed-sedge peat.

F. Peat Humus: For acid-tolerant trees and shrubs, provide moss peat, with a pH range of 3.2 to 4.5, coarse fibrous texture, medium-divided sphagnum moss peat or reed-sedge peat.

G. Sawdust or Ground-Bark Humus: Decomposed, nitrogen-treated, of uniform texture, free of chips, stones, sticks, soil, or toxic materials.

1. When site treated, mix with at least 0.15 LB of ammonium nitrate or 0.25 LB of ammonium sulfate per cubic foot of loose sawdust or ground bark.

H. Manure: Well-rotted, unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

I. Herbicides: EPA registered and approved, of type recommended by manufacturer. Water: Potable.

2.10 FERTILIZER

A. Bonemeal: Commercial, raw, finely ground; minimum of 4 percent nitrogen and 20 percent phosphoric acid.

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B. Superphosphate: Commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

C. Slow-Release Fertilizer: Granular 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.

2.11 MULCHES

A. Organic Mulch: Organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.

B. Asphalt Emulsion Tackifier: Asphalt emulsion, ASTM D977, Grade SS-1, nontoxic and free of plant growth- or germination-inhibitors.

C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth- or germination-inhibitors.

2.12 WEED-CONTROL BARRIERS

A. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 OZ/SQ YD.

2.13 EROSION-CONTROL MATERIALS

A. Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, 0.92 LB/SQ YD minimum, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 IN long.

2.14 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2 by 2 IN by length indicated, pointed at one end.

B. Guy and Tie Wire: ASTM A 641, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 IN DIA.

C. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2 IN DIA, black, cut to lengths required to protect tree trunks from damage.

D. Flags: Standard surveyor's plastic flagging tape, white, 6 IN long.

2.15 LANDSCAPE EDGINGS

A. Steel Edging: ASTM A569, rolled edge, standard steel edging, fabricated in sections with loops stamped from or welded to face of sections approximately 30 IN apart to receive stakes.

1. Edging Size: 3/16 IN wide by 4 IN deep.

2. Stakes: Tapered steel, 15 IN long.

3. Accessories: Standard tapered ends, corners, and splicers as required.

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4. Finish: Standard paint finish; color selected by Architect.
5. Finish: ASTM A525, G 90 zinc coated with standard paint finish; color selected by Architect.
6. Accessories: Manufacturer's standard connecting clips or plugs.

2.16 MISCELLANEOUS MATERIALS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, 4 IN wide minimum, with stretch factor of 33 percent.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, and secure Architect's acceptance before the start of planting work. Make minor adjustments as may be required.

3.03 PLANTING SOIL PREPARATION

A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

B. Mix soil amendments and fertilizers with topsoil at rates indicated. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days.

1. A "Planting Soil Amendments Schedule" is included at the end of this Section.

C. For tree pit or trench backfill, mix planting soil before backfilling and stockpile at site.

D. For planting beds and lawns, mix planting soil either prior to planting or apply on surface of top-soil and mix thoroughly before planting.

1. Mix lime with dry soil prior to mixing fertilizer. Prevent lime from contacting roots of acid-tolerant plants.
2. Apply phosphoric acid fertilizer, other than that constituting a portion of complete fertilizers, directly to subgrade before applying planting soil and tilling.

3.04 LAWN PLANTING PREPARATION

A. Limit subgrade preparation to areas that will be planted in the immediate future.

B. Loosen subgrade to a minimum depth of 4 IN. Remove stones larger than 1-1/2 IN in any dimension and sticks, roots, rubbish, and other extraneous materials.

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C. Spread planting soil mixture to depth required to meet thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen.

1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil mixture.

2. Allow for sod thickness in areas to be sodded.

D. Preparation of Unchanged Grades: Where lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare soil as follows:

1. Remove and dispose of existing grass, vegetation, and turf. Do not turn over into soil being prepared for lawns.

2. Till surface soil to a depth of at least 6 IN. Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 IN of soil. Trim high areas and fill in depressions. Till soil to a homogenous mixture of fine texture.

3. Clean surface soil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

4. Remove waste material, including grass, vegetation, and turf, and legally dispose of it off the Owner's property.

E. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1 IN in any dimension, and other objects that may interfere with planting or maintenance operations.

F. Moisten prepared lawn areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

G. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

3.05 GROUND COVER AND PLANT BED PREPARATION

A. Loosen subgrade of planting bed areas to a minimum depth of 6 IN. Remove stones larger than 1 IN in any dimension and sticks, roots, rubbish, and other extraneous materials.

B. Spread planting soil mixture to depth required to meet thickness, grades, and elevations shown, after light rolling and natural settlement. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil mixture.

C. Till soil in beds to a minimum depth of 8 IN and mix with specified soil amendments and fertilizers. Remove soil to a minimum depth of 8 IN and replace with prepared planting soil mixture.

3.06 EXCAVATION FOR TREES AND SHRUBS

A. Pits and Trenches: Excavate with vertical sides and with bottom of excavation slightly raised at center to assist drainage. Loosen hard subsoil in bottom of excavation.

1. Bare-Root Trees and Shrubs: Excavate at least 12 IN wider than root spread and deep enough to allow setting of roots on a layer of planting soil and with collar set at same grade as in nursery, but 1 IN below finish grade, unless otherwise indicated.

a. Setting Layer: Allow 3 IN of planting soil.

2. Balled and Burlapped Trees and Shrubs: Excavate approximately 1-1/2 times as wide as ball diameter and equal to ball depth, plus the following setting layer depth:

a. Setting Layer: Allow 3 IN of planting soil.

3. Container-Grown Trees and Shrubs: Excavate to container width and depth, plus the following setting-layer depth:

a. Setting Layer: Allow 3 IN of planting soil.

4. Where drain tile is shown or required under planted areas, excavate to top of porous backfill over tile.

B. Dispose of subsoil removed from landscape excavations. Do not mix with planting soil or use as backfill.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6 IN DIA holes into free-draining strata or to a depth of 10 FT, whichever is less, and backfill with free-draining material.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.

E. Fill excavations with water and allow to percolate out, before placing setting layer and positioning trees and shrubs.

3.07 PLANTING TREES AND SHRUBS

A. Set balled and burlapped stock plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.

1. Place stock on setting layer of compacted planting soil.

2. Remove burlap and wire baskets from tops of balls and partially from sides, but do not remove from under balls. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked or broken before or during planting operation.

3. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately 1/2 backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

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B. Set container-grown stock plumb and in center of pit or trench with top of ball raised above adjacent finish grades as indicated.

1. Carefully remove containers so as not to damage root balls.
2. Place stock on setting layer of compacted planting soil.
3. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately 1/2 backfilled, water thoroughly before placing re-mainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

C. Set bare-root stock on cushion of planting soil. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots. Remove injured roots by cutting cleanly; do not break.

1. Set collar 1 IN below adjacent finish grades, unless otherwise indicated.

D. Dish and tamp top of backfill to form a 3 IN high mound around the rim of the pit. Do not cover top of root ball with backfill.

E. Wrap trees of 2 IN caliper and larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures required before wrapping.

3.08 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by Architect, do not cut tree leaders; remove only injured or dead branches from flowering trees Prune shrubs to retain natural character. Shrub sizes indicated are size after pruning.

3.09 TREE AND SHRUB GUYING AND STAKING

A. Upright Staking and Tying: Stake trees of 2 through 5 IN caliper. Stake trees of less than 2 IN caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 IN below bottom of backfilled excavation and to extend at least 72 IN above grade. Set vertical stakes and space to avoid penetrating balls or root masses. Support trees with 2 strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

B. Guying and Staking: Guy and stake trees exceeding 14 FT and more than 3 IN caliper unless otherwise indicated. Securely attach no fewer than 3 guys to stakes 30 IN long, driven to grade. Attach flags to each guy wire, 30 IN above finish grade.

3.10 PLANTING GROUND COVER AND PLANTS

A. Space ground cover and plants as indicated.

B. Space ground cover and plants not more than 24 IN apart.

C. Dig holes large enough to allow spreading of roots, and backfill with planting soil. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

3.11 MULCHING

A. Mulch backfilled surfaces of planted areas and other areas indicated.

B. Weed-Control Barriers: Install the following weed-control barriers according to manufacturer's recommendations, before mulching. Completely cover area to be mulched, lapping edges a minimum of 6 IN.

1. Material and Seam Treatment: Composite fabric with seams pinned.

C. Organic Mulch: Apply the following average thickness of organic mulch and finish level with adjacent finish grades. Do not place mulch against trunks or stems.

1. Thickness: 3 IN.

3.12 HYDROSEEDING NEW LAWNS

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.

1. Mix slurry with nonasphaltic tackiefier.

2. Apply slurry uniformly to all areas to be seeded in a 1-step process. Apply mulch at the minimum rate of 1500 LB per acre dry weight but not less than the rate required to obtain specified seed- sowing rate.

3. Apply slurry uniformly to all areas to be seeded in a 2-step process. Apply first slurry application at the minimum rate of 500 LB per acre dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 LB per acre.

3.13 SODDING NEW LAWNS

A. Lay sod within 24 HRS of stripping. Do not lay sod if dormant or if ground is frozen.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within 2 HRS of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 IN below the sod.

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3.14 INSTALLATION OF EDGINGS

A. Wood Headers: Install wood headers or edgings where indicated. Anchor with wood stakes spaced up to 36 IN apart, driven at least 1 IN below top elevation of header or edging. Use 2 galvanized nails per stake to fasten headers and edging; length as needed to penetrate both members and provide 1/2 IN clinch at point. Predrill stakes when needed to avoid splitting.

B. Steel Edging: Install steel edging where indicated according to manufacturer's recommendations. Anchor with steel stakes spaced approximately 30 IN apart, driven below top elevation of edging.

C. Plastic Edging: Install plastic edging where indicated according to manufacturer's recommendations. Anchor with steel stakes spaced approximately 24 IN apart, driven through upper base grooves of edging.

3.15 INSTALLATION OF MISCELLANEOUS MATERIALS

A. Apply antidesiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.

1. When deciduous trees or shrubs are moved in full-leaf, spray with antidesiccant at nursery before moving and again 2 weeks after planting.

3.16 CLEANUP AND PROTECTION

A. During landscaping, keep pavements clean and work area in an orderly condition.

B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

3.18 SEED MIXTURES SCHEDULE

A. Refer to Landscape Plan for Seed Mixtures for each area.

END OF SECTION

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SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preparing and seeding of disturbed areas of roadbed slopes, ditch bottoms, and areas shown within the grading limits on the plans. Disturbed areas outside the grading limits shall be seeded at the contractor's expense.

2. This work shall consist of furnishing and placing seed, fertilizer and mulch in accordance with these Specifications at locations shown in the plans or designated by the Engineer.

1.02 MATERIAL REQUIREMENTS

A. Seeding, fertilizing and mulching shall be in accordance with the state DOT specifications. Rates of application and seed mixtures shall be based on location of construction and planting time of the year, subject to the approval of the Engineer. The Contractor shall coordinate with the UPRR Engineer as to when seeding shall be done.

B.

PART 2 - PRODUCTS

2.01 EQUIPMENT

A. General:

1. .

The Contractor shall furnish equipment in satisfactory working condition, and in sufficient quantity to perform the work as specified. The equipment shall be on the project site and approved by the Engineer before work on the corresponding item begins.

B. Grass Seed Drilling

1. Grass should be seeded with a grass drill equipped with double coulter furrow openers with depth bands and press wheels (preferred) or drag chains. Seed should be planted 1/4 to 3/4 inch deep.

C. Broadcast Seeding

1. In areas inaccessible to a drill, seed may be broadcasted. Broadcast seed must be covered by harrowing with spike tooth harrow, dragging a chain, raking or other suitable equipment. Seed shall be broadcast at a fifty percent (50%) or higher rate.

D. Corrugated Roller Seeder

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1. The seeder shall be equipped with corrugated roller wheels mounted on tandem axles. The roller wheels shall be spaced on approximately two inch (2") centers and shall place the seed at a depth of one-quarter inch (1/4") to one-half inch (1/2"). The seeder shall be equipped with two (2) separate planter boxes and planting mechanisms, which will plant clean, fine seed and large, chaffy seed simultaneously. The seeder shall weigh approximately one-hundred twenty-five to two-hundred fifty pounds per lineal foot (125-250 lbs./lineal ft.) of rolling width.

E. Hydraulic Hydro-Seeder

1. The seeder shall be capable of mixing and applying seed, commercial fertilizer, stabilizing emulsion and tackifiers, or any combination thereof, with fiber and water. Seeders shall have built-in continuous agitation system of sufficient operating capacity to produce and apply a homogeneous mixture.
2. This equipment shall be factory designed and built with sufficient pump capacity to apply specified quantities. The tank shall hold a minimum of one-thousand (1000) gallons and be equipped with a mechanical agitation system with an operating capacity sufficient to suspend and homogeneously mix the seed and water. The delivery hoses shall be big enough to prevent clogging and be equipped with spray nozzles that will provide even distribution on seeding areas.
3. The equipment shall be mounted on a traveling unit which may be either self-propelled or pulled, capable of getting the tank and nozzles within sufficient proximity of the area to be seeded without the wheels operating on the seeding area.

PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

A. Notice:

1. The Contractor shall notify the engineer at least 48 HRS in advance of the time he intends to begin work and shall not proceed with such work until permission to do so has been granted by the engineer.

B. Weather:

1. Seeding operations shall be performed only during the periods of favorable weather. Seeding shall not be done before or during hot, dry weather except by express permission of the engineer. No work shall be performed during excessively windy weather or when the ground is frozen, excessively wet or untillable.

C. Bed Preparation:

1. Not more than five days prior to the sowing of the seed, the seedbed shall be prepared by loosening the soil to a depth of not less than 2 IN by disking, harrowing, raking or by other approved means. Repeated disking, harrowing or similar means may be required to provide a satisfactory seedbed. Disking, harrowing and raking shall be longitudinal on all slopes. If needed, the seedbed shall be compacted.

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D. Weeding:

1. Existing weed stubble and small weeds shall be cut and partially incorporated into the soil during the seedbed preparation work. All other growth of vegetation that interface with seeding operations shall be removed.

E. Preserving Plants:

1. Extreme care shall be exercised to avoid injury to trees and shrubs that have been designated by the Engineer to be preserved.

F. Fertilizer:

1. Shall be uniformly applied to all areas requiring seeding.

G. Establishing Ground Cover

1. Contractor shall be responsible for establishing a minimum of 80% ground cover from the seed planted on all disturbed areas as determined by visual estimation of the Engineer. Reseeding or other measures may be necessary for the Contractor to meet this requirement, even if failure is due to weather. The Contractor shall submit aerial photography of the seeded area documenting the ground cover condition.

2. The Contractor shall remove silt fence when seeding is established.

3.02 PLANTING METHODS

A. General:

1. All seed shall be sown at the specified rate. When several species are specified and cannot be combined due to different characters such as size, weight, hulled, the seed shall be planted separately to obtain the specified seeding rates. Equipment shall not be operated on areas where rutting or slippage would mar the soil surface.

B. Methods:

1. Grass Drill Seeding Method:

a. The seed shall be planted with a grass seed drill conforming to Section 2.01 b 1. All drilling shall conform to the contour of area.

2. Hand Broadcasting Method:

a. Hand broadcasting shall not be used except in areas that are too small or inaccessible to accommodate the specified equipment.

3. Corrugated Roller Seeder Method:

a. The seed shall be distributed to conform to Section 2.01 d 1 which has been adjusted to accurately apply the proper amount.

4. Hydraulic and Hydro-Seeder Methods:

   a. The seeding shall consist of mixing and applying seed, commercial fertilizer and stabilizing emulsion, or any combination thereof, with fiber and water. The materials and quantities thereof to be mixed with water will be specified in the special provisions. The quantity of water shall be as needed for the application. Except that when stabilizing emulsion is specified, the ratio of total water to total stabilizing emulsion in the mixture shall be as recommended by the manufacturer of the emulsion, but shall not exceed 6 GAL of water for each 5 LBS of stabilizing emulsion solids specified. Tanks shall be of a size that is appropriate to the size of the seeding area.

3.03 METHODS OF MULCHING

A. The Contractor shall apply the protective mulch within 48 HRS after sowing the seed, unless otherwise directed by the engineer. The mulch shall be applied with mulch blowing machine or other approved methods.

B. Immediately following the spreading of the mulch on the seeding areas, the material shall be anchored to the soil by "Cat Walking" with a bulldozer, a V-type wheel land packer, a soil erosion mulch tiller, or other suitable equipment which will secure the mulch firmly to form a soil binding mulch, or by the use of a chemical tackifier.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Seeding will be measured by the ACRE as shown in the bid items. If the area is small, it may be measured in square yards.

4.02 PAYMENT

A. Payment for seeding will be at the contract unit bid per acre. Includes preparing the soil, purchasing and sowing of seed, mulching, fertilizing, tacking, watering, erosion protection and caring for the area until the contract is complete, or the growing season is over, or if placed late in the year, until the seed has germinated in the spring of the following year. Water used in connection with seeding is considered incidental to the job.

B. Final payment for seeding will be released when 80% ground cover has been established and aerial photography of the seeded area documenting the ground cover condition has been approved by the Engineer.

4.03 METHOD

A. The method of applying seed, emulsion, tackifier, water, equipment, and all things required in seeding shall be considered as included in the price for seeding.

B. If the method of seeding is not stated in the bid item or elsewhere in the Contract Documents, hydroseeding shall be the method used.

END OF SECTION

SECTION 33 01 50 - ABOVEGROUND PETROLEUM STORAGE TANK CLEANING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for cleaning Union Pacific Railroad's aboveground diesel fuel storage tanks.

B. The Contractor shall provide all project coordination, supervision, labor, materials, equipment and supplies necessary to clean the tanks. Specific information for each tank or group of tanks can be obtained from the Railroad.

C. The Work requires confined space entry and The Contractor shall certify his workers are properly trained in Confined Space Entry. Anyone entering the tank shall use appropriate personal protection and safety equipment.

1.02 REFERENCED STANDARDS

A. American Petroleum Institute (API):

1. 2015, Cleaning Petroleum Storage Tanks.
2. 2207, Preparing Tank Bottoms for Hot Work.

B. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1910.146, Permit Required for Confined Spaces.

1.03 SUBMITTALS

A. Submit copies of the following:

1. One (1) copy of written Confined Space Entry Program outlining procedures for preventing unauthorized entry, identifying and evaluating hazards, testing, and monitoring conditions, training, rescue, and safe entry. Confined space entry program shall meet the requirements of 29 CFR 1910.146.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 TANK ISOLATION

A. The Contractor shall provide all necessary materials and equipment to properly isolate the storage tank from the piping and power supply prior to beginning the Work. This may include the removal of valves and installation of blind flanges or other methods to ensure complete tank lockout.

B. Care shall be taken to ensure that all fuel spillage is properly contained and transported to the designated waste disposal location. The Contractor shall be responsible for the cost associated with the cleanup of all fuel spills.

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C. All fuel being transferred in this matter must be filtered using a ten (10) micron diesel fuel filter. It is the Contractor's responsibility to ensure the fuel filter is kept clean and operating per the manufacturer's specifications.

3.02 RECLAIMED FUEL TRANSFER

A. Before any fuel is transferred out of the tank, the Contractor shall stick the tank bottom to determine the approximate quantity of reclaimable fuel remaining in the tank and notify the Engineer.

B. The Contractor shall provide the necessary piping connections, pumps, meters, filters and other required equipment for transferring and filtering usable fuel left in the tank into a Railroad provided tank or other location as specified for each site.

C. All fuel being transferred in this manner must be filtered through a ten (10) micron diesel fuel filter. It is the contractor's responsibility to ensure the fuel filter is kept clean and operating per the manufacturer's specifications.

3.03 WASTE OIL REMOVAL

A. All "off-spec" diesel fuel and water remaining in the tank after acceptable fuel is recovered shall be considered waste oil. The Contractor shall collect the waste oil and dispose of as indicated on the Site Data Sheet.

3.04 SLUDGE REMOVAL

A. The Contractor shall collect and dispose of all bottom sludge as indicated on the Site Data Sheet.

B. The disposal method and location shall be acceptable to all Federal, State, and Local governing agencies, including the Environment Protection Agency (EPA), and meet current requirements of the Resource Conservation and Recovery Act of 1981 (RCRA).

3.05 CLEANING AND VAPOR FREEING

A. Cleaning of the tanks shall be conducted in accordance with the requirements of API Publication 2015 – Cleaning Petroleum Storage Tanks and publication 2207 – Preparing Tank Floors for Hot Work using high pressure steam or water.

B. The Contractor shall provide all toxicity tests, reports, labor, safety equipment, washing equipment, pumps, electrical power supply, and material and equipment necessary to clean interior tank surfaces and provide atmospheres suitable for cutting and/or welding to conduct API 653 tests.

C. If an internal tank lining is present, notify the Engineer and proceed with removing all loose liner material during tank cleaning. All tank wash water shall be collected by the Contractor and disposed of to the location as specified.

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D. The Contractor shall test for hydrocarbon vapors with an industry standard vapor indicator. The values obtained shall comply with the American Conference of Governmental Industrial Hygienists (ACGIH) and NFPA (National Fire Protection Association) standard 325M - Fire Hazard Properties of Flammable Liquids, Gasses, and Volatile Solids and NIOSH (National Institute for Occupational Safety and Health) published acceptable lower flammability limit (LFL). Vapor concentration shall be less than 10 percent of LFL.

E. Wash water shall be collected and transported to the designated disposal area as indicated on the Site Data Sheets.

F. The Contractor shall at all times have adequate fire extinguishing equipment and ventilation fans on hand and ready for use. The Contractor's employees shall properly extinguish cigars, cigarettes, and other smoking materials before entering the work area.

3.06 INSPECTION

A. The tank interior shall be free of oils, dirt, debris, and excess water at the bottom, in the sump(s), and a minimum of 8 FT-0 IN up the shell wall after cleaning.

END OF SECTION

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SECTION 33 01 51 - ABOVEGROUND PETROLEUM STORAGE TANK INSPECTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for "out-of-service" inspections of Union Pacific Railroad's API-650 aboveground fuel storage tanks located at various sites.

B. See the Tank Data Sheet to be provided by the Railroad for known information on specific tanks to be inspected.

1.02 REFERENCES

A. American Petroleum Institute (API):

1. 650, Welded Steel Tanks for Oil Storage.
2. 653, Tank Inspection, Repair, Alteration and Reconstruction.

B. American Society for Non-Destructive Testing, Inc (ASNT).

1.03 SUBMITTALS

A. Submit copies of the following:

1. One (1) copy of written Confined Space Entry Program outlining procedures for preventing unauthorized entry, identifying and evaluating hazards, testing and monitoring conditions, training, rescue and safe entry for both "Permit-Required" and "Non Permit-Required" confined spaces.
2. One (1) preliminary copy of inspection results or recommendations for items found NOT to comply with minimum API-653 standards. Results or recommendations shall be delivered or faxed to the engineer for review prior to demobilizing from the site.
3. Three (3) copies of the final inspection report shall be delivered within three (3) weeks after the inspection pit.

1.04 QUALITY ASSURANCE

A. Tank inspectors shall be certified in accordance with API-653 – Aboveground Storage Tank Inspection Certification and shall be knowledgeable with all governing regulations and codes concerning petroleum storage tanks. An ASNT Level II individual certified in the required testing methods shall supervise the on-site inspection. An ASNT Level III individual certified in the required testing methods shall review and approve all test results and sign all report documents.

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PART 2 - PRODUCTS

2.01 INSPECTION REPORT

A. A preliminary hand-written summary of the tank inspection shall be given or faxed to the Engineer prior to demobilizing from the site. This summary shall indicate conditions that preclude the tank from immediate service or that may limit continued service to less than ten (10) years, and recommendations for repairs.

B. In addition to the requirements of API-653, the final inspection report shall include be limited by, the following:

1. Inspection summary and recommendations for repairs (include nameplate data).
2. A general description of the inspected tank and all results of the visual inspection.
3. A complete schedule and location sketch of all tank equipment and nozzles which includes:
    a. Manufacturer, model number, serial number, and function of equipment.
    b. Size and location of equipment or nozzle.
4. Plan sketches and tables of the floor and roof showing thickness readings and their location.
5. Detail of floor showing internal elevations, edge settlement and external elevation readings.
6. Color pictures of equipment, inspection items and conditions such as:
    a. Tank equipment and accessories.
    b. Internal piping and gauge equipment.
    c. General pictures of internal floor and shell condition, and external shell and roof condition.
    d. Other notable inspection findings.

C. The report shall be spiral bound with a heavy plastic windowed cover and back. The first page shall have the Title, which includes the tank number (example TNKD-9805) and a picture of the tank façade.

D. Provide consecutive page numbering, a Table of Contents, and tabs required to make the report organized and easy to follow.

E. Pictures shall be printed or photocopied to standard letter sized paper (8.5 x11 IN) and bound within the report.

PART 3 - EXECUTION

3.01 INSPECTION

A. The Contractor shall inspect the interior and exterior of the out-of-service storage tanks, including all appurtenances, in accordance with API-653 – Tank Inspection, Repair, Alteration and Reconstruction.

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B. The inspection shall include, but not limited to, the following:

1. An exterior visual inspection of the tank to ascertain the apparent general condition of any foundation, shell deformation, paint condition, shell or shell appurtenance deterioration or other indication of a possible problem. Visual inspection shall also include 100 percent inspection of the shell-to-bottom weld to look for pitting, cracks, etc. and sump welds.
2. Interior visual inspection to ascertain the general condition of the internal gauging equipment, structural members, roof supports, shell appurtenances, sumps and coating system (if applicable).
3. Provide a 100 percent magnetic flux leakage inspection, to the extent possible, of floor plates to check for underside corrosion of tank bottom. Indicate areas which could not be scanned by equipment.
4. Ultrasonic Thickness Testing:
    a. The floor plates shall have a minimum of three (3) reading taken per plate. Location selected to provide a uniform distribution. In addition, areas that exhibit pitting or loss of material shall be scanned (B-scan, electronic "coupon") to determine the extent and magnitude of material loss.
    b. The shell plate readings are to be taken 6 IN above the floor, 36 IN apart and a minimum of three (3) points for each shell course along ladders or stairs. In addition, areas that exhibit pitting or loss of material shall also be tested for minimum plate thickness.
    c. Provide a minimum of three (3) ultrasonic reading per plate of the tank roof to document general roof integrity. The test sites to be selected to provide a uniform distribution or areas showing extensive deterioration.
5. Vacuum test all floor plate bottom welds, and other floor areas that exhibit excessive pitting.
6. Inspect level gauges, floats, and other accessible tank appurtenances such as manufacturer, model number, serial number, function, location of tank, etc.
7. Document all field information on all tank appurtenances such as manufacturer, model number, serial number, function, location on tank, etc.
8. Internal floor elevations shall be taken along the eight (8) radial lines (N, NE, E, SE, etc.) at an interval no more than 15 FT apart from the center to the shell.
9. External bottom extension elevations shall be taken along the eight (8) radial lines to check for external settlement.
10. External elevation readings along the shell to check for excessive edge settlement.

END OF SECTION

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SECTION 33 05 23 - PIPE UNDER CROSSING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Construction and placement of pipe and casings under railroad crossings.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. UPRR Contract Section.

B. Section 00 07 00 - General Requirements.

C. Section 31 24 13 - Roadway Excavation and Embankment.

D. Section 31 23 26 - Compaction Control and Testing.

E. Section 40 05 03 - Piping Materials and Methods – Steel Pipe.

1.03 SUBMITTALS

A. Shop Drawings

1. See Section 01 33 00.
2. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
    c. Compliance with submittal requirements of authority or agency having jurisdiction over undercrossing.

B. Operation and Maintenance Manuals:

1. See Section 01 33 00.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Casing Pipe:

1. Structural grade steel.
2. Minimum yield strength of 35,000 psi or greater as required by the permits.
3. Wall Thickness:
    a. Minimum of 1/4 IN or greater as required by permits
4. Diameter:
    a. Minimum of 4 IN or larger than outside diameter of the carrier pipe's jointing system

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PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. Install undercrossing to meet requirements of authority or agency having jurisdiction over the undercrossing.
2. Observe work requirements stipulated in any permit condition.
3. Consult Contract Drawings for limitation of construction Right-Of-Way.

B. Special Requirements:

1. If installation of crossing is by jacking or dry boring, the following will be required unless more requirements are specified by the authority or agency having jurisdiction over the crossing.
   a. Diameter of the hole:
      1) Not exceeding diameter of casing by more than 1-1/2 IN.
   b. Pressure grout all voids outside the casing, including abandoned or misaligned holes.
   c. Fill void between carrier pipe and casing wall with blow sand. Install watertight grouted plug minimum of 1 FT-0 IN deep at both ends.
   d. Undercrossing casing:
      1) Full lengths.
      2) Weld pressure tight.
   e. After casing is installed, band wood blocks 120 degrees apart to each length of carrier pipe to prevent displacement and pull pipe into place. Pipe must be straight and centered in casing when in place.
   f. Coordinate connections to system with authority or agency having jurisdiction over the crossing.

END OF SECTION

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SECTION 33 05 24 - PIPE BURSTING

PART 1 - GENERAL

1.01 SUMMARY

A. The Contractor and their Subcontractor(s) shall furnish all labor, materials, tools, equipment, and services for all pipe bursting applications as indicated in accord with Division 01 and the Contract Documents.

B. Coordinate and obtain permits from local utilities as required.

1.02 QUALITY ASSURANCE

A. The Contractor shall take reasonable care to avoid disturbing other utilities, structures and surface features. In the event that damage is sustained, the Contractor shall repair or replace, at the request of the Railroad or Owner of the damaged utility, those areas at the Contractor's expense.

B. The Contractor shall bear the costs of all excavations to relieve hydraulic pressure from adjacent structures, utilities, or to provide retrieval of pipe bursting equipment, either due to the course of work or accidental loss, equipment rental, or materials to prevent damage.

C. The Contractor shall submit shop drawings, technical data, or demonstrate to the satisfaction of the Engineer the process to be used during pipe bursting or pipe splitting operations.

1.03 SAFETY

A. The Contractor, Subcontractor(s), and their subordinate employees are required for follow all safety rules and regulations in accord with the Occupational Safety and Health Organization (OSHA) and Union Pacific Railroad (UPRR).

1.04 CONTRACTOR QUALIFICATIONS

A. The Contractor and their Subcontractor(s) shall have a minimum of five (5) years experience with pipe bursting technology.

B. The Contractor and their Subcontractor(s) shall provide verification of qualifications to the Railroad. The Contractor shall furnish background information on key personnel to allow the Railroad to ensure they have adequate experience.

1.05 CONSTRUCTION RECORDS

A. The Contractor shall keep and provide at the request of the Railroad, the Engineer, and their Representatives the following documents during the pipe bursting or pipe splitting process:

1. Pre-construction survey.
2. As-built conditions.
3. Construction Logs.

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4. Materials installed.
5. Extent and causes of delays.
6. Locations of effected areas.
7. Unusual problems or conditions encountered.

1.06 SUBMITTALS

A. Construction Documents:

1. The Contractor shall provide submittals that show the method of construction and restoration of existing service connections. These shall include:
   a. Detailed drawings and a written description of the entire construction procedure to install pipe, bypass flow, and reconnection to service connections.
   b. A methodology statement to explain the operation of all pipe bursting or pipe splitting equipment. Include details for:
      1) The bursting tool (based on technique used).
      2) The protective sleeve (if used).
      3) The winching unit.
   c. In the event a lubricant is used, any environmental implications regarding its use and migration away from the pipe alignment shall be brought to the attention of the Engineer or their representative.
   d. Material Safety Data Sheets (MSDS) on materials used during pipe bursting or pipe splitting operations.
2. The Contractor shall submit written information including shop drawings, technical reports and methodology reports explaining the temporary diversion for the pipeline. The Contractor shall verify the capacity and durability of pumps, pipes, hoses and all appurtenances are able to handle all necessary flows while the pipeline is out of service. Continuous service of connections to the line during the execution of the Work shall be the responsibility of the Contractor, including clean-up, repair and property damage cost and claims due to bypassing failures.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 CONSTRUCTION

A. Service Excavations:

1. The Contractor shall flush all pipes with water, to be collected at the end of the pipe run and remove and dispose of in a legal manner, all deleterious matter ejected.

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2. All service connections to be excavated and disconnected prior to pipe bursting. Temporary bypasses are to be installed to allow use of all service connections. Excavate above and below the pipe to reduce humps in main piping during the bursting.

B. Insertion and Reception Pits:

1. All pits should be prepared and shored in an approved manner. For all static rod and cable pull machines, the machine shall be properly braced to resist the horizontal force necessary for the bursting operation. This may require the pit or manhole to have a thrust block with proper structural capabilities. Inadequate structural capacity of the pit wall or thrust block to resist the pull or push forces can cause wall deformation or failure and surface heave near the wall. Sudden movements of jacking rigs, and cable pull systems can raise safety concerns for the contractor and bystanders.
2. For replacement of gas and water lines, service pits can be expanded and used for the insertion and reception pits.
3. After pipe bursting, the Contractor is to restore the connections to original or better condition.
4. Different pipe bursting systems have different requirements in terms of the space required in the reception pit. Some systems may be able to operate within existing manholes and others may need to excavate a pit for the pulling frame. The Contractor is to determine what pipe bursting method is to be used. At the end of the Project, the contractor is to restore existing manholes or fill reception pits to original or better condition.
5. The insertion pit must be large enough to allow the pipe to be inserted. For continuous HDPE pipes, this means that the pipe must be able to be fed from the surface into the existing pipe alignment without overstressing the pipe in bending. Manufacturer's guidelines on minimum bending radius need to be closely adhered to. Instead of creating a long insertion pit, it is sometimes possible to create a pipe entry path using an impact mole or similar device. This is then expanded using the pipe bursting expansion head and the pipe is fed though this new hole to the level of the pipe being replaced.
6. The Contractor is to apply all confined space safety procedures apply as appropriate. Entry and exit holes from existing manholes shall be enlarged to ensure the structural integrity of the manhole. The sewer manhole invert may need modification to allow tool passage. In cases of large upsize or when dealing with large diameter pipe, and where surface conditions allow, complete replacement of manholes may be the simplest and least expensive option. This also can be beneficial in that a complete new system results.

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C. Equipment Installation:

1. When the winch and pulling cables are used to pull the bursting tool though the pipe, the winch is placed in a reception pit, and the cable pulled through the pipe and attached to the front of the bursting unit in an insertion pit. The winch helps to ensure the directional stability in keeping the unit on the line of the existing pipe. The winch must supply sufficient cable in one continuous length so that the pull may be continuous between winching points. The winch, cable and cable drum shall be provided with a safety cage and supports so that it may be operated safely without injury to persons or property.
2. When rigid pulling rods are used instead, they are threaded from the reception pit through the existing pipe until the pipe insertion is reached. The rods are then attached to the bursting head.
3. Equipment used to perform the work shall be located away from buildings so as not to create noise impact. Provide a silent engine compartment with the winch to reduce machine noise as required to meet local requirements.
4. Lubrication may be used as recommended by the manufacturer. Under no circumstances shall the pipe be stressed beyond its elastic limit.

D. Reconnection of Services and Annular Space Sealing:

1. The newly installed pipe shall be left to cool for the manufacturer's recommended time, however not less than 4 HRS, prior to any reconnection of service lines, sealing of the annular space in the manhole wall or backfilling of the insertion pit.
2. Following the relaxation period, the annular spaces in the manhole wall shall be sealed. Sealing is extended a minimum of 8 IN into a manhole wall in such a manner as to form a smooth, watertight joint. Ensuring a proper bond between the PVC or PE pipe replacement pipe and the poured manhole wall joint is critical.
3. Service connections can be reconnected to the new pipe with specially designed fittings by various methods. The saddles, made of a material compatible with that of the pipe, are connected to the pipe to create a leak-free joint. Different types of fused saddles (electrofusion saddles, conventional fusion saddles) are installed in accordance with manufacturer's recommended procedures. Connection of new service laterals to the pipe also can be accomplished by compression-fit service connections. Installation procedures and equipment are to follow manufacturer's installation instructions. After testing, and inspection to ensure that the service meets all required specifications of the service line, the pipeline returns to service.

E. TESTING OF THE REPLACEMENT PIPE

1. All replacement pipe shall be pressure tested after installation to ensure proper installation. In accordance with Section 40 05 03 Subsection 3.04, Paragraph C, Pressure Piping Pneumatic/Soap Test. Pressure test to be performed before and after lateral connections are restored.

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2. If pressure testing cannot be performed, the Contractor shall provide closed circuit television inspection as a post-production method to determine if the pipeline has been installed as required and all joints have been properly finished.
    a. CCTV system shall have a rotating lens camera with an articulating head. Each joint shall be scanned360 degrees.
    b. The camera shall operate in 100 percent humidity conditions.
    c. Lighting for the camera shall minimize relative glare.
    d. Lighting and camera quality shall be suitable to a provide clear, in-focus picture of the entire periphery of the pipe for all conditions encountered during the Work.
    e. Focal distance shall be adjustable through a range from 3 IN to infinity.
    f. The remote reading footage counter shall be accurate to 1 percent over the length of the particular section being inspected.
    g. The camera, television monitor, and other components of the color video system shall be capable of producing a minimum of 350 line resolution.
    h. Documentation consisting of color video tape and a written report detailing the condition of the mainline and joints shall be submitted to the Engineer for approval prior to final payment.

END OF SECTION

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SECTION 33 05 25 - HORIZONTAL DIRECTIONAL DRILLING

PART 1 - GENERAL

1.01 PREFACE

A. The American Railway Engineering and Maintenance-of-Way Association (AREMA) has assigned a working committee to develop a recommended railroad industry practice for Horizontal Directional Drilling (HDD – hereafter) under railroad Rights-of-Way. These interim guidelines are issued by the Union Pacific Railroad (UPRR) pending completion of the AREMA recommended practice, at which time UPRR will review and determine whether to adopt it.

1.02 SCOPE

A. All pipelines proposed for installation under UPRR Right-of-Way and trackage using HDD. Fiber optics installation under the jurisdiction of the UPRR Information Technologies (IT) Department with 10 IN or smaller diameter casing pipe shall follow the guidelines outlined in the current version of the "Fiber Optic Engineering, Construction and Maintenance" Standard Manual.

1.03 DIRECTIVES

A. For all liquid or gas pipelines, only steel pipe may be installed under tracks or UPRR Right-of-Way utilizing HDD. The pipe may be used as a carrier pipe or a casing pipe. Plastic carrier pipe, if used, must be installed in a steel casing.

B. For fiber optics (not under the jurisdiction of UPRR IT Department) or electrical installations, plastic (PVC or HDPE) pipe may be used as a conduit.

C. For all liquid or gas installations or for nominal pipe sizes exceeding 6 IN DIA, minimum cover (measured from base of rail to top of pipe) shall be 2 FT-6 IN regardless of product. For fiber optics or electrical installations, with casing/conduit nominal size of 6 IN or less, minimum cover shall be per Specification Division 26. Applicant submittal shall include actual planned depth of pipe under each railroad track.

D. Applicant must provide pipe specifications. Pipe must specify AREMA recommendations and all applicable government and industry regulations.

E. Applicant must provide qualifications of drilling contractor including specific instances of previous successful experience in drilling under sensitive surface facilities.

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1.04 PRE-DRILLING REQUIRMENTS

A. The contractor must submit an Installation Plan that describes the anticipated rig capacity, the proposed equipment and the method for advancing the borehole though expected soil conditions, angles, depth and exact location of the exit ditch, the pilot hole diameter, the proposed reaming plan, including the number and diameter of pre-reams/back-reams and the diameter of the final reamed borehole, and contingency equipment and plans for dealing with soil conditions that a soil engineer could reasonably expect to be encountered at the proposed HDD installation site. The Installation Plan will also address the anticipated hours of operation during the HDD borehole drilling and installation process, the minimum number of personnel and their responsibilities on-duty and on-site during all HDD drilling operations.

B. The Contractor must provide a detailed Fracture Mitigation (frac-out) Plan including method of monitoring and capturing the return of drilling fluids with particular attention to prevention of inadvertent escape of drilling fluids where they could undermine the railroad tracks.

C. Establish a Survey Grid Line and provide a program of monitoring and documenting the actual location of the borehole during drilling operations.

1.05 RIGHT-OF-WAY SAFETY REQUIREMENTS

A. A railroad observer and an applicant inspector are required to monitor the ground, ballast, and track for movement during the drilling, reaming, and pullback processes. All work within the Railroad Right-of-Way must be coordinated with the Railroad Flagger. The installation process and all train movement must be immediately stopped if movement is detected. The damaged area must be immediately stopped if movement is detected. The damaged area must be immediately reported to the Railroad and immediately repaired subject to Railroad review and approval. The installation process must be reviewed and modified as required before the installation may proceed. Applicant must pay Railroad's expenses for review, observation of installation and flagging.

B. Upon completion of the HDD installation work, the contractor shall provide an accurate as-built drawing of the installed HDD segment. As-built drawings will include both horizontal and profile plans.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 33 05 26 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Identification and labeling of above ground piping, valves and equipment, ductwork, above ground tank connections, and above ground storage tanks.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 09 90 01-Painting and Coatings

B. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

1.03 REFERENCED STANDARDS

A. ASME A13.1 - Scheme for the Identification of Piping System.

B. UPRR Fuel Standard 003-16 – AST Labeling

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

C. Shop drawings required by this Section include, but are not limited by, the following:

1. Schedule of pipe;

2. Tank and valve label designations.

D. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

E. Submit list of wording, symbols, letter size, and color coding for mechanical identification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Allen Systems, Inc.

2. Brimar Industries, Inc.

3. Brady (W.H.) Company, Signmark Division.

4. Industrial Safety Supply Company, Inc.

5. Seton Name Plate Corp.

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6. Craftmark Identification Systems.
7. Approved Equal.

2.02 IDENTIFICATION

A. Aboveground Piping:

1. Color: Conform to ASME A13.1.
2. Provide product identification as listed in this section for all aboveground piping. Paint and stenciled lettering, or metal tags with stamped 1/4 IN minimum letter height. Secure tags with chains which are suitable for the environment.
3. For piping or pipe covering with an outside diameter of less than 3/4 IN, provide metal tags with stamped 1/4 IN minimum letter height. Secure tags with chains which are suitable for the environment.
4. Label the containment pipe of double wall piping per the carrier pipe contents.
5. The length of the color field and the letter size as listed in this section.
6. Color shall conform to ASME A13.1.

B. Underground Piping:

1. Underground Pipe Marker Tape: Bright colored plastic ribbon tape, minimum 6 IN (150 mm) wide by 4 mil (0.10 mm) thick, continuously imprinted to indicate piping service, manufactured for direct burial service.
2. Underground Metallic Detection Tape: Bright colored plastic ribbon tape, minimum 6 IN (150 mm) wide by 4 mil (0.10 mm) thick, metallic film bonded to tape, continuously imprinted to indicate piping service, manufactured for direct burial service.

C. Valves and Equipment:

1. Provide 19-gage (1-1/2 IN) polished brass valve tags with stamp-engraved piping system abbreviation in 1/4 IN high letters and sequenced valve numbers 1/2 IN, and with a 5/32 IN hole for fastener.
2. Equipment shall be identified with paint stencil or other approved method with designation as shown on drawings, or as directed by engineer.

D. Ductwork:

1. Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to ANSI A13.1 color code.
2. Nomenclature: Direction of air flow, Duct service (supply, return, exhaust, etc.).

E. Aboveground Tank Connections:

1. Paint and stencil lettering as indicated on drawings.
2. Legend designation shall be upper case, block type letters with appropriate background color.

F. Aboveground Tanks:

1. Tank labeling including NFPA Hazardous Material identification shall be per UPRR Fuel Standard 003-16-AST Labeling..

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G. Caution Signs:

1. Aluminum, 0.04 IN (1.0 mm) thick, baked enamel finish; plastic face bonded to 20 gauge galvanized steel backing.
2. Minimum size: 10 IN (250 mm) wide by 7-inch (175 mm) high. Heading: "CAUTION"; In yellow letters on black background.

H. Oxy-Acetylene System Signage:

1. Signage shall meet the requirements of NFPA 51.
2. Oxygen manifold:
   a. The following sign shall be conspicuously posted at each manifold:

LOW-PRESSURE MANIFOLD —
DO NOT CONNECT
HIGH-PRESSURE CYLINDERS.
MAXIMUM PRESSURE — 350 PSIG.

   b. Gages on oxygen regulators shall be marked "USE NO OIL."
3. Station outlets shall be clearly marked to indicate the name of the gas in the connected pipe.
4. Signs clearly establishing the location and identity of section shutoff valves shall be provided.
5. Piping shall be painted and labeled in accordance with this Specification.

I. Systems to be identified include, but are not limited by, the following:

Product/System	**Label Wording**	**Color of Pipe**	**Color of Letters**
Diesel fuel (DF)	DIESEL FUEL	White	Black
Industrial water (IW)	INDUSTRIAL WATER	White	Black
Retention Tank	RETENTION TANK	White	Black
Soap (SO)	SOAP	White	White/ Color field: Green
Compressed air (CA)	COMPRESSED AIR	Blue	White
Potable water (PW)	POTABLE WATER	Green	White
Domestic Cold Water (DCW)	DOMESTIC COLD WATER	Green	White
Domestic Hot Water (DHW)	DOMESTIC HOT WATER	Yellow	Black
Domestic Hot Water Recirculating (DHWR)	DOMESTIC HOT WATER RECIRCULATING	Yellow	Black
Sanitary Sewer (SAN)	SANITARY	Yellow	Black
Vent (V)	VENT	Yellow	Black

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Product/System	Label Wording	Color of Pipe	Color of Letters
Natural Gas (G)	NATURAL GAS	Yellow	Black
Acetylene (ACT)	ACETYLENE	Yellow	Black
Non-Potable water (NPW)	NON-POTABLE WATER	Green	White
Tempered water (TW)	TEMPERED WATER	Green	White
Radiator water (RW)	RADIATOR WATER	Green	Black
Toilet waste vacuum (TWV)	TOILET WASTE VACUUM	Green	Yellow
Oxygen (OX)	OXYGEN	Green	White
Lube oil (LO)	LUBE OIL	Gray	Black
Compressor oil (CO)	COMPRESSOR OIL	Gray	Black
Journal oil (JO)	JOURNAL OIL	Gray	Black
Drain/Used oil (DO)	DRAIN OIL	Gray	Black
Reclaim oil (RO)	RECLAIM OIL	Gray	Black
Toilet Fill/Toilet chemical (TC)	TOILET CHEMICAL	Yellow	Black
Fire protection water (FW)	FIRE PROTECTION WATER	Red	White
Fire protection foam (AFFF)	FIRE PROTECTION FOAM	Red	White

Note: If piping is insulated, use colored band over insulation.

J. The length of the color field and the letter size:

Pipe or Outside diameter	Length of Color field	Size of Letters
3/4 to 1 1/4 IN	8 IN	1/2 IN
1 1/2 to 2 IN	8 IN	3/4 IN
2 1/2 to 6 IN	12 IN	1 1/4 IN
8 to 10 IN	24 IN	2 1/2 IN
Over 10 IN	32 IN	3 1/2 IN

2.03 FLOOR STRIPING / PHYSICAL HAZARDS

A. A safety yellow stripe shall be used to mark physical hazards such as striking against, stumbling, falling, tripping and "caught-between". These include building columns in areas of forklift usage, edges of elevated platforms, nosing of stair treads, equipment pits, and projection into a walk/work area or other area where a person needs to be warned of a possible hazard.

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B. In an area with a moving hazard, the entire involved area should be provided with border and diagonal stripping. The width of the stripe to be determined by intent of warning. Recommended is a minimum 4 IN stripe for most instances with 1 to 2 IN for stair tread nosing.

C. Items such as pipe bollards, handrails, building or structural columns shall be painted safety yellow.

D. Building or structural columns shall be painted safety yellow to a height of 10 FT off of finished floor.

E. Walkways shall be painted with a 4 IN white border with 4 IN diagonal stripes.

2.04 CAUTION SIGNS

A. Aluminum, 0.04 IN (1.0 mm) thick, baked enamel finish; plastic face bonded to 20 gauge galvanized steel backing.

B. Minimum size: 10 IN (250 mm) wide by 7 IN (175 mm) high. Heading: "CAUTION"; In yellow letters on black background.

PART 3 - EXECUTION

3.01 PREPARATION

A. Clean surface to receive label or paint. Surface must be free of oil, grease, dust, dirt, or other substances which would affect adhesion. Refer to Section 09 90 01 for surface preparation and painting requirements.

B. Install label or stencils only after coating system is complete and dry.

C. Stencils shall be carefully applied and removed to insure a neat and legible legend.

3.02 LOCATIONS

A. Locate piping labels and banding on piping near connections to equipment, on both sides of wall or grade penetrations, at intervals not to exceed 50 FT. Legends shall be visible from normal line of vision.

B. Identify all mechanical equipment shown on Drawings or specified in this Division, including but not limited to the following:

1. Pumps.
2. Plumbing equipment.
3. Air compressors.
4. Air dryers.
5. Compressed air pressure regulators.
6. Refrigerant compressors and condensers.
7. Furnaces.
8. Unit heaters.
9. Fans.

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10. Control dampers.
11. Fire or smoke dampers.
12. Thermostats.
13. Control panels and switches."

3.03 CAUTION SIGN INSTALLATION

A. Install with corrosion resistant mechanical fasteners.

B. Provide signs printed with the message "EMERGENCY EQUIPMENT - DO NOT CLOSE VALVE" where indicated on Drawings and at the following locations:

1. Shut-off valves on water supply to emergency showers and emergency eye wash stations.

3.04 TAG INSTALLATION

A. Install tags with self-locking nylon ties or zinc plated steel jack chain.

B. Use tags to identify mechanical equipment or components that are too small or have surfaces that prevent secure nameplate installation, including but not limited to the following:

1. Control valves.
2. Isolation valves.
3. Control devices.
4. Instrumentation devices.

3.05 EQUIPMENT IDENTIFICATION

A. All equipment such as controls, relays, gauges, etc.; and handling units, pumps, water heaters, air compressors, air dryers, compressed air pressure regulators, refrigerant compressors and condensers, unit heaters, supply fans, fire dampers, control panels and switches, thermostats, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas. Provide tags for all mechanical equipment and components that are too small or have surfaces that prevent secure nameplate installation such as control valves, isolation valves, control devices, and instrumentation devices.

1. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4 IN minimum letters on light contrasting background.
2. Aluminum Nameplates: Black enamel background with natural aluminum border and engraved letters furnished with two mounting holes and screws.
3. Plastic Tags: Minimum 1-1/2 IN square or round laminated three-layer phenolic with engraved, 1/4 IN minimum black letters on light contrasting background.
4. Brass Tags: Brass background with engraved black letters. Tag size minimum 1-1/2 IN square.

B. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.

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C. Mechanical equipment shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of Standard 90.1.

END OF SECTION

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SECTION 33 31 20 - SANITARY LIFT STATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sanitary lift stations.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to Work of this section.

1.03 REFERENCED STANDARDS

A. UL and NEMA Compliance: Provide electric motors and components which are listed and labeled by Underwriters Laboratories and comply with NEMA standards.

1.04 SUMBMITTALS

A. Submit as specified in Section 01 33 00 - Submittals and Substitutions.

B. Product Data: Submit manufacturer's pump specifications, installation and start-up instructions, and accurate pump characteristic performance curves with selection points clearly indicated.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to pumps. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Maintenance Data: Submit maintenance data and parts lists of each type of pump, control, and accessory, including troubleshooting maintenance guide. Include this data, product data, and wiring diagrams in maintenance manual in accordance with requirements of Division 01.

PART 2 - PRODUCTS

2.01 SANITARY WASTE GRINDER PUMPS

A. General: Provide complete duplex submersible grinder type sanitary type lift pump station capable of pumping sanitary sewage from the support building and waste vacuum station, of size and capacity indicated on the drawings. Manufacturer of the duplex grinder type sanitary lift pump station shall include duplex submersible type pumps, movable breakaway fittings with stainless steel guide rails, stainless steel pump brackets, stainless steel pipe nipples, stainless steel elbows, stainless steel hardware with cast iron check valves, lifting cables, level controls, NEMA-3R duplex control panels and fiberglass basin. Grinder type sanitary lift pump station shall be furnished as a complete factory assembled package.

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B. Pump: Unit shall be submersible, grinder, vertical discharge design. Volute shall be cast iron ASTM A48, Class 30.

C. Impeller: Ten (10) Vane vortex with pump out vanes on back side, dynamically balanced, ISO G6.3, 85-5-5-5 bronzecast iron ASTM A48, class 30 impeller.

D. Shredding Ring: Shall be hardened 440C stainless steel, Rockwell C-55.

E. Cutter: Shall be hardened 440C stainless steel, Rockwell C-55.

F. Seal Plate: Cast iron ASTM A48, class 30.

G. Shaft: Type 416 stainless steel shaft.

H. Square Rings: Buna-N.

I. Seal: Tandem mechanical, oil-filled reservoir. The rotating face shall be carbon and stationary face shall be ceramic. The elastomer shall be Buna-N. The hardware is to be 300 stainless steel.

J. Motor: Motor shall be NEMA B – Single phase torque curve, completely oil filled, squirrel cage induction with class B insulation, dual-voltage, 208/230 VAC, single-phase, 3450 RPM. Upper bearing shall be single row, ball bearing, oil lubricated, radial and thrust load. Motor housing shall be cast iron ASTM A48, class 30. Motor provided with moisture sensor, temperature sensor, and 25 FT-0 IN long power cord, pressure grommet for sealing and strain relief.

K. Basin: The basin for Sanitary Lift Stations shall be constructed of fiberglass. Sized for (see drawings for basin depth) duplex pump installation with 3 IN ballast support flange, stainless steel discharge hub, adapter/inlet hub, steel cover with black asphalt coating, 3 IN bug-free vent, lockable hinged access door, with stainless steel hinges and hardware.

L. Rail Guide System: 304 stainless steel "C" channel.

M. Breakaway Fitting: Heavy duty, cast iron stationary.

N. Junction Box: NEMA 6 rated with cable grips for direct burial cable.

O. Ball Valves: PVC full port design, true union. Supply with 3/8 IN DIA stainless steel extension handles.

P. Movable Sub-Assembly – including the following items:

1. Check Valve – Cast iron body with plug, natural rubber ball.
2. Pump brackets – Shall be 304 stainless steel.
3. Movable – Cast iron.
4. Discharge Piping – Stainless steel.
5. Level controllers – pressure switch level controllers to automatically cycle pumps on, off, and provide high level alarm position.

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6. Control panel – Furnish and install one complete duplex pump control panel in a NEMA 3R rated enclosure. The panel to provide short circuit protection and line disconnect. The panel shall incorporate circuit breakers with through inner door operating handles, tamper-proof door, inner door, run lights, start delays, and magnetic starters with ambient compensated quick trip overloads, alternator, and HOA selector switches, 115 volt control transformer with fused secondary aodn on winding thermal overloads in series with contractor coils, moisture sensor relays with warning lights, temperature sensor relays, with warning lights, and high-level and alarm bell with silencer.

Q. Available Manufacturers – Subject to compliance with requirements, manufacturers offering submersable type sump pumps which may be incorporated in the work include, but are not limited to:

1. ABS, Inc.
2. Barnes Pump, Inc.
3. Myers Pumps, Inc.
4. Weil Pump Co.
5. Weinman Pump LFE Corp.; Fluids Control Division.

PART 3 - EXECUTION

3.01 INSTALLATION OF PUMPS

A. General – Install pumps where indicated on drawings, in accordance with the manufacturer's published installation instructions, complying with recognized industry practices to ensure that pumps comply with requirements and serve intended purposes.

B. Support – Install pumps with anchor bolts poured in place. Set and level pump, grout under pump with non-shrink grout.

C. Electrical Wiring – Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagrams submittal to the Electrical Installer.

END OF SECTION

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SECTION 33 37 17 - ABOVE GROUND WEIR BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Design, fabrication, and installation of a single-wall reinforced polyester fiberglass weir box. The weir box well be used to measure water flow.
2. Weir box shall be approximately 40 IN long by 16 IN wide by 16 IN deep.

B. Box shall be manufactured of 100 percent resin and glass-fiber reinforcement, with no sand fillers and no exposed glass fibers.

1.02 REFERENCED STANDARDS

A. Manufacturer shall be able to provide documentation that the weir box has been built to the requirements of Underwriters Laboratories Standards.

1.03 SUBMITTALS

A. Submit as specified in Division 01.

B. Shop drawings required by this Section include, but are not limited by, the following:

1. Weir box and plate including all accessories and appurtenances.
2. Calibration chart indicating the water height and gallons per minute of flow.

1.04 QUALITY ASSURANCE

A. Box manufacturer shall be in the business of manufacturing weir boxes and weir plates.

PART 2 - PRODUCTS

2.01 FIBERGLASS WEIR BOX AND WEIR PLATE

A. Weir Box Requirements: Box to be molded in one piece of reinforced polyester fiberglass with 1/4 IN minimum wall thickness. Wetted surfaces shall have smooth white gel-coat finish; exterior surfaces shall have a gel-goat finish for UV protection and reinforcing ribs to prevent distortion during shipment, installation and operation. Weir box shall be self supporting and require no external supporting structure during installation and operation. There shall be provided anchor clips permanently attached to the weir box exterior. Clips shall have holes for securing weir box to foundation.

B. Inlet and Outlet Connections: There shall be provided an inlet and outlet connection at each end of the weir box. The connections shall be fiberglass flat face pipe flanges for 4 IN line size with a bolt circle and diameter to match standard 125 LB flange dimensions.

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C. Weir Plate: The box shall be supplied with a V Notch weir plate. The weir plate shall have a notch angle of 45 degrees and a notch depth of 6 IN for a 50 GPM flow rate. The weir plate shall be fabricated from 304 stainless steel. The plate shall have a minimum thickness of 1/4 IN with a smooth upstream face and reinforcing on the downstream side as required. The V Notch stainless steel weir plate shall be a machined notch with a sharp upstream face and the notch shall be at a 90 degree angle with respect to the upstream face of the plate. The notch shall have a 1/16 IN long bevel, and a downstream chamfer of 45 degrees. The weir box shall be supplied with an angle with holes drilled to match those of the weir plate to allow mounting of the plate.

D. Depth Gauge: There shall be supplied with the weir plate a 316 stainless steel depth gauge to be mounted upstream of the weir plate at a distance at least 3 times the depth of the weir notch. The gauge shall be supplied with elongated holes to allow the elevation of the gauge to be adjusted up or down 1/4 IN. The gauge shall be set at an elevation such that the gauge zero is exactly even with the bottom of the weir plate's V Notch. The depth markings on the gauge shall be laser cut through the gauge for long term durability. The markings shall be in units of feet by 1/10th and 1/100th of a foot.

2.02 WEIR BOX ACCESSORIES

A. Riser: Weir box shall have a 12 IN DIA by 24 IN tall riser section with bolt down top and a 304 stainless steel 3/4 IN NPT connector for transducer wiring.

B. Ultrasonic Transducer Mounting Bracket: There shall be supplied with the weir box, an elevation adjustable bracket fabricated from 316 stainless steel piping and fittings with a 1 IN female NPT connector for the transducer. All fasteners shall be stainless steel.

C. Lid: Weir box shall have a fiberglass hinged lid with a stainless steel handle and stainless steel hinges to cover box upstream of riser section.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Weir box shall be installed according to manufacturer's current installation instructions.

END OF SECTION

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SECTION 33 39 13 - MANHOLES AND COVERS FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Modular precast concrete manhole sections for sanitary sewer application with tongue-and-groove joints, covers, anchorage, and accessories. Manholes for electrical application are not covered in this section.

B. This section does not apply to the construction of mainline and/or yard track projects.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 45 00 - Quality Assurance and Control.

C. Section 03 20 00 - Concrete Reinforcement.

D. Section 03 30 00 - Cast-In-Place Concrete.

E. Section 31 23 24 - Backfill.

1.03 REFERENCED STANDARDS

A. ASTM A48 - Gray Iron Castings.

B. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

C. AASHTO HS20-44.

D. OSHA - CFR 29.

1.04 SUBMITTALS FOR REVIEW

A. Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate manhole locations, elevations, piping, sizes and elevations of penetrations, and installation details.

C. Product Data: Provide manhole covers, component construction, features, configuration, dimensions, and accessories.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years experience.

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PART 2 - PRODUCTS

2.01 MATERIALS

A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478. Minimum concrete strength: 5,000 LBS/SQ IN. Use joint sealant as provided and instructed by Manufacturer to make manhole watertight.

2.02 COMPONENTS

A. Lid and Frame: Cast iron construction, machined flat bearing surface, removable lid with a Type I pick hole; AASHTO HS20-44 load rating; lid molded with "SANITARY SEWER" or other appropriate utility lettering on top surface.

B. Manhole Steps: Non-corrosive steps of rubber encased steel or galvanized steel, installed to withstand 400 LBS vertical load and 1,000 LBS pullout. Place steps to allow access straight down one wall of manhole. Steps shall comply with OSHA requirements for fixed ladders.

C. Pipe Penetration Sealing: Positive seal gasket system as manufactured by Press Seal Gasket Corporation.

2.03 CONFIGURATION

A. Shaft Construction: Concentric with eccentric cone top section; lipped male/female joints; blockouts to receive pipe of size and location shown on drawings. Use precast concrete adjusting rings to attain grade elevation if necessary. Limit height of adjusting rings to 12 IN.

B. Shape: Cylindrical, with integral precast concrete base.

C. Clear Inside Dimensions: 48 IN DIA.

D. Design Depth: As indicated.

E. Clear Lid Opening: 26 IN DIA.

F. Pipe Entry: Provide openings sized and located for pipes as indicated on drawings.

G. Floor Concrete: 5,000 LBS/SQ IN concrete mix, using pea gravel aggregate.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify items provided by other sections of work are properly sized and located.

B. Verify that built-in items are in proper location and ready for roughing into work.

C. Verify excavation for manhole is correct.

3.02 PREPARATION

A. Coordinate placement of inlet and outlet pipe.

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3.03 PLACING MANHOLE SECTIONS

A. Excavate to subgrade as indicated. Verify that subgrade is stable. Compact subgrade. Protect excavation from water damage during construction.

B. Place and compact 6 IN thickness of well-graded crushed stone with maximum 6 percent fines beneath manholes and structural fill around the sections, in maximum 6 IN lifts, to 98 percent Standard Proctor.

C. Accurately place manhole base section to line and grade. Install subsequent sections with sealant to form watertight joints.

D. Install pipes as indicated.

E. Invert Channels: Formed in fresh concrete floor, smooth and semi-circular to conform to pipes; large radius turns. Slope floor to channels between 1 and 2 IN/FT. Broom finish floor.

F. Backfill around manhole in 6 IN lifts, compacting to 98 percent Standard Proctor. Use pipe embedment material to elevation 6 IN above top of pipes. Clean excavated material may be used to within 6 IN of finish grade. Use topsoil up to finish grade unless manhole is located beneath paved area. Insure that final grade will slope away from manhole cover.

END OF SECTION

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SECTION 33 40 10 - STORM DRAINAGE FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Encasement for piping.
3. Manholes.
4. Cleanouts.
5. Non-pressure transition couplings.
6. Expansion joints.
7. Stormwater inlets.
8. Pipe outlets.

B. This section does not apply to the construction of mainline and/or yard track projects.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated.
2. Shop Drawings:
   a. Manholes: Include plans, elevations, sections, details, frames, and covers.
   b. Stormwater Inlets: Include plans, elevations, sections, details, frames, covers, and grates.

1.03 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.01 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A74, Service class.

B. Gaskets: ASTM C564, rubber.

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C. Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2.02 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A888 or CISP 301.

B. Heavy-Duty, Shielded Couplings:

1. Description: ASTM C1277 and ASTM C1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

2.03 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

A. Pipe: ASTM A 716, for push-on joints.

B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153, for push-on joints.

D. Gaskets: AWWA C111, rubber.

2.04 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

2. Soiltight Couplings: AASHTO M252M, corrugated, matching tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M294M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

2. Soiltight Couplings: AASHTO M294M, corrugated, matching pipe and fittings.

2.05 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:

1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.

2. Fittings: ASTM F949, PVC molded or fabricated, socket type.

3. Gaskets: ASTM F477, elastomeric seals.

2.06 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C76.

1. Bell-and-spigot ends and gasketed joints with ASTM C443, rubber gaskets.

2. Class III for all pipe 42 IN and smaller.

3. Class IV for all pipe 48 IN and larger.

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2.07 NONPRESSURE TRANSITION COUPLINGS

A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion- resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C443, rubber.
2. For Cast-Iron Soil Pipes: ASTM C564, rubber.
3. For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
4. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Shielded, Flexible Couplings:

1. Description: ASTM C1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.08 EXPANSION JOINTS

A. Ductile-Iron Flexible Expansion Joints:

1. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250 psig minimum working pressure and for offset and expansion indicated.

2.09 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

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2.10 ENCASEMENT FOR PIPING

A. Standard: ASTM A674 or AWWA C105.

2.11 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 IN minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6 IN minimum thickness for floor slab and 4 IN minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4 IN minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps; FRP ladder; or ASTM A615/A615M, deformed, 1/2 IN steel reinforcing rods encased in ASTM D4101, PP wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12 to 16 IN intervals.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6 to 9 IN total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24 IN ID by 7 to 9 IN riser with 4 IN minimum width flange and 26 IN DIA cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.12 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:

1. Cement: ASTM C150, Type II.
2. Fine Aggregate: ASTM C33, sand.

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3. Coarse Aggregate: ASTM C33, crushed gravel.
4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A185/A185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
a. Invert Slope: 2 percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
a. Reinforcing Fabric: ASTM A185/A185M, steel, welded wire fabric, plain.
b. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

2.13 STORMWATER INLETS

A. Curb Inlets: Made with vertical curb opening of materials and dimensions according to utility standards.

B. Gutter Inlets: Made with horizontal gutter opening of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

C. Combination Inlets: Made with vertical curb and horizontal gutter openings of materials and dimensions according to utility standards. Include heavy-duty frames and grates.

2.14 PIPE OUTLETS

A. Head Walls: Reinforced concrete, with apron and tapered sides.

PART 3 - EXECUTION

3.01 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Section 31 00 00 - "Earthwork."

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3.02 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, non-pressure drainage piping according to the following:

1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
3. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
4. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
5. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Install PE corrugated sewer piping according to ASTM D2321.
7. Install PVC sewer piping according to ASTM D2321 and ASTM F1668.
8. Install non-reinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."
9. Install reinforced-concrete sewer piping according to ASTM C1479 and ACPA's "Concrete Pipe Installation Manual."

3.03 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, non-pressure drainage piping according to the following:

1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

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3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
6. Join corrugated PE piping according to ASTM D3212 for push-on joints.
7. Join PVC corrugated sewer piping according to ASTM D2321 for elastomeric-seal joints.
8. Join non-reinforced-concrete sewer piping according to ASTM C14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
9. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
10. Join dissimilar pipe materials with non-pressure-type flexible couplings.

3.04 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
   1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
   2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
   3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 IN deep. Set with tops 1 IN above surrounding earth grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.05 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C891.

C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 IN above finished surface elsewhere unless otherwise indicated.

3.06 STORMWATER INLET AND OUTLET INSTALLATION

A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.

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B. Construct riprap of broken stone, as indicated.

C. Install outlets that spill onto grade, anchored with concrete, where indicated.

D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated. Construct energy dissipaters at outlets, as indicated.

3.07 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318.

3.08 CONNECTIONS

A. Make connections to existing piping and underground manholes.

1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6 IN overlap, with not less than 6 IN of concrete with 28-day compressive strength of 3000 psi.

2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 IN of concrete with 28-day compressive strength of 3000 psi.

3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 IN of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 IN of concrete for minimum length of 12 IN to provide additional support of collar from connection to undisturbed ground.

   a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.

   b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.

4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.09 IDENTIFICATION

A. Materials and their installation are specified in Section 31 00 00 - "Earthwork." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

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3.10 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 IN of backfill is in place, and again at completion of Project.

1. Submit separate reports for each system inspection.
2. Defects requiring correction include the following:
    a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    d. Infiltration: Water leakage into piping.
    e. Exfiltration: Water leakage from or around piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Re-inspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 HRS advance notice.
4. Submit separate report for each test. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
    b. Option: Test plastic piping according to ASTM F1417.
    c. Option: Test concrete piping according to ASTM C924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

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SECTION 33 41 20 - CURED IN PLACE PIPE LINER

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The work necessary to clean, furnish and install, complete and in-place, Cured-In-Place-Piping (hereby known as CIPP) liner for rehabilitation of underground drainage and piping systems as shown on the drawings and specified herein.

B. The Contractor shall provide all materials, labor, equipment, and services necessary for the installation of CIPP and air testing of the completed pipe repairs.

1.02 RECORD OF CLEANING

A. Preliminary cleaning and video logging of pipe will be performed. A video record (either VHS tape or Digital format) of the cleaning operations will be sent for review to Union Pacific Railroad (hereby known as the Railroad). If no video record was performed, the Contractor is to perform a video record of pipe showing pipe condition as cleaned, and present to the Railroad before installation of the liner.

1.03 QUALIFICATIONS

A. The CIPP lining contractor shall be either employees of the lining system manufacturer or certified and satisfactorily trained by the lining system manufacturer that such a company is fully trained and is a licensed installer of their lining system.

B. Manufacturers:

1. Insituform Technologies, Inc., Chesterfield, MO; 800-234-2992.
2. Inliner Technologies, Paoli, IN; 812-723-0704.

1.04 REFERENCED STANDARDS

A. The following references are part of this specification. In case of conflict between the requirements of this specification and those of the listed documents, the requirements of this specification shall prevail. The latest edition of the following references shall be used:

1. ASTM International (ASTM):
   a. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics.
   b. D903, Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
   c. D2990, Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.
   d. D5813, Cured-In-Place Thermosetting Resin Sewer Pipe.

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e. F1216, Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

f. F1743, Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP).

1.05 SUBMITTALS

A. Action Submittals:

1. Resin manufacturer specifications, properties, installation guidelines, details, sketches, and other pertinent information for the CIPP pipe liner installation to work. All materials provided shall be fully in accordance with the requirements of the reference specifications specified above. Refer to section 01 33 00 for submittal compliance.

2. Analysis of design criteria and calculations for CIPP thickness based on ASTM F1216, Appendix XI.

3. Pre-construction closed circuit TV video.

B. Certification:

1. Certified copies of Manufacturing Quality Control (MQC) test reports on the physical and chemical resistance properties of resin.

2. Certified copies of test reports on CIPP samples obtained during installation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Flexible Tube:

1. The flexible tube shall be one or more layers of woven or non-woven material - fiberglass, and/or polyester fiber, polypropylene composite, nylon, Kevlar, or a combination thereof manufactured under quality controlled conditions set by the manufacturer. Tube shall be sized such that it will provide a tight fit within existing pipe with the required thickness following curing of the resin.

2. The length of the tube shall be as necessary to span the distance between catch basins. Allowance shall be provided for stretching or shrinkage due to installation pressures and expansion.

B. Resin:

1. Resin shall produce a cured tube resistant to corrosion and abrasion from sand, silt, and other solid materials carried by stormwater.

2. The resin system shall be manufactured by a company selected by the CIPP supplier. Resin shall be polyester, vinyl ester, or epoxy resins.

3. The resin shall have physical characteristics which allow it to adhere to both wet and dry substrates.

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2.02 CURED PIPE PROPERTIES

A. The CIPP shall meet the minimum post-curing structural properties listed below:

1. Flexural Strength (ASTM D790): 4,500 psi.
2. Flexural Modulus of Elasticity (ASTM D790): 300,000 psi.

2.03 CURED PIPE THICKNESS

A. The CIPP shall have minimum post-curing thicknesses as follows:

Nominal Pipe Diameter	Cured Pipe Thickness	
	Partially Deteriorated	Fully Deteriorated
IN (mm)	IN (mm)	IN (mm)
4 (101.6)	0.05 (1.3)	0.09 (2.3)
6 (152.4)	0.08 (2.1)	0.14 (3.6)
8 (203.2)	0.11 (2.8)	0.19 (4.8)
10 (254.0)	0.14 (3.6)	0.23 (5.8)
12 (304.8)	0.16 (4.1)	0.28 (7.1)
14 (355.6)	0.19 (4.8)	0.32 (8.1)
16 (406.4)	0.22 (5.6)	0.37 (9.4)
18 (457.2)	0.25 (6.4)	0.41 (10.4)

B. The criteria for determination of minimum thickness after curing include the following:

1. The Engineer is to determine if the existing pipe system is partially or fully deteriorated.
2. Existing piping system is assumed to have an ovality of 2 percent in circumference.
3. CIPP is subjected to an assumed full soil load of 120 LBS/CU FT.
4. CIPP is subjected to traffic line loads as calculated by AASHTO Standard Specifications for Highway Bridges, HS-20-44 Highway Loading.
5. Modulus of soil reaction for pipe zone backfill material is 1000 psi.
6. CIPP is subject to a groundwater elevation 6 FT above invert of the pipe.
7. Long-term flexural strength and long-term flexural modulus of elasticity for CIPP is equivalent to 50 percent of the initial flexural strength and initial flexural modulus of elasticity, respectively, as measured in accordance with ASTM F790.
8. Minimum factor of safety is 2.0.

C. The CIPP thickness shall be within –5 percent and +10 percent of minimum thickness.

1. Thickness shall be measured using calibrated calipers.

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PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Tube impregnated with resin at the factory shall be transported, installed, and cured prior to expiration of the manufacturer's recommended shelf life.

B. Impregnated tube shall be stored and transported under refrigerated, ultraviolet light-free conditions.

C. No cuts, tears, or abrasions shall occur during handling. In the event the material is damaged, the damaged tube shall be immediately removed from the project site.

3.02 CLEANING AND INSPECTION

A. The Contractor shall clean the entire pipe system to remove all accumulated debris that will interfere with the installation of CIPP. The Contractor shall be responsible for storage, handling, and disposal of debris removed from the pipeline. The Contractor is responsible for selecting the cleaning method.

B. Water generated during cleaning operations shall be decanted from the vacuum truck and discharged to an Owner-designated location. Solids accumulated during stormwater line cleaning will be temporarily stockpiled onsite in a lined containment area. Water draining from solids will flow to catch basins tied to the IWWTP. The solids will be recovered and no solids or residual water will infiltrate underlying soils.

C. The Contractor is responsible for the transportation and disposal of the solids at an approved waste facility. The Contractor is to provide documentation of solids disposal to the Owner.

D. The lined containment structure may be used as a decontamination station should contaminated materials be encountered during operations.

E. The Contractor shall perform a closed circuit television inspection immediately prior to installation of CIPP. System shall be clean, with pipe conditions adequate for installation of CIPP. A copy of the VHS video tape (or digital media) shall be submitted to the Engineer for review and approval prior to liner installation.

3.03 PREPARATION

A. The Contractor shall provide flow diversion through bypass pumping or plugging of upstream pipe as necessary to keep work area free of running water. All water shall be contained as noted above in Article 3.02.

3.04 INSTALLATION

A. Resin Impregnation:

1. Thoroughly saturate flexible tube prior to installation. Catalyst system or additives compatible with the resin and flexible tube shall be as recommended by the manufacturer.

2. Handle the resin impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.

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B. Insertion:

1. Insert flexible tube through an existing catch basin using procedure approved by the manufacturer.

2. The addition of water, air, or steam pressure shall be adjusted to cause the impregnated flexible tube to invert from catch basin to catch basin, holding the tube tight against the host sewer pipe.

C. Curing:

1. Following insertion, apply suitable heat source with a water or steam recirculation system capable of delivering hot water uniformly throughout the section to achieve a consistent cure of the resin. Curing temperatures and duration shall be as recommended by the manufacturer.

2. The heat source shall be fitted with suitable monitors to gauge the temperature of incoming and outgoing water or steam supply. Addition gauges shall be placed between impregnated tube and invert of the original pipe at manholes to monitor outside liner temperatures during resin curing process. A standby heat source shall be at the site, ready for service in case of breakdown.

3. Heating shall continue uninterrupted until the desired temperature is achieved. Temperatures at both ends shall be measured and recorded. The initials of the Engineer shall be obtained on curing logs. Initial cure may be considered completed when exposed portions of the flexible tube pipe take a hard set and temperatures are adequate, as recommended by the manufacturer.

D. Cool the CIPP in accordance with the manufacturer's instructions. Do not release internal pressure in a way that can create a vacuum and damage the CIPP.

E. The finished CIPP shall be continuous and free from visual defects such as foreign inclusions, dry spots, pinholes, de-lamination, and wrinkles larger than 2 percent of the diameter. Any section of lining with such defects shall be removed and replaced at no additional cost to the Owner.

3.05 MANHOLES AND CATCH BASINS

A. The CIPP shall make a tight seal at the manhole and catch basin openings with no angular gaps. Sealing shall be performed in accordance with the manufacturer's recommendations.

3.06 LATERAL REINSTATEMENT

A. Contractor shall reconnect laterals at locations shown on the Drawings and identified during pre-installation cleaning.

3.07 FIELD TESTING

A. Obtained samples of cured liner according to ASTM F1216 for flexural properties and analyze according to ASTM D790. Analysis shall be performed by an independent laboratory acceptable to the Owner. Submit the report to the Engineer.

B. A sample of cured liner from the testing above shall be subject to delamination tests by aggressively prying and separation into layers with a knife or sharp-edged instrument. No separation shall be included in the report above.

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C. Wall thickness of samples shall be determined in accordance with ASTM F1743.

D. Contractor to pressure test pipe system to ensure proper liner installation. Pipe to maintain minimum 5 PSI for ten (10) minutes.

3.08 POST-INSTALLATION INSPECTION

A. The Contractor shall submit to the Engineer a color VHS video tape (or color digital media) showing the as-constructed conditions of the system.

B. Correction of failed CIPP or CIPP deemed defective from post-installation television inspection or test reports for structural values, thickness, etc., shall be repaired at no extra cost to the Owner. Method of repair shall be in accordance with the Manufacturer's recommendations, or as approved by the Engineer.

END OF SECTION

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SECTION 33 42 00 - CULVERTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Corrugated Aluminum Alloy Pipe (CAAP), Corrugated Steel Pipe (CSP) AND Corrugated Structural Plate Pipe (CPP).

B. Description:

1. These Pipe Culvert Specifications cover the assembly and installation of (a) CSP, (b) CPP and (c) CAAP, each hereinafter referred to as "pipe culverts." Pipe culverts shall be assembled and installed in accordance with these Specifications and Chapter 1, Part 4 of the current AREMA Specifications for Culvert installation and the Union Pacific Railroad Company's Engineering Culvert Pipe Standard Drawings 680000, 680010 and 680030. The most restrictive provisions shall govern when there are differences in the requirements.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 00 07 00 - General Conditions

B. Section 31 37 00 – Rip Rap

1.03 REFERENCED STANDARDS

A. STD DWG 680000 – Round Pipe Culverts

B. STD DWG 680010 – End Treatments for Culverts

C. STD DWG 680030 – Structural Plate Pipe Culverts

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PART 2 - PRODUCTS

2.01 PIPE CULVERT MATERIAL

A. All pipe culverts will be furnished with annular corrugations. The exposed ends of all corrugated pipes shall be square. Pipe culvert material, if any, furnished by the Contractor, must meet the standards for pipe culverts set forth in Chapter 1, Part 4 of the current AREMA Specifications and the Union Pacific Railroad Company's Engineering Culvert Pipe Standard Drawings 680000, 680010 and 680030 or as required and approved by the Engineer. 3 IN x 1 IN annular corrugations shall be used for all CMP pipes with 36 IN DIA and larger, 2-2/3 IN x 1/2 IN or 3 IN x 1 IN annular corrugations shall be used for 30 IN DIA CSP pipes. 3 IN x 1 IN annular corrugations shall be used for all CAAP pipes. 6 IN x 2 IN annular corrugations and a Minimum of 4 bolts per foot for all SPP pipes. Bolts and nuts shall be per the current AREMA Specifications, chapter 41, part 4. Minimum gage requirements are specified in UPRR Engineering Culvert Pipe Standards. All CMP culverts under the railroad shall be aluminized and double-riveted. Any deviations of these Specifications are to be submitted to the Engineer for approval prior to starting construction.

B. All flared end sections furnished by the Contractor must meet the standards for pipe culverts set forth in Chapter 1, Part 4 of the current AREMA Specifications. Flared end sections shall match the annular corrugations and gage of the adjacent pipe culvert. Any deviations of these Specifications are to be submitted to the Engineer for approval prior to starting construction.

PART 3 - EXECUTION

3.01 HANDLING OF PIPE CULVERT MATERIAL

A. The Contractor shall handle pipe culverts and the pipe culvert material carefully in order to prevent damage, including, but not limited to, distortion of the pipes, injury to bituminous and other pipe culvert coatings. Pipe culverts shall never be dragged over the ground, but shall be handled with skids, rolling slings, or cranes. The Contractor shall promptly repair, to the satisfaction of the Engineer, any damage to the pipe culvert or pipe culvert material. In the event such damaged pipe culverts or pipe culvert material cannot be repaired to the satisfaction of the Engineer, replacement pipe culverts or pipe culvert material must be provided by the Contractor at his expense.

3.02 EXCAVATION AND LOCATION

A. Preparation for the culvert bedding shall be included in the culvert installation or extension cost and shall include all necessary clearing and grading necessary to place the bedding material, as well as placement and compaction of aggregate base bedding. The Contractor may use CLSM, for the culvert bedding. Any ditching required, unless there is a bid item for ditching, shall be incidental to the culvert installation. Culvert bedding preparation is included in the cost per foot and will not be classified as subexcavation.

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B. If any shoring is required for culvert work, it shall be incidental to the service item. Shoring plans must conform to the General Shoring Requirements (dwg.# 710000), and must be stamped by a P.E. in the state where the work is to be performed. The shoring plan is to be submitted to the UPRR Structures Design Group for review and approval.

C. Pipe culverts shall be placed at the location, elevation and alignment shown on the Drawings.

D. Culvert Pipe Excavation and Embankment:

1. The Contractor shall perform all pipe culvert excavation. Prior to pipe culvert excavation, embankment must be constructed to a height no less than 2 FT above the top of the proposed pipe culvert. When embankment is placed, alternate methods may be used if approved by the Engineer. Pipe culvert excavations shall be wide enough to permit thorough compaction of the backfill under and around the pipe culvert as required by paragraph "laying culvert pipe" Sub-Section 3.06.B of this Section. The base width of the pipe culvert excavation shall not exceed the external width of the pipe culvert plus:

   a. 12 IN on each side for pipes less than 48 IN DIA.

   b. 18 IN on each side for pipes 54 - 78 IN DIA.

   c. 24 IN on each side for pipes 84 IN DIA or larger.

E. Protection of Foundation and Bedding:

1. Unless soft soil is encountered in which case Sub-Section 3.03.B "Soft Soil Condition" shall govern. Pipe culvert excavation shall be deep enough to permit compliance with the foundation and bedding requirements for pipe culverts. Care shall be taken to assure drainage is diverted away from the pipe bed during preparation. Any damage to or deterioration of pipe bedding prior to installation shall be repaired by the Contractor at no expense to the Railroad.

F. The Contractor shall comply with all current and applicable Federal, State, local rules, and regulations governing the safety of men and materials during pipe culvert excavation, installation and backfilling operations. The Contractor shall observe requirements of the Occupational Safety and Health Administration relating to excavations, trenching and shoring as set forth in Title 29, Part 1926, Subpart Paragraph P, Sections 1926.650 through 1926.653, Code of Federal Regulations, and any subsequent revisions.

3.03 FOUNDATION, BEDDING, AND COMPACTION

A. Pipe culverts shall be placed at the flowline grade and elevation established by the Engineer on a uniform bed of stable earth or granular material such as gravel or sand, and such bedding shall be compacted to not less than 100 percent of maximum density determined by ASTM D1557 with moisture content adjusted. The compacted bed shall contain the camber required by the Engineer or as covered by these Specifications, Sub-Section 3.04. The compacted bed shall also be shaped to fit the bottom one-third (1/3) of round pipe culvert or shaped to fit the entire bottom of pipe arch culvert. Where the granular material is used for bedding, the ends of the pipe culvert in embankment shall be sealed to prevent leaking and infiltration of water along the pipe culvert. Such sealing can often be accomplished by blanketing the ends of the pipe culvert embankment with well tamped clay. In all cases, ends of pipe culverts shall be protected by riprap as outlined in the UPRR Engineering Culvert Pipe Standards.

B. Soft Soil Conditions:

1. Where the flowline grade crosses soft areas of soil which will not provide a suitable uniform foundation for the pipe culvert bed, the Contractor shall excavate 18 IN below the flowline grade for a width equal twice the outside width of the pipe culvert. Prior to backfilling, the Engineer shall inspect the excavation and the Contractor shall perform any additional excavation beneath 18 IN of the flowline grade which may be required by the Engineer; provided, however, that the expense of any such additional excavation beneath 18 IN of the flowline grade shall be considered extra work. Upon completion of the excavation, the Contractor will backfill such excavation with granular material which shall be compacted and formed as described above.

C. Rock:

1. When the flowline grade passes over rock, the Contractor shall excavate such rock to a depth which is at least 12 IN below the flowline grade. Excavations in rock shall maintain sufficient area so that the pipe culvert will not rest on rock at any point. The Contractor will backfill excavation in rock with granular material which shall be formed as described above.

3.04 CAMBER

A. Camber shall be placed in all culverts where it is anticipated that the culvert will settle as the result of high embankment construction or compressible foundation soils below the culvert bedding. Unless otherwise specified by the Engineer, all culverts shall be cambered in accordance with the following:

1. In no case shall the culvert be cambered so high in the center that water will be pocketed at the inlet end of the pipe.

2. Culverts resting on rock foundation need not be Cambered. Refer to Sub-Section 3.03.C.

3. Embankments up to 8 FT high (measured base of rail to flowline) require a 1-1/2 IN camber.

   a. Embankments 8 FT to 12 FT high require a 2-1/2 IN camber.

   b. Embankments 12 FT to 24 FT high require a 4 IN camber.

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c. Embankments 24 FT to 36 FT high require a 6 IN camber.

B. The above camber standards, based on the height of embankments, may be adjusted in the field, where at the discretion of the Engineer a greater or lesser amount of camber should be built into pipe to adjust for soil conditions encountered at the site. For fills higher than 36 FT, the Chief Engineer will provide the camber requirements.

3.05 RIPRAP PROTECTION

A. Both the inlet and outlet ends of all culverts shall be protected by riprap, concrete headwall, or as shown on the Drawings. Riprap shall be installed per detail on Drawing 680000, or as shown on the Plan.

3.06 INSTALLATION

A. Assembly of Culvert Pipe:

1. Pipe culverts will generally be joined using 2 FT wide corrugated metal connecting bands. The inside of corrugated connecting bands and the outside of pipe culverts to be joined by corrugated connecting bands shall be kept clean and free of all dirt or gravel to ensure that the corrugations on the connecting bands and the pipe culvert fit snugly as the connecting bands are tightened. They should be tapped with a mallet or hard rubber hammer to ensure a tight joint. Connecting bands for 48 IN or less coated culvert pipe shall be 2 FT wide, two pieced type, connecting bands and the outside surface of the culvert pipe under the connecting band often need be lubricated with fuel oil or similar solvent to allow the connecting bands to be drawn firmly into place.

2. Corrugated structural plate pipe shall be assembled in accordance with the manufacturer's detailed assembly instructions. Bolts shall be tightened progressively uniformly, starting at one end of the corrugated structural plate pipe after all plates are in place. Tightening shall be repeated to ensure all bolts are tight.

3. When a power wrench is used for tightening bolts, the Contractor shall check the tightening of the bolts with one handed structural or socket type torque wrench. Bolts shall be torqued uniformly to a minimum of 100 FT LB and a maximum of 300 FT LB or as specified in the manufacturer's detailed assembly instructions.

4. Where field cutting of culvert pipes is required, the Contractor shall make saw cuts. Torch burning will not be permitted.

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B. Laying Culvert Pipe:

1. Each pipe culvert shall be laid true to the flowline grade. The minimum gradient for any pipe culvert shall be 0.5 percent unless indicated otherwise on the Plans, or as directed by the Engineer. If two or more pipe culverts are to be laid parallel to each other, such parallel pipe culverts shall be spaced per Drawing 6800000 and to permit thorough compaction of the backfill as required by Sub-Section 3.07. Parallel culverts shall be separated by a distance of at least one-half (1/2) of the nominal diameter of the pipe culverts or one-third (1/3) the span width of pipe arch culverts but not less than 12 IN, nor does it in any case need to exceed 48 IN. Riveted corrugated metal pipe culverts must be placed with the inside circumferential laps pointing downstream. The Contractor shall cover exposed metal on the surface of any bituminous coated pipe culvert before backfilling is commenced. Such exposed metal must be covered with material which is approved by the Engineer and which includes:

   a. Fiber Bonded Bituminous (composite) coating ASTM A825 (steel only).

   b. Polymeric Coating - ASTM A762 or AASHTO M245 (steel only).

   c. Galvanized - AASHTOM218 or Aluminum (Type 2) - AASHTO M274 (steel only).

   d. Asphaltic Coating - AASHTO M190 (steel and aluminum) (only 3 and 4 for structural plate pipe).

   e. Such material shall be applied to a thickness of approximately 1/16 IN.

C. Special Installation Conditions:

1. Strutting:

   a. All pipe culverts with a nominal diameter of 48 IN or greater shall be provided with a five (5) percent vertical elongation. Field strutting shall be required only on very large structural steel pipes (10 FT or greater). Strutting shall be removed immediately after installation and backfill are complete. In all cases, strutting may be required if specifically stated in the Request for Bids

3.07 BACKFILLING AND COMPACTION

A. Backfill materials shall be placed simultaneously on both sides of the pipe culvert in uniform layers not to exceed 6 IN in thickness. For multiple pipes, the backfill shall be placed simultaneously in uniform 6 IN layers between and outside of pipes. Each successive layer shall be compacted, in accordance with the Railroad's Specifications 31 24 13 through 31 35 20, and to not less than 100 percent of maximum density as determined by ASTM D1557 with moisture content adjusted if necessary, and each 6 IN layer shall be properly compacted before the next layer is placed.

B. Backfilling shall be started and completed as quickly as possible after the pipe culvert has been assembled and placed on its bed.

C. Where granular material is used for backfill, the ends of the pipe culvert embankment shall be sealed with well tamped clay to prevent leaking and infiltration of water along the pipe culvert.

D. Where compaction may be difficult to obtain due to space constraints or other factors, the Contractor may, with the approval of the Engineer, utilize Controlled Low-Strength Concrete Fill Material (CLSM), commonly called flowable fill, as backfill material to a point one foot above the top of the culvert per Drawing 680000.

E. Pipe Protection:

1. Materials used to complete the embankment over the pipe culvert should be essentially the same as the material used for the pipe culvert backfill and should be placed and compacted in the same manner as pipe culvert backfill materials are placed. Such material must be used to complete the embankment at least to a height over the top of the pipe culvert equal to the nominal diameter of the pipe culvert, or if the height of the completed embankment over the top of the pipe culvert is less than the nominal diameter of the pipe culvert then such material must be used to complete the embankment. The pipe culvert must be protected from damage during the entire construction period, especially if heavy compaction equipment is used. Heavy construction equipment shall not be operated over the pipe culvert until it has been covered with compacted backfill material to a depth of 24 IN.

3.08 RETIGHTENING OF BOLTS

A. As soon as possible after completion of the embankment over corrugated structural plate pipes, all bolts in the corrugated structural pipe must be retightened to the standards set forth in Sub-Section 3.06.A.3. Such retightening must be started at one end of the pipe culvert and all bolts must be tightened progressively through the length of the pipe culvert.

3.09 PREPARATION OF EXISTING PIPE CULVERTS

A. The Contractor shall remove existing headwalls and the ends of damaged culverts that are to be extended. The Contractor shall also verify the culvert size prior to ordering material for the culvert extension. All culverts in the project limits are to be cleaned by the Contractor unless they are to be removed or plugged and filled.

B. The Contractor shall use Controlled Low-Strength Concrete Fill Material (CLSM) per Drawing 680000, with an unconfined compressive strength of between 50 and 300 PSI, for filling culverts that are to be plugged and filled.

C. Culverts that are to be removed become the property of the Contractor and must be removed from Railroad property, unless otherwise noted.

PART 4 - MEASUREMENT AND PAYMENT

A. The number of linear feet of pipe culvert installed will be determined by measuring the installed pipe culvert along its longitudinal axis and shall be paid for on the unit price bid per linear foot of pipe installed.

B. The cost of RIP RAP is to be included in the price per linear foot of pipe.

C. Included in the above LF cost is the removal and disposal of 18 IN of unsuitable material and the installation of 18 IN of bedding.

D. Below the 18 IN, removal and replacement of bedding material is considered extra work and shall be paid on the Cubic Yard basis.

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E. The number of flared end sections will be measured and paid for at the contract unit price bid per each flared end section acceptably installed.

F. No additional payment will be made for the use of CLSM, or flowable fill, as backfill around culverts, but shall be considered subsidiary to the cost of the culvert pipe.

END OF SECTION

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SECTION 33 42 16 - REINFORCED CONCRETE BOX CULVERTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing of material, construction and curing of, and/or extension of reinforced concrete box culverts, hereinafter referred to as "concrete boxes". Concrete boxes shall be constructed in accordance with this Specifications, the design drawings and Chapter 8 Part 16, reinforced concrete box culverts and Chapter 29 Part 3, Damp proofing, of the current American Railway Engineering and Maintenance of Way Association (AREMA) Specifications.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Documents affecting the work of this Section include, but are not necessarily limited to Division 01, General conditions of these Specifications.

1.03 HANDLING OF CONCRETE BOX MATERIALS

A. All material used in the construction of concrete boxes shall be handled carefully in a workmanlike manner to avoid damage and/or contamination. Reinforcing steel reduced in section or with bends or kinks not shown on the plans shall not be used.

B. In the event materials are damaged and/or contaminated and cannot be repaired to the satisfaction of the engineer, replacement of such material must be provided by the Contractor at his expense.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Box Material:

1. Concrete box material shall meet the standards set forth in Chapter 8 Part 16 of the current AREMA Specifications. Reinforcing steel shall conform to ASTM A615, Grade 60. The minimum 28 day compressive strength of concrete shall be 4,000 psi.

B. Reinforcing steel, fabricated to shapes and dimensions shown, shall be placed where indicated on the Drawings or where required to carry out the intent of the Plans.

C. Damp-proofing materials shall meet the standards set forth in Chapter 29, Part 3 of the current AREMA MANUAL.

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PART 3 - EXECUTION

3.01 EXCAVATION AND LOCATION

A. Concrete box culverts shall be placed at the location, elevation and alignment as shown on the Drawings. The Contractor shall preserve all stakes established until authorized by the Engineer to remove them. Additional layout required will be the responsibility of the Contractor and he alone shall be responsible for restoring any points destroyed.

B. The Contractor shall perform all concrete box embankment and excavation. Excavations shall be made wide enough to permit thorough compaction of backfill around the concrete box culverts. Care shall be taken to ensure that methods used in excavation will not reduce the stability of the material adjacent to the excavation.

C. If soft soil conditions are encountered, Sub-Section 3.02 shall govern. Excavation shall be deep enough to permit compliance with the foundation requirements set forth in Sub-Section 3.03.

3.02 SOFT SOIL CONDITIONS

A. For concrete boxes, where the soil encountered will not provide a suitable uniform foundation, the Contractor shall excavate 18 IN below the foundation grade and at least 1 FT beyond the horizontal limits of the structure on all sides. The Engineer shall inspect the excavation and the Contractor shall perform any additional excavation required to obtain a stable foundation. The Contractor will backfill these areas with granular material formed as required in Sub-Section 3.06.

B. Protection of Foundations and Bedding:

1. Unless soft soil conditions are encountered, in which case Sub-Section 3.02 shall govern, concrete box excavation shall be deep enough to permit compliance with the foundation and bedding requirements for the concrete boxes. Care shall be taken to ensure drainage is diverted away from the concrete box bedding during preparation. Any damage or deterioration shall be repaired by the Contractor at no expense to the Railroad.

C. Trenching:

1. The Contractor shall comply with all current applicable Federal, State and local rules and regulations governing the safety of men and materials, during concrete box excavation, installation, and backfilling operations. The Contractor shall comply with all requirements of the Occupational Safety and Health Administration relating to excavations, trenching and shoring as set forth in Title 29,, Part 1926, Subpart Sections 1926.650 through 1926.653, Code of Federal Regulations, and any subsequent revisions. The contractor shall also comply with the Railroad's Chief Engineer's instruction bulletin 124.0 Trenching Safety Rules and Shoring Standards. Where there is a conflict between the two standards, the more restrictive will apply.

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3.03 FOUNDATION, BEDDING, AND COMPACTION

A. Concrete boxes shall be placed at the flowline, with grade and elevation established by the Engineer. The concrete box culverts shall be placed on a uniform bed of stable earth or granular material such as sand or gravel, and such bedding shall be compacted to not less than 100 percent of maximum density, and with moisture content at the optimum moisture content or within -4 percentage points of optimum moisture content as determined by ASTM D1557 and field density in place test D 1556. The compacted bed shall contain the camber required by the drawings, by the Engineer, or as covered by Section 33 42 00. The compacted bed shall be shaped to fit the bottom of the box and shall conform to the entire bottom of the box. Where granular material is used for bedding, ends of the concrete box excavation shall be sealed to prevent leaking and infiltration of water along the concrete box. Such sealing can often be accomplished by blanketing the ends of the concrete box embankment with well tamped clay.

3.04 ROCK

A. When the concrete box foundation is resting entirely on rock or other hard foundation material, the foundation shall be freed from all loose material, cleaned and cut to a firm surface. Excavation in rock or other hard material shall be made as near as practicable to the size required to properly construct the concrete box.

3.05 COMPRESSIBLE AND INCOMPRESSIBLE

A. Where the material encountered at the foundation grade is found to be partially rock or incompressible material and partially a soil or material that is compressible but otherwise satisfactory for the foundation the incompressible material shall be removed for a depth of 6 IN below the foundation grade and backfilled with a material similar to the compressible foundation used for the rest of the concrete box.

3.06 CONSTRUCTION

A. All work shall be constructed on a reasonably dry foundation material. The Contractor shall, at his expense, perform all bailing, pumping, and draining to protect the area and provide this condition. Should the Contractor's operation damage the foundation, the Contractor shall restore the foundation to its previous condition at the Contractor's expense. All cleanup and removal of temporary facilities shall be the Contractor's responsibility.

B. Each concrete box shall be constructed true to the following grade. The minimum gradient for any concrete box shall be 0.2 percent, unless shown otherwise on the plans, or as directed by the Engineer. If two or more concrete boxes are to be constructed parallel to each other, such parallel concrete boxes shall be spaced to permit thorough compaction of the backfill as required by Sub-Section 3.07. Parallel box culverts shall be separated by a distance of at least one-half of the nominal height of the concrete boxes but not less than 48 IN.

C. Installation including, but not limited to forms, construction joints, curing and all that is required or incidental to the proper construction of the concrete box culvert shall be done in accordance with Chapter 8 of the AREMA Specifications.

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3.07 BACKFILLING AND COMPACTION

A. Backfill shall not be placed until the top slab has been in place for at least four (4) days or the concrete has attained at least 85 percent of its required strength.

B. Backfill materials shall be placed simultaneously on both sides of the concrete box in uniform layers not exceeding 6 IN in thickness. For multiple boxes, the backfill shall be placed simultaneously in uniform layers between and outside of the boxes. Each successive layer shall be compacted to not less than 100 percent of maximum density as determined by ASTM D1557, with moisture content adjusted, if necessary. Each 6 IN layer shall be properly compacted before the next layer is placed.

C. Special care must be taken to obtain adequate compaction along the side walls of the concrete box; however. Where the concrete box is placed in a confined area, making it difficult to obtain adequate compaction along the sides of the concrete box through tamping, special backfill material consisting of fine dry sand shall be used and shall be compacted by vibrating. Compaction shall be accomplished by rodding the special backfill material with a power vibrator. The special backfill material shall be compacted by vibrating the material until compaction can be obtained in a conventional manner.

D. All backfilling material placed around and adjacent to culverts to a point at least one foot above the top of the pipe culvert shall consist of sand-gravel material containing less than 15 percent material passing the No. 200 sieve.

E. Where sand-gravel material is used for backfill, the ends of the concrete box embankment shall be sealed with well tamped clay to prevent leaking and infiltration of water along the concrete box.

F. Where compaction may be difficult to obtain due to space constraints or other factors, the Contractor may, with the approval of the Engineer, utilize Controlled Low-Strength Concrete Fill Material (CLSM), commonly called flowable fill, as backfill material to a point one foot above the top of the culvert. Unless specified or shown elsewhere in the plans the CLSM shall meet the requirements for flowable fill of the respective Department of Transportation.

G. Box Culvert Protection:

   1. Materials used to complete the embankment over the concrete box should be essentially the same as the materials used for the concrete box backfill and should be placed and compacted in the same manner as concrete box backfill materials are placed. The concrete box must be protected from damage during the entire construction period, especially if heavy compaction and/or construction equipment is used. Heavy equipment shall not be operated over the concrete box until it has been covered with compacted backfill material to a depth of at least 24 IN.

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3.08 REMOVAL OF EXISTING HEADWALLS OR CULVERTS IN PREPARATION FOR EXTENSION OF EXISTING CONCRETE BOXES

A. The Contractor shall remove that portion of the existing apron, curtain, toe, head or wingwalls, and/or culverts or arches that interferes in whole or in part as shown on the Drawings, or stated in the Specifications, and shall perform all work that is required to extend, adapt, or reconstruct the existing concrete boxes, including required excavation and backfilling. Except as otherwise provided for in this Specification, the Contractor will determine the method of extending existing concrete box structures by consulting with the Engineer.

B. When extending a structure, dowel bars are to be placed as shown on the drawings for the box or into holes drilled into the face of the existing box at locations to match the horizontal steel of the new concrete box extension. Dowels shall be 18 IN long and set with an epoxy adhesive. A sufficient amount of epoxy should be used to ensure a strong bond between the dowels and dowel holes. Dowel holes shall be drilled and cleaned.

C. Care shall be taken to prevent uneven settlement at the joint between the existing and the extension. The face of the existing box shall be prepared to ensure a tight bond at the connection.

3.09 RIPRAP PROTECTION

A. Both the inlet and outlet ends of all concrete box culverts shall be protected by riprap, concrete headwall, or as shown on the Drawings. Riprap shall be installed as shown on the Plan.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. The number of linear feet of concrete box installed will be determined by measuring the installed concrete box along its longitudinal axis and shall be paid for by the contract unit price per linear foot of box installed per the Specifications.

B. The cost of riprap required per Engineering Standard drawings, is to be included in the price of the concrete box culvert.

C. Included in the cost of the concrete box culvert is the 18 IN of bedding, removal and disposal of the excavated unsuitable soil and the replacement of that soil with acceptable bedding.

D. Below 18 IN, the bedding, removal, disposal and replacement of unsuitable soils will be paid for on the cubic yard "C.Y." basis.

E. No additional payment will be made for the use of CLSM, or flowable fill, as backfill around culverts, but shall be considered subsidiary to the cost of the culvert pipe.

END OF SECTION

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SECTION 33 42 20 - SMOOTH STEEL PIPE CULVERTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fabrication, furnishing, and installation of smooth steel pipe culverts in accordance with these special conditions, standard construction specifications and the details shown on the plans.

B. The size, type, length, wall thickness, and location of pipe culverts will be shown on the plans or as directed by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. See Standard Plan No. 680010 for material requirements, diameter, wall thickness, and welding requirements.

B. Fabrication and materials shall be in accordance with Chapter 1, Part 4 of the AREMA Manual for Railway Engineering except as specified otherwise.

2.02 END TREATMENT

A. End treatments shall be provided as specified on the plans or as directed by the Engineer.

B. Ends of smooth steel pipes shall be finished square.

PART 3 - EXECUTION

3.01 HANDLING

A. Material shall be handled to final position in such a manner as to prevent its damage. Steel pipes shall not be dropped to, or dragged over, the ground, but shall be handled with rolling slings, on skids, or with cranes.

B. Bent or otherwise damaged steel pipes shall be straightened and repaired, if feasible and as directed by the Engineer, before being placed in final position. No extra payment will be allowed for this work unless authorized in writing by the Engineer.

3.02 PIPE CONNECTIONS

A. Pipe connections shall be as shown on the plans or as stated in the specifications.

B. Sections of smooth steel pipe shall be joined by complete joint penetration welds in accordance with Standard Plan No. 680010 and AWS D1.1 Structural Welding Code unless specified otherwise on the plans or by the Engineer.

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3.03 PIPE EXTENSIONS

A. Connection of smooth steel pipe for extensions shall be as shown on the plans or as stated in the specifications. Sections of smooth steel pipe shall be welded as specified.

B. Prior to performing any pipe/culvert extensions, the pipe shall be cleaned out. Pipes shall be free of any obstructions that could impede the flow. The clean out of the pipe/culvert is incidental to the cost of performing the pipe extension and shall be included in the contract unit price for pipe extensions.

3.04 PIPE ABANDONMENT

A. All pipes/culverts being abandoned will be plugged and filled as indicated on the plans or special conditions. No abandoned pipes will be left open, unless otherwise directed by the Engineer. The abandoned pipes will be indicated on the plans.

B. Culverts that are to be removed become the property of the Contractor and must be removed from Railroad property, unless otherwise noted.

3.05 FOUNDATION PREPARATION

A. No foundation preparation shall be required for the length of pipe installed by jacking and boring.

B. Foundation preparation shall be performed as required by Section 33 42 00.

3.06 PROTECTION OF FOUNDATIONS

A. The Contractor shall by diversion ditches, dikes, or other means, keep the foundations free of water at all times after the work is started, and until the embankment is placed over the pipe. Any channel work necessary to allow free flow through the pipe shall be completed before the embankment is placed.

3.07 EARTH BORING AND JACKING CULVERT PIPE

A. General:

1. Only smooth steel pipe shall be used for installation by jacking or boring.
2. Pipe damaged in jacking or boring operations shall be repaired in place to the satisfaction of the Engineer. Pipe damage beyond repair shall be removed and replaced. Repair or removal and replacement of damaged pipe shall be done at the Contractor's expense.
3. Excessive voids shall not be permitted in the jacking process. If voids develop during installation, or track or ballast movement exceeds 1/4 IN, stop work immediately, notify UPRR and submit a corrective action plan.

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4. If the grade of the pipe at the jacking or boring end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking or boring operation and for placing end joints of the pipe. The pits shall be a minimum of 12 FT from centerline of the nearest track. Shoring for jacking pits shall comply with the Railroad's Chief Engineer's instruction bulletin 124.0 Trenching Safety Rules and Shoring Standards. Jacking pits will not be permitted in Zone A unless approved by the Engineer. Design of shoring for jacking pits shall be performed, signed and sealed by a licensed Civil Engineer in the respective State the project is located. Temporary guardrail shall be provided for protection of the pit or trench when specified by the Engineer. Excavations greater than 5 FT in depth shall be protected in accordance with OSHA Trench Safety Guidelines.
5. Where pipe is required to be installed under railroad embankments, highways, streets, or other facilities by jacking or boring methods, installation shall be made in such a manner that it will not interfere with the operation of the railroad, street, highway, or other facility, and shall not weaken or damage any embankment or structure.
6. The pits or trenches excavated to facilitate jacking or boring operations shall be backfilled immediately after the installation of the pipe has been completed.

B. Jacking:

1. Heavy duty jacks suitable for forcing the pipe through the embankment shall be provided. In operating jacks, even pressure shall be applied to all jacks used. A suitable jacking head and suitable bracing between the jacks and the jacking head shall be provided so that pressure will be applied to the pipe uniformly around the ring of the pipe. Joint cushioning material of plywood or other material may be used as approved by the Engineer. Plywood cushioning material shall be 3/4 IN minimum thickness. Cushioning rings may be made up of single or multiple pieces. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides, properly braced together, to support the section of the pipe and to direct the pipe in the proper line and grade. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe. In general, the embankment material shall be excavated just ahead of the pipe, the material removed through the pipe, and the pipe forced through the embankment with jacks, into the space thus provided.
2. The excavation for the underside of the pipe, for at least one-third of the circumference of the pipe, shall conform to the contour and grade of the pipe. Over-excavation to provide not more than 1 IN of clearance may be provided for the upper half of the pipe. This clearance shall be tapered to zero at the point where the excavation conforms to the contour of the pipe. Over-excavation in excess of 1 IN shall be pressure grouted the entire length of the installation.
3. The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but shall not exceed 2 FT. This distance shall be decreased when directed by the Engineer.

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4. Preferably, the pipe shall be jacked from the low or downstream end. The final position of the pipe shall not vary from the line and grade shown on the plans, or established by the Engineer, by more than 1/8 IN per 1 FT. The maximum deviation shall be ± 2 IN from the line and grade shown. The variation shall be regular and in one direction and the final flow line shall be in the direction shown on the plans.
5. The Contractor may use a cutting edge of steel plate around the head end of the pipe extending a short distance beyond the end of the pipe with inside angles or lugs to keep the cutting edge from slipping back onto the pipe.
6. Work should be done continuously to minimize the tendency of the material to "freeze" around the pipe.
7. Excavated material shall be disposed of by the Contractor, as approved by the Engineer.

C. Boring:

1. The boring shall proceed from a pit provided for the boring equipment and workmen. The location of the pit shall be approved by the Engineer. The boring shall be done mechanically either using a pilot hole or by the auger method.
2. When the pilot hole method is used, an approximate 2 IN pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. This pilot hole shall serve as the centerline of the larger diameter hole to be bored.
3. When the auger method is used, a smooth steel pipe of the appropriate diameter equipped with a cutter head to mechanically perform the excavation shall be used. Augers shall be of sufficient diameter to convey the excavated material to the work pit.
4. Excavated material shall be disposed of by the Contractor, as approved by the Engineer. The use of water or other fluids in connection with the boring operation will be permitted only to the extent necessary to lubricate cuttings; jetting will not be permitted.
5. In unconsolidated soil formations, a gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade carefully processed bentonite may be used to consolidate cuttings of the bit, seal the walls of the hole, and furnish lubrication for subsequent removal of cuttings and immediate installation of the pipe.
6. Allowable variation from line and grade shall be as specified in Sub-Section 3.07.B.4.

END OF SECTION

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SECTION 33 44 16 – TRENCH DRAINS FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for a precast, polymer concrete drain system. No product shall be accepted unless previously approved in accordance with design criteria.
2. This section does not apply for the construction of mainline and/or yard track projects.

B. Scope of Work:

1. Furnish precast polymer concrete surface drainage system including all components and sub-components necessary to install system as shown on the drawings and as specified herein.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Drawings and general provision of contract apply to work of this section.

1.03 DESIGN CRITERIA

A. The design of trench drains shall be in accordance with specified criteria, ASTM Standard testing procedures, and generally accepted structural design practice.

B. The design of the polymer concrete trench system shall be the responsibility of the manufacturer and shall be approved by the UPRR Engineering Department.

C. Design loads on the drainage systems shall range from light pedestrian use to axle loads up to 2000 LBS plus 30 percent of load for impact. Where not specified, the tolerances and dimensions called out by the manufacturer shall be considered acceptable.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Shop drawings shall be completed by the manufacturer and sent to the UPRR Engineering Department.

C. Manufacturer's catalog data showing:

D. Materials of construction.

E. Dimensions, spacings and construction of trench system.

F. Chemical resistance guide.

G. Installation guide.

1.05 QUALITY ASSURANCE

A. Material covered by these specifications shall be furnished by a reputable and qualified manufacture and installer of polymer concrete drainage systems.

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B. Substitution of any component or modification of system shall be made only when approved by the UPRR Engineering Department.

C. In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for work.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials used in the manufacture of trench drain systems shall be first-run product of the best quality and shall be free from all detects and imperfections that might affect the performance of the finished product.

B. All materials shall be of the kind and quality specified. Where the quality is not specified, it shall be of the respective kinds and suitable for the purpose intended.

C. Trench drain channels shall be precast polymer concrete formed with a matched metal tooling utilizing polyester resin.

D. Precast, polymer concrete drain components will be non-sloped as shown on the approved plans.

E. Precast, polymer concrete drain system shall be installed flush to the grade or finished surface.

2.02 TRENCH DRAIN CHANNELS

A. Each system consisting of a variable number of units are precast with no slope.

B. Channel units shall be manufactured to an external width of about 6 IN with an internal width of about 4 IN. The inside of the channels shall have vertical side walls and about 2 IN radius bottom.

C. Channels shall be provided with tongue and groove ends and shall interlock fully and evenly with adjoining channels.

D. Each channel shall have horizontal anchoring ribs located along the bottom of the channel as a means of mechanical engagement into the adjacent concrete. Anchoring rib must be centered and run continuously for at least 60 percent of the length of each channel. The base of the channel shall be about 4 IN wide to provide maximum load distribution.

E. Materials used in the manufacture of the precast polymer concrete drain system shall have the properties specified in this section and test reports must be available.

1. Accelerated Service:

   a. Test Method: ASTM D756-E.

   b. Criteria: Retains 75 percent strength at <2 percent change in weight or dimension.

2. Chemical Corrosion:

   a. Test Method: ASTM DS43-7.1.

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b. Criteria: Retains 75 percent strength at <2 percent change in weight or dimension.

3. Water Absorbtion:

a. Test Method: ASTM D57.

b. Criteria: <1 percent.

F. The test specimens shall show no cracking, crazing, checking, blistering, or surface pitting. Changes in color will be permitted only if the change does not indicate degradation of the material and in the opinion of the user, the change will not be detrimental to the overall appearance of the product.

2.03 CHANNEL GRATES

A. All channel grates and catch basins shall be equipped with galvanized steel gratings. Gratings shall bear evenly on the channel edges and shall provide an intake cross section of approximately 10 SQ IN per linear foot.

2.04 ACCESSORIES

A. Male and female end caps shall be provided where required.

B. Transition pieces for female to female connections male to male connections shall be available and provided where specified.

C. Catch basins shall be precast polymer concrete with galvanized steel trash buckets. Any trench drains entering catch basins shall interlock fully with tongue and groove connections. Discharge pipe shall be 6 IN DIA.

PART 3 - EXECUTION

3.01 PREPARATION

A. An area must be excavated for channel placement in trenches 4 IN wider and 4 IN deeper than channel sections to accommodate channel and bedding concrete.

3.02 INSTALLATION

A. The drain system shall be installed in strict accordance with manufacturer's recommendations and approved shop drawings.

B. When indicated, proper adhesive will be used to interlock adjoining surfaces during installation.

C. Channel placement shall begin at catch basin.

D. Channels are placed in sequence with arrows all pointing in the same direction. Channel ends are to be interlocked with surfaces reasonably flush and even. The joints are to be unsealed unless otherwise specified. Channels are to be firmly anchored in place during installation to prevent floating and movement during placement of concrete.

PART 4 - MEASUREMENT AND PAYMENT

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END OF SECTION

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SECTION 33 47 13 – HDPE INDUSTRIAL WASTEWATER POND LINERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Information related to labor, materials, and equipment for installation of new high density polyethylene (HDPE) liner systems for industrial wastewater pond applications.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals

B. Section 31 00 00 - Earthwork

1.03 REFERENCED STANDARDS

A. American Society for Testing and Materials (ASTM)

1. D746 – Brittleness Temperature of Plastics and Elastomers by Impact (2014)

2. D792 – Density and Specific Gravity (Relative Density) of Plastics by Displacement (2013)

3. D1004 – Tear Resistance (Graves Tear) of Plastic Film and Sheeting (2013)

4. D1204 – Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature (2014)

5. D1505 – Density of Plastics by the Density-Gradient Technique (2018)

6. D1603 – Carbon Black Content in Olefin Plastics (2014)

7. D3776 – Mass Per Unit Area (Weight) of Fabric (2017)

8. D3895 – Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry (2014)

9. D4218 – Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique (2015)

10. D4355 – Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus (2018)

11. D4437 – Nondestructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes (2018)

12. D4533 – Trapezoid Tearing Strength of Geotextiles (2015)

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13. D4632 – Grab Breaking Load and Elongation of Geotextiles (2015, Rev. a)

14. D4751 – Determining Apparent Opening Size of a Geotextile (2016)

15. D4833 – Index Puncture Resistance of Geomembranes and Related Products (2013, Rev. e1)

16. D5397 Appendix – Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test (2012)

17. D5596 – Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics (2016)

18. D5820 – Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes (2018)

19. D6365 – Nondestructive Testing of Geomembrane Seams Using the Spark Test (2018)

20. D6693 – Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes (2015, Rev. e1)

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Submit shop drawing of liner system indicating sheet and seam layout, attachment details, anchorage details, and penetration details.

C. Submit qualifications for liner installer and manufacturer's certified field supervising technician.

D. Submit Product Data including:

1. A written certification shall be provided by the liner manufacturer stating the producer, product designation, batch number and production data of all resin used in manufacture of all HDPE materials shipped to the site. This certification shall be submitted to the Engineer for approval prior to shipment of the liner material. HDPE material shall not be accepted unless all required certifications for the resin have been received and approved by the Engineer.

2. Manufacturer's standard catalog information and specifications, installation instructions, and general recommendations from membrane materials manufacturer for type of membrane required.

3. Pipe to liner adhesive.

4. Penetration assemblies.

E. Field testing procedures and equipment.

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1. A written certification shall be provided by the impervious membrane liner installer which describes in detail the construction quality control program of the liner installation. Documentation shall include, but not be limited to, nondestructive seam testing equipment and procedures, repair methods and locations, temperature and weather conditions during installation, equipment temperatures, etc.

F. Closeout Submittals:

1. Furnish an affidavit signed by the lining system supplier's field supervising technician stating that the liner has been properly installed, is free of defects and ready for use.

2. Manufacturer's Warranty.

3. Installation Warranty.

4. Manufacture's maintenance instructions.

1.05 QUALITY ASSURANCE

A. Lining system shall be installed by a manufacturer certified liner installer capable and experienced in HDPE liner installation and testing, with a minimum of 5 years' experience on similar sized projects.

B. Installation shall be observed by a field technician certified by the liner system manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver liner material to the site in largest sizes possible to minimize field seaming.

B. Contractor shall be responsible for receiving, storing and handling of geomembrane liner and welding material, as recommended by manufacturer. Protect from sunlight and other ultraviolet light sources during storage. Keep all materials clean and dry.

C. Within warranty period, the Contractor shall replace or repair defective materials and workmanship, including significant leakage, abnormal aging or deterioration of materials and other failures of membrane liner to perform as required.

D. Keep adhesives from extreme cold or heat.

1.07 WARRANTY

A. The liner system manufacturer shall provide a written warranty, signed by an officer of each of the parties, guaranteeing material, weathering resistance and workmanship for not less than two (2) years, beginning as of final acceptance of the entire project work under this Contract.

B. The liner system installer shall provide a written warranty, signed by an officer of each of the parties, guaranteeing installation and workmanship for not less than one (1) year and materials, beginning as of final acceptance of the entire project work under this Contract.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

2.02 MATERIALS

A. All lining materials shall be 60 mil, first quality, non-recycled, spark-testable high-density polyethylene with co-extruded single-sided textured surfaces.

B. Material shall be designed and manufactured for containment of liquid in hydraulic structures.

C. Liners shall be free of holes, blisters, undispersed raw materials, and other defects.

D. Rolls of liner material shall have labels clearly identifying thickness, length, width, date of manufacture, catalog number, net weight, lot number, and factory inspection identifier.

E. Liner material shall be compatible with and show no detrimental effects from storm water that may contain concentrations of diesel fuel or other hydrocarbons.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Material performance requirements should comply with the following table:

Property	Value	Test Method	MQC Test Frequency (min.)
Density, g/cm^3 (min. avg.)	0.94	ASTM D1505/D792	per 200,000 lb
Tensile Properties (min. avg.) 1. Tensile Strength at Break, lb/in-width 2. Tensile Strength at Yield, lb/in-width 3. Elongation at Break, % 4. Elongation at Yield, %	 90 126 100% 12%	ASTM D6693, Type IV Dumbbell, 2 ipm	per 20,000 lb

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Tear Resistance, lb (min. avg.)	42	ASTM D1004	per 45,000 lb
Puncture Resistance, lb (min. avg.)	90	ASTM D4833	per 45,000 lb
Stress Crack Resistance, hr (1) (min.)	300	ASTM D5397, Appendix	per 200,000 lb
Carbon Black Content, % Range	2.0 - 3.0	ASTM D1603/D4218 (2)	per 20,000 lb
Carbon Black Dispersion	Note (3)	ASTM D5596	per 45,000 lb
Oxidative Induction Time, minute	>100	ASTM D3895	per 200,000 lb
Low Temp Brittleness, °C	< -77	ASTM D746	
Dimensional Stability, % change each direction	±2	ASTM D1204	

Note (1): For HDPE geomembrane, the yield stress used to calculate the applied load for test method ASTM D5397 (Appendix) shall be the manufacturer's mean value.

Note (2): Either testing method ASTM D1603 or D4218 may be used as long as there is an appropriate correlation between the two tests.

Note (3): Carbon Black dispersion (only near spherical agglomerates) for 10 different views:

- 9 of 10 views fall into Categories 1 or 2,

- Only 1 view may be allowed in Category 3.

B. All welding materials shall be made from the same type of resin as the geomembrane is manufactured from. The minimum roll width shall be 21 feet.

2.04 ACCESSORIES

A. Anchoring bolts and clamps:

1. Where anchoring bolts are indicated or required, bolts shall be of stainless steel, ½-inch diameter and length as required for proper installation and sustained functional containment.

2. Where batten bars are indicated or required, bars shall be minimum ¼ inch x 2 inch 304 stainless steel.

3. Clamps shall be of stainless steel.

B. Embeds:

1. Provide HDPE embed channels which are compatible with the liner and are compatible with attachment by heat-extrusion welding.

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C. Penetrations:

1. Provide manufacturer's recommended standard factory fabrication penetration assemblies. Make penetration assemblies of the same base material as liner and at least an equivalent thickness.

D. Sealants and Adhesives:

1. Provide bonding and jointing material resistant to water containing concentrations of diesel fuel or other hydrocarbons, and recommended by liner manufacturer for bonding to structures and sealing projections through liner.

E. Geotextile Fabric:

1. Geotextile fabric for use in separation and protection of HDPE liner material shall be nonwoven pervious sheets of polymeric material consisting of long-chain synthetic polymers composed of at least 95 percent by weight polyolefins, polyesters, or polyamides. The use of woven slit film geotextiles (i.e. geotextiles made from yarns of a flat, tape-like character) will not be allowed. Material shall contain stabilizers and/or inhibitors to the base polymer, as needed, to make the filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure. Regrind material, which consists of edge trimmings and other scraps that have never reached the consumer, may be used to produce the geotextile. Post-consumer recycled material may also be used. Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. Material shall have the following property values:

a. Apparent opening size (AOS) (ASTM D4751). 100-120 sieve

b. Puncture strength (ASTM D4833): $\geq$ 150 pounds

c. Grab strength (ASTM D4632): $\geq$ 250 pounds

d. Trapezoidal tear strength (ASTM D4533): $\geq$ 100 pounds

e. Minimum average weight (ASTM D3776): $\geq$ 10.0 ounce per square yard.

f. Ultraviolet Degradation (ASTM D4355): $\geq$ 70 at 500 hours

g. Compatible with water containing concentrations of diesel fuel or other hydrocarbons.

PART 3 - EXECUTION

3.01 PREPARATION

A. Install geotextile fabric between the liner and subgrade in all areas.

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B. Excavate a minimum of 3 inches below finish grade in all areas to be lined and hand rake the surface to remove all rocks (larger than ¾-inch (20 mm) in size), spent welding rods, debris and any other sharp objects. Fill in holes, including stake holes. Inspect subgrade surface and correct defects prior to continuing construction.

C. Notify Engineer at least 48 hours prior to completion of the subsurface preparation for inspection. Engineer will document the subsurface inspection in the field inspection report.

D. After Engineer's inspection of the subgrade is complete, import 3" of river sand free of rocks and debris greater than .25".

E. Smooth the surface to be lined to obtain a smooth and planar surface having no projections exceeding ¼ inch. Smoothing shall be accomplished by passage of a smooth steel double-drum roller providing 200 pounds per lineal inch of drum width. Two passes of the roller will normally be required, although additional passes may be required if necessary in the Owner's opinion. Winching the roller up and down the slopes may be necessary. Smooth any depressions left by roller edges. Areas too small to smooth with a roller may be smoothed with a tamper or other mechanical means approved by Engineer.

F. Maintenance: Maintain the areas to be lined in good condition, to include maintaining finish grade, elimination of debris, vegetation, and deleterious material, until the lining system has been successfully installed.

3.02 INSTALLATION

A. All liner installation activities are to be observed by the manufacturer certified field technician.

B. Placement:

1. Position liner on previously prepared surface as indicated. Unroll carefully. Avoid stretching. Allow liner to lie in a relaxed state for a minimum of ½ hour prior to seaming.

C. Weather Criteria:

1. The liner installer shall establish site-specific limits of weather conditions including, but not limited to, temperature, humidity, precipitation, wind speed and direction, during which seaming can be conducted. In the absence of more stringent site-specific criteria, the following limitations shall apply:

a. No seaming shall be conducted in the presence of precipitation, such as rain, snow, sleet, dew or fog.

b. No seaming shall be conducted in the presence of high winds, when dirt or debris is blown into seam area, or when seam temperatures cannot be adequately monitored and controlled.

c. Seaming shall not be conducted when ambient temperature falls below 35°F (2° C). The geomembrane installer shall be prepared to preheat the seam area prior to production seaming in accordance with the geomembrane manufacturer's recommendations.

d. Seaming shall not be conducted when ambient temperature exceeds 104°F (40°C).

D. Seams and Laps:

1. Provide personnel handling or applying heat seaming, with protective clothing and other appropriate safety equipment. Perform heat weldable seams using fusion welding equipment or extrusion type of welding equipment in accordance with the manufacturer's requirements. Seams shall be free of wrinkles.

2. Weld seaming equipment shall be capable of continuously monitoring and controlling temperature in the welding contact zone to ensure uniformly satisfactory welds under varying environmental conditions.

3. Joints shall be installed in north/south direction (when possible). Liner shall be overlapped during seaming to not create a waterstop. Minimize seaming in center drainage depression of containment area.

E. Repairs:

1. Make repairs to liner as required or as directed by manufacturer certified field technician with same material as liner. Extend patch 6 inches (150 mm) in all directions from puncture. Use same method as for seams. Repair any areas of liner showing injury from scuffing, penetration by foreign objects, distress from rough subgrade, or other unacceptable conditions.

3.03 ANCHORAGE

A. Provide anchor trenches to the dimensions shown on the drawings, or the manufacturer's recommendations.

B. Anchorage to Structures:

1. Remove curing compounds and coatings from structures in joint areas. Use bonding materials recommended by manufacturer to make joints. Make joint to structures with width indicated. Attach walls and structures using batten bars or by welding to embedded HDPE channels as indicated on the drawings in accordance with manufacturer's recommendations.

C. Embeds shall be but fusion welded together at corners and joints so that the embeds form a continuous point of attachment for the liner without holes or drainage paths that will leak. Additionally, embeds shall be attached to formwork or otherwise held in place so that the embed does not move or become displaced or misaligned during construction and placement of concrete. Holes through embeds caused by the restraints shall be sealed with melted HDPE material or by other approved method.

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3.04 FIELD QUALITY CONTROL

A. Field Tests:

1. Visual Inspection: Visually inspect all field welds. Welds shall be smooth and shall have a neat, even appearance. Allow no "fish mouths" within the seamed area. If fish mouths occur, clearly mark and repair.

2. Perform all testing in field technician's presence. Clearly mark all unsatisfactory areas, and repair. Before beginning each day's seaming, each welding machine operator shall produce a 3-foot long sample weld under identical working conditions. Do not begin actual field seaming until each sample weld has passed the weld strength tests.

3. Perform field testing for 100 percent of the field seams using a vacuum box seam tester operated by a qualified technician or other approved method. Show no leakage for 10 seconds minimum at 10 inches of mercury vacuum minimum.

4. Wedge welded seams shall be air pressure tested in sections of 50 feet or less per ASTM D 5820 at 30 psi for 15 minutes. Ultrasonic testing will not be acceptable.

5. Extrusion Weld Testing: Perform field testing for 100% of the extrusion welded field seams using spark testing. Spark test using a hand-held device with an audible alarm. Clearly mark all unsatisfactory areas and repair. Corner joints shall also be vacuum tested

6. Repair all unsatisfactory areas and seams in strict accordance with liner manufacturer's instructions and satisfactory to field technician. Overlap and cover all holes or unsatisfactory areas as required to attain maximum lining system integrity. Extrusion welding over holes or abrasions is not acceptable.

B. Weld Strength Testing:

1. Submit test data on welded seams identical to those proposed for work on this Project. Submit samples to an independent testing laboratory to perform shear strength tests and peel tests as described in below.

2. Field sampling: Every 400 feet of seam, take samples of field seaming for shear and peel strength testing as described herein. Field technician will select locations of all destructive test samples. Perform destructive shear and peel tests, as well as field tear bond tests. For every sample required above for shear and peel testing, store two (2) additional samples in case further testing should be required. Clearly label each such sample with date, time, location, and welding machine number for third party testing and certification.

C. Destructive test methods:

1. Shear test: Test samples in accordance with ASTM D 4437 methods. Cut dumbbells with the weld located in the center and test to apply a shear to the weld. The weld passes if the recorded stress exceeds 113 pounds per inch of width before the weld fails.

2. Peel test: Test samples in accordance with ASTM D 4437 methods. Test dumbbells with the weld located in the center and stress the top sheet in relation to the over-lapped edge. The weld passes if the recorded stress exceeds 88 pounds per inch of width for wedge weld and 63 pounds per inch of width for extension weld before the weld peels.

D. Field tear bond test methods:

1. Shear test: Apply a shear to the dumbbell sample. The weld passes if the upper or lower sheet fails before the weld fails.

2. Peel test: Peel the weld back until the sheet fails. The weld fails if it peels before the sheet fails.

E. Liner Material Spark Testing:

1. Spark test the entire surface of the containment with a 6-foot-wide brass brush spark tester with audible alarm. Note the location of all leaks and repair appropriately. Testing shall be performed under the observation of the field technician in accordance with ASTM D 6365.

F. Leak testing:

1. After liner installation is complete, test pond for leakage by filling with water. Determine leakage rate. Leakage rate (Q) must not exceed the lesser of 1 gallon per minute or the amount given by the following formula. Q (Leakage rate in gallons per minute) equals A (Area of liner in thousands of square feet) multiplied by the square root of H (Depth of liquid in feet), the product then divided by 80.

3.05 CLEANING

A. Contractor shall remove all equipment from the site, and remove and dispose of all trash, leftover materials, and other debris. Return any disturbed areas adjacent to the construction area to their original condition. Grade, reseed, or replace surfacing if required.

END OF SECTION

SECTION 33 52 19 - FLEET FUEL STORAGE AND DISPENSING SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Packaged above ground fuel storage tank and dispensing system including all wiring, accessories, safety devices, structures and appurtenances required for a complete operating and approved installation.
2. Packaged diesel fuel point of dispense cabinet.
3. Diesel and Gasoline fuel dispensing systems:
    a. Tank mounted fuel pumps.
    b. Tank mounted dispensers.
    c. Piping.
4. Fuel Tank Overfill / Leak Detection System.
5. Fuel Control System.
6. Diesel fuel point of dispense cabinet; only standardized equipment, compatible with diesel fuel are permitted to be used on UPRR.
7. Furnish all labor, materials, tools, equipment, and services for fuel dispensing systems as indicated, in accord with provisions of Contract Documents.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 61 02 – Basic Mechanical Requirments

C. Section 09 90 00 - Painting and Protective Coatings.

D. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

E. Section 33 05 26 - Mechanical Identification.

F. Section 40 05 03 – Piping Materials and Methods

1.03 REFERENCED STANDARDS

A. International Fire Code (IFC):

B. American Society of Mechanical Engineers (ASME):

1. B16.5, Pipe Flanges and Flanged Fittings.
2. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
3. B16.11, Forged Steel Fittings, Socket Welding and Threaded.

C. American Society for Testing and Materials (ASTM):

1. A27, Standard Specification for Steel Castings, Carbon, for General Application.

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2. A36, Specification for Carbon Structural Steel.
3. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

D. National Fire Protection Association (NFPA):
1. 30, Flammable and Combustible Liquids Code.
2. 30A, Automotive and Marine Service Station Code.
3. 70, National Electrical Code.

E. Underwriters Laboratories Inc. (UL):
1. UL Gas and Oil Equipment Directory.
2. File MH7991 and MH9061, Storage of Flammable Liquids.
3. 87, Power Operated Dispensing Devices for Petroleum Products.
4. 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.
5. 330, Hose and Hose Assemblies for Dispensing Flammable and Combustible Liquids.
6. 2080, Standard for Fire Resistant Tanks for Flammable and Combustible Liquids
7. 2085, Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids.

F. Petroleum Equipment Institute (PEI)
1. RP200: Installation of Aboveground Storage Systems
2. RP300: Installation and Testing of Vapor Recovery Systems
3. RP600: Overfill Prevention for ASTs

G. UPRR Fuel Standards
1. Standard 003-015, Overfill Protection
2. Standard 003-16, AST Labeling

1.04 SUBMITTALS

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

B. Approval Submittals:
1. Complete detailed Drawings of equipment provided including dimensions and connection locations.
2. Wiring and control system diagrams and piping layouts.
3. Manufacturer's standard catalog data, prior to the purchase or installation of the particular component, highlighted to show brand name, model number, size, options, performance charts and curves, etc., in sufficient detail to demonstrate compliance with contract requirements on all parts and equipment.
   a. Copy of the Certificate of Approval for all equipment and devices where required by code.

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4. Exterior above ground piping Drawings (minimum scale 1/8 IN equals 1 FT) with information including:
    a. Dimensions of piping from wall surfaces.
    b. Centerline dimensions of piping.
    c. Centerline elevation and size of intersecting conduit/conduit racks, or other potential interferences requiring coordination.
    d. Location and type of pipe supports and anchors.
    e. Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
    f. Line slopes and air release vents.
5. Project Data:
    a. Product technical data including:
        1) Acknowledgement that products submitted meet requirements of standards referenced.
        2) Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
        3) Separate schedule sheet for each piping system scheduled in this Section showing compliance of all system components.
            a) Attach technical product data on gaskets, pipe, fittings, and other components.
6. Test Data
    a. Submit documentation of all test data.
7. Training
    a. Submit training materials per Section 01 61 02.

C. Quality Assurance Submittals.
1. Test reports.
    a. Copies of pressure test results on all piping systems.
    b. Copies of pressure test results on primary and secondary tanks.
    c. Notification of time and date of piping pressure tests.

D. Closeout Submittals:
1. Operation & Maintenance (O&M) Manual Content: Provide O&M manual documentation as required by Division 01.
2. Electronic copies of the manuals are sufficient for initial submittal to Railroad. One hard copy print should be provided to Railroad at completion of the project.

1.05 QUALITY ASSURANCE

A. Fuel pumps and hoses shall be listed by UL and labeled for use with gasoline or diesel, as applicable.

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B. Qualifications:

1. Installer shall have successfully completed at least three (3) projects of the same scope and the same size or larger within the last 6 years.

   a. Installer shall demonstrate specific installation experience in regard to the specific system installation to be performed.

   b. Installer shall have taken, if applicable, manufacturer's training courses on the installation of piping, leak detection, and tank management systems and meet the licensing requirements in the project jurisdiction.

1.06 SYSTEM DESCRIPTION

A. Coordinate with Owner for final fuel system requirements prior to selection/purchase of equipment.

B. The Work shall include the design, fabrication and installation of the entire fuel storage and dispensing system in conformance with pertinent federal, state, and local code requirements.

1. The completed installation shall conform to NFPA and IFC as applicable.

2. Unattended self-service dispensing system shall comply with IFC 2204.3

C. Obtain all applicable permits associated with the fueling facility.

D. For gasoline systems, the work shall include but is not limited to:

1. Install new 1,000 GAL aboveground double wall tank, and associated safety devices.

2. Install fuel piping and associated safety devices.

3. Install tank mounted pump package.

4. Install tank fill box will associated piping, valves, and adapters.

5. Install tank mounted dispenser.

6. Install overfill / leak detection system.

E. For diesel fuel tank systems, the work shall include but is not limited to:

1. Install new appropriately sized aboveground double wall tank, and associated safety devices.

2. Install fuel piping and associated safety devices.

3. Install tank mounted pump package.

4. Install tank fill box will associated piping, valves, and adapters.

5. Install tank mounted dispenser.

6. Install overfill / leak detection system.

F. For diesel fuel point of dispense systems, the work shall include but is not limited to:

1. Install UPRR standard point of dispense cabinet.

2. Install pressure regulator.

3. Install fuel piping and associated safety devices.

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1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment, piping, pipe coatings and pipe jackets during handling using method recommended by manufacturer.

1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to equipment and pipe during transit.

1. Repair abrasions, scars, and blemishes.

2. If repair of satisfactory quality cannot be achieved replace damaged material immediately.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Fleet Fueling System:

a. Convault.

b. Containment Solutions, FUELMASTER.

c. Or equal.

B. Submit requests for "or equal" substitutions in accordance with Section 01 33 00.

2.02 NEW ABOVEGROUND STORAGE TANK

A. New tank shall be rectangular, above ground, fire rated, double wall vault type design

1. Capacity: 1,000 GAL.

2. Fuel: Gasoline.

B. Tank shall be designed with ballistic and vehicle impact protection.

C. Tank system shall be a standard size, standard option tank system or equal.

1. Galvanized materials (zinc coated) shall not be allowed in direct contact with any fuel.

D. The storage tank system must be provided with all safety and overfill prevention devices required by IFC 2006, NFPA 30, NFPA 30A, and local codes.

E. Tank system shall be a factory fabricated, concrete encased storage tank with integral secondary containment, in accordance with NFPA 30 and NFPA 30A.

1. Design and manufacture tank system for horizontal above ground installation.

2. Primary tank:

a. Construct primary storage tank of single wall ASTM A36 steel in accordance with UL 142.

1) Continuous welds on all exterior seams.

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3. The outer surface of the primary steel tank shall be covered by a minimum of 1/4 IN thick Styrofoam insulation panels. Secondary containment:
    a. The secondary containment shall be impervious to corrosion.
    b. The secondary containment shall consist of a 30 mil thick, high density, polyethylene liner enclosing the steel tank and insulation material.
4. The primary steel tank and secondary containment shall be encased by a minimum of 6 IN of 4000 psi strength, monolithically poured, reinforced concrete.
5. Tank system shall conform to the requirements of UL 2085, bear the UL 2085 label and provide at least two (2) HRS fire protection.
    a. No exterior enclosure shall be allowed to cover the reinforced concrete.
6. Skid mount tank system and provide with lifting lugs which allow tank relocation.
7. Provide the tank system with the manufacturer's standard ladder and platform assembly, except as modified herein.
    a. Construct the assembly of structural steel and allow access to the top of the tank system.
8. All openings shall be located in the top of tank.
    a. Provide openings only for access, inspection, filling, emptying and venting of the tank.

F. Tank exterior protective coating: See Section 09 97 50.

G. Tank Piping Penetrations:
1. Pipe penetrations will enter through the top of a tank.
    a. Drains located at the bottom of a primary storage tank will not be allowed.
2. Provide the number of tank piping penetrations as required per Plans.
3. Provide nylon dielectric bushings on all pipe connections to a tank.
4. Pipe connections to a tank shall be through welded-in-place double tapered NPT couplings.
5. Provide the termination of fill lines within a tank with an anti-splash deflector.
    a. Fill line shall terminate within 6 IN from the bottom of the tank.
6. Piping shall be ASTM A53 black steel construction. Minimum wall thickness shall be schedule 40.

H. Tank Atmospheric Venting:
1. Provide pressure vacuum vent designed to provide normal venting for above ground storage tank.
2. Pressure vacuum vent shall be:
    a. OPW, 623V.
    b. Morrison Brothers Figure 748.

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c. Or equal.

3. Vent must be used in conjunction with emergency vent.
   a. Pressure/vacuum vent opening pressure shall be set below that of the emergency vent so that the normal vent relieves first.
4. Vent pipe and vent shall be in accordance with NFPA 30, NFPA 30A, UL 142 and UL 2085.
5. Vent pipe sizing shall be not less than 2 IN nominal diameter.
6. Discharge point shall be at least 12 FT above adjacent ground level.

I. Tank Emergency Venting:
1. Vent shall be designed to relieve only at a pressure setting above that of the normal vent.
2. Emergency vent shall be:
   a. OPW, 201 or 202.
   b. Morrison Brothers Figure 244.
   c. Or equal.
3. Vent shall comply with NFPA 30, NFPA 30A, UL 2085 and UL 142.
4. Vent capacity shall comply with NFPA 30, NFPA 30A, UL 2085 and UL 142 for the size of tank and fuel specified.

J. Tank Overfill Prevention Device:
1. Provide tank with an overfill prevention device installed at the fill port.
2. Device shall stop flow of product when the tank reaches a preset warning level.
   a. Device shall stop flow of product at 95% tank level.
3. Tank overfill prevention device shall be:
   a. OPW, 61fSTOP.
   b. Morrison Brothers Figure 9095A.
   c. Gullotine Fill Limiter.
   d. Or equal.
4. Overfill prevention device shall comply with NFPA 30 and NFPA 30A.
5. Use adapters per manufacturer.

K. Tank Gages:
1. Provide tank with clock gage.
2. Gage shall be activated by float switch.
3. Gage shall be:
   a. Morrison Brothers 818 Series.
   b. Or equal.

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4. Gage shall be accessible and viewable when the tank is filled.
    a. Gage shall be viewable from 20 FT to 30 FT minimum.
    b. Orientate gage facing towards tank load out location.
5. Furnish each tank with two (2) copies of calibrated charts which indicate the liquid contents in gallons for each 1/8 IN of tank depth.

2.03 EQUIPMENT

A. Vehicle Refueling Pump Package and Dispenser:
    1. Provide one (1) tank mounted dispenser. Dispenser can be located on side or front of tank.
    2. Provide dispenser only for use with tank mounted pumps located on the aboveground storage tank.
    3. Dispenser:
        a. Gasoline.
        b. Provide lockable nozzle via padlock.
    4. Corrosion resistant cabinet.
    5. Electric Register: LCD type for 999 GAL delivery with battery backed 999,999 Gal totalizer.
    6. Display on front of cabinet.
    7. Pulser:
        a. Selectable pulse/gallon output: 1, 10, 100, 250, 500, or 1,000 pulses per gallon.
    8. Meter: Multi-piston positive displacement meter accurate to within +/-1 percent.
    9. Solenoid valve: Electrically operated 1 IN, 115 V.
    10. Hose: Smooth bore, 1 IN black rubber, 12 FT long for gasoline.
        a. Provide automatic nozzles, breakaway valves and swivels.
        b. Automatic nozzle:
            1) Restrict flow when tank is full.
    11. Filter and strainer: Suitable for use with gasoline.
    12. Base, frame and panels designed for outdoor use to provide vibration free support and weather protection for items above.
        a. Provide exterior finishes of stainless steel or electrostatically primed and finished with a durable non-fading baked enamel.
        b. Color to be approved by Engineer.
    13. All items UL listed for gasoline as appropriate.
    14. Provide lights to illuminate product panels and register areas.
    15. Provide high post mounted retractors.

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16. Dispenser shall be:
    a. Gasboy,
    b. Tuthill Fill-Rite
    c. Or equal.
17. Pumps:
    a. Pump shall be self lubricating and easily removable without disconnecting discharge piping.
        1) The pump and motor assembly shall be readily separable from the pump column pipe to allow for simple field replacement of pump and / or motor.
    b. Pump shall be provided with check valve, air eliminator, expansion relief valve, siphon nozzle and venturi, siphon check and pressure test screw.
    c. Submersible pumps shall fit standard 4 IN NPT tank openings.
    d. Pump intake inlet shall be horizontal to prevent drawing sediment from the tank bottom into the pump inlet.
    e. Pump manifold shall be completely sealed against product leakage to the ground and water leakage to the tank.
    f. Siphon system shall include integral siphon check valve to maintain liquid level after pump has been de-energized.
    g. Submersible pump for dispensing gasoline:
    h. Flow rate: 15 GPM minimum.
        a) 115 V.
        b) 1/3 HP.
    i. General Description:
        1) Fixed speed.
        2) Pumps shall be Class 1, Group D Atmospheres, UL Listed for specified fuel, 1 PH., 115 V, hermetically sealed motor windings, thermal overload protection. Suitable for exposed outdoor installation.
    j. Pump materials of construction shall be suitable for the fuel pumped as specified.

B. Emergency Switch:
    1. Provide easily accessible emergency switch within 100 FT, but not closer than 25 FT of dispenser for emergency power shut-off.

2.04 ADAPTERS, COUPLERS AND ACCESSORIES

A. Tank Fill:
    1. Tight-Fit Fill Adapter
        a. Provide bronze adapter fitted with a Buna-N or Viton gasket in the API standard 4 IN size.

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1) Adapter shall be a top seal adapter and with a tight-fit connection to prevent vapor emissions during filling.

a) Adapter shall be:

(1) OPW.

(2) Morrison Brothers Figure 800A.

(3) Or equal.

2) Provide adapter with a locking cap.

a) The cap shall mate with the adapter and have a latching mechanism which provides a water tight seal.

b) The cap shall provide some type of locking provision and be easily attachable and removable.

c) Cap shall be:

(1) OPW.

(2) Morrison Brothers Figure 800C.

(3) Or equal.

2. Locking Ball Valve:

a. Provide a UL listed locking full port ball valve for each product fill line.

b. Ball valve: Forged brass body, chrome plated ball, blowout proof stem, Teflon seals, and carbon steel handle.

c. Ball valve shall be:

1) Morrison Brothers Figure 691B.

2) OPW, 21 BV (with locking handles).

3) Or equal.

3. Check Valve:

a. Provide a swing check valve for each product fill line.

b. Check valves shall be constructed for use with fuel types as specified.

c. Check valves shall be:

1) Morrison Brothers Figure 246.

2) OPW, 175.

3) Or equal.

4. Overfill Prevention Valve:

a. See Part 2.02.K of this Specification Section.

B. Tank Fill Spill Container:

1. Provide a UL listed tank mounted spill container with tank for use during tank filling operations.

2. 12 gage powder coated steel construction or stainless steel.

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3. Minimum capacity of 15 GAL.
4. Container shall have a pedestal mount, lockable lid, and a 1-1/2 IN drain with lockable ball valve.
    a. Valve shall be normally closed to release spilled product into the primary steel tank.
5. Spill container shall be:
    a. Morrison Brothers 515 series.
    b. Pomeco/OPW, 211-RMOT.
    c. Or equal.

C. Fuel Discharge Line Accessories:
1. External Emergency Valve:
    a. Provide an external emergency valve in each product discharge line.
    b. Valve shall have a fusible link. Valve shall activate and stop flow in the event of a fire.
    c. External Emergency Valve shall be:
        1) Morrison Brothers Figure 346.
        2) OPW, 1785.
        3) Or equal.
2. Solenoid Valve:
    a. Provide solenoid valve in each product discharge line.
    b. Valve shall be normally closed and shall open upon receipt of an electronic signal from fuel control system when switched on.
    c. Operates on 120 volts.
    d. Enclosure shall be watertight and rated for hazardous locations – NEMA 3, 4X, 7 and 9; groups C and D.
    e. Built-in expansion relief.
    f. Soleniod valve shall be:
        1) Morrison Brothers Figure 710.
        2) OPW, 821.
        3) Or equal.
3. Expansion Relief Valve:
    a. Provide an expansion relief valve in each product discharge line.
    b. Valve shall be used for relief of excess pressure, product shall return back to storage tank.
    c. Expansion relief valve shall be:
        1) Morrison Brothers Figure 78DI.

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2) OPW, 82RV.

3) Or equal.

D. Fire extinguishers:

1. Provide a minimum of one (1) fire extinguisher per IFC 2205.5.
   a. Minimum rating of 2-A: 20-B: C per IFC 2205.5.
2. Locate extinguisher as shown on Drawings.

E. Warning signs:

1. Provide warning signs per IFC and/or NFPA.
2. See Section 33 05 26 for additional information.

2.05 FUEL TANK MONITORING SYSTEM

A. Electronic Overfill / Leak Detection Panel:

1. Panel produce an audible and visual alarm in the event of a detected leak or tank overflow
   a. Audible alarms shall be a buzzer sounding at 70 decibels or greater.
   b. Each visual alarm shall indicate the type and location of the alarm condition.
   c. Visual alarms shall be capable of delineating between individual alarm conditions.
2. Panel shall initiate a remote tank fill audible/visual alarm at 90 percent tank level; State of Texas mandates audible/visual alarms at 85%
   a. Alarm device shall be located near tank fill box in view of operator.
   b. Alarm shall be manually acknowledged by switch located at alarm.
3. Panel shall provide a means of delineating between individual alarm conditions.
4. House panel in a NEMA 4 enclosure.
5. Panel using computer memory shall be capable of maintaining current programmable information in the event of a power failure.
6. Provide panel with a manual acknowledge switch which shall be capable of deactivating the audible alarm.
   a. The acknowledge switch shall not be capable of deactivating subsequent audible alarms unless depressed manually again for each occurrence.
   b. Under no circumstance shall this acknowledgement switch extinguish the visual alarms until the alarm condition has been corrected.
7. Panel shall be capable of producing hardcopy printouts of all tests and/or leak notification reports.

B. Aboveground Vaulted Tanks:

1. The interstitial space of each vaulted tank shall be continuously and automatically monitored to detect breaches in the integrity of the primary tank and the exterior vaulted shell.

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2. The interstitial space shall be monitored by an electric leak detector.
    a. Sensors shall be intrinsically safe for use in Class 1, Division 1, Group D environment as defined by NFPA 70.
    b. Sensors shall be easily removed from the tank.
    c. Sensors shall be compatible with the electronic monitoring panel.
    d. Sensors shall be UL listed.

2.06 DIESEL FUEL POINT OF DISPENSE CABINET

A. UPRR stock item 315-1083, Diesel Dispensing Cabinet, Snyder part number SECO-PC-DFO-M1

B. Cla-Valve 90-50 DS.SS.SS.150s pressure reducing valve with CRA pressure reducing control

2.07 OIL COMMODITY STRAINERS

A. Strainer shall be in-line basket type strainer. The housing and flanges shall be carbon steel with a 304 stainless basket. Seals shall be Teflon and base seal shall be FKM (Viton). Maximum working pressure shall be 285 psi at 100 degrees F. Strainer shall be 40 mesh for diesel fuel oil systems; 20 mesh for all other oil commodities. Strainer shall be FMC Technologies Smith Meter 2" – 8" In-Line Series Strainer or approved equal.

B. Body shall have a bolted cover for easy removal of the basket.

C. Body shall include a ¾" NPT drain connection with ball valve and cam and groove connection with dust cap.

D. Piping connections shall be in-line ANSI 150-pound raised face flanged.

E. A 0-5 PSI, diaphragm type, differential pressure gauge shall be plumbed from the inlet port of the strainer (high pressure) to the outlet of the strainer (low pressure). The gauge body shall be 304/316 stainless steel 600 PSI minimum working pressure. Seals and diaphragm shall be FKM (Viton) elastomers. The gauge shall be connected with 1/4" diameter stainless steel tubing. Gauge shall be Mid-West Instruments model 522 or approved equal.

    The gauge face shall be color coded as follows:

    1. 0-3 PSI range - Green (Normal)
    2. 3.0-4.0 PSI range - Yellow (Inspect and clean)
    3. 4.0-5.0 PSI range - Red (Dirty)

F. Instrument Tubing:

    1. Material shall be ASTM A269 Type 304 annealed stainless steel.
    2. Wall thickness shall be as required by the fittings, but not less than .049".

G. Fittings:

    1. Manufacturer shall be Parker-Hannifin "Ferulok" or Swagelok stainless steel bit-type tube fittings for flareless tubes."

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PART 3 - EXECUTION

3.01 INSTALLATION

A. The fuel storage tank and dispensing system must be installed by or under the supervision of a licensed motor fuel tank installer.

B. The installation of the aboveground motor fuel storage tank and dispensing system must comply with the provisions of NFPA 30, NFPA 30A, IFC 2006 and local codes.

C. Handle storage tanks with extreme care to prevent damage during placement and install in accordance with the manufacturer's installation instructions and NFPA 30 or NFPA 30A, as applicable.

D. Inspect the exterior surface of each tank for obvious visual damage prior to the placement of each storage tank.

1. Correct surface damage to a storage tank according manufacturer's requirements before proceeding with the system installation.

E. Field Painting:

1. Painting required for surfaces not otherwise specified, and finish painting of items only primed at the factory, shall be painted, piping shall be painted, and have identification markings applied as specified in Section 09 90 00.

3.02 TESTS

A. Aboveground Storage Tank Tightness Tests:

1. Testing shall meet the requirements of UL 142 and UL 2085.

2. Pressure tests shall be performed in the presence of a Fire Department representative.

3. Perform a tightness test on each aboveground storage tank.

a. Perform the tests prior to making piping connections.

4. Tests shall be capable of detecting a 0.1 gph leak rate from any portion of the tank while accounting for effects of thermal expansion or contraction.

5. Gages used in the tightness tests shall have a scale with a maximum limit of 10 psig.

6. Hydrostatically pressurize test each storage tank compartment to 20 psig and monitored for a drop in pressure over a 2 HR period during which there shall be no drop in pressure in the tank greater than that allowed for pressure variations due to thermal effects.

a. Pneumatic test the annual space at three (3) psig.

b. Any test failure shall require corrective action and retest.

7. Piping shall be hydrostatically tested at 100 psig and monitored for a drop in pressure over a 2 HR period during which there shall be no drop in pressure in the tank greater than that allowed for pressure variations due to thermal effects.

a. Any test failure shall require corrective action and retest.

B. Manufacturer's Tank Tests:

1. Following the tank tightness test, leak test each storage tank in accordance with the manufacturer's written test procedure if the manufacturer's test procedure is different from the tightness tests already performed.
2. Any test failure shall require corrective action and retest.

C. System Performance Tests:

1. After all components of the system have been properly adjusted, test the system to demonstrate that the system meets the performance requirements for which it was designed.
2. Test the maximum rated capacity of the system by using several tank trucks simultaneously, if applicable.
    a. The use of tank trucks shall be coordinated with the Project Representative prior to testing.
3. If any portion of the system or any piece of equipment fails to pass the tests, the Contractor shall make the necessary repairs or adjustments and the test shall be repeated until satisfactory performance is obtained from the Project Representative.
4. The tests shall demonstrate the following:
    a. The capability of each fuel pump to deliver the indicated flow of fuel.
    b. The alarm and control panels are operational and perform as designed.
    c. Each fuel meter is operating accurately.
    d. Vent piping is clear of debris and each pressure/vacuum relief vent is operating properly.
    e. Dispensor and nozzles are operational and perform as designed.
    f. Fuel filtration system is operational and performing as designed.
    g. Each safety device works properly and is tested per NFPA requirements as necessary.

D. High Liquid Level Alarm Test:

1. Each storage tank compartment shall be initially overfilled with the appropriate product in order to verify the high liquid level alarms in the remote alarm panel function as designed.
2. The initial overfill shall also verify that the storage tank overfill protection.

3.03 FLUSHING, CLEANING AND ADJUSTING

A. Following installation and equipment testing but prior to system performance testing, the following flushing, cleaning, and adjustments shall be performed.

1. Initial System Cleaning:
    a. Visually inspect and clean free of debris, dust, and moisture the interior of each fuel storage tank before filling. Cleaning products shall be compatible with tank material and gasoline. Verify use of cleaning material with tank manufacturer prior to use.

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b. In the event of entry into a storage tank, the Contractor shall ensure a safe atmosphere exists.

c. Contractor shall remove all preservatives and foreign matter from valves, line strainers, pumps, and other equipment coming in contact with fuel.

d. No fuel will be delivered to the system until the Contractor has satisfactorily completed this initial system cleaning.

2. Initial Fuel Supply:

   a. Following the preparations for flushing, fill each storage tank to a 25 percent capacity with the proper fuel according to the fueling system's final operational requirements.

   b. Following the initial fuel supply, measure and record each storage tank's fuel temperature and liquid level.

      1) The liquid level shall be measured using a manual tank gage.

3. Dispensing Flushing:

   a. Fuel shall be pumped at the system's maximum design flow rate from a storage tank through the fuel supply piping, through dispenser, and then into an empty fuel truck or tank as supplied by the Project Representative.

   b. Periodic samples for inspection by the Project Representative shall be taken during the flushing procedure.

      1) A minimum of 100 GAL shall be flushed through each hose reel nozzle.

      2) The flushing procedure shall be continued until the fuel being delivered is acceptable to the Project Representative.

      3) Each dispensing line shall be flushed in the exact same manner.

4. Disposal of Initial Fuel Supply:

   a. In the event the fuel contained in the piping system at the conclusion of the flushing operation is not considered by the Project Representative to be of satisfactory quality for the desired use, the Contractor shall be responsible for pumping out the entire fuel supply from the storage tanks and the piping system.

   b. Disposition of the fuel removed from the system shall be the responsibility of the Contractor.

5. Initial System Adjustments:

   a. Following the flushing and cleaning operations, each system component shall be initially adjusted, if necessary, to meet the system's final operational requirements.

   b. The Project Representative will deliver enough fuel to the storage tanks to enable the Contractor to make final adjustments to equipment and controls.

   c. Flow rates and pressures shall be adjusted as required to meet the indicated requirements.

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d. The sequence of control for each component shall be adjusted to meet the indicated system requirements.

e. Following the initial system adjustments, the equipment tests shall be performed in order to determine any necessary final system adjustments.

3.04 TRAINING

A. Contractor shall conduct a training course for the operating staff as designated by the Project Representative.

1. The training period shall consist of a total of 8 HRS of normal working time and shall start after the system is functionally completed but prior to final system acceptance.

2. The field instructions shall cover all of the items contained in the operation and maintenance manuals as well as demonstrations of routine maintenance operations.

3. For additional training requirements see section 01 61 02.

END OF SECTION

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SECTION 33 56 05 - TEMPORARY CLOSURE AND RETURN TO SERVICE FOR ABOVEGROUND PETROLEUM STORAGE TANKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Preparation of aboveground storage tanks containing diesel fuel for removal from service and temporary closure.
2. Preparation of aboveground storage tanks for diesel fuel storage for placement back in service.

B. Work Furnished by Owner:

1. Tank cleaning will be done under separate contract by the Owner.
2. Removal of tank gauging equipment associated with the Fuel Management System (FMS), if present, will be done under separate contract by the Owner.
3. Cathodic Protection System, if present, will be modified and monitored under separate contract by the Owner.
4. Tank inspections will be done under separate contract by the Owner.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 09 97 50 – Fuel and Oil – Tank and Pipe Coatings

B. Section 33 56 10 – Aboveground Petroleum Tank Cleaning

C. Section 33 56 15 – Aboveground Petroleum Storage Tank Inspection

D. Section 01 61 02 - Basic Mechanical Requirements

E. Section 40 05 03 – Piping Materials and Methods

F. Section 26 05 00 – Electrical Basic Requirements

1.03 REFERENCED STANDARDS

A. UPRR Standard Practice

1. Aboveground Storage Tank Labeling

B. National Fire Protection Association (NFPA)

1. NFPA 30 Flammable and Combustible Liquids Code
2. NFPA 70 National Electrical Code
3. NFPA 326 Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair

C. International Fire Code

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D. American Petroleum Institute (API)

1. API STD 650 Welded Tanks for Oil Storage
2. API STD 653 Tank Inspection, Repair, Alteration and Reconstruction
3. API STD 2000 Venting Atmospheric and Low-Pressure Storage Tanks
4. API STD 2015 Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

E. Occupational Safety and Health Administration (OSHA)

1. 29CFR1910.146 Permit Required Confined Spaces

F. Local Codes and Standards as Applicable

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Submit the following:

1. One (1) copy of written Confined Space Entry Program outlining procedures for preventing unauthorized entry, identifying and evaluating hazards, testing and monitoring conditions, training, rescue and safe entry for both "Permit-Required" and "Non Permit-Required" confined spaces.
2. Tank stabilization calculations as indicated below.
3. Submit applicable materials as required by Related Requirements (Sections).

1.05 QUALITY ASSURANCE

A. Company specializing in performing the work of this section with minimum documented experience as outlined in Related Requirements (Sections).

PART 2 - PRODUCTS

2.01 MATERIALS

A. Piping materials, including blind flanges, gaskets, bolts, nuts, etc. shall be provided per section 40 05 03 Piping Materials and Methods.

B. Coatings shall be provided per section 09 97 50 – Fuel and Oil – Tank and Pipe Coatings.

C. Tank labeling shall be per UPRR Standard Practice, Aboveground Storage Tank Labeling.

1. "Tank Out of Service" decal, 3" letters on black background, 5" x 20", UPRR Stock Item #315-1130.
2. Decals shall be applied using UPRR Stock Item #412-0391 spray adhesive on the tank and around the edges.
3. Date of out of service event will be stenciled on tank
4. Report of tank status change will be reported to the UPRR project point of contact. UPRR project POC is responsible for notifying the environmental management group for SPCC plan updates reflecting change in tank status upon completion.

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PART 3 - EXECUTION

3.01 PREPARATION

A. The Owner will remove all fuel from the tank and perform tank cleaning prior to the work required in this specification.

B. Furnish all necessary clothing and equipment required for the work and protection of personnel and property.

C. Review inspection reports and/or drawings of the tank to be closed. Brief proper personnel on the location of sumps or other tank appurtenances considered hazardous to personnel.

D. Prepare the tank and personnel for tank entry as required the Confined Space Entry Program.

E. Lockout/Tagout all associated equipment feeding, drawing from or connected to the tank.

1. For locations where the tank being closed is the only tank, leave lockout/tagout measures in place after the work is complete.

2. For locations where there is more than one tank, ensure that the systems are placed back in service after the prescribed tank closure measures have been put in place.

F. Drain down any piping associated with the tank as required. Coordinate any fuel system disruptions with the Owner prior to beginning the work.

G. Confirm material ordered for tank outage is compliant and complete prior to work commencement.

3.02 INSTALLATION

A. General

1. Maintain a vapor-free condition throughout the course of the work inside the tank. The air movers if required shall be non-sparking, explosion-proof, electrically operated or air-driven exhaust type.

2. Safeguard the tank from unauthorized entry during the entire course of the work, until all nozzles and manways have been closed.

B. Tank Nozzles and Associated Piping

1. Remove all shell nozzle valves. Blind flange any tank nozzle flanges and cap any threaded or coupling connections. Blind flanges shall have the prescribed gaskets and threaded connections shall have appropriate thread compound as specified in section 40 05 03.

a. For valves that are in working condition, clean valves with high pressure water and steam as required by UPRR project point of contact. Prepare for long term storage by lubricating per manufacturer's recommendations. Palletize and wrap valves and ship to the following address:

MBA Engineering, Inc. Attn: VMI Process

8651 Naples St NE, Suite 200

Blaine, MN 55449

b. For valves that are not in working condition, dispose of in an approved bins/facility.

2. Blind flange or cap associated piping.

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a. For locations where the tank being closed is the only tank, system decommissioning will take place and be under separate contract.

b. For locations where there is more than one tank, pressure test blind flanges and caps after installation to ensure there are no leaks when the system is placed back in service.

C. Tank Venting

1. Inspect and ensure that all normal tank vents are free and clear of debris. Clean as required.

2. Any emergency tank venting devices or valves shall be left in place.

D. Electrical

1. Disconnect and terminate any electrical service if present to devices associated with the tank. DO NOT disconnect any cathodic protection system rectifiers.

2. Coordinate removal of MTS gauge, if present, with the Owner.

3. Grounding to remain in place if present.

E. Cathodic Protection Systems

1. Cathodic protection systems if present shall be left in place and remain energized. Rectifiers will continue to be monitored by the Owner.

2. If the rectifier is not functioning, notify the Owner immediately.

F. Tank Stabilization

1. Provide calculations by a registered professional engineer (within the jurisdiction of the tank) certifying that the tank anchorage, if present, will prevent overturning or other damage to the tank and foundation due to, but not limited to, wind loads, buoyancy loads if the containment becomes flooded, etc.

2. If the tank is not anchored, said engineer shall either provide calculations that show anchorage is not required, or a design to protect the tank from damage, which may include internal ballast, external anchorage, and any additional information mandated.

3. Contractor shall implement the required tank stabilization recommendations once they are approved by the Owner.

G. Labeling

1. Apply required labels per UPRR Aboveground Storage Tank Labeling standard.

3.03 RETURN TO SERVICE

A. Tank Inspection

Tank shall be inspected per API 653 and all recommended repairs made and testing done prior to tank being placed back in service.

B. Coatings

1. Verify coating thickness and integrity on the interior of the tank if present. Repair as required.

2. If no coating is present on the tank interior, coat per Section 09 97 50 – Fuel and Oil – Tank and Pipe Coatings.

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C. Tank appurtenances

1. For nozzles 8-inches and smaller, install new ball valves, gaskets, bolts and nuts per Section 40 05 03 Piping Materials and Methods.
2. For nozzles 10-inches and larger, install new high performance butterfly valves, gaskets, bolts and nuts per Section 40 05 03 Piping Materials and Methods.
3. Reinstall MTS gauging if removed; no alternates without approval.
4. Inspect and ensure that all normal tank vents are free and clear of debris. Clean as required.
5. Inspect and ensure that all emergency venting devices are functional.
6. Reconnect any electrical appurtenances that were disconnected.
7. Test all tank level and gauging systems. Calibrate as required per manufacturer's recommendations.
8. Verify and test all overfill systems.

D. Piping

1. Remove all blind flanges and plugs and reconnect all piping that was disconnected from the tank.
2. New piping and associated materials shall conform to Section 40 05 03 Piping Materials and Methods.
3. Test all piping for leaks prior to placing tank back in service.
4. Report of tank status change will be reported to the UPRR project point of contact. UPRR project POC is responsible for notifying the environmental management group for SPCC plan updates reflecting change in tank status upon completion.

END OF SECTION

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SECTION 33 56 13 - ABOVEGROUND PETROLEUM STORAGE TANKS - FIELD ERECTED

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Design, fabrication and erection of API-650 field fabricated, welded steel aboveground fuel storage tanks and associated appurtenances. The tank shall be used to store {Storm Water} {No. 2 diesel fuel} with a specific gravity of {1.0 for water} {.84 to .88. for diesel}

   a. The tank shall be{Tank Diameter In Feet} in diameter by {Tank Height In Feet} tall with a nominal capacity of {Number of Barrels} barrels or {Number of Gallons}.

   b. The designed flow rate into and out of the tank is {Flow Rate # In GPM} gpm.

B. Provide tank with cathodic protection. Design and install Cathodic protection system to conform to NACE Publication SP0169-2007 Current Edition - Standard Practice, Control of External Corrosion Underground and Submerged Metallic Piping Systems. Design and installation shall be by individuals certified by NACE.

C. Provide tank grounding per UPRR Electrical Specification 26 05 26 - Grounding and Testing.

D. Tank to be weakened roof to shell design.

E. Wind, temperature, and seismic conditions shall be site specific. Fabricator to verify these conditions with the locales building codes authority.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

B. 40 05 53 – Mechanical Identification

C. 40 46 50 – Cathodic Protection Impressed Current

1.03 REFERENCED STANDARDS

A. American Petroleum Institute (API):

1. 650, Welded Steel Tanks for Oil Storage

2. 2000, Venting Atmospheric and Low-Pressure Storage Tanks.

B. ASTM International (ASTM):

1. A36, Standard Specification for Carbon Structural Steel.

C. UPRR Standard Practice – Bulk Product Tank Roof Hand Rail Detail

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1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop drawings required by this Section include, but are not limited by, the following:

1. Aboveground tanks including all accessories and appurtenances.

2. Contractor to submit an internal laser strapping chart of the tank, stamped and dated by a registered Professional Engineer of the state where the tank is erected.

C. Contractor shall perform radiographic weld and vacuum box testing and provide the test locations and the results of tests. Results will be either "Pass" or "Fail". If the results were "Fail" contractor shall document what corrective actions were taken, re-test results showing "Pass", and certification of weld(s) tested.

D. All results of tests referenced in this Specification.

E. Certificates:

1. Welding Procedure Specifications (WPS)

2. Welding Procedure Qualification Records (PQRs)

3. Welder Performance Qualification Records (WPQ)

4. Qualifications of Tank Erector

5. Qualifications of API Std 653 Inspector

6. Weld Inspector Certification

7. NDE Personnel Certification

8. Qualifications of Testing Agency

9. Tank Calibration Experience

1.05 QUALITY ASSURANCE

A. The tank manufacturer and installer shall have a minimum of five (5) years experience in design and erection of API-650 storage tanks of similar size.

PART 2 - PRODUCTS

2.01 ABOVEGROUND TANKS

A. The aboveground storage tank shall be designed, fabricated, and erected in accordance with the latest revision of API-650 – Welded Steel Tanks for Oil Storage

B. Fixed cone style roof (1:10 pitch) with center and rafter support. Connection with the shell shall have top angle turnout. Lap roof 3/16 IN minimum.

C. Fabrication of steel plates conforming to ASTM A36. Plate thickness shall be in accordance with API 650 with 1/16 IN additional thickness for corrosion allowance for the bottom plates, first shell course, and structural steel members.

D. The tank shall be furnished with connections for the following accessories, size as required unless specified:

1. Roof access manhole (36 IN).

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2. Roof access inspection manhole (24 IN) placed 16 IN to 36 IN from outside face of tank.
3. Varec Model 6700 Storyboard Level Gauge, with Varec Model 226 – 24 IN manhole cover, and Varec Model 228 inspection hatch.
    a. Contractor shall mount storyboard supports @ 4 FT-0 IN OC using locknuts.
4. Magnatrol High level and High-High level switches – Provide one (1) of each with the following:
    a. Stainless steel construction and displacers.
    b. 150# 4" flanged connection.
    c. Double pole, double throw switches.
    d. Magnatrol "Proof-er" test mechanism and chain.
5. MTS Level Gauge (4 IN flanged).
6. Pressure/Vacuum vent – sized according to API 650 design variables.
7. Drain line (3 IN) and water draw off (1 IN), valves to be lockable ball type valves.
8. Tank suction {6 IN, 8 IN, 10 IN, 12 IN verify with project manager} with 150 LB flanged nozzle)
9. Tank fill {6 IN, 8 IN, 10 IN, 12 IN verify with project manager} provided with 150 LB flanged interior 90 degree discharge nozzle.
10. Spare {6 IN, 8 IN, 10 IN, 12 IN verify with project manager} shell nozzle with blind flange.
11. Emergency vent – per API 650 design variables.
12. Shell manhole (Two (2) each. 36 IN – Hinged).
13. Floating suction.

E. The tank shall be externally painted and fully internally coated as specified in Section 09 90 01 – Paint and Protective Coatings.

F. Label the tank shell as indicated on the drawings.

G. Fill and suction connections to the tank shall have dielectric isolation flanges.

2.02 TANK ACCESSORIES

A. Floating suction – Provide a floating suction swing joint complete with supports, height limiting chain, turndown elbow, with anti-vortex baffle, and swing joint as detailed on the drawings. Floats shall be sized to ensure flotation of the complete swing line assembly for a specific gravity of {1.0 for water} {.84 to .88. for diesel}. Swing joint shall be Staytite or equal.

B. Gauge and sampling hatch – Shall be 4 inch flanged with spark-proof cover. Varec Model 42 or equal.

C. Pressure/Vacuum vent – Vent shall be in accordance with API 2000 and set to maintain a maximum of 1/2 OZ/SQ IN pressure and vacuum. Varec Model 2010B or equal.

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D. Emergency vent – Provide an emergency vent in accordance with API 2000 set at one ounce per inch. Varec 221 or equal.

E. High-level switch – Shall be Magnatrol "Proof-er" Series Place Magnatrol (narrow differential) Part Number Here displacement-type level switch, 120 vac, magnetic snap, DPDT (Double Pole, Double Throw) switch. Activation level shall be set as directed on the drawings or as directed by the Engineer.

F. Level gauges:

1. Electronic gauge – MTS Systems Corporation Level Plus M-Series Digital Level Gauge:

a. Stainless steel construction, Nitrophyl floats for product level.

b. Rigid gauge for probe lengths of 25 FT-0 IN or lower. Flexible gauge with bottom magnet for gauges longer than 25 FT-0 IN.

c. Single chamber enclosure, single 4-20mA continuous outputs.

d. Level monitor readout:

1) Remote-mounted 6 digit with floating decimal, 1 IN high numerals, red LED digital display in feet with NEMA 3 enclosure.

2) 110 Vac powered, two (2) 24 Vdc loop power supplies, two (2) programmable alarm relay/set points.

3) Mount display where indicated on the drawings.

2. Mechanical gauge – Varec 6700 or equal board gauge. Accuracy 1 IN, indication in feet and inches, aluminum board with vinyl face, complete with all mounting and anchoring hardware.

G. Spiral Stair – Shall be in accordance with OSHA extending from grade level to the tank roof. Handrail and toe boards at the top of the tank shall extend the full perimeter of the tank.

1. If stairs are to be welded into place, welds shall not be re-welded over previous placed tank welds.

H. Grounding Lugs – Provide grounding lugs, four (4) per tank for exothermic type field connection of #2 bare copper tank grounding wire. Connect grounding wires to 3/4 IN x 10 FT-0 IN long ground rods and connect ground rods together with #2 bare copper wire. Coordinate with Division 26 - Electrical requirements.

PART 3 - EXECUTION

3.01 TESTING OF WELDED JOINTS

A. Testing of welded joints shall comply with all requirements of API-650 (notably Sections 5 and 6) as well as the following:

1. Provide the testing services of an independent testing laboratory to perform all radiographic examination of welds. The testing laboratory shall submit test results directly to the Engineer with copies to the manufacturer. All defective welds shall be removed and re-welded at the Manufacturer's expense.

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2. All tank bottom fillet welds shall be subjected to a soap test, from the inside, using a vacuum device prior to application of internal coating and hydrostatic testing.

3. The initial pass of the shell-to-bottom weld shall be tested using a "diesel" test.

   a. The "diesel" test shall consist of spraying the weld with diesel fuel, and after (a prescribed time period) checking the reverse side to see if any diesel fuel is present.

B. After all joint tests are completed and all appurtenances are installed, the interior of the tank shall be cleaned of all debris and inspected by the Railroad's Representative prior to hydrostatic testing.

3.02 HYDROSTATIC TEST

A. The Contractor shall provide all temporary equipment, accessories, hoses, and connections necessary for performing the test. The Railroad will provide a water hydrant that can be used for the test. The Contractor is responsible for removing water from the tank and piping and discharging it into the Railroad's storm sewer connection. The Contractor shall also contact the local municipality to determine the acceptable flow rate.

B. The Tank Manufacturer shall notify the Railroad's Representative a minimum of seven (7) days prior to commencing the test. An estimate of the total filling time should also be given. The water test shall be completed prior to tank painting or connection to external piping.

C. Tanks shall be filled to the top of the shell and then drained to a level of 6 IN below the top. Tanks shall be allowed to stand filled for a minimum period of 48 HRS.

D. The Contractor shall monitor for leaks and record any settlement of the tank during the hydrostatic test. Settlement checks shall be made at the four (4) compass points of the tank. Submit test results to the Engineer.

E. Record and verify level gauge, and high level settings when filling the tank for hydrostatic test.

END OF SECTION

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SECTION 33 56 15 - ABOVEGROUND STORAGE TANKS - SHOP FABRICATED

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Design, fabrication and erection of Aboveground UL tanks with tank volumes of 500 to 30,000 U.S. gallons and their associated appurtenances.

2. Both single wall and double wall UL tanks.

B. Wind, temperature, and seismic conditions shall be site specific. Fabricator to verify these conditions with the local building code authority.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 09 90 01 – Painting and Coating

B. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

C. Section 33 05 26 – Mechanical Identification

D. Section 40 46 50 – Cathodic Protection – Impressed Current

E. Section 40 46 51 – Cathodic Protection - Galvanic

1.03 REFERENCED STANDARDS

A. Underwriters Laboratories Inc. (UL):

1. 142, Steel Aboveground Tanks for Flammable and Combustible Liquids.

2. 2080, Standard for Fire Resistant Tanks for Flammable and Combustible Liquids

3. 2085, Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids

B. ASTM International (ASTM):

1. A36M, Standard Specification for Carbon Structural Steel.

C. Occupational Safey and Health Administration (OSHA)

1. 1910.D. Walking and Working Surfaces

D. National Fire Protection Association (NFPA)

1. 30, Flammable and Combustible Liquids Code

1.04 NOMINAL TANK DIMENSIONS

Tank Volume (in gallons)	Tank Diameter	Tank Height
500	4 FT-0 IN	5 FT-5 IN
1,000	5 FT-4 IN	6 FT-0 IN
1,400	5 FT-4 IN	8 FT-5 IN
2,000	5 FT-4 IN	12 FT-0 IN

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3,000	5 FT-4 IN	18 FT-0 IN
5,000	8 FT-0 IN	13 FT-4 IN
6,000	8 FT-0 IN	16 FT-0 IN
8,000	10 FT-0 IN	14 FT-0 IN
10,000	10 FT-0 IN	17 FT-0 IN
12,000	10 FT-0 IN	20 FT-6 IN
15,000	10 FT-0 IN	25 FT-6 IN
16,000	10 FT-0 IN	27 FT-2 IN
20,000	10 FT-0 IN	34 FT-0 IN
25,000	10 FT-6 IN	38 FT-9 IN
30,000	10 FT-6 IN	46 FT-6 IN

1.05 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop drawings required by this section include, but are not limited by, the following:

1. Aboveground tanks including all accessories and appurtenances.

C. Qualifications of:

1. Manufacturer
2. Installer

1.06 QUALITY ASSURANCE

A. Tank manufacturer and installer shall have a minimum of 5 years experience in design and erection of UL 142 storage tanks of similar size.

PART 2 - PRODUCTS

2.01 ABOVEGROUND TANKS

A. Aboveground storage tank shall be designed, fabricated, and erected in accordance with the latest revision of applicable UL standard for a Seismic Zone as indicated in local building codes.

B. Fixed cone style roof (1:10 pitch) with center and rafter support. Connection with shell shall have top angle turnout. Lap roof 3/16 IN minimum.

C. Fabrication of steel plates conforming to ASTM A36M. Plate thickness shall be in accordance with UL 142 with 1/16 IN additional thickness for corrosion allowance for the bottom plates, first shell course and structural steel members.

D. The tank shall be furnished with connections for the following accessories, size as required unless specified:

1. Roof Access Manhole (36 IN).
2. Story Board Connection (1-1/2 IN, NPT threaded connection w/ 6 IN nipple).
3. High Level Switch (4 IN, 150 LB flanged connection).

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4. Level Gauges – Electronic (4 IN, 150 LB flanged connection).
5. Pressure / Vacuum Vent.
6. Water Draw-Off (decant) line (1 IN with valve, locked).
7. Tank Suction ({2 IN, 4 IN, 6 IN, 8 IN verify with project manager}, 150 LB flanged connection).
8. Tank Fill ({2 IN, 4 IN, 6 IN, 8 IN verify with project manager}, 150 LB flanged connection) – provided with interior 90 degree discharge nozzle.
9. Two (2) Spare (4 IN 150 LB flanged connection) with blind flange.
10. Emergency Vent.
11. Shell Manhole (36 IN, hinged).

E. Tank shall be externally painted and fully internally coated as specified in Section 09 97 50.

F. Tank Labeling: Tanks should be labeled as shown on the drawings, stenciled in black and include the following information:
1. Union Pacific Shield – per Union Pacific Graphic Standards.
2. Commodity Contained Within the Tank – i.e., Diesel Fuel, Storm Water, Used Oil, etc.
3. Tank Capacity – in gallons – use comma for 1,000 separator.
4. Nozzle indicators – Water Draw-Off, Suction, and Fill.
5. Tank overfill protection level gauge mark
6. NFPA (National Fire Protection Association) Diamond Codes, see NFPA 704 Placarding table at the end of this Section.

G. All piping connections to tank that have cathodic protection shall have insulating flange kits at the first flange connection from the tank to the pipe.

2.02 DOUBLE WALLED TANKS

A. Double walled tanks shall be constructed similarly to single walled tanks, and shall include all tank accessories as noted.

B. All tank penetrations for double walled tanks shall be made at the top of tank, or where otherwise indicated by the design engineer.

C. For double wall tanks, provide a monitoring tube the height of the tank and topped with 2 IN diameter threaded fitting for monitoring the interstitial space between the inner and outer walls.
1. Interstitial monitoring tube shall be provided with a warning label identifying it as a monitoring tube only.
2. Provide optic leak detection switch. See Part 2.03.I.1 for requirements.

2.03 TANK ACCESSORIES

A. Pressure / Vacuum / Emergency Vent: Vent shall be in accordance with UL 142.

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B. High-level switch: Magnatrol "Proof-er" series displacement-type level switch, 120 VAC, non-mercury, double pull double throw (DPDT) switch. Activation level shall be set as directed on the drawings or by the Engineer.

C. Level Gauges:

1. Electronic Level Gauge: MTS Level Plus M-Series

a. Model – Magnetostrictive Level Sensor.

b. Type – Digital Output Level Transmitter.

c. Input Power – 24 VDC.

d. Output – MTS DDA Protocol.

e. Housing Type – NEMA 4X, 316L stainless steel with NPT and internal terminal blocks.

f. Electronics Mounting – Integral Electronics.

g. Sensor Pipe – Flexible with bottom fixing magnet and stainless steel float.

h. Material of Construction – 316L stainless steel.

i. Process Connection Type – 150 LB Welded RF Flange.

j. Process Connection Size – 4 IN.

k. Thermometer – None.

l. Unit of Measure – U.S. Customary.

m. Length – To be determined by the Contractor.

n. Level Readout:

1) Remote-mounted 6 digit with floating decimal, 1 IN tall numerals, red LED digital display in feet with NEMA 3 enclosure.

2) 110 VAC powered, two (2) 24 VDC loop power supplies, two (2) programmable alarm relay/set points.

3) Mount display readout where indicated on drawings.

2. Mechanical Gauge: Varec 6700 Liquid Level Indicator – Mount supports @ 4 FT-0 IN OC using locknuts.

a. Indicator Board – 0.08 IN aluminum with vinyl facing – English measure.

b. Sheave Elbows – 316 stainless steel.

c. Indicator Target – 316 stainless steel HMWPE.

d. Float – 316 stainless steel.

e. Float Cable – 316 stainless steel.

f. Guide Cable – 316 stainless steel.

g. Top Anchors – 316 stainless steel.

h. Bottom Anchors – 316 stainless steel.

i. Cable Fastener – 316 stainless steel.

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j. Cable Crimp – Nickel plated copper.

D. Fixed Tank Ladder: Shall be constructed and installed in accordance with OSHA and UL 142 guidelines, extending from grade level to tank roof. All fixed ladders installed or replaced (where the fall distance to the lower level exceeds 24 feet) must have a ladder safety system or personal fall protection system installed in addition to installed cage. Handrail and toe board at the top of the tank shall extend the full perimeter of the tank.

E. Grounding Lugs: Provide grounding lugs, four per tank, for exothermic type field connection of #2 bare copper tank grounding wire. Connect grounding wires to four (4) 3/4 IN x 10 FT long ground rods and connect ground rods together with #2 bare copper wire. Coordinate with Division 26 requirements.

F. Tank Pad: A 3/16 IN thick nitrile pad shall be placed under the tank, trimmed to fit after tank placement, and secured to the tank foundation using an approved adhesive.

G. Anchor Bolts: Anchor bolt quantity shall be provided per UL 142 specifications, and secured as shown in the drawings.

H. Heater (If indicated on drawings):

1. Manufacturer: Chromalox – No substitutions.
2. Drywell Type.
3. Type J and K Thermocouples.

I. For RIP Track IW Holding Tank provide:

1. Tank Leak Switch: Provide an optic leak detection switch which shall be installed on the leak detection interstitial monitoring pipe. Leak switch shall be manufactured by Flowline Inc. model Switch-Tek LO10 or approved equal. Switch shall contain at least 1 SPST relay with selectable (NO/NC) contact. Switch shall be NEMA 4X rated. Cable length shall be 50 FT. Contractor shall field verify required cable length and shall coordinate with Owner if 25 FT cable is sufficient.
2. Tank Leak Switch Remote Relay: Provide a remote relay controller to which the tank leak switch shall be wired. Relay shall be manufactured by Flowline Inc. model LC42 or approved equal. Relay shall accept leak switch LO10 input which shall be hardwired to the relay and it shall provide at least one (1) latched SPDT and one (1) SPDT relay outputs each rated for 250 VAC, 10A. Relay mode shall be field selectable between NO or NC. Relay supply voltage shall be 120 VAC, 50 - 60 Hz. Relay shall be mounted inside the tank alarm station. The NO contact of the relay shall be wired to the leak indication pilot light mounted on the front of the tank alarm station.

3. Tank Alarm Station: Provide NEMA 4X 316SS enclosure that shall be installed near the IW Holding Tank (TK-410). Install the remote relay for the tank leak switch inside the enclosure. Enclosure shall be provided with two (2) 30.5 MM pilot lights with amber colored lens. Pilot lights shall be heavy duty push-to-test (PTT) type Allen Bradley Bulletin 800H NEMA 4X rated, 120 VAC LED type or approved equal. Also provide one (1) process meter mounted on the front of the enclosure. Process meter shall be manufactured by Precision Digital model PD6000-6H2 and shall have a SunBright sublight readable display or approved equal. Process meter shall accept the tank level transmitter 4-20mA signal which shall be calibrated to display the tank level in feet. Provide a fiberglass sunshade on the tank alarm station. Sunshade shall be directly mounted on the station with a gap of 6 IN between the sunshade and the top of the station. Also provide a general purpose 4PDT relay manufactured by Allen Bradley model 700-HC14A1 mounted inside the enclosure. The tank level switch (Magnetrol) contact shall be wired to energize the relay and one NO contact of the relay shall be wired to energize the tank high level pilot light. The second NO contact shall be wired to the IW Pump Local Control Panel for high level control.

PART 3 - EXECUTION

3.01 TESTING OF WELDED JOINTS

A. Testing of welded joints shall comply with all requirements of UL 142 (notably sections 5 and 6) as well as the following:

1. The tank manufacturer shall provide the testing services of an independent testing laboratory to perform all radiographic examination of welds. Testing laboratory shall submit test results directly to the Railroad with copies to the Manufacturer. All defective welds shall be removed and re-welded at the Manufacturer`s expense.

2. All tank bottom fillet welds shall be subject to a soap film test, from the inside, using a vacuum device prior to application of internal coating and hydrostatic testing.

3. The initial pass of the shell-to-bottom weld shall be tested using a “diesel” test.

B. After all joint tests are completed and all appurtenances are installed, the interior of the tank shall be cleaned of all debris and inspected by a Railroad Representative prior to hydrostatic testing.

3.02 STORMWATER STORAGE / PROCESSING TANKS

A. All interior surfaces of UL 142 tanks to be used for the containment of stormwater and or “oily water” shall be subject to the following:

1. All interior surfaces (including the bottom, top and full length sides) shall besandblasted to a Near-White Finish, as per SPCC-SP10, and Section 09 90 01.

2. The tank shall then be coated with a 6 mil thick coating of zinc rich epoxy coating. The coating is to fully coat all inside surfaces and be applied in accordance with Section 09 90 01 requirements for interior tank coatings. The epoxy prime must fully cover the bottom, full length sides, and top interior surfaces of the tank.

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3. Upon completion, the tank interior will be inspected by a Railroad Representative. Photos must also be submitted to the Engineer for approval prior to placing the tank into service.

END OF SECTION

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Commodity Description / Sign Verbiage	NFPA 704 Placarding				
	Vendor (Safety Sign.com) Part #	Large NFPA 704 Diamond Outdoor Durable Vinyl (Adhesive Backed)	UP Stock Item #	Medium NFPA Diamond Outdoor Durable Vinyl (Adhesive Backed)	UP Stock Item #
WATER TREATMENT (RUST INHIBITOR) SODIUM BORATE NITRATE (UN3139) UP ITEM # 060-7274	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
LOCOMOTIVE TOILET FLUSH (PROPYLENE GLYCOL / SANI-TRETE) UP ITEM # 061-4483 / 4481	HEALTH 1 , FLAMMABILITY 1	HR24003 (1-1-0) - 24X24	315-1116	HR11008 (1-1-0) - 11X11	315-1121
CLEANER, ALL GREEN KLEEN (GK LWC-SO1CB) UP ITEM # 061-4538	HEALTH 2	HR24002 (1-1-0) - 24X24	315-1115	HR11010 (2-0-0) - 11X11	315-1123
CONCENTRATED LOCOMOTIVE CLEANER UP ITEM # 061-4890	HEALTH 1	HR24001 (1-0-0) 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
CLEANER, GENERAL PUPOSE (SOAP) UP ITEM # 061-4895	HEALTH 1	HR24001 (1-0-0) 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
CLEANER, LOCOMOTIVE (SOAP) UP ITEM # 061-6160	HEALTH 1	HR24001 (1-0-0) 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
DIESEL FUEL ADDITIVE UP ITEM # 310-0051	HEALTH 1, FLAMMABILITY 2	HR24004 (1-2-0) - 24X24	315-1117	HR11007 (1-2-0) - 11X11	315-1120
LOCOMOTIVE AIR COMPRESSOR OIL (SAE 20) ISO VISCOSITY GRADE 68 UP ITEM # 310-0354	HEALTH 1, FLAMMABILITY 1	HR24003 (1-1-0) - 24X24	315-1116	HR11008 (1-1-0) - 11X11	315-1121
DIESEL ENGINE LUBRICATING OIL 710L520W40 11 TBN BULK UP ITEM # 310-1515	HEALTH 1, FLAMMABILITY 2	HR24004 (1-2-0) - 24X24	315-1117	HR11007 (1-2-0) - 11X11	315-1120
DIESEL ENGINE LUBRICATING OIL 9 TBN SINGLE GRADE 40W UP ITEM # 310-1551	HEALTH 1, FLAMMABILITY 2	HR24004 (1-2-0) - 24X24	315-1117	HR11007 (1-2-0) - 11X11	315-1120
DIESEL ENGINE LOCOMOTIVE CRANKCASE LUBRICATING OIL (MULTI-GRADE 20W40 11TBN) UP ITEM # 310-1560 / 1562	HEALTH 2, FLAMMABILITY 2	HR24005 (2-2-0) - 24X24	315-1118	HR11006 (2-2-0) - 11X11	315-1119
LOCOMOTIVE TRACTION MOTOR JOURNAL SUPPORT BEARING OIL (AAR-M-963) UP ITEM # 310-3756	FLAMMABILITY 1	HR24012 (0-1-0) - 24X24	315-1125	HR11009 (0-1-0) - 11X11	315-1124
LOCOMOTIVE TRACTION MOTOR JOURNAL SUPPORT BEARING OIL (AAR-M-963) UP# 310-3801	FLAMMABILITY 1	HR24012 (0-1-0) - 24X24	315-1125	HR11009 (0-1-0) - 11X11	315-1124
TRACTION MOTOR GEAR CASE OIL (M-SHC-634) UP ITEM 310-7486	FLAMMABILITY 1	HR24012 (0-1-0) - 24X24	315-1125	HR11009 (0-1-0) - 11X11	315-1124
DIESEL FUEL	HEALTH 2, FLAMMABILITY 2	HR24005 (2-2-0) - 24X24	315-1118	HR11006 (2-2-0) - 11X11	315-1119
WASTE WATER	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
WASTE WATER TREATMENT	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
USED OIL	HEALTH 2, FLAMMABILITY 2	HR24005 (2-2-0) - 24X24	315-1118	HR11006 (2-2-0) - 11X11	315-1119
INDUSTRIAL WATER	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
STORM WATER	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122
KEROSENE	HEALTH 2, FLAMMABILITY 2	HR24005 (2-2-0) - 24X24	315-1118	HR11006 (2-2-0) - 11X11	315-1119
GASOLINE	HEALTH 1, FLAMMABILITY 3	HR24013 (1-3-0) - 24X24	315-1132	HR11012 (1-3-0) - 11X11	315-1133
POTABLE WATER	HEALTH 0, FLAMMABILITY 0, STABILITY 0	HR24014 (0-0-0) -24X24	315-1135	HR11013 (0-0-0) - 11X11	315-1134
NON POTABLE WATER	HEALTH 1	HR24001 (1-0-0) - 24X24	315-1114	HR11011 (1-0-0) - 11X11	315-1122

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SECTION 33 71 14 - OVERHEAD ELECTRIC SERVICE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Overhead electric service.

B. Overhead distribution systems shall be built to 15 kV requirements unless stated otherwise.

C. Contractor shall furnish all materials for the work herein specified, and for delivery, storage, uncrating, installation, and final acceptance except where otherwise noted on the drawings or specifications.

D. Distribution class surge arrestors are required on the overhead distribution system.

E. Pole details shall be as indicated on UPRR Electrical Construction Manual.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 26 05 00 – Electrical Basic Requirements.

B. Section 26 05 13 – Medium Voltage Cable.

C. Section 26 08 13 – Acceptance Testing.

D. Section 26 10 00 – Medium Voltage Electrical Distribution.

E. Section 26 12 13 – Pole-Mounted Distribution Transformers.

F. Section 26 12 19 – Pad-Mounted Distribution Transformers.

G. Section 26 18 19 – Medium Voltage Lightning Arresters.

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI).

B. American Wood Protection Association (AWPA).

C. Edison Electric Institute (EEI).

1.04 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data.

a. Provide submittal data for all products specified in this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

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PART 2 - PRODUCTS

2.01 POLES, CROSSARMS, AND OTHER WOOD MEMBERS

A. Poles shall be ASA Class 2 or 3, as indicated on the plans, Douglas Fir or Southern Yellow Pine, roofed only, not gained, or drilled. The wood species Western Red Cedar is not permitted for substitution. Set the poles at depths as indicated on the "Minimum Dimensions and Setting Depths for Poles" detail in the UPRR Electrical Construction Manual. All poles shall be treated with Copper Naphthenate, Dichloro-octyl-isothiazolinone (DCOI), or Pentachlorophenol (Penta) per standards of the American Wood Preservers Association, and EEI Specifications.

B. Poles supporting primary lines crossing tracks shall be 55 FT long unless otherwise indicated.

C. Poles supporting secondary lines (with or without communication lines) shall be 45 FT long unless otherwise indicated.

D. All crossarms shall be 3-1/2 IN x 4-1/4 IN x 8 FT-0 IN long standard EEI distribution type, pre-drilled for steel pins and double arming bolts per standard EEI dimensions. Crossarms shall be pressure treated with Copper Naphthenate, Dichloro-octyl-isothiazolinone (DCOI), or Pentachlorophenol (Penta) per standards of the AWPA and EEI Specifications.

E. All other wood members shall be as specified on the plans and shall be pressure treated with Copper Naphthenate, Dichloro-octyl-isothiazolinone (DCOI), or Pentachlorophenol (Penta) per standards of the AWPA and EEI Specifications unless otherwise noted.

2.02 HARDWARE AND GUYS

A. All hardware installed shall be hot-dipped galvanized steel. Hardware shall include bolts, washers, nuts, and all other members required to complete the specified work.

B. Guy wire shall be 3/8 IN diameter steel, high strength, galvanized. Guy assemblies shall be as detailed on the drawings. The down guy angle shall not be greater than 60 or less than 25 degrees from the horizontal unless detailed otherwise.

C. Guy anchors shall be of the type required for the installation.

D. Existing poles on which contractor works shall have steps removed below 8 FT above grade.

2.03 INSULATORS

A. Suspension insulators shall be of standard ANSI classification for strength and voltage as specified on the drawings.

B. All pin type insulators shall be as specified on the drawings and shall be suitable for use with standard 1 IN lead threaded steel support pins. Pin type insulators shall be of standard ANSI classification for voltage as specified on the plans. Ties shall be made per standard REA recommendations. Preformed tie wraps are preferred.

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2.04 TERMINATION KITS

A. Termination kits shall be 3M, 15kV, QT-III, 7640 series. Select proper size termination kit for the application. Cable shall be protected by non-metallic, U-shaped, cable guards.

2.05 POLE BANDING

A. All new poles and existing poles which have work as part of this contract shall have a self-adhering, plastic, reflective, 4 IN wide safety yellow pole bands from BriteStripe (part #BS364-Y) completely around pole diameter. The band shall be mounted 3 to 4 FT from grade. The band shall be securely affixed with #6 aluminum nails or non-rusting screws for a permanent installation. Bands shall be installed between any risers or equipment and the pole. Bands shall not be installed around risers or other equipment.

2.06 POLE NUMBERING

A. All new poles and existing poles which are reused as part of this project shall be numbered according to the design drawing(s).

1. Numbers shall be metal, at least 3 IN in height, and shall be securely affixed to poles with #6 aluminum nails.
2. All poles designated as Primary will have the numbers attached horizontally to the pole.
3. All Secondary poles will have the numbers attached vertically to the pole.
4. Pole numbers shall be located on the pole side visible from an access road where an access road is present. The pole numbers shall not be installed in a location visible only from the track side.

B. If there is no pole numbering scheme on the design drawing(s), or the existing numbers conflict with the design drawing(s), a numbering plan (created according to the UPRR Pole Numbering Procedure) shall be submitted to the UPRR Electrical Design Group Project Engineer for approval prior to numbering poles.

2.07 AERIAL CABLE MARKERS

A. Union Pacific Railroad requires all new and replacement aerial power cables that cross track(s) be marked to enhance the visibility of the cables.

B. Markers shall be molded acrylic plastic or molded ABS plastic. Markers shall be Danger Orange in color with the coloring agent incorporated into the molded material. Where recommended by the manufacturer, other colors may be submitted for approval. Provide provisions for attaching to the cables. Where applicable, provide corona effect protection.

C. Markers shall be installed on the lowest hanging conductor.

D. Markers for cables over 50 FT above top of rails shall be 36 IN in diameter. Markers for cables below 50 FT but above 29.5 FT above top of rails shall be 20 IN in diameter. Markers for cables below 29.5 FT shall be 12 IN in diameter.

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PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 33 71 19 - PRECAST CONCRETE MANHOLES FOR BUILDINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Precast electrical manholes and pullboxes.

B. Scope of Work:

1. Manhole and pullbox locations are shown in approximate locations unless dimensions are indicated. Route and locate as required to complete duct bank system.

C. This section does not apply to the construction of mainline and/or yard track projects.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 - Submittals and Substitutions.

B. Section 01 77 10 - Project Closeout and Cleaning.

C. Section 31 23 10 - Excavation and Fill.

1.03 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. A48, Gray Iron Castings.
2. C857, Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
3. C858, Underground Precast Concrete Utility Structures.
4. C891, Installation of Underground Precast Utility Structures.
5. C1037, Inspection of Underground Precast Utility Structures.

B. Code of Federal Regulations Occupational Safety and Health Administration Title 29 - Labor, Subpart D, Walking - Working Surfaces

C. American Association of State Highway and Transportation Officials (AASHTO) Roadside Design Guide, 4th Edition.

1.04 SUBMITTALS

A. See Section 01 33 00 for requirements.

B. Shop Drawings: Indicate dimensions, reinforcement, size and locations of openings, and accessory locations for precast manholes. Also indicate design load capacities and shipping weight of individual pieces.

C. Manufacturer's Installation Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

D. Closeout Submittals:

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1. Section 01 77 10 - Project Closeout and Cleaning.
2. Project Record Documents: Record locations and sizes of manholes and pullboxes.

1.05 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years documented experience.

1.06 COORDINATION

A. Coordinate the work with existing underground utilities, sitework, and structures.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE MANHOLES

A. Product Description: Precast manhole designed in accordance with ASTM C858 comprising modular, interlocking sections, complete with accessories. Use concrete with a minimum 28-day compressive strength of 5,000 LBS/SQ IN minimum for manhole sections.

B. Manufacturer is responsible for providing lifting devices for manhole sections under the provisions of ASTM C857. The Manufacturer shall furnish information for proper lifting hardware and handling procedures.

1. Loading: ASTM C857, Class A-16; include impact factor, and AASHTO HS20.
2. Shape and size: As indicated by design drawings.
3. Frames and Covers: ASTM A48; Class 30B gray cast iron, 36 IN size, machine finished with flat bearing surfaces. Provide marked covers indicating type of utility enclosed (e.g. HIGH VOLTAGE, SIGNAL, ELECTRIC, etc). Also provide "UPRR" on label. Permanently secure frame in top section of manhole structure.
4. Duct Entry Provisions: Window areas shall be provided only as shown on design drawings other openings shall be core drilled in place. See design drawings for manhole window details.

C. Manufacturer is to locate pulling eyes, rack inserts, embedded strut, ladders and other inserts as detailed on drawings. Inserts will not be aluminum.

1. Cable Pulling Irons: Use galvanized rod and hardware.
2. Cable Rack Inserts: Minimum load rating of 2,000 LBS.
3. Cable Tray/Support Rack Concrete Inserts: 1-5/8 IN x 1-5/8 IN Hot-dip galvanized steel strut channel with tieback anchors. Cut channels to length as required.
4. Cable Tray Support Racks: 1-5/8 IN x 1-5/8 IN Hot-dip galvanized steel strut channel, with fittings to match as recommended by manufacturer.
5. Cable Supports: Cable tray in accordance with Section 26 05 36, Engineer approved fiberglass grating or Engineer approved equal. Fiberglas grating shall be manufactured without grit for a smooth surface for cables.

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6. Source Quality Control: Inspect manholes in accordance with ASTM C1037.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Section 01 31 10- Project Coordination and Scheduling: Coordination and Critical Path Progress Schedule

B. Verify locations of manholes prior to excavating for installation.

3.02 EXISTING WORK

A. Insure access to existing duct bank and other installations which remain active and require access. Modify installation, or provide access panel, as appropriate.

3.03 INSTALLATION

A. Excavate for manhole installation under the provisions of Section 31 23 10.

B. Install and seal precast sections in accordance with ASTM C891.

C. Install manholes plumb.

D. Use precast neck and shaft sections to bring manhole cover to finished elevation.

E. Clean and line entire inside of manhole, including the inside portion of frame and cover, with pvc, "Sauereisen No. 210" or approved equal.

F. Manufacturer shall apply waterproofing compound on all exterior surfaces of manholes.

G. Backfill manhole excavation under the provisions of Section 31 23 10 and the drawings.

END OF SECTION

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SECTION 34 11 10 - RAILROAD TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Unloading, stockpiling, transporting and inventory of material, distributing and placing of ties, tie plates, all other track material (OTM), fittings and fastenings. Track Construction shall also include the laying, bolting, gauging and spiking of rail and all thermal corrections, welding and adjustments of rail, the installing of bumping posts, derails, frogs, switches, guardrails, switch stands, road crossings, the placing of ballast, lining, surfacing and finishing of tracks, on previously prepared sub-grade or sub-ballast.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Documents affecting work of this section include, but are not limited to, the General Requirements, Section 00 07 00 –General Conditions, and any Special Conditions required for this work.

1.03 REFERENCED STANDARDS

A. Current versions of the following rules, standards, specifications, and references shall apply to all track work:

1. Union Pacific Railroad Safety Rules.
2. Union Pacific Railroad Maintenance of Way Rules.
3. Union Pacific Railroad Engineering Standards.
4. Union Pacific Railroad Chief Engineer's Bulletins.
5. Union Pacific Railroad Engineering Track Maintenance Field Manual.
6. Union Pacific Railroad Track Welding Rules and Prodedures
7. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.
8. Track Safety Standards of the Federal Railroad Administration.

1.04 QUALITY ASSURANCE

A. Construction Supervision - The track construction shall be progressed with skilled supervision and labor and the Contractor shall assemble the track material in such a manner as may be required by the Engineer. Any supervisor or laborer not satisfactory to the Company shall be removed from the project on request of the Engineer.

B. Inspection Of Subgrade - Shall be made just prior to track laying. Track construction shall not commence until the subgrade and subballast has been approved by the Engineer.

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C. Damage And Restoration - The Contractor shall perform hauling, loading and unloading operations as well as track construction in such a manner as to cause no damage to the roadbed, ditches, shoulders, slopes, drainage pipes, risers, drop inlets, roads and any other facilities. Any damage to the foregoing shall be repaired or replaced, where necessary, in a manner satisfactory to the Engineer and at the expense of the Contractor. In making repairs and replacements, equivalent materials shall be used and the method of placement shall be as directed by the Engineer.

PART 2 - PRODUCTS

2.01 TRACK MATERIAL

A. Summary:

1. Track material for the project, if provided by the Railroad, will be delivered to the closest available siding or nearest available location at no cost to the Contractor. All material furnished by the Railroad, including that which will be installed by the Railroad, shall be unloaded by the Contractor and carefully handled to avoid damage when unloading, hauling, stockpiling, and installing. The Contractor shall also be responsible for unloading rail from the rail train. All track material shall be provided loose and transported in railroad cars or other means of transportation. The Contractor shall supply a waterproof container or trailer for storage of weld kits, supplies, and any other material that requires protection from the weather. Storage and security of all track material shall be at the expense of the Contractor and will be incidental to the appropriate pay item.

2. When handling track material, the Contractor must abide by Union Pacific Railroad Engineering Track Maintenance Field Manual and Maintenance of Way Rules.

B. CWR, continuous welded strings of rail, and stick rail shall be handled in accordance with Engineering Track Maintenance Field Manual, using special equipment provided for that purpose. With the exception of bonded joint plugs, rail less than 15 FT shall not be installed in the track without the engineer's approval. Bonded joint plugs shall be paid for as part of track construction and welds shall be paid for per each successfully installed weld. The temporary joint bars and bolts will be the responsibility of the contractor and incidental to the track construction.

C. Ballast, if provided by the Railroad, will be delivered to the job site in ballast cars, unless otherwise stated. The contractor shall unload and place or stockpile the ballast; clean, close and lock the doors and release the cars to the engineer within 2 working days after delivery to the job site. The Contractor shall be required to stockpile the ballast if it cannot be dumped directly on the track. Ballast shall be uniformly distributed and the track raised, lined, surfaced and tamped, with the finished surface of the ballast dressed in accordance with the Engineering Track Maintenance Field Manual, standard drawings and plan drawings.

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D. All material delivered will be counted and recorded as it is unloaded by the Contractor and quantities checked against the waybill. Any discrepancies are to be reported immediately to the Engineer. If the quantities check, the Contractor or his Superintendent will sign for the material, and the Contractor is then responsible for the security of the material, including costs to replace from loss or theft. A copy of the inventory sheets showing the car number, date received, material inventoried from the car or truck, and storage location, if stored, shall be furnished the Engineer. Any shortage or overage of materials shall be immediately reported to the Engineer. At the end of the project, the contractor shall load all excess material in rail cars and/or stockpile at a designated location as directed by the Engineer.

PART 3 - EXECUTION

3.01 GENERAL

A. All horizontal and vertical field track survey layout required, for both Contractor and Railroad work, shall be provided by the Contractor in accordance with Section 01 71 23 and included in the unit track price. The Company will furnish horizontal and vertical control points and track layout plans or coordinate files. The final track surface, cross level and line shall not deviate from the plans more than limits defined in the Engineering Track Maintenance Field Manual for the specified class of track.

B. All track construction will conform to the Engineering Track Maintenance Field Manual with the following modifications:

1. New treated ties shall not be adzed without authority from the Engineer. If adzing is authorized, an approved preservative shall be applied to the adzed surface.

2. Insulated joints shall be installed as indicated on the plans. If not indicated on the plans, insulated joints may be required at locations as directed by the Engineer. Insulated joints shall be installed per the manufacturer's recommendations, which may require rail cuts and drilling. "I" bonds or prefabricated insulated joints will be welded into the track.

3. Tie plugs, where required, shall fill holes from which spikes are drawn. The plugs shall conform to the current AREMA Specifications for tie plugs. All spike holes must be filled with standard wooden tie plugs or another suitable plugging material as approved by the Chief Engineer, before re-spiking.

4. Rail anchors shall be installed after the ballast operation and the track is raised, lined and destressed. Anchors shall be installed on the same side(s) of the tie on both rails. Anchors must not be applied to one rail only, but must be applied to both rails in a uniform pattern.

5. When using sledge to remove rail anchors, the foot must be placed on top of the rail anchor in such a manner to prevent the anchor from flying and causing injuries. Spike mauls must not be used in lieu of sledges for applying and removing rail anchors.

6. Track panels may be utilized in track construction when approved by the Engineer. Care shall be taken in unloading or moving the panel sections so as not to skew or bend the section.

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7. Rails shall not be moved into position with a hammer, maul, or similar tool, but shall be moved with rail tongs, rail forks, or lining bars.
8. Laying of continuous welded rail in track using a track-laying machine is acceptable.
9. Where track panels have been utilized in track construction and are to be relayed with CWR, the provisions governing CWR and thermal correction shall apply. All spikes removed shall have the holes plugged with approved tie plugs. Anchors shall be applied per these specifications. All jointed rail and OTM shall be loaded in rail cars or stock piled as directed by the Engineer.
10. When rail is released from track, it shall be promptly classified by the Engineer in accordance with Chief Engineer's instructions.
11. The Contractor shall mark clearance points in accordance with Standard Drawing 0026C and mark culvert locations in accordance with Standard Drawing 0519B.
12. Welding shall be performed under the direct supervision of an experienced and certified welding foreman or supervisor. All welds given fault indication by ultrasonic inspection, magnetic particle inspection, or visible inspection, shall be replaced at no expense to the Company, including the addition of the rail plug and additional welds as required. All initial testing shall be performed as directed by the Engineer. If a defective weld is found, it shall be cut out and replaced with a section of rail not less than 15 FT long. The Contractor shall inform the Engineer of the location of completed welds in order for the Engineer to arrange testing, if required. A record shall be kept by the Contractor for each completed weld. All welds shall be marked on the rail per requirements of Form 7913.
    a. The Contractor shall perform the following incidental work to complete rail welds:
        1) Re-space cross ties as necessary to prevent a weld from sitting on a tie.
        2) Tamp and dress the track as necessary to provide firm support at the weld.
        3) Plug ties and re-spike as necessary.
        4) Reapply and adjust anchors as necessary to conform to the anchor pattern.
        5) Clean up all waste from the welding process and dispose of superfluous materials.
        6) The cost incurred by the Contractor for this work shall be included in the bid price of the weld.
    b. Ultrasonic Testing of Rail Welds:
        1) All thermite and electric flash-butt rail welds installed as part of the project shall be hand tested ultrasonically for defects or inclusions before track is placed into service. Prior to ultrasonic inspection, each weld will be ground to a finish that eliminates grooves, heavy facets, or debris that could interfere with hand test operation. All test surfaces will be free of debris, scale, grease and heavy rust, which may inhibit inspection.

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2) The operator in charge of the testing crew shall have a minimum of American Society of Nondestructive Testing (ASNT) Level II training and experience. Documentation of each qualified operator's certification and a proposed written procedure for testing will be provided to Railroad for approval. The written procedure shall be prepared and the approved testing program shall be administered by a certified ASNT Level III or comparable individual. The written procedure shall describe the program for the control and administration of the testing personnel training, examination and certification. Qualifications shall be specific to the equipment and method used. The Railroad reserves the right to disqualify an operator from testing on Railroad property because of previous experience with operator's performance or operator's ability without further explanation. Any exceptions to these rail testing qualifications shall be pre-approved in writing by the Railroad.

3) Functionality of the UT hand testing instrumentation shall be checked, and the equipment shall be calibrated and normalized by use of a calibration standard at the beginning and end of the daily testing operation, after inactivity or delay if practical, and any time when a malfunction is suspected. If any malfunction is discovered, all material shall be reexamined to the previous valid calibration and normalization.

4) Each weld will be hand tested with each of the following transducer angles: 70 degree, 37.5 or 45 degree, and 0 degree.

   a) The 70 degree (+/-) sound envelope hand test transducer, full railhead coverage (gage, center and field) shall be capable of detecting transverse flaws, with calibration and detection minimums of a 1/32 inch flat bottom hole.

   b) The 37.5 (+/-) degree or 45 (+/-) degree transducer will inspect fillet, web and base of rail with calibration and detection minimums of a 1/32 IN flat bottom hole.

   c) The 0 degree transducer will inspect the head, web and base. Detection capabilities for web, head web flaw minimums 1/32 IN. In addition to detection of transverse or horizontal flaws from top of rail, the 0 degree transducer will be employed to inspect the head from side of the rail, at 90 degrees to vertical, for vertical split head separations. 0 degree detection minimums shall be 1/32 IN flat bottom hole.

5) All testing shall be performed by personnel qualified and certified in accord with the approved written procedure. The testing operator will locate and mark defects found according to Railroad specifications and accuracy requirements. Each defective weld shall be marked with a highly visible marking on both sides of the rail web and base. The Railroad also reserves the right to independently re-test suspect welds at the Contractor's expense.

6) Welds with single 1/16 IN or greater reflective surface shall be rejected. Welds with three or more 1/32 IN reflective surfaces within range of transducer scan shall be rejected also. Defective welds will be reported and subsequently repaired at Railroad's direction.

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7) The Railroad will be provided all test records following the UT inspection. The Contractor shall certify all test records and maintain a copy of all test records for a minimum of four years following the test.

13. At the end of the project, the Contractor shall perform VERSE testing after destressing rail to ensure the rail was installed at specified neutral temperature. The Contractor shall support the VERSE tester with labor and equipment to remove and replace rail clips required to perform each test. The Contractor shall be responsible for replacing any damaged or lost clips and inserts. Locations for the VERSE tests will be chosen by the Engineer. Anticipate testing to occur every 500 to 1000 FT on both rails of main and siding tracks. Testing on yard and other subsidiary tracks is not required. The Engineer shall be present for each test unless waived by the Engineer. The approved VERSE tester is:

    Keith Lane
    Pandrol - Vortok US
    3013 Notting Hill Court, SW
    Conyers, Georgia 30094
    Phone: (770)-262-4956
    E-mail: keith@vortok.com

    The Railroad may elect to perform VERSE testing. In this case, the Contractor shall support the VERSE tester with labor and equipment to remove and replace rail clips required to perform each test.

3.02 TURNOUTS

A. Turnouts:

1. Shall be constructed in strict conformity with the Engineering Track Standard plans. The switch stands shall be fastened securely to headblocks and shall be square with the track. The targets shall be lined parallel with the rails of the major track when the switch is lined for the major track. All switch ties shall be fully tie plated. All frogs, with the exception of self-guarded frogs, shall be protected by guardrails installed in accordance with the standard plans before any train is allowed to pass over them. Turnouts shall also include switchman walkways.

B. Panel Turnouts

1. Shall be constructed in strict conformity with the standard plans and these specifications. Care shall be taken in unloading or moving the panel sections so as not to skew or bend the sections or cause damage to the prepared subgrade. The Contractor shall adjust anchors, ties, spikes, switch plates, braces, etc., as necessary to conform to the standard plan.

3.03 DERAILS & BUMPERS

A. Where required, derails and bumpers shall be installed in conformity with standard plans and/or instructions, and shall be inspected and approved by the Engineer before final acceptance and operation over the track.

B. It is the Contractor's responsibility to install temporary derails as necessary to protect the main track or any track in that may be in operation.

3.04 BALLASTING AND SURFACING

A. SURFACING

1. The track shall be laid and connected before ballast is spread and track raised. Immediately prior to unloading ballast for the final raise of not more than four (4) inches, the track shall be lined as close as practical to the stakes and all ties straightened and re-spaced as necessary. Ballast shall then be spread evenly and leveled to the required section, taking care to assure that subgrade material is not intermixed with the ballast. Ballast shall be spread and the track raised in a series of lifts to the approved elevation.

2. No single lift shall be higher than 4 IN. In raising track, the operation shall be so regulated as to avoid the bending of angle bars or straining of joints. Care shall be taken to avoid sharp breaks or bends in the rail when the track is raised. Both rails shall be raised simultaneously and to proper cross-level. Ballast shall be tamped with an approved tamping machine (Jackson 6700 or equivalent) and/or tamping tools in good condition with less than 20 percent surface area missing. The number of insertions by the tamper on each lift should be monitored to ensure adequate and even ballast compaction, yet prevention of center bound track must also be considered.

3. The Contractor shall coordinate work to avoid unnecessary stockpiling of ballast material. In the event that the material is required to be stockpiled, the Contractor shall take care not to mix in fines and other foreign material. The Engineer may reject stockpiled material or require the Contractor to perform additional testing on field samples if the material does not appear to meet the UPRR standard gradation or other physical properties for ballast.

B. If track is raised above the designed and staked grade, the cost to lower the track shall be borne by the Contractor.

C. Turnouts shall be tamped using a switch/production tamper designed to tamp turnouts. Tamping may also be done, in areas where a production tamper cannot be utilized, with tamping bars, "jitter bugs" or by machines approved by the Engineer in a manner that will produce uniform compaction. Locations in turnouts, which can not be mechanically tamped (example, heel blocks or frogs), shall be thoroughly hand tamped under the rail seat areas. Switchman walkways shall be constructed as required using walkway or Class 2 ballast.

D. Tamping must not disturb subgrade and subballast. Dressing of the ballast by placing earth higher than the toe of ballast, thus preventing proper drainage, will not be permitted.

E. Thorough tamping under the rail seat is required, and joint ties shall be tamped especially firm. Tamping will not be permitted at the middle of a tie where ballast is to be left to settle on its own accord. Both ends of a tie, inside and outside of the rail, shall be tamped simultaneously. All ties that are pulled loose or skewed in the track raising operation shall be placed in their proper position and properly tie-plated, plugged and fully spiked before tamping, insuring all rail seat areas are clean and free of dirt and ballast. Any anchors, bolts, braces or switch material which has been damaged, loosened or does not comply with these specifications shall be adjusted accordingly. The track shall be true to line, grade and cross level as designed and staked.

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F. During each track raise, the track is to be tamped in such a manner that it will be uniform. During the raising and tamping operations, approved track level boards or other approved measuring devices shall be constantly used to ensure the correct surface and cross level in the track after tamping work is completed. After ballasting is completed and the track is in correct gauge, surfaced and lined according to the stakes, the ballast shall be neatly trimmed or regulated to the section shown on the drawings, and any surplus material shall be spread evenly along the slopes of the ballast section.

G. Unless specified otherwise, construct yard tracks with 8 IN ballast under the ties, and main tracks and siding tracks with 12 IN of ballast under the ties. Some areas may vary slightly. In all cases it is necessary that the top of rail elevations be followed as indicated.

PART 4 - PAYMENT AND MEASUREMENT

4.01 MEASUREMENT

A. Track construction shall be measured by the track foot as measured in feet along the centerline of track, excluding turnouts and switch point derails. The unit price for track construction shall include surfacing and lining as required to achieve proposed top of rail elevation. For the purpose of determining the proportionate value of completed track each month, the following criterion shall be used:

1.	All track material unloaded	10%
2.	All ties placed, OTM distributed and ready for rail placement	30%
3.	Track structure completely built and ready for ballast placement	60%
4.	Ballast unloaded and first raise is complete	80%
5.	Track structure completed (as per these specifications and contract documents)	100%
6.	Testing support will be incidental to track construction.	

B. Turnouts:

1. Turnouts installed or assembled shall be measured per each completed. Turnouts assembled by the Contractor and installed in track by the Railroad will be counted as assembled turnouts. Turnouts assembled and installed in track by the Contractor will be counted as installed turnouts.

2. A turnout is considered both the straight side and diverging side.

3. Turnout lengths will be based on the following chart and excluded from track construction measurements:

TURNOUT SIZE	WOOD LENGTH	CONCRETE LENGTH
No.9	107	107
No.11	125	125
No.15	180	169
No.20	249	235
No.24	281	267

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C. Switchman Walkways:

1. Switchman walkways will not be measured separately, unless otherwise specified.

D. Prefabricated Road Crossings:

1. Shall be measured in track feet along the centerline of track.

E. Relay Track:

1. Shall include surface and line track and relay jointed rail with CWR and shall be measured by the track foot as measured in feet along the center line of track. This shall include bringing the track to surface, line and grade, dumping ballast as needed, adjusting tie spacing, relaying the jointed rail with CWR and all other items to bring the track to completion per these specifications. It shall also include the stockpiling or loading of rail and OTM as directed by the Engineer.

F. Thermite and Electric Flash Butt Welds:

1. Welds in track and turnouts will not be measured separately for payment. The standard number of welds required for each turnout are provided on the following chart:

TURNOUT SIZE	**Number of Welds**
No.9	18
No.11	18
No.15	18
No.20	22
No.24	26

G. Insulated Joints:

1. Insulated joints will not be measured separately for payment.

H. Ultrasonic Testing of Rail Welds:

1. Ultrasonic Testing of rail welds shall be incidental to track or turnout construction.

I. VERSE tests:

1. VERSE tests will not be measured separately for payment, including labor and equipment necessary to support the VERSE tester, i.e. clip removal and replacement, if the testing is performed by the Railroad.

J. Other Items:

1. Shall be measured at the contract unit of measure shown on the Proposal and Bid Form for that item.

4.02 PAYMENT:

A. Payment shall be made at the contract unit price per unit acceptably completed. This price shall be full compensation for all labor, equipment, tools, and incidentals necessary to unload, handle, stockpile, transport, prepare and install materials as per Contract and these specifications.

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B. Installation of transition rails, insulated joints, flash butt and Thermite welds, transition ties, curve blocks, OTM, VERSE and Ultrasonic Testing, clearance and culvert markings, and switchman's walkways shall be incidental to track and/or turnout construction.

END OF SECTION

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SECTION 34 11 27 - SUBBALLAST

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Foundation course for pavement or railroad track shall be composed of crushed stone from an approved source and shall be constructed as herein specified in one or more courses in conformity with the typical sections shown on plans and to the lines provided by the Engineer.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. 01 43 26 Laboratory and Field Testing Services

1.03 DEFINITIONS AND TERMS:

A. Compaction - The process of mechanically stabilizing a material by increasing its density within a range of acceptable moisture contents. "Degree of Compaction" is expressed as a percent of maximum density obtained by the test procedure described in ASTM D1557, Test Method for Determining Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT^3 (2,700 Kn-m/m^3)).

B. Density in place – Field testing to determine the density and degree of compaction of fill in place shall be determined in accordance with ASTM D2922, Density of Soils and Soil-Aggregate in Place by Nuclear Methods; or other methods approved by the Engineer and/or Soils Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Subballast material shall meet the specifications provided on Union Pacific Railroad Engineering Standard Drawing 0010.

PART 3 - EXECUTION

3.01 PREPARATION

A. Preparation of Subgrade:

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1. The road bed shall be shaped in conformity with the typical sections shown on plans and to the line and grades provided by the Engineer. All unstable or otherwise objectionable material shall be removed from the subgrade and replaced with approved material. All holes, ruts and depressions shall be filled with approved material and if required, the subgrade shall be properly wetted with water and reshaped and rolled to the extent directed in order to place the subgrade in an acceptable condition to receive the subballast material. Sufficient subgrade shall be prepared in advance to insure satisfactory progression of the work.

3.02 CONSTRUCTION

A. If the required compacted depth of the subballast exceeds 6 IN, the subballast shall be constructed in two or more layers of approximate equal thickness. The maximum compacted thickness of any one layer shall not exceed 6 IN and shall be compacted to a minimum of 95 percent modified Proctor density (ASTM D1557).

B. If the material is laid and compacted in more than one layer, the Contractor shall plan and coordinate this work in such a manner that the previously placed and compacted layers be allowed ample time for curing and development of sufficient stability before vehicles hauling materials for the succeeding layers, or other heavy equipment are permitted on the subballast. Prior to placing the succeeding layers of material, the top of the under layer shall be sufficiently moist to insure a strong bond between the layers. The edges and/or edge slopes of the subballast shall be bladed or otherwise dressed to conform to the lines and dimensions shown on the plans and present straight, neat, and workmanlike lines and/or slopes as free of loose material as practicable.

C. The Contractor shall coordinate work to avoid unnecessary stockpiling of subballast material. In the event that the material is required to be stockpiled, the Contractor shall take care not to mix in fines and other foreign material. The Engineer may reject stockpiled material or require the Contractor to perform additional testing on field samples if the material does not appear to meet specifications for gradation or other physical properties in Part 2 of this Section.

3.03 MOISTURE AND DENSITY CONTROL

A. Unless otherwise shown on the Drawings, or designated by the Engineer, subballast shall be constructed with moisture and density control. Unless otherwise directed by the Engineer, the moisture content of the subballast at the time of compaction shall be near the optimum moisture content as determined by ASTM D1557 content to facilitate compaction of cohesionless material.

B. The application of water to subballast shall be done with sprinkling equipment consisting of tank trucks, pressure distributors, or other equipment designed to apply water uniformly and in controlled quantities and at variable widths. Mobile sprinkling equipment shall have adequate tractive power and shall be equipped with controls operated from the driver's seat to control the rate of water flow. The Contractor shall be required to furnish sufficient water equipment to ensure proper and uniform moisture content required for the material.

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3.04 FIELD QUALITY CONTROL

A. Frequency of moisture and density tests (ASTM D2922) shall be 1 test per 1000 SY on each lift but no greater than 500' spacing on each lift for narrow grading operations.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Placement of subballast shall be measured in cubic yards within the neat lines of the typical sections, line, grades and slopes established.

4.02 PAYMENT

A. Subballast shall be paid for at the contract unit price as placed according to the specifications including furnishing, unloading, hauling, compacting, dressing, testing and incidental work or equipment required.

END OF SECTION

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SECTION 34 76 10 - LOCOMOTIVE TRACTION MOTOR DROP TABLE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The requirements for purchase of one (1) new 50 ton capacity traction motor drop table for placement into a new Union Pacific Railroad Locomotive Repair Facility.

1.02 SAFETY REQUIREMENTS

A. The equipment and all its related components must meet all applicable requirements for Federal, State, County and OSHA safety codes and regulations in effect at the date of purchase. In the case of discrepancies between the requirements of this specification and applicable safety codes and regulations, the most stringent code, regulation, or standard shall govern. Operator safety must be the utmost consideration in the design and construction of this machine.

1.03 NOISE ABATEMENT REQUIREMENTS

A. This equipment must comply with OSHA Occupational Noise Exposure Standard 29 CFR, Part 1910.95 (b.1) table G-16 at the operator's location as indicated in 29 CFR, Part 1910.95 (a) for duty cycle or machine speed. Any failure of this equipment to meet noise exposure standards must be stipulated on your quotations. The reason noise exposures cannot be met must be outlined along with alternatives and costs to meet these requirements.

1.04 WARRANTY REQUIREMENTS

A. The manufacturer shall warrant the materials and workmanship applied to the equipment and all components for a period of not less than one (1) year from the date of first operation at the receiving location. REPLACEMENT AND INSTALLATION OF DEFECTIVE PARTS, COMPONENTS, OR WORKMANSHIP WILL BE AT NO COST OF THE UNION PACIFIC RAILROAD DURING THE WARRANTY PERIOD INCLUDING ANY ASSOCIATED TRANSPORTATION COSTS FOR EITHER THE EQUIPMENT ITSELF OR ANY OF ITS PARTS. Warranty is to include both parts and labor for the covered period. The manufacturer will be expected to rectify major warranty concern by making site visit. Minor warranty problems will be corrected by Union Pacific with the guidance and assistance of the manufacturer. The manufacturer will pay for all parts deemed to be defective and reimburse Union Pacific for labor a rate of $50.00 per hour. The manufacturer may also assign a local, reputable contractor to perform the warranty work on the machine in lieu of Union Pacific. The placement of a contract representative to perform warranty work as well as other maintenance is preferred.

B. The quotation must include all warranty information and specify any variances from our indicated warranty policy. Bidders must indicate the nearest source of parts and service to the specified delivery point of the drop table in the space provided below:

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Dealer Name: _____

Dealer Address: _____

Dealer City and State: _____

Dealer Phone Number (including Area Code): _____

1.05 VARIANCES

A. Any and all variances from these specifications must be listed and outlined, including the reason the specification cannot be met, cost changes and alternatives.

1.06 EXCLUSIONS

A. The equipment shall not be excluded from consideration on the basis of minor variations from specifications, provided that all essential requirements are met relative to safety, operation, materials, and performance.

1.07 DELIVERABLES

A. The successful bidder shall furnish Union Pacific Railroad with the following upon receipt of purchase order:

1. Three (3) each copies of drawings that thoroughly depict all foundation, electrical and other installation requirements for the drop table.
2. Three (3) each copies of schedule of delivery of drop table to Union Pacific's facility.
3. Three (3) each copies of general arrangement and construction drawings for approval by authorized representative of Union Pacific prior to commencement of construction.

B. The successful bidder shall furnish the Union Pacific Railroad with the following upon delivery of the equipment:

1. Three (3) each copies of operator's manuals.
2. Three (3) each copies of maintenance and parts manuals.
3. Three (3) each copies of electrical, mechanical, and hydraulic schematic drawings.
4. Three (3) each copies of recommended spare parts lists.

1.08 SHOP TESTING

A. Prior to shipment, the machine is to be fully erected, and tested at the successful bidder's plant. The drop table must meet the requirements described in this specification. Successful completion of the test will constitute the necessary authority to ship the machine as authorized by a representative of Union Pacific. Any failure to meet our specification criteria must be corrected at no additional costs to Union Pacific. Changes must be made to meet this specification will be the responsibility of the successful bidder. Changes requested by Union Pacific above and beyond the scope of these specifications will be the responsibility of Union Pacific. All changes made to the specifications for this table must be agreed upon by a representative of Union Pacific and placed in writing.

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1.09 VENDOR INFORMATION

A. Please indicate in the space provided below the person that should be contacted to answer any questions or receive further information regarding the quotation.

Name: _____

Company: _____

Address: _____

City, State: _____

Phone Number (including Area Code): ___ _____

1.10 SCOPE OF WORK

A. The successful bidder will be responsible for designing and construction of the drop table in accordance with these specifications. The table will be installed at a new Locomotive Repair Facility. It will be used to remove and replace locomotive traction motors assemblies on shop track(s). A separate traction motor release area will be provided. Locomotive traffic will not traverse over the release area. The table will be expected to efficiently accomplish all functions of traction motor replacement across both tracks and the motor release area. The manufacturer must supply all necessary components and equipment to effectively achieve a "turn-key" operation of the table.

B. Foundations, pit rails, anchor bolts, grouting, curb angles, and pit lighting will be provided by Union Pacific.

C. The tables will be operating at an indoor environment with temperatures typically ranging from 45 to 110 DegF. The pit environment of the table is dirty, oily and greasy. Water may enter the pit from high rain levels, or washing of locomotives. All components, including controllers, electrical equipment and hydraulic systems, if used, will be expected to operate effectively within this climate. All components must be sealed and protected against damage from water, oil, diesel fuel and soap.

D. Safety of operation will be the utmost consideration for the drop table system and will supersede all other design considerations. Open pits must be kept at a minimum. Operator protection must be provided for any open pit.

E. Vendors must submit complete and descriptive product literature with their quotations. This literature must accurately describe actual machine weight, make, model, capacities and other information to verify compliance with bid specifications. Vendors must also submit a requested payment schedule.

1.11 ON-SITE INSPECTION

A. Since the equipment will be installed within a new building, an on-site inspection will not be necessary. Drawings of the new building with drop table locations and details will be provided to the successful bidder.

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1.12 MAINTENANCE CONTRACT

A. Bidders must submit a proposal to provide a maintenance contract for the drop table. The contract must include both preventative and reactive maintenance. The proposal should include a schedule, work description, and related cost for preventative maintenance and servicing, and a cost to work on unscheduled machine break-downs. Prices should be broken down into preventative and reactive categories. The name of the dealer or servicing shop that will be established to perform the work must be indicated. The dealer should be located within 60 miles radius of the city of installation. The reactive maintenance contract will not commence until the specified machine warranty period has terminated. This proposal must be listed as a separate, optional consideration.

1. Servicing Dealer Information:

   Dealer Name: _____

   Address: _____

   City, State: _____

   Phone Number (including Area Code): ___ _____

1.13 "AC" TRACTION MOTOR CONSIDERATIONS

A. Union Pacific Railroad has acquired a number of new locomotives that are equipped with "AC" as opposed to "DC" traction motors. Additionally, newer UPRR locomotives are equipped for simplistic replacement of AC traction motors. It must also take the new style radial truck into consideration.

B. Bidders should contact employees working at North Platte, Nebraska in respect to the replacement of AC motors. Several AC motors and radial trucks have been replaced at this location. Any concerns that arise involving AC motor replacement or radial trucks that directly involve the drop table and its operation must be addressed prior to construction of the table.

C. The pits and tables on both the working tracks must be designed in a manner to allow drop table operators sufficient room to access and remove the traction motor connection rod on the new style traction motors. The connection rod is mounted on the rear of the motor assembly.

1.14 SPECIFICATIONS

A. General:

1. Minimum rated capacity of drop table to be 50 tons.
2. Table may be of either screw, ball screw, or hydraulic construction.
   a. Screw and ball screws must be completely enclosed to prevent damage from contaminates.
   b. Screw and ball screws must have a locking mechanism to support columns in the event of ball screw failure.
   c. Controls must have been incorporated to stop the table and set the locking mechanism in the event any of the ball screws lose their synchronization.

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d. Screw and ball screw drive must complete with all necessary drives, motors, and controls.

e. Hydraulic tables must be equipped with the same fail safe locking.

f. Hydraulic table must be equipped with all necessary pump, motors, fittings, piping, filtration system, and hydraulic fluid tank.

3. Hoisting and traverse must have two (2) speeds:

   a. Low speed at top and bottom portions of hoisting travel is to be approximately 2 FT per minute.

   b. All other portion of hoisting travel is to be not less than 6 FT per minute.

   c. Low table traverse speed for positioning at the release tracks and shop tracks must be 5 FT per minute.

   d. All other portions of table traverse speed must be not less than 30 FT per minute.

   e. Table must be equipped with a protective mechanism to prevent damage in the event of over-travel in either the hoisting up or down stroke or the table traverse movements.

   f. The drop table must be capable of completely automatic operation form a point 36 IN below the service track level. Controls to manually override the automatic operation must be included.

   g. The drives for mechanical table should be variable speed.

4. Vendor is to furnish drop table complete with all necessary motors, drives, controls, piping, wiring, work tables, traction motor support systems, hydraulics and other equipment as necessary to provide a turn-key operation.

5. Machine must be equipped with automatically actuated continuous lubrication. Systems on all components requiring periodic lubrication.

6. Machine must include one (1) traction motor work table.

   a. The table must have capacity of less than 50 tons.

   b. The table must be equipped with:

      1) All support and locking mechanisms. Locking mechanism may be mechanically or hydraulically actuated.

      2) A complete 2-speed hydraulic tilting system capable of raising and lowering the rear of the traction motor for removal and replacement.

      3) All necessary interfaces and connections with the traction motor transport system.

      4) All working surfaces of the worktable must be equipped with anti-skid steel plates.

7. All machine components must be cleaned, primer coated, and painted in accordance with current OSHA colors for shop machinery.

8. Upon completion of installation at NAME OF YARD HERE, the manufacturer must demonstrate successful operation of the drop table.

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B. Electrical:

1. The primary voltage of this machine is to be 440 Volt, Triple Phase.
2. All control voltages are to be no greater than 110 Volt, Single Phase.
3. In pit electrical components to be NEMA 4. Motor to be TEFC.
4. All electrical control panels and cabinets are to be located above the drop table pit.
5. An operator control panel must be included.
    a. Panel must include all necessary switches or buttons to achieve all aspects of automatic or manual table operation.
    b. An emergency stop function must be included.
    c. Lights or indicators must be included to indicate table operational status.
6. All electrical equipment must comply with all existing state, county, and city wiring codes in effect at the time of construction.
7. All necessary take-up reels to provide power to the table must be included. Reels must be spring type automatic extend and retract.
8. The table and all its operational functions are to be Programmable Logic Controlled (PLC).
    a. The controller and all related components for machine operation must be included.
    b. The controller must be equipped with a phone modem for on-line troubleshooting and re-programming support.
    c. The controller must be programmed to prevent operation of the drop table if any unsafe operation of the drop table if any unsafe mechanical conditions exist.
    d. All programming for complete machine operation must be installed.
    e. PLC must be capable of simplistic re-programming in case of memory failure.
9. All electrical enclosures must be waterproof rated.
10. All electrical components necessary for turn-key operation must be included.

C. Release Track Bascule Top:

1. A bascule style top must be provided for the release track.
2. Release track bascule top bascule top must be capable of supporting the cross-over load of a forklift carrying a traction motor set. It will not be required to support the load of a locomotive.
3. Top may be mechanically or hydraulically raised and lowered.
4. All walking surfaces on table top must be constructed of a non-slip steel plate.
5. All components of the top must be included as required for installation upon receipt.

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6. Guard rail must be provided for operator protection when the release track top is in the open position.
7. Top must automatically open during the traction motor hoisting operation.

D. Drop Table Installation and Start-Up Supervision:
1. Vendor must provide a quote for installation supervision only.
2. Quote should list all costs of labor, transportation, lodging and other expenses.
3. Installation and start-up supervision must be listed as a separate, optional item.

E. Traction Motor Shimming Operations:
1. Provisions must be made for the shimming of traction motor spring packs.
2. The shimming operation may be performed by the drop table or separate equipment.
3. The shimming equipment should be hydraulically powered.
4. he minimum capacity of the shimming table should be 50 tons.
5. All operator controls for the shimming operations must be included.
6. If separate shimming equipment is used, detailed foundation and installation instructions must be included.

1.15 TRAINING REQUIREMENTS

A. Successful bidder must provide on-site training on Union Pacific employees for safe operation of this table. Training must include but not limited to all aspects of machine motion and control; alignment with service and release tracks; table involvement with actual removal and replacement of motors, and emergency situations. Safety will be the utmost concern in all aspects of operator training. Upon completion of training, all operators must demonstrate their ability to safely and competently control all aspects of the operation of this equipment.

B. Training must also be provided for maintenance personnel. Training in this area must include, but not limited to:
1. All operational aspects of the table.
2. Adjustments and lubrication.
3. Preventative maintenance scheduling and procedures.
4. General repairs to the equipment.

C. Safety will be the utmost concern in all aspects of maintenance training. Upon completion of training, all maintenance personnel must demonstrate a general knowledge of the operation if the machine, and competence in its proper care and maintenance.

1.16 DELIVERY POINT

Name: _____

Title: _____

Address: _____

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City: _____

State: _____

Zip Code: _____

Phone Number (including Area Code): ___ _____

1.17 PROJECT CONTACTS

A. The Project Drawings shall include a table that specifies Project Contacts as follows:

1. A contact in Omaha at the Union Pacific Headquarters for questions regarding technical aspects of the quotation
2. A contact for the Local Manager of Locomotive Maintenance at the installation location, for questions regarding on-site application of the drop table
3. A contact in UPRR Supply in Omaha at the Union Pacific Headquarters, for questions regarding submissions of quotation or pricing
4. A contact for Manager of Mechanical Systems Design in Omaha at the Union Pacific Headquarters, for questions regarding application with the new locomotive facility

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

SECTION 40 05 03 - PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping system materials, installation and testing.

B. All work covered by this Specification shall be in strict compliance with any and all applicable codes, regulations and ordinances. The Contractor shall obtain and pay all fees, required for permits and inspection that may be required locally.

1.02 REFERENCED STANDARDS

A. American Petroleum Institute (API):

1. 5L, Specification for Line Piping.

B. American National Standards Institute (ANSI):

1. B1.20.1, Pipe Threads, General Purpose (Inch).
2. B16.5, Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.
3. B16.9, Factory-Made Wrought Steel Buttwelding Fittings.
4. B16.11, Forged Fittings, Socket-Welding and Threaded.
5. B16.20, Metallic Gaskets for Pipe Flanges – Ring-Joint, Spiral Wound and Jacketed.
6. B16.25, Buttwelding Ends.

C. American Society of Mechanical Engineers (ASME):

1. Boiler and Pressure Vessel Code – Section I and IX.
2. B31.3, Process Piping.

D. ASTM International (ASTM):

1. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
2. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
3. A105, Standard Specification for Carbon Steel Forgings, for Piping Applications.
4. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
5. A181, Standard Specification for Carbon Steel Forgings, for General Purpose Piping.
6. A193, Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications.
7. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.

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8. A234, Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
9. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
10. A563, Standard Specification for Carbons and Alloy Steel Nuts.
11. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
12. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
13. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
14. D1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
15. D1785, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe. Schedules 40, 80 and 120.
16. D2241, Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
17. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
18. D2466, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
19. D2467, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
20. D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
21. D2665, Standard Specification for Polyvinyl Chloride (PVC) Plastic Drain, Waste and Vent Pipe and Fittings.
22. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
23. D3034, Standard Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
24. D3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
25. F1417, Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.

E. American Water Works Association (AWWA):

1. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 12 in., for Water Transmission and Distribution.
2. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. Through 36 in., for Water Transmission and Distribution.

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F. American Welding Society (AWS):

1. AWS D1.1, Structural Welding Code.

G. Cast Iron Soil Pipe Institute (CISPI):

1. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.
2. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications.

H. National Fire Protection Association (NFPA).

1.03 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittal Procedures

B. Section 09 90 01 – Painting and Coatings

C. Section 09 97 50 – Tank and Piping Coatings for Fuel and Oil Systems

D. Section 33 05 26 – Mechanical Identification

E. Section 40 46 50 – Cathodic Protection, Impressed Current

F. Section 40 46 50 – Cathodic Protection, Galvanic

1.04 SUBMITTALS

A. Submit as specified in Division 01 specification.

B. Shop drawings required by this Section include, but are not limited by, the following:

1. Piping and accessories.
2. Pipe testing procedures and results.
3. Welder qualifications.
4. Welding test results, including radiograph test reports, magnetic particle test reports, dye penetrate test reports, and visual test reports including name and signature of railroad representative present.

C. As-built drawings that include an accurate record of the exact location and elevation of aboveground and belowground piping installed.

PART 2 - PRODUCTS

2.01 GENERAL

A. Cathodic Protection:

1. Install cathodic protection to below grade, single and double wall steel piping per drawings or as otherwise indicated.

B. Painting and Coatings:

1. Steel pipe:

a. Above grade (exposed):

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1) All piping shall be painted per Section 09 90 01 or 09 97 50, as applicable.

2) In Secondary Containment systems all carrier pipe within containment pipe shall be epoxy coated. All joints of the carrier pipe shall be tested per these specifications before the epoxy coating is applied.

b. Below grade:

1) All piping (carrier and containment pipe) shall be epoxy coated. All joints of the carrier pipe shall be tested per these specifications before the epoxy coating is applied.

C. Pipe Marking:

1. Label above grade piping as per Section 33 05 26.

D. Pipe Identification:

1. Label above grade piping, valves, equipment, and other accessories per Section 33 05 26.

E. Tracing:

1. Tracer wire is to be taped to any below grade piping with marker tape above the pipe per drawings or as otherwise stated.

2.02 MANUFACTURERS

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

1. Dielectric-Flange Insulating Kits:

a. Calpico, Inc.

b. Central Plastics Co.

c. PSI, Inc.

2. Mechanical Sleeve Seals

a. Advance Products & Systems

2.03 STEEL PIPING

A. General:

1. Pipe shall be ASTM A53 Grade A or B or APL 5L Grade B, seamless or electric resistance welded. All pipe two and one half inches (2-1/2") or larger shall be Schedule 40 or Standard Thickness whichever is less, butt welded, unless otherwise indicated on the Drawings. Piping two inches (2") or smaller shall be Schedule 80, socket welded, unless otherwise required at process and instrument connections.

2. Fittings for Welded Pipe:

a. Pipe 2 1/2 IN or larger:

1) Fittings shall be butt welding type carbon steel, ASTM A234 Grade B, ANSI B16.9. Wall thickness shall match pipe.

b. Pipe 2 IN or smaller:

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1) 3000 LB forged steel conforming to ANSI B16.11. Threads shall be full, clean, sharp and true. Screwed pipe joint compound shall be resistant to the effects of diesel fuel.

2) For petroleum and industrial wastewater, fuel/oil /sludge service, fittings two inches (2") or smaller shall be socket welded, class 3000, confirming to ASTM A105 and ASME B16.11. Threaded connections are only acceptable as required at process and instrument connections.

c. Elbows shall be long radius unless otherwise indicated.

d. Tee connections 2 IN or larger shall be butt welded. Fabricated tees may be used in lieu of butt welding provided they are accomplished using weldolets or elbolets.

3. Flanges:

a. Standard weld neck type flanges shall be ASTM A181 forged steel and conform to ANSI B16.5. Rating shall be 150 LB forged steel, except where 300 LB flanges are required to match the equipment to which the piping is jointed.

b. Flange facings shall be standard 1/16 IN raised face, unless otherwise required to match equipment flanges.

c. Flange bolts shall be alloy steel, Teflon coated, conforming to ASTM A193 Grade B7.

d. Flange nuts shall be heavy hexagon carbon steel conforming to ASTM A194 Grade 2H.

B. Double Wall

1. Pipe shall be ASTM A53 Grade A or B or APL 5L Grade B, seamless or electric resistance welded. All carrier pipes shall be Schedule 40 or Standard Thickness whichever is less, unless otherwise indicated on the Drawings. Containment pipe shall be Schedule 20 or standard thickness, whichever is less, unless otherwise indicated on the drawings.

2. Piping shall consist of a steel carrier pipe inside of a steel containment pipe that shall be fully testable to ensure its integrity.

3. Carrier pipe shall be supported at intervals within the containment piping based on the structural requirements for the diameter of piping utilized. Pipe supports shall be fixed and any fluid buildup shall be allowed to drain to the nearest leak detection port.

4. Containment piping shall be sized to contain the carrier piping with sufficient clearance for field assembly and thermal expansion or contraction.

5. Where insulated piping is required, insulation shall be factory injected polyurethane foam to completely fill the annular space between the steel carrier pipe and the steel containment pipe. Provide with leak detection or heat trace channel to allow for leak detection or installation of heat tracing.

2.04 BURIED COMPRESSED AIR PIPE

A. Piping shall be Asahi/American Air-Pro(R) compressed air pipe.

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B. All pipe transitions shall be done a minimum of 1 FT-0 IN below grade.

C. Transitions fittings as approved by the pipe manufacturer shall be used when connecting underground pipe to aboveground steel pipe.

D. Piping 1-1/2 IN and smaller will be socket fused together. Piping 2 IN and greater to be butt fused.

E. Piping to be welded per manufacturers' recommendation including protecting pipe welding during cold temperatures.

2.05 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. Piping shall be single wall, SDR-11 thickness, PE3408 black pipe compatible with diesel fuel and water for gravity drain applications.

B. Fittings shall be factory fabricated SDR-11 minimum thickness with plain ends for butt fusion per ASTM D3261 unless otherwise specified or indicated.

C. For connections to materials or pipe other than HDPE (steel, PVC, basin liners, etc.), provide fittings and adapters as recommended by the pipe manufacturer. Submit connection details for review.

D. Piping 1-1/2 IN and smaller will be socket welded. Piping 2 IN and greater to be butt welded.

E. Provide piping in maximum lengths provided by manufacturer to minimize field joints.

2.06 CAST IRON PIPE

A. Piping and fittings shall be service weight and conform to the requirements of ASTM A74 or ASTM A888.

B. Joints for hubless pipe and fittings shall conform to the manufacturer's installation instructions and local code requirements. Hubless couplings shall be composed of a stainless steel shield, clamp assembly, and a neoprene sealing sleeve conforming to ASTM C1277.

C. Joints for hub and spigot pipe shall be installed per the manufacturer's installation instructions and shall utilize neoprene compression gaskets conforming to the requirements of ASTM C564.

D. Under no circumstances will cast iron piping or fittings be used in petroleum services, to include industrial wastewater collection.

2.07 DUCTILE IRON PIPE

A. Ductile Iron Pipe: AWWA C151 with push on type joints. Cement mortar line in accordance with AWWA C104.

1. Fittings: Ductile iron mechanical joint per AWWA C110. Cement mortar line in accordance with AWWA C104.

2. Joints: AWWA C111 Viton push-on-gaskets.

3. Polyethylene encasement: ASTM A674 or AWWA C105 polyethylene film 0.008 IN (0.20 mm) minimum thickness, tube or sheet.

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2.08 PVC PIPE

A. Refer to Section 40 05 32 for details.

2.09 DIELECTRIC-FLANGE INSULATION KITS

A. Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gaskets, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

2.10 TRACER WIRE

A. Wire Material: 10 AWG, Copper Clad Steel (CCS).

B. Jacket Material: High Density Polyethylene (HDPE) or High Molecular Weight Polyethylene (HMWPE) designed for direct burial.

C. Terminations shall be suitable for direct burial and wet location electrical connections.

1. Connector Manufacturers:

a. Copperhead SnakeBite.

b. 3M DBR.

c. Or Approved Equal.

2.11 FLEXIBLE CONNECTORS

A. General:

1. Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. End connections shall have a minimum working pressure of 150 psig and will be as follows:

a. 2 IN NPS (DN50) and Smaller – Threaded.

b. 2-1/2 IN NPS (DN65) and Larger – Flanged.

B. Stainless Steel Hose Flexible Connectors:

1. Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

C. Rubber, Flexible Connectors:

1. CR or EPDM elastomer rubber construction, with multiples plies of NP fabric, molded and cured in hydraulic presses. Include 125 psig minimum working-pressure rating at 220 DegF. Units may be straight or elbow type, unless otherwise indicated.

2.12 MECHANICAL SLEEVE SEALS

A. Sleeves:

1. The following materials are for wall, floor, slab and roof penetrations:

a. Steel Sheet Metal – 0.0239 IN (0.6-mm) minimum thickness, galvanized, round tube closed with welded longitudinal joint.

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b. Steel Pipe – ASTM A53, Type E, Grade A, Schedule 40, galvanized, plain ends.

2.13 PROCESS PIPING SYSTEMS

A. Industrial Waste Piping (Gravity), Buried:

1. Ductile Iron Pipe: AWWA C151 with push on type joints. Cement mortar line in accordance with AWWA C104.

a. Fittings: Ductile iron mechanical joint per AWWA C110. Cement mortar line in accordance with AWWA C104.

b. Joints: AWWA C111 Viton push-on-gaskets

c. Polyethylene encasement: ASTM A674 or AWWA C105 polyethylene film 0.008 IN (0.20 mm) minimum thickness, tube or sheet.

2. High Density Polyethylene (HDPE) Pipe, as outline above, is also acceptable for this application

B. Industrial Waste Piping (Force Main):

1. Above grade:

a. Steel, ASTM A53 Grade B, Schedule 40.

b. Fittings: Malleable iron meeting ASTM A197 and ANSI B16.3, Class 150.

c. Joints: Threaded or flanged, joint compound resistant to piped fluid.

d. Gaskets: gaskets shall be fire resistant Flexitallic CGI Style – 304 Stainless steel spiral wound metal with Flexicarb filler material for Class II liquid which is compliant with UPRR diesel specifications. Installation shall be in accordance with the manufacturer's recommendations.

2. Below grade:

a. PE4710 HDPE, ASTM D2513.

b. Fittings: Socket fusion or butt fusion fittings complying with ASTM D2683 and ASTM D3261.

c. Joints: Fusion joint system.

C. Water Piping, Buried Within 5 FT of Building:

1. Copper Tubing: ASTM B88, Type K, annealed.

a. Fittings: ASME B16.18 cast bronze, ASME B16.22 wrought copper and bronze, or ASME B16.24 150 psi flanged.

b. Joints: No joints allowed below concrete slab.

c. Include suitable homogeneous backfill material (e.g. washed sand, limestone sand or small limestone chips, small smooth river stone, or washed pea gravel) a minimum of 4 IN above and below pipe.

D. Water Piping, Above Grade:

1. Copper Tubing: ASTM B88, Type L, hard drawn.

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a. Fittings: ASME B16.18 cast bronze, ASME B16.22 wrought copper and bronze, or ASME B16.24 150 psi flanged.

b. Joints: ASTM B32, solder, alloy Sn95, Sn94, E, HA, or HB or AWS A5.8, BCuP silver braze.

c. Unions: 150 psi copper, solder type socket ends.

E. Compressed Air:

1. Above grade:

a. Steel, ASTM A53 Grade B or API-5L Grade, schedule 40, seamless or ERW. Condensate lines shall be type M copper.

b. Fittings:

1) Pipe 2 IN or larger: Butt welding type carbon steel, ASTM A234 Grade B, ANSI B16.9. Wall thickness shall match pipe.

2) Pipe 1-1/2 IN and smaller: Threaded pipe fittings shall be 3000 LB, forged steel conforming to ANSI B16.11.

3) Piping is not to present a tripping hazard, a maintenance obstacle, or violate NEC required clearances.

c. Pipe dope to be used on all threaded connections, no Teflon tape shall be used.

2. Below grade:

a. Piping shall be Asahi/American Air-Pro compressed air pipe, no substitutions.

1) All pipe transitions shall be done a minimum of 1 FT below grade.

2) Transitions fittings as approved by the pipe manufacturer shall be used when connecting underground pipe to aboveground steel pipe.

3) Piping 1-1/2 IN and smaller will be socket fused together. Piping 2 IN and greater to be butt fused.

4) Piping to be welded per manufacturers' recommendation including protecting pipe welding during cold temperatures.

F. Oxygen and Acetylene Gas Piping, Above Grade:

1. Steel Pipe up to and including 1-1/2 IN: ASTM A53, Schedule 40 black, Type E Grade B, or Type S Grade B. Meeting requirements of ASME B31.3 and NFPA 51.

a. Fittings: ASME B16.11, 2000 psi forged steel, welded or threaded type; Class 300 black malleable iron, threaded, ASME B16.3.

b. Joints: NFPA 51, threaded or welded to ANSI B31.2, ANSI B31.8.

1) Tapered threaded connections in oxygen pipe shall be tinned or made up with polytetrafluoroethylene (such as Teflon) tape or other thread sealants suitable for oxygen service. Sealants shall be applied to the externally threaded portion only.

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c. Oxygen pipe sealant shall be OXY-TITE, Loctite (Thread Sealant for Oxygen Systems) or equal.

d. Couplings: ASME B16.11, forged steel, 3000 psi, threaded or welded; Class 300 black malleable iron, threaded, ASME B16.3

e. Unions: Forged steel, 3000 psi SWP, threaded, bronze to steel seat; Class 300 black malleable iron. Use dielectric insulating unions to electrically isolate underground piping from aboveground piping.

f. Provide grounding at suitable intervals to protect against the effects of lightning and static electricity. The electrical resistance to earth of the installed aboveground piping system should not exceed 10 Ohms for lightning protection.

g. Provide isolating pads at all pipe supports.

h. Hose and hose connections: Shall comply with CGA E-1, Standard for Rubber Welding Hose and Hose Connections for Gas, Welding, Cutting, and Allied Processes.

2. See Section 22 05 28 for manifold requirements.

G. Fuel and Oil Piping:

1. Above-grade.

a. Steel

b. Gaskets shall be full-faced type for flat-faced flanges, and ring type for raised-face flanges conforming to ANSI B16.5 "Group I Gaskets"

1) Gaskets utilized outside tank containment areas shall be 1/16 IN thick compressed asbestos-free with Nitrile binder resistant to the effects of diesel fuel. Spiral wound metallic gaskets as outlined below are also acceptable outside tank containment areas.

2) Inside tank containment areas, gaskets shall be fire resistant Flexitallic CGI Style – 304 stainless steel spiral wound metal with Flexicarb filler material for Class II liquid which is compliant with UPRR diesel specifications. Installation shall be in accordance with the manufacturer's recommendations

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall keep an accurate record of the exact location and elevation of all underground and aboveground piping installed and shall, upon completion of the piping systems, furnish these records to the Railroad as required by the condition of the Contract.

B. Clean interior of all pipe, fittings, and joints prior to installation. Installed piping shall be temporarily plugged at the end of each day's work or other interruption to progress. Plugging shall be installed in a manner satisfactory to the Engineer and shall be adequate to prevent entry of water, animals, and debris into the pipe and equipment.

C. Install piping in accordance with the manufacturer's recommendations where applicable.

3.02 INSTALLATION

A. Steel Pipe:

1. General:

a. Install each piping run with a minimum of joints and couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Provide all bolts, studs, nuts, and gaskets for makeup of all connections of piping and equipment or fittings.

b. Reduce pipe sizes where indicated by use of reducing fittings.

c. Align pipe accurately at connections within 1/16 IN misalignment tolerance.

d. Provide all necessary supports, brackets, or foundations required to properly install piping and equipment.

e. Provide high point vents and low point drains as required to effectively vent and drain the entire piping system or where indicated on the drawings. Vent valves shall be a lockable ball type and the open end shall be sealed with a threaded plug or blind flange as appropriate.

f. Piping shall be painted and labeled as indicated on the drawings and as specified sections 09 90 01, 09 97 50, and 33 05 26..

2. Welding:

a. Welding shall be accomplished by the shielded metallic arc process and shall be in strict accordance with ASME B31.3 welding rods, whose physical characteristics are not less than the parent metal.

b. The Contractor shall use welders qualified per ASME B31.3 and AWS standards and shall be capable of supervising all welding and installation.

c. Welders assigned to the work shall be duly qualified in accordance with ASME Section IX Boiler and Pressure Vessel Code for Welder's Qualification Test, Welding Procedures, and Quality Requirements, and Procedures and Tests for Qualifying Welders; and AWS B2.1 6G E6010 open root and E7018 fill and cap pipe welding certification. Contractor will provide copies of welder certification demonstrating certification renewal within six (6) months of project start date at project commencement to the designated project manager. Contractor is responsible for ensuring that welder's certifications are maintained for the duration of the project.

d. All welding shall be conducted in a "Gas-Free" condition. All welding of pipes that may have previously contained fuel shall be sufficiently purged fuel and vapors to provide for a safe welding environment. It is the responsibility of the Contractor to maintain safe conditions.

3. Welding Methods:

a. No welding shall be done if the metal temperature is below zero degrees Fahrenheit or if the surfaces are wet. All surfaces shall be prepared and with the temperature range prescribed by the AWS standard.

b. All joints shall conform to the latest published standard of the AWS, IAW, and ANSI codes.

c. In the installation of socket weld fitting and valves, a 1/16 IN clearance shall be left between the end of the pipe and the shoulder in the socket.

d. Align pipe joints with pipe clamps prior to welding. Clamps or other alignment devices shall not reduce the pipe diameter. Tack welds in the grooves may be used if fixtures cannot be used but shall be kept to a minimum.

e. Clean each joint before welding into the system to remove all grease, rust, paint, burrs and loose debris.

f. The number of passes for welding joints and the methods of welding shall be in accordance with AWS D1.1.

g. Complete fusion shall be obtained and care shall be taken that full penetration is obtained through thickness of metal without stalactite or dripping.

h. All slag and flux shall be removed by wire brushing before each succeeding pass is made.

i. The completed weld shall be free from all defects including undercutting, porosity, and cracking.

j. Welds shall present a smooth, regular workmanship appearance.

k. No weld metal shall project within the piping at completion of the welding.

4. Inspection:

a. All piping welded pipe shall be subject to inspection. All costs of labor and material required for testing shall be the responsibility of the Contractor.

1) Petroleum tanks and pipelines welding inspection requirements to be done in accordance with ASME B.31.3 process piping.

Welding Work Inspection			
	Above Ground	Below Ground	Tanks
	20%	100%	100%
Small job exemption: No weld inspection required for non-tank, above ground pipe welding less than 8′ in height where less than 5 welds are made.			

b. Welding defects considered cause for rejection shall be defined as follows:

1) Undercutting.

2) Cracks.

3) Lack of fusion.

4) Weld reinforcement in excess of 1/8 IN.

5) Gas pockets (slag inclusions over 1/8 IN in longest dimension).

6) Surface porosity (more than six (6) gas pockets per square inch of etched surface).

c. If more than 20 percent of the welds tested are found defective, a second group of welds shall be tested. If more than 20 percent of the second group are found defective, all welds in the system shall be removed, without further testing and shall be re-welded without any additional cost to the Railroad.

d. Defective welds shall be repaired in accordance with ASME B31.3 at the Contractors' expense.

B. HDPE Pipe:

1. Heat Fusion Procedures:

a. All joining of HDPE pipe and fittings shall follow the general guidelines given in ASTM D2657 and specific guidelines as recommended by the manufacturer.

b. Personnel trained in heat fusion joining using tools approved by the pipe manufacturer shall do procedures necessary for correct assembly of pipe and fittings.

c. Pipe ends and fittings shall be cut square, cleaned, beveled and prepared for heat fusion as recommended by the manufacturer.

d. When piping installation will occur in cold weather, below 55 DegF, trial melt patterns shall be made on extra pieces of pipe to establish proper melt times.

2. Gravity pipe testing:

a. Perform air tests per ASTM F1417 and submit proposed testing procedure for approval prior to conducting tests.

C. Tracer Wire:

1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.

2. Continuous pass from each valve box and above grade at each structure.

3. Coil enough wire at each valve box to extend wire a foot above the ground surface.

4. If split bolts are used for splicing, wrap with electrical tape.

5. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.

6. Use continuous strand of wire between valve box where possible.

a. Continuous length shall be no shorter than 100 FT.

7. Tracer Wire Testing:

a. Contractor to perform conductivity test and spot locate testing.

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3.03 TESTING

A. General:

1. All tests shall be made in the presence of the Engineer or railroad representative. Any preliminary tests that the Contractor may make without such tests being observed by the Engineer will not be accepted unless prior approval is obtained. The Contractor shall notify the Engineer at least 48 HRS before any work is to be inspected or tested.

2. If inspection or test shows defects, the piping system(s) shall be repaired and/or replaced and the inspection repeated, until such piping is acceptable to the Engineer. Any repair or replacement necessary due to faulty materials furnished by the Railroad will be considered additional work.

3. Short sections of line may be isolated for testing. If shorter sections are tested, test plugs or bulkheads required at the ends of the test section shall be furnished and installed by the Contractor, together with all anchors, braces, and other devices required to withstand the hydrostatic pressure without imposing any thrust on the pipeline. The Contractor shall be solely responsible for any damage that may result from the failure of test plugs or supports. If sections of the system are tested and not accepted they shall be promptly corrected and re-tested.

4. All piping systems shall be tested in accordance with this Specification in addition to any tests required by Local and State codes or building authorities. Obtain and pay for all necessary approvals, acceptances, and permits.

5. All apparent leaks discovered within one year from the date of acceptance of the Work by the Railroad shall be located and repaired by the Contractor, regardless of the total line leakage rate.

6. All necessary testing equipment and materials including tools, appliances, and devices shall be furnished and all tests shall be made by and at the expense of the Contractor.

B. Pressure Piping Hydrostatic Test:

1. Piping shall be slowly filled with water and all air expelled. Care shall be taken that all air valves on high point vents are installed and open in the section being filled, and that the rate of filling does not exceed the venting capacity of the air vents.

2. The pressure shall be gradually increased until a gauge pressure of one-half (1/2) the test pressure is attained, at which time a preliminary check of the pipe shall be made. This preliminary test pressure shall be maintained for a minimum of ten (10) minute, or for as long as necessary for the Engineer to complete the inspection of the line under test. The pressure shall then be gradually increased until the test pressure is reached. Hydrostatic test pressure shall be one and one half (1.5) times the designed operating pressure, but in no case less than 100 psig. Do not exceed the pipe manufacturers recommended test duration.

3. Subject the piping to pressurization cycles by venting pressure at the high points and then increasing pressure again to the maximum test pressure. Hold test pressure again for a ten (10) minute period at the test pressure. Maintain the final pressure cycle for 2 HRS and check for leaks.

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4. If defects are noted, repairs shall be made and the test cycle repeated until all parts of the line withstand the test pressure.

5. After the hydrostatic pressure test has been completed, the lines shall be subjected to a hydrostatic leak test. The pressure range of the leak test will be 50 to 100 percent of maximum test pressure, and will be determined by the Contractor. A successful test will be the pressure maintained within a maximum variation of 5 percent during the entire leak test, over a cycle of 2 HRS minimum, or for such additional time necessary for the Engineer to complete inspection of line under test. Test duration shall not start until a constant pressure has been established. The line leakage shall be measured by means of a water meter installed on the supply line of the pressure pump.

6. After the successful completion of the pressure tests the line tested shall be pigged three (3) times to completely purge all water.

C. Pressure Piping Pneumatic / Soap Test:

1. Piping shall be slowly pressurized with clean, dry air until a gauge pressure of one-half (1/2) the test pressure is attained, at which time a preliminary check shall be made. Maintained preliminary test pressure for a minimum of ten (10) minutes and for such additional period necessary for the Engineer to complete the inspection of the line under test. Thereafter, gradually increase pressure until the test pressure is reached. Pneumatic test pressure shall be one and one half times (1 1/2x) times the designed operating pressure, but in no case less than 5 psig or more than 50 psig. Do not exceed the pipe manufacturer's recommended test duration.

2. Maintain the final pressure for 1 HR minimum and check for leaks using a soap solution.

3. If defects are noted, repairs shall be made and the test repeated until all parts of the line withstand the test pressure.

4. Containment Piping:

   a. Provide boots and end seals with pressure connections as required to pressure test containment piping. Loosen boots or end seals upon successful completion of pressure testing in order to allow carrier piping leaks to be visually detected.

   b. Pressure test at 5 psig for a minimum period of twenty (20) minutes, and as long as required to visually test each joint with a soap solution.

D. Gravity Drainage and Venting Systems:

1. Test by filling with water to the level of the highest vent stack or 10 FT-0 IN above highest grade, whichever is higher. Openings shall be plugged as necessary. To be considered free of leaks, the system shall hold the water for thirty (30) minutes without any drop in the water level.

E. Double Wall Containment:

1. Testing:

   a. An air pressure leak test shall be performed on the containment pipe.

b. All welds on the containment piping are to be leak tested with dye penetrant and by soapy water during the pressure testing requirement listed in this specification. The joints that pass are to be cleaned and either epoxy coated and wrapped in bituminous tape.

c. A hydrostatic test of the carrier pipe shall be performed as outlined in the Uniform Plumbing Code, Section 318 as directed by the Local Administrative Authority having jurisdiction.

d. Leak detection shall be provided to monitor the integrity of the carrier piping according to details listed on the drawings.

e. For system drainage applications, a hydrostatic test of one and one half times (1-1/2x) the working pressure is required for the carrier pipe.

2. Welding Inspection:

a. All welded joints on carrier pipe to be contained are to be 100 percent X-ray tested prior to painting and installation in of the containment piping.

b. Any carrier pipe 8 FT above the ground shall be 100 percent X-ray tested. All X-ray testing is to be done in accordance with ASTM E915.

c. All X-ray testing required must be documented and the inspection records turned over to the Engineer prior to the installation of the secondary containment piping.

d. All X-ray testing is subsidiary to these work items and no additional payment will be made by the Railroad for this requirement beyond the original bid amount.

e. All X-ray testing must pass the ASTM E915 requirement prior to incorporating the work on the project.

f. All welds on the containment piping are to be leak tested with dye penetrant and by soapy water during the pressure testing requirement listed in this specification. The joints that pass are to be cleaned and either epoxy coated and wrapped in bituminous tape.

g. Both the secondary containment and carrier pipe are to be fully (100 percent) epoxy coated. any joints may be field coated after welding and wrapped pin bituminous tape.

END OF SECTION

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SECTION 40 05 07 - HANGERS AND SUPPORT

1.01 SUMMARY

A. Section Includes:

1. Hangers and supports for mechanical system piping and equipment.

B. Pipe hanger and support locations indicated on drawings are shown for information only and not to describe the exact location(s) of required supports. The Contractor shall ensure that all piping is properly supported along its entire routing.

1.02 REFERENCED STANDARDS

A. Manufacturers Standardization Society (MSS):

1. SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture.
2. SP-69, Pipe Hangers and Supports – Selection and Application.

B. National Fire Protection Association (NFPA):

1. 13, Installation of Sprinkler Systems.
2. 70, National Electric Code (NEC).

C. Underwriters Laboratories (UL).

1.03 SUBMITTALS

A. Submit as specified in Section 01 33 00 – Submittals and Substitutions

B. Product Data – Submit manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing manufacturer's figure number, size, location, and features for each required pipe hanger and support.

C. Coordinate submittals with piping submittals to show support locations and type on all spool drawings for pipe systems.

1.04 QUALITY ASSURANCE

A. Fire protection piping hangers and supports shall comply with NFPA 13, UL and FM.

B. Prepare hanger and support design drawings and calculations for seismic restraint of piping and equipment if required by local jurisdiction.

PART 2 - PRODUCTS

2.01 MANUFACTURERS OF HANGERS AND SUPPORTS

A. Available Manufacturers – Subject to compliance with requirements, manufacturer's offering hangers and supports which may be incorporated in the work include, but are not limited to, the following:

1. B-Line Systems Inc.
2. Carpenter and Paterson Inc.

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3. Elcen Metal Products Co.
4. Fee and Mason Mfg. Co.
5. ITT Grinnell Corp.
6. Pipe Shields Inc.

2.02 HORIZONTAL – PIPING HANGERS AND SUPPORTS

A. Except as otherwise indicated, provide factory-fabricated horizontal-piping hangers and supports complying with MSS SP-58, selected by the Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information.

2.03 HANGER-ROD ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, selected by the Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturers published product information.

2.04 STRUCTURAL ATTACHMENTS

A. Except as otherwise indicated, provide factory-fabricated building attachments complying with MSS SP-58, selected by the Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information.

2.05 SADDLES AND SHIELDS

A. Except as otherwise indicated, provide saddles and shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shield for exact fit to mate with pipe insulation.

2.06 MISCELLANIOUS MATERIALS

A. Metal Framing – Provide products complying with NEMA STD ML 1.

B. Steel Plates, Shapes and Bars – Provide products complying with ASTM A36.

C. Heavy-Duty Steel Trapezes – Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.01 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure; comply with MSS SP-69.

B. Arrange for grouping of parallel runs of horizontal piping supported together on trapeze type hangers where possible. Install supports with maximum spacings complying with MSS SP-69.

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C. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.

3.02 ADJUSTING AND CLEANING

A. Hanger Adjustments – Adjust hangers so as to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION

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SECTION 40 05 32 - POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. 4 - 27 IN buried polyvinylchloride (PVC) pressure pipe. PVC pressure pipe shall be furnished complete with all fittings, jointing materials, anchors, blocking, encasement, and other necessary appurtenances. Pressure and leakage tests and cleaning are covered in other sections. Pipe trenching, bedding, and backfill are covered in Section 31 00 00 - Earthwork.

1.02 REFERENCED STANDARDS

A. Except as modified or supplemented herein, all PVC pressure pipe shall conform to the applicable requirements of ANSI/AWWA C900 and C905.

B. The supplementary information required in the governing standards is as follows:

Affidavit of Compliance	Required
Plant Inspection	Not Required
Special Markings	Not Required
Special Preparation for Shipment	Not Required
Certification	Required

1.03 SUBMITTALS

A. Drawings and data shall be submitted in accordance with the submittals section. Drawings and data shall include, but shall not be limited to, the following:

1. Gasket Material.
2. Pipe Length.
3. Affidavit of Compliance (ANSI/AWWA C900, Sec. 1.4).
4. Affidavit of Compliance (ANSI/AWWA C905, Sec. 1.4).
5. Certification (ANSI/AWWA C900, Sec. 2.1.4).
6. Certification (ANSI/AWWA C905, Sec. 2.2.2).

1.04 STORAGE AND HANDLING

A. Pipe, fittings, and accessories shall be handled in accordance with Chapter 6 of AWWA Manual M23, to ensure installation in sound, undamaged condition. Pipe shall not be stored uncovered in direct sunlight.

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PART 2 - PRODUCTS

2.01 MATERIALS

A. Pipe:

1. ANSI/AWWA C900 or C905; cast iron pipe OD, DR = 18.

B. Fittings:

1. Cast iron ANSI/AWWA C110/A21.10, 250 psi pressure rating, except shorter laying lengths will be acceptable.

C. Joints:

1. PVC to PVC – ANSI/AWWA C900 or C905, stab type, with elastomeric synthetic rubber gaskets. Gaskets of natural rubber will not be acceptable.
2. PVC to Cast Iron – ANSI/AWWA C111/A21.11, except gaskets shall be synthetic rubber. Natural rubber will not be acceptable.

D. Tapping Saddles:

1. Ductile iron, with galvanized steel straps and synthetic rubber sealing gasket, 250 psi. pressure rating.

E. Tapping Sleeves:

1. Ductile iron, 250 psi pressure rating.

F. Polyethylene Encasement:

1. Tube or sheet, ANSI/AWWA C105/A21.5.

G. Joint Tape:

1. Self-sticking, PVC or polyethylene, 10 mils thick; Chase "Chasekote 750", Kendall "Polyken 900" or 3M "Scotchrap 50".

H. Conductive Tracer:

1. Detection Tape, 3 IN wide; aluminum foil core, 0.5 mils thick, encased in a protective inert plastic jacket.
2. 5000 psi min. tensile strength; 2.5 LBS per in per 1000 FT min. mass.
3. Color coded in accordance with APWA Uniform Color Code.
4. Allen Systems "Detectatape", Lineguard "Type III" or Reef Industries "Terra Tape D".
5. Manufacturing quality control shall be maintained by frequent, regularly scheduled sampling and testing. Testing shall comply with the governing standards.

2.02 SHOP COATING AND LINING

A. The exterior surfaces of cast iron fittings shall be coated with a bituminous coating. The interior surfaces of cast iron fittings shall be lined with cement mortar.

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PART 3 - EXECUTION

3.01 NOTICE:

A. Before beginning any work under these specifications, Contractor shall, without fail, telephone the Union Pacific Railroad at 1 800 336 9193 (a 24 hour number) to determine if fiber optic cable is buried anywhere on the Railroad's premises to be used by the Contractor. If fiber optic cables are buried on the premises, the Contractor shall telephone the telecommunications company(ies) involved, arrange for the cable locator, make arrangements for relocation or other protection of the fiber optic cable, and shall not commence any work on the premises until all such protection or relocation has been accomplished. If the Contractor contacts the Railroad and telecommunications company(ies) as required, the Contractor will not be responsible for the cost to locate, relocate, or protect the fiber optic cable.

3.02 INSPECTION

A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; spigot ends and bells shall be examined with particular care. All defective pipe and fittings shall be removed from the site of the work.

3.03 LAYING PIPE

A. Pipe shall be protected from lateral displacement by pipe embedment material installed as specified in the earthwork section. Pipe shall not be laid in water or under unsuitable weather or trench conditions.

B. During cold weather, particular care shall be taken in handling and laying pipe to prevent impact damage.

C. Pipe shall be laid with bell ends facing the direction of laying, except when reverse laying is specifically permitted by the Engineer.

D. Foreign matter shall be prevented from entering the pipe during installation.

E. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug. All water shall be removed from the trench prior to removing the plug.

F. Pipe shall be kept shaded and as cool as possible during installation and shall be covered with backfill immediately after installation.

G. Conductive tracer shall be buried above PVC pipe, not more than 18 IN below the ground surface.

3.04 CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until the work has been accepted.

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3.05 ALIGNMENT

A. Piping shall be laid to the lines and grades indicated on the drawings. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the maximum deflections specified by the manufacturer. Unless otherwise specified or indicated on the drawings, and subject to acceptance by the Owner, either shorter pipe sections or fittings shall be installed as required to maintain the indicated alignment or grade.

3.06 JOINTING

A. Slab-Type Joints – Jointing shall conform to the instructions and recommendations of the pipe manufacturer. All surfaces for gasketed joints shall be lubricated immediately before the joint is completed. Gaskets and lubricants shall be supplied by the pipe manufacturer, shall be suitable for use in potable water, shall be compatible with the pipe materials, shall be stored in closed containers, and shall be kept clean. Each spigot shall be suitably beveled to facilitate assembly.

B. Mechanical Joints – Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Overtightening of bolts to compensate for poor installation practice will not be permitted.

3.07 POLYETHYLENE ENCASEMENT

A. All cast iron fittings, tapping saddles, tapping sleeves, valves, or other cast iron accessories shall be provided with polyethylene tube or sheet protection, installed in accordance with ANSI/AWWA C105/A21.5, Method A or C.

3.08 CONNECTIONS WITH EXISTING PIPING

A. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by the Owner. Facilities shall be provided for proper de-watering and for disposal of water removed from the de-watered lines and excavations without damage to adjacent property.

B. The following paragraph applies only to connections with lines carrying potable water:

C. Special care shall be taken to prevent contamination of potable water lines when de-watering, cutting into, and making connections with existing pipe. No trench water, mud, or other contaminating substances shall be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with, or dipped in, a 200 mg/L chlorine solution.

3.09 SERVICE CONNECTIONS

A. Tapping saddles or tapping sleeves shall be used for all service connections 2 IN and smaller. Direct tapping of PVC pipe will not be permitted. Fittings shall be used for service connections larger than 2 IN.

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3.10 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed as directed by the Engineer. Concrete and reinforcing steel shall be as specified in the cast in place concrete section. All pipe to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.

3.11 REACTION ANCHORAGE AND BLOCKING

A. All bell and spigot or all bell tees, Y branches, bends deflecting 11-1/4 degrees or more, valves, and plugs which are installed in piping subjected to internal hydrostatic heads in excess of 30 FT shall be provided with suitable reaction blocking or other acceptable means of preventing movement of the pipe caused by internal pressure.

B. Concrete blocking shall extend from the fitting to solid, undisturbed earth and shall be installed so that all joints are accessible for repair. The dimensions of concrete reaction blocking shall be as indicated on the drawings or as directed by the Engineer. If the absence of suitable solid vertical excavation face is due to improper trench excavation, the Contractor shall furnish and install acceptable metal harness anchorages using ductile iron pipe of the appropriate class at no additional cost to the Railroad.

C. Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground shall be provided as directed by the Engineer.

3.12 HYDROSTATIC TESTS

A. After installation, PVC piping shall be hydrostatically tested for defective workmanship and materials as specified in the pipeline pressure and leakage testing section.

3.13 LEAKAGE

A. All PVC piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of the Contractor.

3.14 CLEANING AND DISINFECTION

A. After installation, all PVC piping shall be cleaned as specified in the cleaning and disinfection section. PVC piping for potable water supply shall be disinfected as specified in the cleaning and disinfection section.

END OF SECTION

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SECTION 40 05 39 - REINFORCED CONCRETE PIPE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fabrication and installation of concrete:

a. Round, elliptical, arch pipes.

b. Manhole riser.

c. Flared end pipes.

d. Each of which will be referred to as "pipe culverts". Pipe culverts may be for culverts, siphons, drains, and conduits as shown on the plans or directed by the Engineer in accordance with these Specifications, C.E. Drawings 680000, and in all accordance with Chapter 8 Part 10 of the current American Railway Engineering and Maintenance of Way Association (AREMA) Specifications for Culverts.

PART 2 - PRODUCTS

2.01 PIPE CULVERT MATERIAL

A. Pipe culvert material must meet the standards set forth in Chapter 8, part 10 of the current AREA Specifications. RCP pipe culvert materials shall be furnished in lengths not less than 4 FT. Material is to be new material.

B. All pipe material shall be designed for Cooper E80 loading and no pipe lighter than Class IV will be permitted. The minimum factor of safety against formation of a 0.01 IN crack shall be 1.0. In lieu of design analysis, the Contractor may furnish Class V pipe for installations with 14 FT maximum cover.

PART 3 - EXECUTION

3.01 HANDLING OF PIPE CULVERT MATERIAL

A. The Contractor shall handle pipe culverts, and the pipe culvert material, carefully in order to prevent damage including, but not limited to, injury to bituminous and other pipe culvert coatings. The pipe culverts shall never be dragged over the ground but shall be handled with skids, rolling slings, or crane. The Contractor shall promptly repair, to the satisfaction of the Engineer, any damage to the pipe culverts or culvert material which the Contractor causes. In the event that such damage to culverts or pipe culvert material cannot be repaired to the satisfaction of the Engineer, replacement of pipe culvert and/or pipe culvert material must be provided by the Contractor at his expense.

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3.02 EXCAVATION AND LOCATION

A. Pipe culverts shall be placed at the location, elevation and alignment shown on the Drawings.

B. The Contractor shall perform pipe culvert excavation. Prior to pipe culvert excavation, embankment must be constructed to a height no less than 2 FT above the top of the proposed pipe culvert when it is in place. Pipe culvert excavations shall be wide enough to permit thorough compaction of the backfill under and around the pipe culvert, as required by Sub-Section 3.07, and the base width of the pipe culvert excavation shall not exceed the external width of the pipe culvert plus:

1. 12 IN on each side for pipes less than 48 IN DIA.
2. 18 IN on each side for pipes 54 - 84 IN DIA.
3. 24 IN on each side for pipes 84 IN DIA or larger.

C. Protection of Foundations and Bedding:

1. Unless soft soil conditions are encountered in which case Sub-Section 3.03.B. shall govern, pipe culvert excavations shall be deep enough to permit compliance with the foundation and bedding requirements for pipe culverts. Care shall be taken to insure drainage is diverted away from the pipe bed during preparation. Any damage or deterioration of pipe bedding prior to installation shall be repaired by the Contractor at no expense to the Railroad.

D. Trenching: The Contractor shall comply with all current applicable Federal, State and local rules and regulations governing the safety of men and materials during pipe culvert excavation, installation, and backfilling operations. The Contractor shall comply with all requirements of the Occupational Safety and Health Administration relating to excavations, trenching and shoring as set forth in Title 29, Part 1926, Subpart Sections 1926.650 through 1926.653, Code of Federal Regulations, and any subsequent revisions.

3.03 FOUNDATION, BEDDING AND COMPACTION

A. Pipe culverts shall be placed at the flowline grade and elevation established by the Engineer on a uniform bed of stable earth or granular material such as sand, gravel and such bedding shall be compacted to not less than 100 percent of maximum density as determined by ASTM D1557, with moisture content adjusted as necessary. The compacted bed shall contain the camber required by the Engineer or as covered by these Specifications, Sub-Section 3.04. The compacted bed shall be shaped to fit the bottom of the pipe and shall conform to Class A, B or C bedding (see Table 10.33.4 bedding factors) AREMA chapter 8-10. Where sand-gravel material is used for bedding, the ends of the pipe culvert excavation shall be sealed to prevent leaking and infiltration of water along the pipe culvert. Such sealing can often be accomplished by blanketing the ends of the pipe culvert embankment with well tamped clay. In all cases, the ends of pipe culverts shall be protected by riprap as outlined in Sub-Section 3.05 and C.E. Drawing 680000.

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B. Soft Soil Conditions:

1. Where the flowline grade crosses soft areas of soil which will not provide a suitable uniform foundation for the pipe culvert bed, the Contractor shall excavate 18 IN below the flowline grade for a width equal to twice the outside width of the pipe culvert. Prior to backfilling, the Engineer shall inspect the excavation and the Contractor shall also perform any additional excavation below 18 IN of the flowline grade which may be required by the Engineer; provided, however, that the expense of such additional excavation beneath 18 IN of the flowline grade shall be considered extra work. Upon completion of all the excavation, the Contractor will backfill such excavation with sand-gravel material formed as required in Sub-Section 3.06.B.

C. Rock:

1. When the flowline grade passes over rock, the Contractor shall excavate such rock to a depth which is at least 6 IN below the flowline grade. The pipe culvert will not rest on rock at any point. The Contractor will backfill excavations in rock with sand-gravel material which shall be compacted and formed as required by Sub-Section 3.07.

3.04 CAMBER

A. Camber shall be placed in all culverts were it is anticipated that the culvert will settle as the result of high embankment construction or compressible foundation soils below the culvert bedding. Unless otherwise specified by the Engineer, all culverts shall be cambered in accordance with the following:

1. In no case shall the culvert be cambered so high in the center that water will be pocketed at the inlet end of the pipe.
2. Culverts resting on rock foundation need not be cambered. In accordance with Sub-Section 3.03.C.
3. Embankments up to 8 FT high (measured base of rail to flowline) require 1-1/2 IN camber.
4. Embankments 8 FT to 12 FT high require a 2-1/2 IN camber.
5. Embankments 12 FT to 24 FT high require a 4 IN camber.
6. Embankments 24 FT to 36 FT high require a 6 IN camber.

B. The above camber standards, based on the height of embankments, may be adjusted in the field where, at the discretion of the Engineer, a greater or lesser amount of camber should be built into pipe to adjust for soil conditions encountered at the site. For fills higher than 36 FT, the Chief Engineer - Design will provide the camber requirements.

3.05 RIPRAP PROTECTION

A. Both the inlet and outlet ends of all culverts shall be protected by riprap, packaged riprap, concrete headwalls, or as shown on the Drawings. Riprap shall be installed per detail on C.E. Drawing 680000 or as shown on the Drawings.

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3.06 INSTALLATION

A. Joining Pipe:

1. Pipe may be bell and spigot or tongue and groove unless otherwise specified. When bell pipe is used, a shallow excavation shall be made underneath the bell of sufficient depth so the bell does not rest on the bedding material. Ends of reinforced concrete pipe shall be of such design that when properly laid, they shall have a smooth and uniform interior surface. In areas where the pipe will tend to separate, suitable ties shall be installed.

2. Joints shall be made with mortar, grout, rubber gaskets, plastic mastic compounds, or by a combination of these types. Any joint system must be approved by the Engineer prior to installation.

3. Curved pipes shall have one or both ends beveled to provide a smooth curve. In no case shall any pipe end be beveled greater than 7-1/2 degrees for a change in grade or more than two degrees for a horizontal change. If the resulting gap is less than 1 IN, the resulting space is to be filled with mortar concrete. For gaps of 1 IN or greater, a reinforced concrete collar shall be poured around the joint as directed by the Engineer.

B. Laying Culvert Pipe:

1. Each pipe culvert shall be laid true to the following grade. The minimum gradient for any pipe culvert shall be 0.5 percent unless indicated otherwise on the Plans, or as directed by the Engineer. If two or more pipe culverts are to be laid parallel to each other, such parallel pipe culverts shall be spaced to permit thorough compaction of the backfill as required by Sub-Section 3.07. Parallel culverts shall be separated by a distance of at least one-half of the nominal diameter of the pipe culverts or one-third (1/3) of the span width of pipe arch culverts, but not less than 12 IN nor more than 48 IN.

2. Pipe laying shall begin at the downstream end of the culvert. The bell or groove end of the pipe shall be placed facing upstream. No culvert shall be placed in service until a suitable outlet is provided.

3. Elliptical and elliptically reinforced pipe shall be placed with the vertical axis within 5 degrees of a vertical plane through the longitudinal axis of the culvert.

C. Special Installation Conditions:

1. Jacking Pipe:

   a. Shall be accomplished by the AREMA Specifications, Chapter 8 Part 10. The Contractor shall prepare and submit plans showing the construction details to the Engineer for approval before installing pipe.

2. Constructing Culverts in Tunnels:

   a. When necessary to place pipe by tunneling, (AREMA) Specification Chapter 8, Part 10.4.3.6 and the Plans and Specifications for the completed structure shall be prepared by the Engineer. The Contractor shall set forth construction procedures and other necessary details and submit for review by the Engineer before starting the installation.

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3.07 BACKFILLING AND COMPACTION

A. Backfill materials shall be placed simultaneously on both sides of the pipe culvert in uniform layers not exceeding 6 IN in thickness. For multiple pipes, the backfill shall be placed simultaneously in uniform layers between and outside of the pipes. Each successive layer shall be compacted to not less than 100 percent of maximum density as determined by ASTM D1557, with moisture content adjusted, if necessary, and 6 IN layers shall be properly compacted before the next layer is placed.

B. Backfilling shall be started and completed as quickly as possible after the pipe culvert has been assembled and placed on its bed.

C. Special care must be taken to obtain adequate compaction under the pipe culvert haunches; however, care must be exercised to avoid lifting of the pipe culvert as the result of tamping to compact material under the haunches.

D. Where compaction may be difficult to obtain due to space constraints or other factors, the Contractor may, with the approval of the Engineer, utilize Controlled Low-Strength Concrete Fill Material (CLSM), commonly called flowable fill, as backfill material to a point one foot above the top of the culvert. Unless specified or shown elsewhere in the plans the CLSM shall meet the requirements for flowable fill of the respective Department of Transportation.

3.08 PIPE PROTECTION

A. Materials used to complete the embankment over the pipe culvert should be essentially the same as the materials used for the pipe culvert backfill and should be placed and compacted in the same manner as pipe culvert backfill materials are placed. Such material must be used to complete the embankment at least to a height over the top of the pipe culvert equal to the nominal diameter of the pipe culvert, or if the height of the completed embankment over the top of the pipe culvert is less than the nominal diameter of the pipe culvert, then such material must be used to complete the embankment. The pipe culvert must be protected from damage during the entire construction period, especially if heavy compaction and/or construction equipment is used. Heavy equipment shall not be operated over the pipe culvert until it has been covered with compacted backfill material to a depth of at least 24 IN.

3.09 REMOVAL OF EXISTING HEADWALLS OR CULVERTS IN PREPARATION FOR EXTENSION OF EXISTING PIPE CULVERTS

A. The Contractor shall remove existing headwalls and/or culverts in whole or in part as shown on the Drawings and shall perform all work called for, as shown on the drawings, and in the Specifications and which may be necessary to adapt existing pipe culverts for extension or reconstruction, including required excavation and backfilling. Except as otherwise provided for in the Specifications, the Contractor will determine the method of extending existing pipe culvert structures by consulting with the Engineer.

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PART 4 - MEASUREMENT AND PAYMENT

4.01 GENERAL

A. The number of linear feet of pipe culvert installed will be determined by measuring the installed pipe culvert along its longitudinal axis and shall be paid for on the contract unit price per linear foot of pipe installed per the Specifications.

B. The Cost of Riprap required per the Engineering Standard Drawings is to be included in the price per linear foot of pipe.

C. Included in the L.F. cost is the 18 IN of bedding, and the removal and disposal of the excavated unsuitable soil.

D. Below 18 IN, the bedding and removal and disposal of unsuitable soils will be paid for on the Cubic Yard, "C. Y.". basis.

E. No additional payment will be made for the use of CLSM, or flowable fill, as backfill around culverts, but shall be considered subsidiary to the cost of the culvert pipe.

END OF SECTION

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SECTION 40 05 51 - VALVES AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Valves and valve accessories used for water, chemicals, petroleum and other fluids used by the railroad.
2. Hose and fittings for hose reels.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittal Procedures

B. Section 33 05 26 – Mechanical Identification

C. Section 40 05 57 – Fuel System Motor Operated Valves

1.03 REFERENCED STANDARDS

A. American Petroleum Institute (API):

1. 594, Check Valves: Wafer, Wafer-Lug and Double Flange Type.
2. 600, Steel Gate Valves – Flanged and Buttwelding Ends.
3. 607, Fire Tests for Soft-Seated Quarter-Turn Valves.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):

1. A216, Standard Specification for Steel Casings, Carbon, Suitable for Fusion Welding for High-Temperature Service.

D. American Water Works Association (AWWA).

E. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS).

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00 - Submittals and Substitutions.

B. Shop drawings required by this Section include, but are not limited by, the following:

1. Manufacturer's product data for all components, drawings, operation and maintenance manuals and testing results if required.
2. Piping diagrams for new or modified control valves.

PART 2 - PRODUCTS

2.01 OWNER SUPPLIED EQUIPMENT

A. None, or as indicated on drawings.

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2.02 BALL VALVES

A. Materials shall be of carbon steel body with 316 stainless steel ball and stem with Viton seals and or seats.

B. Petroleum and industrial wastewater oil/sludge service.

1. Valves 2-1/2 IN or larger – Two piece, full port, split body construction with ANSI 150 LB raised face flanged connections. Manufacturer shall be WKM Dynaseal or equal.

2. Valves 1 to 2 inch – three-piece, standard port, bolted connections, with ANSI 150 LB raised faced, flanged connections.

3. Valves 3/4 IN or smaller – Three-piece, standard port, bolted connection with threaded end connections. Manufacturer shall be Neles-Jamesbury or equal.

C. Valves 2 IN and smaller for air and water service shall be of bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever and threaded end connections. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be driptight in both directions. Apollo 70-100 series or equal.

1. For compressed air:

a. Standard Ball Valves; Apollo 70-100 series or equal.

b. Block / Bleed Ball Valves; Apollo 7K-106-01.

D. Valves 3 IN and larger for air service shall be of carbon steel construction with two-piece body, stainless steel ball, Viton seals and seats, removable operating lever and flanged end connections. Valves shall be rated not less than 285 psi non-shock cold WOG and shall be driptight in both directions.

1. Valve box valves all sizes: Provide ductile iron construction with two-piece body, stainless steel ball, Viton seals and seats, removable operating lever and grooved end connections. Coupling gaskets shall be Nitrile with Gruvlok Xtreme lubricant or equal.

E. Where noted, valves shall have a quick-closing, spring return handle.

2.03 BUTTERFLY VALVES

A. Shall be ANSI 150 LB raised face single flanged lug style, carbon steel body, 316 stainless steel disc and shaft, TFE/316SS seat, high performance with a 275 psig working pressure.

B. The disc shall have a double-offset design and be capable of bi-directional flow with the same flow characteristics.

C. Valves for petroleum service located within tank dikes shall be certified “fire safe” per API 607.

D. Valves 6 IN and smaller shall have a spring-loaded, squeeze trigger handle with locking device. Valve sizes 8 IN and larger shall have a weatherproof gear operator.

E. Where noted or indicated on drawings, provide with valve actuator as specified herein. Valve and actuator shall be pre-assembled, tested and adjusted at the factory.

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2.04 CHECK VALVES

A. Fusible-link safety check valves:

1. Carbon steel body with stainless steel trim, quick closing swing check, 212 DegF fusible link.
2. Flange connections shall be ANSI 150 LB raised face.
3. Manufactured by Greenwood or equal.

B. Petroleum and industrial wastewater fuel/oil/sludge service:

1. Valves shall be carbon steel and have flanged end connections unless otherwise noted and conform to ASME B16.34, Class 150. Provide stainless steel stem and trim for each valve. Valves shall have a weatherproof housing. Seats, body seals, and stem seals shall be Viton.
2. Swing type check valve – Shall be the full-opening, tilting disc, non-slam, swing type. Discs and seating rings shall be renewable without removing from the line. The disc shall be guided and controlled to contact the entire seating surface.
3. Wafer type check valve - Wafer type check valves may be provided in lieu of swing check valves in piping sizes larger than 4 inches. Valve shall be the dual-plate, double flanged, wafer type that conforms to API Std 594. Valve disc shall be constructed of ASTM A351/A351M, Grade CF8M stainless steel. Valve spring, hinge pin, stop pin, and radial-thrust bearing materials shall be constructed of Type 316 stainless steel. Manufactured by Marlin (Duo-Chek II) or equal.

C. Check valves 3 IN and larger:

1. Carbon steel body with stainless steel pins and springs, Viton elastomers.
2. Valve shall be dual-plate, wafer style design to fit between raised face flanges suitable for 275 psig working pressure (API-594).
3. Manufactured by Marlin (Duo-Chek II) or equal.

D. Check valves 2 IN and smaller: Forged steel, class 800, lift check with Viton elastomers. Socket welded or threaded.

E. Check valves 2 IN and smaller shall be MSS SP-80, Class 125 brass or bronze construction with threaded or soldered end connections, Teflon packing and malleable iron handwheel. Class 150 valves meeting the above requirements shall be provided where system pressure requires.

F. Check valves 2 IN and smaller for compressed air service shall be MSS SP-80, Class 125 brass construction with threaded end connections, Teflon packing. Class 150 valves meeting the above requirements shall be provided where system pressure requires. Kinston Model 205 or equal.

2.05 GLOBE VALVES

A. 2 IN and smaller valves for air service shall be Class 150 valves of bronze construction with bronze seat, Viton disc, union bonnet, rising stem, Viton impregnated packing, and threaded ends.

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2.06 PLUG VALVES (DB&B)

A. Valve body shall be steel with drain plug and drain valve suitable for double block and bleed service. Plug seals shall be Viton. End connections shall be 150 LB Class flanged.

B. Handwheel operator for valves 8 IN and smaller. Gear operator for valves 10 IN and larger.

C. Valves shall be General Twin Seal or Orbit TruSeal.

D. For Compressed Air Service:

1. Valves 2 IN and smaller for air service shall be bronze construction with two-piece body, chrome plated ball, Viton seals and sets, and threaded end connections. Valves shall be rated not less than 500 psi non-shock cold WOG and shall be drip tight in both connections. Apollo 78-620.

2.07 OVERFILL PREVENTION VALVES

A. Shall be utilized for aboveground diesel fuel storage tank applications with pressurized delivery systems to provide positive shutoff of product delivery with no line shock.

B. Overfill prevention valves valve shall be hydraulically operated and shall be provided with a testable tank exterior or interior mounted float. Activation point of the float for opening and closing the high liquid level shut-off valve shall be as shown on the drawings. Upon a rise in fluid level to the float activation point, the float control system shall cause the main valve to close tightly. The main valve shall remain closed until a drop in tank fluid level occurs. Upon a drop in fluid level beneath the float activation point, the float control shall cause the main valve to open completely.

C. Valve shall include the following features:

1. Check valve feature.

2. Ability to manually test the valve and the exterior/interior mounted float's automatic opening and closing of the valve.

3. The valve shall be equipped with a minimum differential pressure pilot to maintain a differential pressure across the valve. Pressure shall be adjustable with a range of 5 to 25 psi.

D. Valve shall meet all requirements for control valves as outlined in Subsection 2.08 below..

2.08 CONTROL VALVES

A. Control valves shall be single-seated globe type, diaphragm actuated, hydraulically operated valves. In the event of diaphragm failure, valve shall fail closed against flow, unless otherwise indicated. The main valve shall be drip-tight when closed. Each valve shall have an external indicator to show the position of the valve disc at all times. Control valves shall be shipped from the factory as a complete assembly with all pilot controls and pilot auxiliary piping properly installed on the main valve. Materials for control valves, and items to be mounted on the valves shall be as follows:

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1. Bodies, bonnets and covers shall be constructed of cast steel conforming to ASTM A216, Grade WCB or Ductile iron conforming to ASTM A536, and shall have flanged inlet and outlet connections. Valve shall have a screwed bottom drain plug.
2. Valve seat shall be stainless steel. Valve disc shall be Viton. Valve stem shall be stainless steel. All other materials shall be compatible with the fluid specified.
3. Pilot control system and auxiliary piping shall be stainless steel, seamless, fully annealed tubing conforming to ASTM A269, Grade TP316. Wall thickness for 1/2-inch tubing to 0.049-inch. Threaded connections shall be used in pilot system piping and shall be o-ring type with FKM o-rings. Tubing connections shall not be welded.
4. Solenoids for operation of pilot valves shall operate on 120 volts, 60 cycle, single phase, alternating current. A manual type operator or needle valve to bypass the solenoid valve shall be provided for emergency manual operation.
5. Pilot valves shall have the field adjusted start up setting engraved on a plastic tag, white with black lettering.

2.09 SOLENOID VALVES

A. Solenoid valves for air line control shall be ASCO Red Hat or equal, 2-way normally closed, 120VAC solenoid in NEMA 4 enclosure, 0 - 150 LB psig minimum pressure range. Valve size shall match pipe diameter.

2.10 PNEUMATIC VALVE ACTUATORS

A. Actuators shall be spring-return type pneumatic actuators that fail close upon loss of air pressure or electrical signal.

B. Accessories include a 120V/60Hz single phase NEMA 4 (3-way) solenoid with two single-pole double-throw (SPDT) adjustable open/close limit switches and high visibility valve position indicator.

C. Actuator output torque shall be sufficient to fully seat and open the valve with 80 psig air pressure.

2.11 PRESSURE RELIEF VALVES

A. For Petroleum and industrial wastewater service:

1. Valves shall have integral flanged end connections and conform to ASME B16.34, Class 150 except as modified herein. Provide stainless steel stem and trim for each valve. Valves shall have a weatherproof housing. Seats, body seals, and stem seals shall be Viton.
2. Valve shall be the fully enclosed, spring loaded, angle pattern, ball seated type with lift lever. Valve shall have corrosion-resistant valve seats. Valve stem shall be fully guided between the fully opened and fully closed positions. Valve shall be factory set to open at the indicated pressure (plus or minus ten percent deviation). Valve set point shall be field adjustable within a minimum range of plus or minus 20 percent of the indicated set point. Valves shall be installed vertically oriented unless otherwise allowed by the manufacturer.

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3. For thermal relief applications where inventory control is not involved, a flange insert spring check valve may be used. Provide carbon steel insert check valve, class 600 for use in schedule 80 piping, with 10 psig cracking pressure, Check-All F6 or approved equal.

2.12 HOSE END ACCESSORIES

A. Lube oil: The hose assembly shall have a 1" MPT swivel connection on both ends fitting with male pipe threads and a OPW 210 drip proof nozzle and spout or equal.

B. Compressor oil: The service end of the hose shall have a fitting with male pipe threads. The nominal pipe size of the service end hose fitting shall be the same size as the inside diameter of the hose.

C. Compressed air: The service end of the hose shall have a 1/2 IN quick disconnect fitting for air-operated tools.

D. Radiator water: Provide a non-dripping (when fully closed) ball valve at the end of the pendant length of hose. The ball valves shall be "Clincher Type 2000" manufactured by Jamesbury Corporation or equal. Valves shall have brass bodies with stainless steel trim and TFE seats. Downstream of valve provide an additional foot of hose cut at one end and threaded to valve at the other.

PART 3 - EXECUTION

3.01 GENERAL

A. Install where indicated on the drawings and in accordance with Manufacturer's recommendations.

B. Inspect valves and equipment for cleanliness, corrosion, and operability prior to installation.

C. Actuate valves through an open-close cycle and examine for proper movement and seating.

3.02 VALVE AND EQUIPMENT INSTALLATION

A. Arrange all valves during installation such that operating handles and controls are accessible and have sufficient clearance for proper operation.

B. Provide spool pieces or spacers in the piping as necessary to ensure valve parts, operators, and butterfly discs have sufficient operating clearances.

C. Ensure valve actuators are properly wired and adjusted to proper torque and limit settings.

3.03 TUBING INSTALLATION

A. Route, assemble and tighten tube and fittings as recommended by the manufacturer to interconnect the instrumentation and equipment provided.

3.04 VALVES

A. Unless shown otherwise on Drawings and drawing schedules, provide valves as follows:

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SERVICE	LOCATION	MANUFACTURER MODEL#	SIZE	END CONNECTION	TYPE
Compressed Air (CA)					
	Hump Air System	Nibco F-515-CS-F-66-FS	3 IN and Larger	150 LB ANSI Flange	Ball valve, carbon steel construction with two-piece body, stainless steel ball, Viton seals and seats, removable operating lever.
	Hump Air System	Apollo 70-100 series	2 IN and smaller	Threaded	Ball valve, bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever.
	Hump Air Valve Boxes	Gruvlok Series 7500	All sizes	Grooved	Ball valve, ductile iron construction with two-piece body, stainless steel ball, Viton seals and seats, removable operating lever. Coupling gaskets shall be Nitrile with Gruvlok Xtreme lubricant or equal
	Yard Air & RIP Container	Apollo	2 IN and smaller	Threaded	Ball valve, ANSI Class 600 with lever handle, carbon steel body, Teflon seats, stainless steel trim and NPS ends. See Section 22 15 10.
	Yard Air System	American Valve Model 4000	2 IN and 3 IN	150 LB ANSI Flange	Curb Valve; 125# full port ball valve with 2 IN SQ key stem. See Detail 9/U502.
	Yard Air System	Apollo 70-100 series	2 IN and smaller	Threaded	Ball valve, bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever.
	Yard Air System	Apollo 7K-106-01	2 IN and smaller	Threaded	Block / Bleed Ball Valves, bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever .
	Yard Air System	Apollo 78-620	2 IN and smaller	Threaded	Plug valve, bronze construction with two-piece body, chrome plated ball, Viton seals and sets.
	Yard Air System	Kinston Model 205	2 IN and smaller	Threaded	Check valve, MSS SP-80, Class 125 brass construction with threaded end connections, Teflon packing. Class 150 valves
Industrial Waste Force (IWF)					
	RIP Canopy	Apollo 70-100 series	2 IN and smaller		Ball valve, bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever
	RIP Canopy	Nibco 413B	2 IN and smaller	Threaded	Check valve, MSS SP-80, Class 125 brass or bronze construction with threaded or soldered end connections, Teflon packing, horizontal swing, renewable disc.
Oxygen (OX)					
	RIP Canopy	Rexarc 1-02-1238	1 1/2 IN and smaller	Threaded	Ball valve, 300 psi WOG, forged brass uni-body, Teflon seat, reinforced stem packing, ball thrust washer, stainless steel ball, lever handle. Rated for oxygen service
	RIP Canopy	Rexarc 2-01	1 1/2 IN and smaller	Threaded	Check valve, brass body, stainless steel operating spring and valve disc, Buna-N seat, UL listed, meet or exceed requirements of CGA.
Acetylene (ACT)					
	RIP Canopy	Rexarc 1-02-1238	1 1/2 IN and smaller	Threaded	Ball valve, 300 psi WOG, forged brass uni-body, Teflon seat, reinforced stem packing, ball thrust washer, stainless steel ball, lever handle.
	RIP Canopy	Rexarc 2-01	1 1/2 IN and smaller	Threaded	Check valve, brass body, stainless steel operating spring and valve disc, Buna-N seat, UL listed, meet or exceed requirements of CGA.
Domestic Cold Water (DCW)					
	RIP Canopy	Apollo 70-100 series	2 IN and smaller	Threaded	Ball valve, bronze or brass construction with two-piece body, bronze or brass ball, Viton seals and seats, removable operating lever

END OF SECTION

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SECTION 40 05 57 - FUEL SYSTEM MOTOR OPERATED VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. This section of the specification includes general valves for use in isolating various segments of the diesel fuel system. This section also includes motor operators. General values specified in this section include the following:

   a. Ball Valves, 2 1/2" - 8"

   b. Butterfly Valves, 10" and Over

   c. Motor Operators

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittal Procedures

B. Section 33 05 26 – Mechanical Identification

1.03 REFERENCED STANDARDS

A. American Petroleum Institute (API)

1. 6D – Specification for Pipeline Valves
2. 6FA – Specification for Fire Test for Valves
3. 607 – Fire Test for Soft-Seated Quarter-Turn Valves
4. 609 – Butterfly Valves: Double Flanged, Lug and Wafer-Type

B. American Society of Mechanical Engineers

1. 16.34 – Valves – Flanged, Threaded, and Welding End.

C. Underwriters Laboratory (UL)

D. Oil Companies Materials Association (OCMA)

E. American Society of Mechanical Engineers (ASME)

F. Factory Mutual (FM)

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submittals shall include, but not be limited to:

1. All valves and accessories, indicating the make, model, type, material, size, and pressure rating.
2. Actuators

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1.05 QUALITY ASSURANCE

A. The valve and motor operator manufacturers shall have products in satisfactory use in similar applications for a minimum of five years.

B. Valves and motor operators shall be of the same Manufacturer throughout. Manufacturer's name and pressure rating shall be located on a permanent nameplate on outside of valve.

PART 2 - PRODUCTS

2.01 MATERIALS

A. BALL VALVES (2-1/2-inch to 8"):

1. The valve shall be Flow-Tek Model F15 or approved equal. The valve shall be of two-piece full port ball valve. The valve shall be capable of not less than 275 psi, and shall have a working temperature range of at least -20°F to 300°F.
2. Valves shall consist of carbon steel, two part assembly with replaceable body seal of SS316/Graphite. The ball and stem shall be 316 Stainless Steel. The replaceable ball seat shall be 15%RPTFE and stem packing shall be constructed of Graphite.
3. Valves shall have a "fire safe" rating per API 607.
4. Valves shall have a lever type handle with vinyl grip and a 90-degree stop on the extended stem. Handle shall be carbon steel suitable for padlocking in both the open or closed position.
5. All valves shall have ANSI 150# raised face flanged connections.
6. Reference Specification

a.	Valve Size:	2 1/2" to 8"
b.	Type:	Ball Valve, Two Piece, Flanged, Full Port
c.	Pressure class:	ANSI Class 150 with rated working pressure of the valve to be not less than 275PSI
d.	End Connections:	ANSI class 150 raised face
e.	Body Material:	ASTM A216 WCB Carbon Steel
f.	End Cap:	ASTM A351 CF8M Stainless Steel
g.	Ball Material:	ASTM A351 CF8M Stainless Steel
h.	Stem Material:	ASTM 479 Type 316 Stainless Steel
i.	Ball Seat:	TFM 1600 (RPTFE)
j.	Body Seal:	Spiral Wound, 316/Graphite
k.	Stem Packing:	RPTFE/Graphite
l.	Fire Safe:	Valves shall have a "Fire Safe" rating per API 607

B. QUARTER TURN BUTTERFLY VALVES (10" and Over)

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1. Butterfly valves shall be used for bi-direction bubble-tight shut-off of flow within the system. Valves shall be mounted between ANSI Class 150 flanges with rated working pressure of the valve to be not less than 275 psi.
2. The valves shall have a carbon steel ASTM, A216 full lug body, drilled and tapped lugs, 316 ASTM stainless steel disc, stainless steel stem, and 316 stainless steel seat with TFE insert material. Valves shall have a "fire safe" rating per OCMA and/or API 607.
3. Valves shall be WKM "Dynacentric", Posi-Seal "Phoenix III", FlowSeal "Fire-Flow", or approved equal.
4. Reference Specification:
    a. Valve Size: 10" and larger
    b. Type: Butterfly, High Performance
    c. Pressure class: ANSI class 150 with rated working pressure of the valve to be not less than 275PSI
    d. End Connections: Lug
    e. Body Material: ASTM A216 WCB Carbon Steel
    f. Disc Material: ASTM A351 CF8M Stainless Steel
    g. Stem Material: 17-4PH Stainless Steel
    h. Seat Material: 316L Stainless Steel
    i. Seal Ring: Stainless Steel & Graphite
    j. Leakage: Zero leakage per API 598 in the direction specified
    k. Fire Safe: per OCMA and/or API 607

C. ELECTRIC VALVE ACUATORS FOR quarter-turn valves

1. General: Actuators, their controls and accessories shall be the responsibility of the valve/actuator supplier for sizing, assembly, certification, field-testing and any adjustments necessary to operate the valve as specified. The electric valve actuators shall include as an integral unit, but not be limited to, the electric motor, actuator unit gearing, reversing starter, limit switch gearing, position limit switches, torque switches, drive bushing or stem nut, declutch lever, control power transformer, local controls, communication card, wiring terminals for power, remote control and indication connections, and hand-wheel. The electrically actuated valves are used as isolation valves and shall be set to close completely in a maximum of 45 seconds and designed to fail in position.
2. Design basis is for Rotork IQ series motor actuators, no substitutions.
3. The actuators shall be suitable for use on a nominal volt, phase and Hz power supply as specified in the engineering design documents.

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4. Actuator Sizing: The actuator shall be sized to guarantee valve closure at the specified differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. For linear operating valves, the operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the data sheet. For 90° valve types the operating time will be specified.
5. Enclosure
    a. The valve actuator motor and all electrical enclosures shall be rated NEMA 4X and shall be suitable for operation in a Class I Division 1 Groups C and D outdoor location.
    b. The valve actuator shall be suitable for mounting in the vertical or horizontal positions as required.
    c. Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from -33°C (22°F) to 70°C (140°F), up to 100% relative humidity. Actuators for hazardous area applications shall meet the area classification, gas group and surface temperature requirements specified in engineering design documents.
6. Motor
    a. The electric motor shall be specifically designed for valve actuator service and shall be of high starting torque, totally enclosed, non-ventilated construction.
    b. Motor insulation shall be a minimum NEMA Class F, with a maximum continuous temperature rating of 155 degrees C (rise plus ambient) for the duty cycle specified.
    c. The motor shall be of sufficient size to open or close the valve at the maximum stated torque. The motor shall be capable of complete operation at plus or minus 10 percent of specified voltage. The motor duty rating shall be sufficient for one complete cycle (open-close-open, or close-open-close) without exceeding its temperature rating or rated to allow 15 minute operation at 33 percent of maximum rated torque without exceeding its temperature rating. Motor bearings shall be of the antifriction type and permanently lubricated.
    d. The motor shall be an independent removable subassembly to allow for motor or gear or ratio changes dictated by system operation requirements.
        1) The motor shall be equipped with internal thermal sensors embedded in the windings to protect against motor overload. Maximum temperature rating of motor shall be T3B-329° F as defined by NFPA 70. Thermostats shall automatically set.
    e. A motor winding heater shall be provided in the motor. Space heaters shall be powered via the motor input power supply.
7. Integral Starter and Transformer:

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a. The reversing contactor starter, control transformer and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation buildup.

b. The starter shall be suitable for 60 starts per hour and shall comprise mechanically and electrically interlocked reversing contactors of rating appropriate to motor size.

c. Control power to be specified by the engineer. Control power to be a nominal voltage, phase and Hz.

1) Supply for local controls and indication, and where required, for remote control.

d. Easily replaceable cartridge-type fuses shall protect the primary and secondary windings.

8. Power Gearing:

a. The actuator shall be a single or multiple reduction unit with power gearing consisting of spur, helical or bevel gears and/or worm gearing. The spur, helical, or bevel gearing and worm shall be of hardened alloy steel, and the worm gear shall be alloy bronze. All gearing shall be accurately cut. Nonmetallic aluminum or cast gearing shall not be allowed.

b. All gears and shafting shall be supported on anti-friction bearings. Where thrust is a consideration, tapered roller bearings (to accept thrust) shall be provided.

9. Lubrication:

a. All rotating power train components shall be immersed in grease or oil with provisions for inspection and re-lubrication without disassembly.

b. Seals shall be provided at all exit points of the gear case to prevent leakage of lubricant. Critical areas subject to high wear shall be double sealed.

c. Lubricants shall be suitable for ambient conditions of minus 20 degrees F to 150 degrees F.

10. Lost-Motion Device:

a. The actuator shall have a built-in device (independent of gear backlash), incorporated in the power train, to permit load impact under dynamic efficiency conditions, with a hammer blow effect, to allow the motor to reach full speed before engaging the valve load.

11. Manual Operation:

a. Integral to the actuator shall be local controls comprising push-button switches for Open, Close and Stop, and a Local/Remote selector switch pad-lockable in any one of the following three positions: Local control only, Off (no electrical operation), Remote control plus local stop only.

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b. A metallic hand-wheel shall be provided for manual operation. An arrow and the word "open" to indicate open rotation direction shall be provided. The hand-wheel shall operate in the clockwise direction to close. The hand-wheel shall not rotate during motor operation and operation by hand-wheel shall not rotate during motor operation and operation by hand-wheel shall not cause the motor to rotate.

c. A fused motor shall not prevent manual operation.

d. When in the manual operating mode, the actuator will remain in this mode until the motor is energized, at which time the actuator will automatically return to electric operation. Use of the hand-wheel shall not negate the hammer blow feature.

e. The hand-wheel shall require an effort of no more than 80 pounds on the rim for seating or unseating load, or 60 pounds for running load.

f. Movement from motor operation to hand-wheel operation shall be accomplished by a positive declutch lever which mechanically disengages the motor and related gearing. Declutch lever shall be pad-lockable in either the manual (hand-wheel) or motor mode.

g. It shall be impossible for simultaneous manual and motor operation to occur. Friction type declutch mechanism is not acceptable.

12. Stem Nut:

    a. The valve actuator shall have a removable stem nut (or drive bushing) of high tensile bronze or other material compatible with the valve stem material.

13. Position Limit Switches:

    a. Position limit switches and the associated gearing shall be an integral part of the valve actuator. Limit switch gearing shall be functional at all times, whether the unit is operated electrically or manually.

    b. Gearing shall be made of bronze or stainless steel, grease lubricated and totally enclosed to prevent dirt and foreign matter from entering the gear train.

    c. Switches shall be field adjustable, allowing for trip points from fully open to fully closed positions or any intermediate point of valve travel. They shall not be subject to breakage or slippage due to over-travel.

    d. Limit switch contacts shall be heavy-duty, silver or silver plated

    e. Provide a minimum (4) programmable contacts. Contacts shall be convertible from N/O to N/C or reverse. Use of cams or setscrews in securing switches or the drive system is unacceptable.

    f. Switch design shall permit visual verification of switch position without disassembly.

14. Microprocessor Control Unit

    a. Each valve actuator shall be provided with an electronic microprocessor based control unit (field unit) as an integral part of the valve actuator enclosure.

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b. The field unit shall also allow for 120 VAC input/output (I/O) control. Field unit shall accept dry contact closures from remote devices as inputs and shall open/close integral dry contacts for interface with (1) remote hardwire programmable logic controller (PLC) located in the Fuel System Control Panel and (2) dry contact inputs from tank High High Level Switches signaling emergency closing of valve on fuel storage tanks inlets.

15. Torque Switch:

    a. Each valve actuator shall be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs or when valves require torque seating in the closed or open position.

    b. Contacts shall be silver or silver plated having a minimum rating of 5 amperes (break) inductive at 120 volts ac.

    c. The torque switch shall be independently adjustable for both open and close directions of travel, with a positive means to limit the adjustability so as not to exceed the actuator output torque capability.

    d. Switch design shall permit visible verification of switch position without disassembly.

16. Control Compartment Heating:

    a. The control compartment shall be provided with a space heater suitable for operation from the motor power supply power.

17. Start-Up Kit:

    a. Each actuator shall be supplied with a start-up kit comprising installation instruction, electrical wiring diagram and sufficient spare cover screws and seals to make good any site losses during the commissioning period.

18. A non-intrusive hand-held programmer must be provided and left with Owner at completion of project. Hand-held programmer shall be micro-processor based and shall be capable of two-way communication for uploading and downloading all actuator variables and performing detailed diagnostics.

19. Actuator Operating Conditions

    a. Actuators shall be capable of operating with a 275-psi upstream to downstream line pressure differential, with corresponding 275 psig upstream and 0 psig downstream pressures, while complying with hand-wheel requirements specified in paragraph I.

20. Performance Test Certificate:

    a. Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load and the following parameters should be recorded.

        1) No load current

        2) Current at max torque setting

        3) Stall current

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4) Torque at max torque setting

5) Stall torque

6) Test voltage and frequency

7) Flash test voltage

8) Actuator output speed

b. In addition, the test certificates should record details of specification such as gear ratios for both manual and automatic drive, closing direction, wiring diagram code number and, when applicable, remote position transmitter resistance and interposing relay voltage.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with manufacturer's recommendations and as indicated on the plans.

B. Each valve shall be installed in an easily accessible location such that valve operator shall not have to interfere with adjacent equipment for operation and maintenance. Provide spool piping, whether indicated on the drawings or not, if required for proper movement of valve operator and disc.

C. Replace all valves that prove defective during system testing.

D. Install all butterfly valves with valve shaft in the horizontal position.

E. Manufacturer's Service Engineer

1. Furnish the services of an experienced motor operator service engineer for a minimum of two days on the jobsite to verify proper installation and assist in start-up, check-out and calibration. Allow for two separate trips to the jobsite if required by the construction schedule. Service engineer shall be fully qualified to troubleshoot and correct both mechanical and electrical issues with motor operated valves. If required to meet this criteria, provide two service engineers on the jobsite to commission system. Electrical issues shall include power, control via hardwire controls, electrical programming of actuator, communications card in MOVs, communication to Pakscan P3 controller and to troubleshoot P3 controller issues.

END OF SECTION

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SECTION 40 42 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing of insulation, jackets, and accessories for mechanical piping, ductwork, tanks and equipment. Building insulation materials are specified in other sections.

B. Materials furnished and installed under this section shall be in full conformity with the drawings, specifications, engineering data, instructions, and recommendations furnished by the insulation manufacturer unless exceptions are approved by the Owner.

1.02 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
2. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
3. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. C574, Standard Specification for Mineral Fiber Pipe Insulation.
5. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
6. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.03 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Product Data – Submit manufacturer's technical product data and insulation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.04 QUALITY ASSURANCE

A. Flame / Smoke Ratings – Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics, and adhesives) with flame-spread index of 25, or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method.

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PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:

1. Armstrong.
2. CertainTeed Corp.
3. Knaff Fiberglass.
4. Manville Products Corp.
5. Owens-Corning Fiberglass Corp.
6. Pittsburgh Corning Corp.

2.02 PIPING INSULATION

A. Type PMF1 pipe insulation shall be a mineral fiber pipe insulation. The insulation shall be a one-piece molded glass fiber pipe insulation with all-purpose jacket. The all-purpose jacket shall be a factory applied fiberglass reinforced vapor barrier type with white kraft bonded aluminum foil and self-sealing adhesive lap. The insulation shall be suitable for a temperature range of -20 to 450 DegF and shall have a maximum thermal conductivity (k) of 0.24, at 75 DegF. The insulation shall conform to ASTM C547. Manufacturer shall be Fibrex "Epitherm 1200" or equal.

B. Type PMF2 pipe insulation shall be a high temperature mineral fiber pipe insulation. The insulation shall be sectional or segmented mineral fiber forms with thermosetting binder suitable for a maximum temperature of 1200 DegF, and shall be provided in multiple layers. Fittings and valves shall be insulated with factory made molded fiber fittings or built up sections of pipe covering. The insulation shall conform to ASTM C547. Manufacturer shall be Fibrex "Epitherm 1200" or equal.

C. Type PFC1 pipe insulation shall be a one-piece, molded elastomeric or polyolefin foam insulation. The insulation shall be suitable for a temperature range of -40 to 210 DegF, and shall have a maximum thermal conductivity (k) of 0.28 at 75 DegF. The insulation shall be suitable for exposure to weather and direct sunlight or where not indicated to be jacketed, shall be suitable for exposure to weather and direct sunlight or where not indicated or be jacketed, shall be given two coats of ultraviolet resistant finish as recommended by the manufacturer. The insulation shall conform to ASTM C534. Manufacturer shall be Armstrong "Armaflex", Rubatex "R-180-FS", IMCOA "Imcolock / Imcoshield", or equal.

2.03 DUCTWORK INSULATION

A. Flexible Fiberglass Ductwork Insulation: ASTM C533, Type 1, Class B-4.

B. Rigid Fiberglass Ductwork Insulation: ASTM C612, Class 1.

2.04 TANK AND EQUIPMENT INSULATION

A. Tank and equipment insulation shall be closed cell, flexible foamed plastic in sheet form. Insulation shall have a K factor of 0.28, maximum, at 75 DegF mean temperature and shall have a built-in vapor barrier.

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2.05 ALUMINUM INSULATION JACKETS

A. Insulation jackets shall be furnished and installed piping systems as indicated herein and on the drawings.

B. Fittings in insulated piping systems and piping or equipment where indicated shall be provided with an aluminum jacket. Piping systems where indicated to have aluminum jackets shall be insulated with the same aluminum jacketing material.

C. The aluminum jacket shall comply with ASTM B209 Alclad 3004 requirements. Jacketing shall be a nominal minimum thickness of 0.020 IN with an embossed finish. A factory asphalt and kraft paper vapor barrier or polyethylene film and kraft paper vapor barrier shall be applied to the full width of the jacket.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall install all insulation materials as required and as specified herein for the piping systems, ductwork, tanks and equipment which is not factory insulated.

B. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried.

C. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label indicating the name of the manufacturer and the description of materials.

D. Seams in exposed insulation and jackets shall be located in the least visible location.

3.02 PIPING INSULATION

A. General:

1. Apply insulation to clean, dry piping with joints tightly butted.
2. Adhere "factory applied vapor barrier jacket lap" smoothly and securely at longitudinal laps with a white vapor barrier adhesive.
3. Adhere 3 IN wide self-sealing butt joints strips over end joints.
4. Fittings:
    a. Insulate fittings with same type and thickness of insulation as pipe, with ends of insulation tucked snugly into throat of fitting and edges adjacent to pipe insulation tufted and tucked in.
    b. Cover insulation with one piece PVC fitting cover secured by taping ends to adjacent pipe covering.
    c. Contractor Option – built-up to equivalent thickness with insulating cement. Finish jacket to adjacent piping. Jacket to extend 2 IN into adjacent insulation.

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5. Valves – Insulate and finish by one (1) of the following:
    a. With hydraulic setting insulating cement, or equal, to a thickness equal to adjoining pipe insulation.
    b. With segments of molded insulation securely wired in place.
    c. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
    d. One-piece PVC insulated cover with cover secured by taping the ends to adjacent pipe covering.

B. Type PMF1 Insulation:

1. Insulation shall be installed to cover piping, fittings and appurtenances. Insulation shall be full length of the factory unit using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. The insulation end joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.
2. Insulated pipe conveying fluids below ambient temperatures shall be insulated with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and sealed off with vapor barrier coating. The vapor barrier coating shall be at intervals not exceeding 15 FT-0 IN for straight runs and not more than 6 IN from fittings. Fibrous insulation laps and butt strips shall be secured with adhesive and stapled if not factory self-sealing. Staples and seams shall be coated with vapor barrier coating.
3. On piping 2 IN or larger where insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be the same thickness and contour as the adjoining insulation and installed to maintain a continuous vapor barrier through the support. Insert material shall be constructed of wood or heavy density insulating material suitable for the system operating temperature range.

C. Type PMF2 Insulation:

1. The insulation shall be installed in layers as required to obtain the specified minimum thickness. Joints between insulation sections and sections or segments shall be staggered between insulation layers.
2. The insulation shall be applied with tight seams and joints using stainless steel wire loops on 6 IN centers. The wire shall be embedded into the outer layer of the insulation and all cracks, voids, and depressions shall be filled with insulating cement suitable for the piping temperature. The surfaces to receive outer coverings shall be smooth and uniform. Flanges and exhaust piping shall not be insulated.

3.03 DUCTWORK SYSTEMS INSULATION

A. Insulate ductwork in accordance with the manufacturer's recommendations and as shown on the drawings.

END OF SECTION

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SECTION 40 46 20 - HYDRO-POX CORROSION CONTROL LINING SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. This application data-sheet covers surface preparation, application, inspection and testing of the HYDRO-POX 212 GL protective lining system.

B. HYDRO-POX lining systems with documented resistance to microbial influenced corrosion, hydrogen sulfide gases, and other chemicals will fill, coat, seal, and protect the interior concrete surfaces of manholes, wet wells, clarifiers, digesters, sedimentation basins, sludge thickeners, chlorine contact basins, and all related collection and treatment system substrates. When applied in accordance with this application data-sheet.

1.02 CONTRACTORS

A. The ultimate performance of HYDRO-POX depends on application by Licensed Professional Applicators, which shall be manufacture approved on a non-exclusive basis.

1.03 QUALITY ASSURANCE

A. The Contractor shall quality assure all work prior to owner furnished inspection.

1.04 INSPECTION

A. The entire procedure of inspection; surface preparation and application should be inspected. Such inspection shall not relieve the contractor from its responsibility to furnish materials and perform work in accordance with these procedures.

B. When the owner furnishes an inspector, all coating work shall be done in the presence of the inspector. Any coating work done in the absence of the inspector is subject to rejection unless specifically allowed by the inspector.

PART 2 - PRODUCTS - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

A. All surfaces to be coated with HYDRO-POX 212 GL must be clean, sound, dry and have an “open” capillary system to ensure penetration and mechanical bond (adhesion). Remove all dirt, dust, cement laitence, efflorescence, form release agents, curing compounds, grease, oils, growths, etc. Surface preparation is best accomplished by mechanical means, such as abrasive air blasting or high pressure water blasting above 5000 psi to achieve an anchor pattern similar to coarse sandpaper. For concrete reference applicable standards, ASTM D4259 or NACE RPO892-92.

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B. Any ferrous metal surface contained within the structure to be lined shall be cleaned according to SSPC SP-10, or NACE #2 and coated prior to flash rusting.

3.02 APPLICATION

A. All prepared concrete surfaces shall be fully saturated with HYDRO-POX 251 penetrating primer. (See HYDRO-POX 251 Data-sheet.)

B. For optimum application properties pre-condition material to 70 - 80 DegF prior to mixing and application. Mix the entire contents of A + B with a power mixer, scraping the sides until a smooth homogenous consistency is obtained. Jiffy mixers have been proven to be very effective. Material is supplied as a unit. Do not apply material below 40 DegF.

C. The lining system shall be applied over a freshly primed in a single-coat multiple-pass application to achieve an 80 - 150 mil thickness. Successive coats must be applied within the re-coat time period for proper bonding (See HYDRO-POX 212 GL data-sheet). For successive coats applied after the re-coat interval has been exceeded, a sweep blast will be necessary to remove any gloss to achieve a 2 - 4 mil anchor pattern to achieve proper bonding.

D. Eliminate pin-holing, and shadowing, of the applied HYDRO-POX 212 GL system by fully saturating the surface with HYDRO-POX 251, and applying HYDRO-POX 212 GL in a decreasing temperature or shaded surface condition. Always use a multiple pass method when applying.

E. Complete cure of the HYDRO-POX system will take 3 days. Down time is avoided by allowing a structure to be returned to service after a thin film set. For immersion, a minimum 24 HR cure is required.

END OF SECTION

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SECTION 40 46 50 - CATHODIC PROTECTION - IMPRESSED CURRENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. A complete Cathodic Protection system shall be installed as indicated on the Drawings, including all necessary materials and labor for testing.
2. The Cathodic Protection system shall be installed in accordance with the provisions of the specifications, applicable plans, codes and standards, and is subject to other terms and conditions of the project.

B. Design Criteria:

1. The cathodic protection system shall be designed in accordance with the minimum standards established for the structure(s) by the National Association of Corrosion Engineers.
   a. Theoretical Design Life: 30 years (minimum).
   b. Criteria for Protection: The NACE -850 mV 'Instant Off' criterion shall be used as the primary criterion or as an approved equal 100 mV depolarization criterion to a $Cu/CuSO_4$ reference electrode for the tank bottom cathodic system. It is noted that the -850 mV 'Instant Off' criterion may require additional cathodic current that may have a tendency to dry the sand surrounding the anode and also create depolarizing gasses

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals

B. Section 26 05 00 – Electrical Basic Requirements

1.03 REFERENCED STANDARDS

A. National Association of Corrosion Engineers (NACE):

1. RP0193 "External Cathodic Protection of ON-Grade Carbon Steel Storage Tank Bottoms" (latest edition)

B. Underwriter' Laboratories, Inc. (UL) Publications:

1. Standards for Safety

C. National Fire Protection Association (NFPA):

1. No. 70: National Electrical Code (NEC)

D. Institute of Electrical and Electronic Engineers (IEEE):

1. Standards and Specifications

E. American Society for Testing and Materials (ASTM):

1. Testing Methods and Materials

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1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Manufacturer's Product Data: Submit material specifications and installation data for products specified under Part 2 - Products, to include:

1. Rectifier
2. Remote monitoring
3. Reference Electrode
4. Junction Box
5. MMO Wire Anode
6. Conductors/Cable
7. Copper Crimps
8. Exothermic Weld

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract documents.

D. Record Drawings:

1. Provide a complete set of system manufacturer's product data and shop drawings indicating all post bid revisions and field changes.

1.05 QUALITY ASSURANCE

A. Coordinate the system installation with the contract documents and other contractors. Adjust installation to eliminate conflicts and provide the fastest overall installation schedule.

B. All materials shall be new.

C. Where equipment, materials or systems are specified by designation of manufacturer, such designation is intended to convey the minimum requirements for construction, electrical characteristics and ratings, and operating function. Equipment having electrical characteristics and ratings, construction features and operating functions not less than those specified shall be acceptable upon approval of the Engineer.

D. Design Responsibility:

1. Contractor shall include in his Bid to provide services of a Corrosion Engineer who is a NACE-certified Corrosion Specialist or Cathodic Protection Specialist. Qualifications of the Corrosion Engineer shall be provided.
2. The Contract Documents establish the design intent of the cathodic protection system and include schedules, notes, and typical details to show the major system components and suggested methods of installation.
3. The installed cathodic protection system shall meet the minimum requirements indicated, include components not indicated but necessary for proper function and performance, and shall be a complete and operational system.

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4. Cathodic protection Suppliers shall be firms regularly engaged in the fabrication of the materials required by this Specification whose products have been in satisfactory use in similar service for not less than 5 years. The products of any reputable Supplier regularly engaged in the commercial production of cathodic protection materials required by this Specification will not be excluded on the basis of minor differences, provided all essential requirements of the specification relative to materials, capacity, and performance are met.

E. DRAWINGS:

1. The drawings indicate the arrangement of cathodic protection equipment. Coordinate the installation of the cathodic protection equipment other disciplines.
2. Do not scale drawings. Obtain dimensions for layout of equipment from Civil, Mechanical or Architectural plans unless indicated on Electrical plans.
3. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

F. DEVIATIONS:

1. The Contractor shall provide written notice of any deviations from the requirements of the contract or construction documents that are proposed. The Contractor remains liable for any deviations unless reviewed and written acknowledgment is received from the Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspect material upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material.

B. Provide trailers or shed for storage of materials, equipment, tools, etc., requiring such a facility. Contractor shall provide areas for general storage and storage trailers or sheds. Provide a dry, weather-tight place for storing materials requiring protection from weather.

C. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact.

D. Handle and store materials in accordance with manufacturer's and supplier's recommendations and in manner to prevent damage to materials during storage and handling. Replace damaged materials.

E. Containers which are broken, opened, watermarked, or otherwise damaged materials are unacceptable and shall be removed from premises.

F. Provide protection against direct sunlight, rain, snow, wind, ice, or heat for suitable storage of materials or equipment delivered to site to be incorporated into Project.

G. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

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H. Damaged, oxidized, warped, or improperly stored material or material with excessive amounts of foreign debris shall be removed from the project and replaced with new materials.

1.07 WARRANTY

A. The materials, equipment, and workmanship furnished under this section of the specifications shall be guaranteed for a period of 1 year from the date of acceptance. Prior to expiration of the warranty period, the Owner will conduct a System voltage and current output test of the cathodic protection system to determine if the system and equipment are performing in accordance with the plans and specifications and that no significant deterioration of the system or components therein has occurred during the first year of operation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rectifier:

1. Description: Rectifier shall be air cooled. For multiple circuit units, individual transformers and stacks shall be provided.
2. AC power: 120/240 volts, single phase, 60 Hz. A dedicated 20 ampere circuit is required.
3. DC output: As indicated on the drawings.
4. Taps: 36 tap settings minimum (6 coarse, 6 fine).
5. Stacks: Silicon.
6. Case: Galvanized, stainless steel, or aluminum (painted case is not acceptable).
7. Surge protection: Protect silicon diodes with AC and DC lightning arrestors against over-voltage and with current limiting device against over-current surges.
8. Grounding provisions: Rectifier shall be grounded with grounding terminal in cabinet, No. 6 AWG solid copper wire and copper ground rod (8' length minimum).

B. Remote Monitoring:

1. Elecsys Watchdog Scout
   a. NEMA4x Enclosure: 8" X 10" X 4" with two relay control outputs 4 analog measurement channels, 2 digital dry-contact/pulse accumulator channels and 1 AC detection probe input is a minimum requirement.
   b. Digital cellular Communications
   c. GPS synchronized interruption Modules that syncs with other industry leading interrupters.

C. MMO (MIXED METAL OXIDE) ANODES:

1. MMO Wire Anode:
   a. Anode Dimensions (MMO wire only): 1.5 mm (diameter)

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b. Current Rating: 5 milliamperes/lineal foot for 50 years (minimum)

2. Anode Lead Wires:

a. The header cable for the anodes shall be No. 10 AWG stranded copper wire with Type HMWPE (cathodic type) insulation. Lead wires shall be of sufficient length to extend to the junction box location without splicing.

D. WIRE, CABLES & SPLICING MATERIAL:

1. Test Wires for Cathodic Protection:

a. Structure test wires shall be No. 12 AWG stranded copper wire with THHN / THWN insulation, white in color, of sufficient length to extend to their termination point without splicing.

2. Anode Header, Structure Lead and Bonding Cables for Cathodic Protection:

a. Anode header, structure lead and bonding cables shall be No. 8 AWG stranded copper wire with THHN / THWN insulation, black in color, of sufficient length to extend to their termination point without splicing.

3. Anode Feeder Cables for Cathodic Protection:

a. Anode feeder cables shall be No. 10 AWG stranded copper wire. Cable under tanks shall have HMWPE insulation; cable in conduits shall have THHN / THWN insulation.

4. Compression Crimp Splice Connectors:

a. All underground spliced connections used within the DC cathodic protection circuit shall be made through the use of copper compression crimp connectors.

1) The proper size connectors shall be used in accordance with the manufacturer's recommendations.

2) Connectors shall be crimped with a hand tool capable of delivering a minimum of 12 tons of compressive force.

5. Splice Encapsulation:

a. All underground spliced connections used within the DC cathodic protection circuit shall be sealed with a two-part epoxy encapsulation.

b. All aboveground spliced connections used within the DC cathodic protection circuit shall be sealed with rubber and plastic tape contained within a waterproof coating.

6. Warning Tape for Buried Cable:

a. All underground DC cathodic protection cable shall be installed with a continuous 3" wide plastic line marking tape labeled "Caution – Cathodic Protection Cable Below" or similar.

E. JUNCTION BOXES:

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1. Junction boxes shall be standard duty, non-metallic, post or wall mount (as indicated on drawings), furnished with a non-metallic terminal board equipped with terminal posts to permit ready access and testing and shall be constructed as follows:
    a. Housing: Non-metallic with hinged cover (stainless steel hardware).
    b. Terminal Board: Non-metallic.
    c. Terminal Posts: Stainless Steel.

F. CATHODIC PROTECTION INSTRUMENTS AND ACCESSORIES:

1. $Cu/CuSO_4$ Reference Electrodes:
    a. Description: $Cu/CuSO_4$ electrodes shall be used for soil environments to provide a stable electrical benchmark from which to measure the cathodic protection system's effectiveness. Electrodes shall be constructed as follows:
    b. Element: Saturated gelled $Cu/CuSO_4$.
    c. Design life of the electrode shall be no less than 20 years.
    d. Lead Wire: No. 14 AWG (minimum) HMWPE or RHW stranded copper wire. Lead wire shall be sufficiently long to reach its termination point without splicing.
2. $Zn/ZnSO_4$ Reference Electrodes:
    a. Description: $Zn/ZnSO_4$ electrodes shall be used for soil environments to provide a stable electrical benchmark from which to measure the cathodic protection system's effectiveness. Electrodes shall be constructed as follows:
    b. Element: Saturated gelled $Zn/ZnSO_4$.
    c. Design life of the electrode shall be no less than 20 years.
    d. Lead Wire: No. 14 AWG (minimum) HMWPE or RHW stranded copper wire. Lead wire shall be sufficiently long to reach its termination point without splicing.

G. EXOTHERMIC WELDS AND ACCESSORIES:

1. All below grade connections to steel structures used within the DC cathodic protection system circuit shall be by exothermic welds. The proper size welders, metal charges, and wire sleeves shall be used in accordance with the manufacturer's recommendations. Mechanical clamps or exothermic welds may be used for above ground connections to steel structures within the DC cathodic protection circuit.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. The Cathodic Protection system shall be installed in accordance with the contract Drawings and contract Specifications.

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2. The Contractor shall provide all necessary technical installation documents, such as situation plans and diagrams.
3. The installation of the Cathodic Protection system shall be by a contractor with a minimum of 5 years experience of installing Cathodic Protection systems.
4. The Contractor shall be responsible for the correct location of all equipment. If there are any discrepancies between the details in the shop drawings, contract drawings, or contract specifications the real dimensions of equipment, rooms, or buildings, they shall be reported in writing immediately upon discovery to the Engineer.

B. MMO ANODES AND ACCESSORIES:
1. Install anodes as shown on the Drawings.
2. All anode lead wires shall be of sufficient length to extend to their termination point without splicing.
3. Maintain electrical isolation between tank bottom and anodes (and reference electrodes) during construction.

C. WIRE, CABLES & SPLICING MATERIAL:
1. Wire and Cable:
   a. Install wiring as shown on drawings.
   b. All collector cables and electrode lead wires shall be placed in GRS/PVC conduit when run above-grade.
   c. No splices shall be permitted inside conduit.
2. Epoxy Splice Encapsulation: Splices not allowed.

D. EXOTHERMIC WELDS AND ACCESSORIES:
1. All exothermic welding shall be performed in accordance with the manufacturer's recommendations for welding equipment, weld metal charge size and applicability to the structure.
   a. Obtain a "Hot Work Permit" before performing any exothermic welding in hazardous (classified) areas.
2. Do not use exothermic weld equipment if the graphite mold is wet.

E. JUNCTION BOXES:
1. Attach test/structure wires to the structure using exothermic welds.
2. Route the test/anode header/structure lead/reference electrode wires to the terminal board.
3. Exercise care in backfilling the structure to avoid damaging lead wires or connections.
4. Locate the junction box as shown on the Drawings.

F. CATHODIC PROTECTION INSTRUMENTS AND ACCESSORIES:
1. Reference Electrode:
   a. Install reference electrodes as shown on the Drawings.

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b. Route the reference electrode lead wire to the junction box.

3.02 FIELD QUALITY CONTROL

A. Field Tests:

1. General: After the cathodic protection system components have been installed, the system shall be inspected and commissioned by the Contractor's Corrosion Engineer (NACE certified Corrosion Specialist or Cathodic Protection Specialist) or by a NACE certified Corrosion Technician under direct supervision of a Corrosion Engineer. Contractor shall include in these services in his Bid.

2. Commissioning:

   a. The Corrosion Engineer/Corrosion Technician will perform the initial energization of the cathodic protection systems.

3. Method:

   a. Record native structure-to-electrolyte potential measurements at the permanently installed test points, permanent reference electrodes, and other locations deemed representative by the Corrosion Engineer/Corrosion Technician.

   b. Determine the effectiveness of all accessible electrical isolation materials.

   c. Ensure that there is a minimum of 3' of liquid in the tanks. Adjust the rectifier to provide a current density of approximately 0.3 to 0.5 milliampere/square foot of tank bottom steel. After allowing the metallic structures to sufficiently polarize (amount of time required to be determined by Corrosion Engineer/Corrosion Technician), record 'instant off' and 'on' structure-to-soil potential measurements at the permanently installed test points, permanent reference electrodes, and other locations deemed representative.

   d. Determine if electrical continuity exists on the underground structures after installation of the test stations.

   e. Determine if interference exists on the structures under cathodic protection, and if so, take steps to find a satisfactory solution to the problem.

   f. Prepare a written report to include all test data, an analysis of the data, and necessary recommendations for additional work. The report will be submitted to the Owner.

END OF SECTION

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SECTION 40 46 51 - CATHODIC PROTECTION - GALVANIC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. A complete Cathodic Protection system shall be installed as indicated on the Drawings, including all necessary materials and labor for testing.
2. The Cathodic Protection system shall be installed in accordance with the provisions of the specifications, applicable plans, codes and standards, and is subject to other terms and conditions of the project.Products Furnished by Owner and Installed under this section

B. Design Criteria:

1. The cathodic protection system has been designed in accordance with the minimum standards established for the structure(s) by the National Association of Corrosion Engineers.
   a. Theoretical Design Life: 20 years (minimum).
   b. Criteria for Protection: -850 mV, current applied, to a $Cu/CuSO_4$ reference electrode.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals

B. Section 26 05 00 – Electrical Basic Requirements

1.03 REFERENCED STANDARDS

A. National Association of Corrosion Engineers (NACE):

1. SP 0169-07 (formerly RP 0169-01)

B. Underwriter' Laboratories, Inc. (UL) Publications:

1. Standards for Safety

C. National Fire Protection Association (NFPA):

1. No. 70: National Electrical Code (NEC)

D. Institute of Electrical and Electronic Engineers (IEEE):

1. Standards and Specifications

E. American Society for Testing and Materials (ASTM):

1. Testing Methods and Materials

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

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B. Manufacturer's Product Data: Submit material specifications and installation data for products specified under Part 2 - Products, to include:

1. Magnesium Anode
2. Reference Electrode
3. Flush Mount Test Station / Above Grade Test Station (Junction Box)
4. Splice Kit
5. Conductors/Cable
6. Copper Crimps
7. Exothermic Weld

C. Shop Drawings:

1. Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract documents.

D. Record Drawings:

1. Provide a complete set of system manufacturer's product data and shop drawings indicating all post bid revisions and field changes.

1.05 QUALITY ASSURANCE

A. Coordinate the system installation with the contract documents and other contractors. Adjust installation to eliminate conflicts. Coordinate installation sequence with other contractors to avoid conflicts including equipment access and provide the fastest overall installation schedule.

B. All materials shall be new.

C. Where equipment, materials or systems are specified by designation of manufacturer, such designation is intended to convey the minimum requirements for construction, electrical characteristics and ratings, and operating function. Equipment having electrical characteristics and ratings, construction features and operating functions not less than those specified shall be acceptable upon approval of the Engineer.

D. Design Responsibility:

1. Contractor shall include in his Bid to provide services of a corrosion engineer who is a NACE-certified Corrosion Specialist or Cathodic Protection Specialist. Qualifications of the Corrosion Engineer shall be provided.
2. The Contract Documents establish the design intent of the cathodic protection system and include schedules, notes, and typical details to show the major system components and suggested methods of installation.
3. The installed cathodic protection system shall meet the minimum requirements indicated, include components not indicated but necessary for proper function and performance, and shall be a complete and operational system.

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4. Cathodic protection Suppliers shall be firms regularly engaged in the fabrication of the materials required by this Specification whose products have been in satisfactory use in similar service for not less than 5 years. The products of any reputable Supplier regularly engaged in the commercial production of cathodic protection materials required by this Specification will not be excluded on the basis of minor differences, provided all essential requirements of the specification relative to materials, capacity, and performance are met.

E. Contractor's Quality Control System:

1. The Contractor shall implement a quality control system to ensure the cathodic protection system components conform to the applicable plans and specifications established by the Contract Documents.

2. The quality control system shall ensure that standards for materials, workmanship, construction, and functional performance are adhered to throughout the course of the Work.

3. The Contractor's superintendent shall be used to monitor the Contractor's quality control system.

F. DRAWINGS:

1. The drawings indicate the arrangement of cathodic protection equipment. Coordinate installation of cathodic protection equipment with structural system and mechanical equipment and access there to.

2. Do not scale drawings. Obtain dimensions for layout of equipment from Civil, Mechanical or Architectural plans unless indicated on Electrical plans.

3. Bring all discrepancies shown on different drawings, between drawings and specifications or between documents and field conditions to the immediate attention of the Engineer.

G. DEVIATIONS:

1. The Contractor shall provide written notice of any deviations from the requirements of the contract or construction documents that he proposes to undertake. The Contractor remains liable for any deviations unless reviewed and written acknowledgment is received from the Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Inspect material upon arrival at Project and verify conformance to Contract Documents. Prevent unloading of unsatisfactory material.

B. Provide trailers or shed for storage of materials, equipment, tools, etc., requiring such a facility. Contractor shall provide areas for general storage and storage trailers or sheds. Provide a dry, weather-tight place for storing materials requiring protection from weather.

C. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact.

D. Handle and store materials in accordance with manufacturer's and supplier's recommendations and in manner to prevent damage to materials during storage and handling. Replace damaged materials.

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E. Containers which are broken, opened, watermarked, or otherwise damaged materials are unacceptable and shall be removed from premises.

F. Provide protection against direct sunlight, rain, snow, wind, ice, or heat for suitable storage of materials or equipment delivered to site to be incorporated into Project.

G. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable to protect the equipment or materials. Conditions shall be those for which the equipment or materials are designed to be installed. Equipment and materials shall be protected from water, direct sunlight, cold or heat. Equipment or materials damaged or which are subjected to these elements are unacceptable and shall be removed from the premises and replaced.

H. Damaged, oxidized, warped, or improperly stored material, or material with excessive amounts of foreign debris shall be removed from the project and replaced with new materials.

1.07 WARRANTY

A. The materials, equipment, and workmanship furnished under this section of the specifications shall be guaranteed for a period of 1 year from the date of acceptance. Prior to expiration of the warranty period, the Owner will conduct a System voltage and current output test of the cathodic protection system to determine if the system and equipment are performing in accordance with the plans and specifications and that no significant deterioration of the system or components therein has occurred during the first year of operation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Sacrificial Anodes and Accessories:

1. High Potential Magnesium Anodes:

a. Description: Magnesium anodes shall be capable of delivering a minimum efficiency of 500 amp-hours per pound of magnesium and shall have the following metallurgical analysis and physical properties:

b. Anode Dimensions (approximate): 2.75" (width) x 2.75" (height) x 56.75" (length)

c. Ingot Weight: 20 pounds

d. Package Weight (approximate): 72 pounds

e. Metallurgy:

1) Aluminum: 0.01% (max.)

2) Manganese: 0.50% - 1.3%

3) Copper: 0.02% (max.)

4) Nickel: 0.001% (max.)

5) Iron: 0.03% (max.)

6) Other (each): 0.05% (max.)

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7) Other (total): 0.30% (max.)

8) Magnesium: Balance

2. Packaged Magnesium Anode Backfill:

a. Magnesium anodes shall be packaged in a special chemical backfill having the following proportions:

1) Ground Hydrated Gypsum: 75%

2) Powdered Bentonite: 25%

3) Anhydrous Sodium Sulfate: 5%

b. Backfill shall have a grain size such that 100% is capable of passing a 20-mesh screen and a 100-mesh screen shall retain 50 %.

c. Backfill shall completely surround the anode ingot without voids.

3. Anode Lead Wires:

a. The standard lead wire for a magnesium anode shall be No. 10 AWG stranded copper wire with 'direct bury' rated insulation (RHW or HMWPE), black in color, of sufficient length to extend to their termination point without splicing.

4. Lead Wire Connection to Anode Core:

a. Magnesium anodes shall be cast with a minimum 20 gauge galvanized steel core.

b. One end of the anode shall be recessed to expose the core for silver-soldering the lead wire.

c. The silver-soldered lead wire connection and anode recess shall be filled with an electrical potting compound before packaging.

B. Wire, Cables & Splicing Material:

1. Test Wires for Cathodic Protection:

a. Structure test wires shall be No. 10 AWG stranded copper wire with 'direct bury' rated insulation (RHW or HMWPE), white in color, of sufficient length to extend to their termination point without splicing.

2. Anode Header, Structure Lead and Bonding Cables for Cathodic Protection:

a. Anode header, structure lead and bonding cables shall be No. 10 or No. 8 AWG stranded copper wire with 'direct bury' rated insulation (RHW or HMWPE), black in color, of sufficient length to extend to their termination point without splicing.

3. Compression Crimp Splice Connectors:

a. All underground spliced connections used within the DC cathodic protection circuit shall be made through the use of copper compression crimp connectors.

1) The proper size connectors shall be used in accordance with the manufacturer's recommendations.

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2) Connectors shall be crimped with a hand tool capable of delivering sufficient compressive force.

4. Split Bolt Splice Connectors:
   a. All aboveground spliced connections used within the DC cathodic protection circuit shall be made through the use of copper split bolt connectors.
      1) The proper size connectors shall be used in accordance with the manufacturer's recommendations.
5. Splice Encapsulation:
   a. All underground spliced connections used within the DC cathodic protection circuit shall be sealed with a two-part epoxy encapsulation.
   b. All aboveground spliced connections used within the DC cathodic protection circuit shall be sealed with rubber and plastic tape contained within a waterproof coating.
6. Warning Tape for Buried Cable:
   a. All underground DC cathodic protection cable shall be installed with a continuous 3" wide plastic line marking tape labeled "Caution – Cathodic Protection Cable Below" or similar.

C. Test Stations and Junction Boxes:
1. Flush-Type Test Stations:
   a. Monitoring stations shall be a flush-type station designed for use in heavy traffic areas set in a concrete pad. The bottom of the test station shall be open with access to native soil. Do not fill test station with concrete. Test station shall be furnished with a non-metallic terminal board equipped with labeled terminal posts to permit ready access and testing and shall be constructed as follows:
      1) Body: Fiberglass, ¼" thick, 9" inside diameter, with integral concrete anchors, bottom open to native soil.
      2) Cover: Cast aluminum with integral handle cover labeled to display "Cathodic Protection Test Station".
      3) Terminal Board: Non-metallic with nickel plated brass or stainless steel hardware.
2. Above Grade Type Test Stations (Junction Boxes):
   a. Junction Boxes shall be non-metallic, strut or wall mount (as indicated on drawings), furnished with a non-metallic terminal board equipped with labeled terminal posts to permit ready access and testing and shall be constructed as follows:
      1) Housing: Non-metallic (fiberglass) with hinged cover (stainless steel hardware).
      2) Terminal Board: Non-metallic with nickel plated brass or stainless steel hardware.

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3) Mounting hardware: All mounting hardware shall be stainless steel (except strut – shall be stainless steel or aluminum).

4) Conduit: GRS with seal fittings installed as required.

D. Cathodic Protection Instruments and Accessories:

1. $Cu/CuSO_4$ Reference Electrodes:

a. Description: $Cu/CuSO_4$ electrodes shall be used for soil environments to provide a stable electrical benchmark from which to measure the cathodic protection system's effectiveness. Electrodes shall be constructed as follows:

b. Element: Saturated gelled $Cu/CuSO_4$.

c. Design life of the electrode shall be no less than 20 years.

d. Lead Wire: No. 14 AWG stranded copper wire with 'direct bury' rated insulation (RHW or HMWPE), yellow in color, of sufficient length to extend to its termination or test station without splicing.

E. Coating Systems:

1. Coating of Wire and Cable Connections to Underground Structures:

a. The structure coating shall be repaired using Royston 'Handy Cap IP'. The 'Handy Cap IP' is a prefabricated assembly designed to provide quick, field applied coating repair to test lead wire welds on metal pipe.

F. Exothermic Welds and Accessories:

1. All buried connections to steel structures used within the DC cathodic protection system circuit shall be by exothermic welds. The proper size welders, metal charges, and wire sleeves shall be used in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:

1. The Cathodic Protection system shall be installed in accordance with the contract Drawings and contract Specifications.

2. The Contractor shall provide all necessary technical installation documents, such as situation plans and diagrams.

3. The installation of the Cathodic Protection system shall be by a contractor with a minimum of 5 years experience of installing Cathodic Protection systems.

4. The Contractor shall be responsible for the correct location of all equipment. If there are any discrepancies between the details in the shop drawings, contract drawings, or contract specifications the real dimensions of equipment, rooms, or buildings, they shall be reported in writing immediately upon discovery to the Engineer.

B. Sacrificial Anodes and Accessories:

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1. Remove paper or cardboard shipping containers from all anodes leaving cotton sack exposed to the soil.
2. Install prepackaged anodes horizontally as shown on the Drawings.
3. Cover anode bag with a minimum of 6" native soil or clay. Wet thoroughly prepackaged anode and dry soils with water prior to backfilling.
4. All anode lead wires shall be of sufficient length to extend to their termination or test station without splicing.

C. Wire, Cables & Splicing Material:

1. Wire and Cable:
   a. All underground wires, cables, and connections shall be installed at a minimum 18 inches below final grade with a minimum separation of 6 inches from other underground structures.
   b. All collector cables and electrode lead wires shall be placed in rigid galvanized steel or PVC conduit when run above grade.
   c. No splices shall be permitted inside conduit.
   d. All cathodic protection cables (structure, anode, reference electrode, test, other) shall be labeled at the test station/terminal board with permanent metallic or laminated tags.
2. Epoxy Splice Encapsulation:
   a. Install epoxy encapsulation kits at material temperatures greater than 40° F.
   b. Ensure that the epoxy material completely covers the copper connectors.
3. Tape Splice Encapsulation:
   a. Cover the splice with moldable splice putty to round all sharp edges.
   b. Wrap the spice in a layer of rubber splicing tape with ½ lapping layers.
   c. Wrap the spice in a layer of vinyl splicing tape with ½ lapping layers.
   d. Coat the connection with a waterproofing sealant.
   e. Repeat the process using another layer of rubber tape covered with a layer of vinyl tape and seal the connection with waterproofing sealant.
   f. Ensure that the taping material completely covers the copper connectors.

D. Exothermic Welds and Accessories:

1. All exothermic welding shall be performed in accordance with the manufacturer's recommendations for welding equipment, weld metal charge size and applicability to the structure.
   a. Obtain a "Hot Work Permit" before performing any exothermic welding in hazardous (classified) areas.
   b. Do not use exothermic weld equipment if the graphite mold is wet.

E. Test Stations and Junction Boxes:

1. Flush-Type Test Stations / Above Grade Junction Boxes:

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a. Attach test/structure wires to the structure using exothermic.

b. Route the test/anode header/structure lead/reference electrode wires to the terminal board allowing a minimum of 18" of slack.

c. Exercise care in backfilling the structure to avoid damaging lead wires or connections.

d. Install ring tongue connectors at terminal board for test wires.

e. Set the test station enclosure level with final grade in a minimum 24" square, thickness to match existing concrete.

2. Above Grade Junction Box:

a. Install junction box as indicated. Mount to existing wall / structure or used galvanized strut as required.

F. Cathodic Protection Instruments and Accessories:

1. Reference Electrode:

a. Install reference electrodes 12" from the cathodically protected structure at locations shown on the Drawings.

b. Route the reference electrode lead wire to the monitoring station enclosure.

G. Coating Systems:

1. Coating of Wire and Cable Connections to Underground Structures:

a. Surface preparation: Clean all weld splatter/slag, mud, dirt, grease, oil and other contaminants from the metal surface which is to be covered.

b. Application: Remove the release paper from the bottom of the 'Handy Cap IP'. Bend the plastic sheet inward at the serrations when applying to a small diameter pipe. Position and place the 'Handy Cap IP' on the welded area with the tunnel over the lead wire. Push the dome of the cap firmly into the weld area. Lift the lead wire away from the pipe and squeeze the adhesive compound completely around and underneath the wire. Push the wire back down on the pipe and press the elastomeric compound into the firm contact with the pipe over the entire area. The 'Handy Cap IP' incorporates an integrated primer and does not require the use of a liquid primer prior to application.

c. Backfilling: Exercise care in backfilling to avoid damaging the coating repair.

3.02 FIELD QUALITY CONTROL

A. POST-INSTALLATION TESTING:

1. General: After the cathodic protection system components have been installed, the system shall be inspected and commissioned by the Contractor's Corrosion Engineer (NACE certified Corrosion Specialist or Cathodic Protection Specialist) or by a NACE certified Corrosion Technician under direct supervision of a Corrosion Engineer. Contractor shall include in these services in his Bid.

2. Commissioning:

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a. The Corrosion Engineer/Corrosion Technician will perform the initial energization of the cathodic protection systems.

3. Method:

a. Record native structure-to-electrolyte potential measurements at the permanently installed test points, permanent reference electrodes, and other locations deemed representative by the corrosion technician.

b. Determine the effectiveness of all accessible electrical isolation materials.

c. Connect the anodes to the pipeline through the test stations and after allowing the metallic structures to sufficiently polarize (a minimum period of 12 hours), record the current-applied structure-to-soil potential measurements at the permanently installed test points, permanent reference electrodes, and other locations deemed representative. Measure potentials with the local anodes disconnected. Measure the anode current drain.

d. Determine if electrical isolation exists between the pipelines and all other foreign structures.

e. Determine if interference exists on the structures under cathodic protection, and if so, take steps to find a satisfactory solution to the problem.

f. Prepare a written report to include all test data, an analysis of the data, and necessary recommendations for additional work. The report will be submitted to the Owner.

END OF SECTION

SECTION 40 50 02 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following basic mechanical materials and methods to compliment other Division 23 Sections:

1. Concrete base construction requirements.
2. Equipment nameplate data requirements.
3. Labeling and identifying mechanical systems and equipment.
4. Non-shrink grout for equipment installations.
5. Field-fabricated metal and wood equipment specification sections.
6. Installation requirements common to equipment specification sections.
7. Mechanical demolition.
8. Cutting and patching.

1.02 REFERENCED STANDARDS

A. ASTM International (ASTM):

1. A47, Standard Specification for Ferritic Malleable Iron Castings.
2. A47M, Standard Specification for Ferritic Malleable Iron Castings (Metric).
3. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
5. A536, Standard Specification for Ductile Iron Castings.
6. B32, Standard Specification for Solder Metal.
7. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
8. D709, Standard Specification for Laminated Thermosetting Materials.
9. D1785, Standard Specification of Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80 and 120.
10. D2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
11. D2564, Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.
12. D2657, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

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13. D2661, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
14. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
15. D2846, Standard Specification for Chlorinated Polyvinyl Chloride (CPVC) Plastic Hot-and Cold-Water Distribution Systems.
16. D2855, Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.
17. D3138, Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Polyvinyl Chloride (PVC) Non-Pressure Piping Components.
18. F402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
19. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
20. F493, Standard Specification for Solvent Cements for Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe and Fittings.
21. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Polyvinyl Chloride (PVC) Plastic Pipe and Fittings.

B. American Society of Mechanical Engineers (ASME):
   1. A13.1, Scheme for Identification of Piping Systems.
   2. B1.20.1, Pipe Threads, General Purpose (Inch).
   3. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   4. B18.2.1, Square and Hex Bolts and Screws Inch Series.

C. American Water Works Association (AWWA):
   1. C110, Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch (75 mm through 1200 mm), for Water and Other Liquids..
   2. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

D. American Welding Society (AWS):
   1. A8.5, Specification for Filler Metals for Brazing and Braze Welding.
   2. D1.1, Structural Welding Code - Steel.
   3. D10.12, Guide for Welding Mild Steel Pipe.
   4. Brazing Manual.
   5. Soldering Manual.

E. Copper Development Association Inc:
   1. Copper Tube Handbook.

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1.03 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. ABS – Acrylonitrile-Butadiene-Styrene plastic.
2. CPVC – Chlorinated Polyvinyl Chloride plastic.
3. NP – Nylon Plastic.
4. PE – Polyethylene plastic.
5. PVC – Polyvinyl Chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. CR – Chlorosulfonated polyethylene synthetic rubber.
2. EPDM – Ethylene Propylene Diene Terpolymer Rubber.

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Submit info for the following:

1. Product Data – For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.
2. Shop Drawings – Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.
3. Coordination Drawings – For access panel and door locations.
4. Coordination Drawings – Details major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:
   a. Planned piping layout, including valve and specialty locations and valve-stem movement.
   b. Clearances for installing and maintaining insulation.

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c. Clearances for servicing and maintaining equipment, accessories and specialties, including space for disassembly required for periodic maintenance.

d. Equipment and accessory service connections and support details.

e. Exterior wall and foundation penetrations.

f. Fire-rated wall and floor penetrations.

g. Sizes and location of required concrete pads and bases.

h. Scheduling, sequencing, movement and positioning of large equipment into building during construction.

i. Floor plans, elevations, and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

j. Reflected ceiling plans to coordinate an integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers and other ceiling mounted items.

5. Samples – Of color, lettering style, and other graphic representation required for each identification material and device.

1.05 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors and viewing angles of identification devices.

B. Equipment Selection – Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment bases are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings of efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps through shipping, storage, and handling to prevent pipe from end damage and prevent the entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties form moisture and dirt.

D. Store plastic pipes protected form direct sunlight. Support to prevent sagging and bending.

1.07 SEQUENCING AND SCHEDULING:

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

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C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

D. Sequence, coordinate and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8.

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 GROUT

A. Non-shrink, non-metallic Grout: ASTM C1107, Grade B.

1. Characteristics – Post-hardening, volume-adjusting, dry, hydraulic cement grout, non-staining, non-corrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix – Five thousand pound per square inch gauge (5000 psig), twenty-eight (28) day compressive strength.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. Fire-Barrier Penetrations – Maintain indicated fire rating at walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations, with firestopping materials. Refer to Division 07 for firestopping materials.

B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to the Railroad's Engineer.

C. Install equipment level and plumb, parallel and perpendicular to other buildings systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

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E. Install equipment giving right-of-way to piping, installed at the required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

END OF SECTION

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SECTION 40 63 43 - PROGRAMMABLE LOGIC CONTROLLERS (PLC)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Programmable Logic Controllers (PLC) and Human-Machine Interfaces (HMI).
2. PLC and HMI systems are used for the following systems. The schedule is a list of principal systems only. Refer to Drawings for systems not specifically scheduled.
    a. Fueling Systems.
    b. Industrial Wastewater (IW) Systems.
    c. Movable Bridge Control Systems.
    d. Tree Watering Systems.
    e. Tunnel Ventilation Systems.
    f. Generator Control Systems, where indicated on the design drawings.
    g. Switch Heater Control Systems, where indicated on the design drawings.

B. Provide and install complete, in operating condition, required PLC(s). Include all required components and appurtenances. Provide electronic copies of the operational program required, including documented source code and all related passwords. Include field service during start-up, including travel and per diem expenses for the site visit.

1. Approved PLC design and programming companies for all systems other than fuel and industrial wastewater systems are as follows:
    a. Snyder Equipment, a Division of New York Air Brake, Contact: Jason Hagenow, Telephone: 417-725-4067, website: www.snyderequip.com.
    b. Interstates, Contact: Seth Vis, Telephone: 712-772-1662, website: www.interstates.com.
    c. Huffman Engineering, Inc., Contact: Jeff Austin, Telephone: 402-464-6823, website: www.huffmaneng.com.
    d. CSE Automation, LLC., Contact: Ed Lachowicz, Telephone: 402-861-6100, website: www.cseautomationllc.com.
    e. Electrical Engineering and Equipment, Contact: Nick Graber, Telephone: 515-273-0100, website: www.3e-co.com.
    f. CSE Services, Contact: Tony Schmitz or Jon Mislivec, Telephone: 402-733-2100, website: www.cse-ne.com.
2. Approved PLC design only companies for fuel and industrial wastewater systems:

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a. Arcadis Engineering, Contact: Matt Flint, Telephone: 206-726-4707, website: www.arcadis.com

b. HDR Engineering, Contact: John Nelson, Telephone: 402-740-4412, website: www.hdrinc.com.

c. Orbital Engineering, Contact: Justin Wood, Telephone: 816-980-9985, website: www.orbitalengr.com

d. Wilson Engineering, Contact: Clayton Abbott, Telephone: 785-201-4411, website: www.wilsonco.com

3. Approved PLC design and programming companies for fuel and industrial wastewater systems:

a. Casne Engineering, Contact: Travis Kinder, Telephone: 360-430-3396, website: www.casne.com

b. CSE Services, Contact: Tony Schmitz or Jon Mislivec, Telephone: 402-733-2100, website: www.cse-ne.com.

c. Telemetry Process & Controls, Contact: Drew Anderson, Telephone: 952-500-0222, website: www.tpcusa.com

C. Provide UPRR a complete set of as built control drawings if installation differs from project drawings.

D. The use of DC wet cell battery power supplies and interfacing PLC logic controls with external DC relays is prohibited unless authorized by the Manager of Electrical Design.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions.

B. Section 01 45 00 – Quality Assurance and Control.

C. Division 26 – Electrical.

D. Section 33 56 13 – Aboveground Petroleum Storage Tanks – Field Erected.

E. Section 33 65 15 – Aboveground Petroleum Storage Tanks – Shop Fabricated.

F. Division 40 – Process Interconnections.

1.03 REFERENCED STANDARDS

A. American Society for Testing and Materials International (ASTM).

B. The International Society of Automation (ISA).

C. National Electrical Manufacturers Association (NEMA).

D. Institute of Electrical and Electronics Engineers (IEEE).

E. American National Standards (ANSI) & Telecommunication Industry Association (TIA)

1. ANSI/TIA 568 – Commercial Building Telecommunication Cabling Standard.

2. ANSI/TIA 568.2D – Balanced Twisted-Pair Telecommunications Cabling and Components Standard.

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F. UPRR Electrical Design Manual.

G. UPRR Fuel Design Guide.

H. UPRR Industrial Wastewater Design Guide.

1.04 DEFINITIONS

A. HMI: Human-Machine Interface Screens.

B. I/O: Input/Output

C. PLC: Programmable Logic Controller.

D. UPS: Uninterruptible Power Supply.

1.05 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data.

a. Provide submittal data for all products specified in this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

3. As built drawings shall include a schematic of the logic that controls all functions and I/O points for the operation. The documentation shall include real world names of each device such as limits switches, pressure switches, push button stations, pump motors, tank level floats, etc. Electrical symbols shall conform to IEEE 315 standard. The control drawings shall be clear and defined to the extent that would allow maintenance personal to trouble shoot the control logic without having to refer to other drawings or specification sheets.

4. A fully documented copy of the on-site operational program for PLCs, Panelview, HMIs, & Ethernet devices for system in the project shall be provided to the UPRR Manager of Electrical Design. The documentation shall include all I/O points with symbol names, I/O addressing comments, and logic rung comment information. Software submittals will be conveyed to the Manager of Electrical Design, as indicated above. They may be in the form of attachment(s) to e-mail(s) or transmitted as a submittal on an authorized UPRR File Transfer website. For assistance in determining which transfer method to use, contact the UPRR Electrical Design Group.

5. A fully documented copy of the on-site operational program for PLCs, HMIs, and Ethernet connected devices supporting industrial wastewater and/or fuel projects shall be submitted via Union Pacific Support Central (UPSC), link: https://upsc.myuprr.com/ and notification shall be provided to UPRR Manager of Fuel & Environmental Capital Projects for installation to the GITLAB central UP PLC repository.

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1.06 QUALITY ASSURANCE

A. Programming software for PLC and HMI applications shall be performed using Allen Bradley Studio 5000 Logix, revision 32 or better platforms. The PLC program shall be developed using basic ladder logic. Function blocks are permissible. Advanced methods of programming (such as State Logic, Sequential Function Charts, Structured Test or Instruction List) will require approval of the Manager of Electrical Design prior to initiating programming. Panelview programs shall be Allen Bradley's FactoryTalk View Studio, version 12 or better.

1. For systems not related to IW systems or Fueling systems, contractor shall contact the UPRR Manager of Electrical Design to determine the latest version of *approved* programming software by the UPRR Information Technology (IT) Department prior to programming.

2. For IW systems and Fueling systems, contractors shall be required to the latest version available for the virtual machine (VM) provided by UPRR for writing the programming software.

B. The installation shall have all control devices wired as inputs or outputs to the PLC. All field devices shall be terminated on terminal strips. Terminals shall be identified for easy identification. This shall include hand-off-auto selector switches, auxiliary run contacts on motor starters, level position floats, push button stations, valve position indication, etc. No control devices shall be installed in a manner that their function would not be monitored or hard-wired external to the PLC logic controller.

C. The HMI (if used) and PLC shall use a common tag name database. Shared tags between PLC systems shall be fully identified in all systems. Program tags, numbers, and names shall be fully defined and consistent throughout both PLC and HMI programming.

D. When programming a tank level control that has an analog 4 - 20 MA input, the operational program shall be set so that the integer files math results will allow for monitoring tank levels in inches for IW systems, and feet for fueling and other systems, percentage of fill, gallons, and barrels. 4 MA = 0 percent full, 20 MA = 100 percent full. All commodity tanks containing petroleum products shall require a high level shut off at 90%, with the exception of a high level shut off at 85% for the state of Texas. The address location for each of these fields shall be clearly documented.

E. Program addressing for internal bits, timers, counters, shall consist of a short description of the function. Start description with the equipment name to group the timers, counters, and bits together when sorting.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. When programmable logic controllers are required, Allen-Bradley / Rockwell Automation PLCs shall be used – no substitutions will be allowed. HMI products shall be selected from the Allen-Bradley / Rockwell Automation PanelView Plus 7 family of graphic terminals. All hardware products must be reviewed to ensure compatibility with UPRR-approved software.

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1. The fueling systems and IW Lift Stations shall require the CompactLogix controllers.
2. For all other systems, the only acceptable control systems shall be from the ControlLogix control system family.
3. If the HMI is required to access multiple PLC controllers, the HMI shall be thePanelView Plus 7 Performance.

2.02 EQUIPMENT

A. The PLC processor model should be selected to completely satisfy all operating conditions. The unit supplied (including rack and power supply) shall, at a minimum, allow for a growth in I/O of 33% above final design, have 33% additional memory above the amount used in the final design, and allow for 33% additional tag names in the database above the amount used in the final design. An imbedded Ethernet port shall be present and available in the PLC processor(s). Other communication ports may be provided given project requirements.

B. The PanelView HMI graphic interfaces shall be of a size and programmed to provide operating, alarm, and maintenance information in a clear and concise manner. Alarms and Warnings may be displayed in convenient formats throughout the screens, but there shall be at least one separate Alarm Detail screen, and will be, at a minimum, capable of displaying the following Alarm and Warning condition status elements:

1. Current Status of the Alarm
2. Description of the Alarm
3. Assigned priority of the Alarm (if used)
4. When the Alarm came in
5. When the Alarm was acknowledged
6. When the Alarm cleared or was reset.

C. The HMI alarm display shall be capable of being filtered and/or sorted by any of the parameters. The HMI shall have at least one imbedded Ethernet port.

D. I/O Rack power supply shall be a minimum of 120 volt A/C.

E. Each PLC processor cabinet / HMI cabinet shall be equipped with an UPRR IT provided switch/router equipment unless a substitution for an Allen-Bradley Stratix Managed Switch for Ethernet Communication is approved by the Manager of Electrical Design prior to installation.

1. Existing systems being brought into the UPRR network shall be evaluated and approved by the UPRR IT department on a case by case basis.

2.03 INPUT/OUTPUT MODULES

A. Input/Output (I/O) Module selection shall be made from the Allen-Bradley / Rockwell Automation ControlLogix 1756 or CompactLogix 1769 family of modules.

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1. Discrete I/O modules shall be of the 120 VAC input and output type. Output modules shall employ relays. The maximum number of discrete I/O points per module shall be 32. Modules with I/O points higher than 16 shall be provided as pre-wired modules. Alternative voltage / control element and/or higher density modules may be used only with prior permission of the Manager of Electrical Design.
2. Analog I/O shall be of the 4-20 mA DC type. The minimum number of configured I/O points per module shall be 8 with a maximum of 16. Alternative signal and/or point density modules may be used only with prior permission of Manager of Electrical Design.
3. Exceptions to the above requirements shall be approved by the UPRR Manager of Electrical Design and the UPRR project manager prior to implementation in the field.

B. The final PLC hardware system shall include 20% installed spare I/O points of each type used unless otherwise noted on the project drawings.

2.04 COMMUNICATIONS

A. The preferred Device-to-Device communication will be "Ethernet/IP", unless conditions dictate a different technology. All network communication equipment shall be provided by or approved UPRR Department. All communication systems shall include complete documentation (including configuration) for each system employed.
1. The use of Radio Modems shall require UPRR IT approval. The radio modems shall be selected from the currently approved models in the Data-Linc Group smart spectrum family.
2. If Ethernet is not available or feasible, the Prosoft Modbus modules are acceptable for non-Ethernet communications.

B. The Ethernet cables used with PLCs shall be a shielded CAT 6A type and associated connectors to reduce electronic noise from other equipment.

2.05 UPS POWER SUPPLY

A. For critical plant operations, the contractor shall include a 120 VAC uninterruptible power supply. The UPS shall be appropriately sized for the equipment served to provide 120 VAC for the PLC, modem and all input and output control functions. The UPS shall be Allen Bradley Tripp Lite model BC PRO 1400 (10"x 6-1/2 IN x 14 IN) or approved equal.

2.06 SURGE SUPPRESSOR

A. The A.C. power supply shall have surge protection and a disconnecting means located at or near the control panel power strip.

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2.07 LEVEL SENSORS

A. MTS, Electrolab, or Ametek tank level sensors shall have 24 VDC power supply, 4-20 ma output, PVC housing, accuracy of ±0.25 percent, operating range of 2 FT to 50 FT, operating temperature of -22 DegF to 140 DegF, 2 - 4 IN NPT vented still pipe, with calibration capabilities. The UPRR Manager of Electrical Design shall approve any alternate.

B. Fuel Tank Sensors for aboveground storage tank shall be as specified in Specification Section 33 56 13 for field erected tanks or Specification Section 33 56 15 for shop fabricated tanks.

2.08 PRESSURE TRANSMITTERS

A. Transmitter shall have 4-20 ma output, accuracy of ±0.25 percent, 0 to 160 DegF operating temperature, stainless steel construction, 1/4 IN NPT male thread connector for mounting, 0 - 300 PSI operating range, Omega Model # PX305-300 G.I.

B. Endress+Hauser transmitters shall be used on IW systems.

2.09 FLOW TRANSMITTERS

A. Transmitter shall be insertion type paddlewheel sensor, 0.3 – 30 FPS, accuracy 1-1/2 FPS, maximum pressure 250 PSI, pipe size 2 IN to 10 IN, operating temperature 250 DegF, fitting six brass 1-1/2 IN NPT. Seametrics model # IP101-B, with flow control interface, 4-20 ma output, 6-digit display, K factor range of 0.50 to 2000, NEMA 4X, Seametrics model # FT420 flow computer.

B. Parshall Flume Type Flow measurement transmitter shall be permitted for IW systems.

C. Refer to Specification Section 40 71 10 Flow Measurement Equipment for Industrial Wastewater for additional requirements.

PART 3 - EXECUTION

3.01 START-UP, FIELD TESTING AND CALIBRATION

A. General:

1. The electrical contractor and panel builder shall provide start-up, validation, checkout and programming modifications to the PLC and/or PanelView to assure a working system.

2. The electrical contractor and/or PLC controller's integrator contractor, with the direct participation of the instrument supplier and control panel supplier, shall demonstrate the operability and suitability of all instrumentation with regard to installation, proper connection, pressure tests and calibrated accuracy. The electrical contractor shall provide all test equipment necessary to demonstrate this performance. An On-site Project Representative and/or Owner shall witness the calibration and testing of each control loop.

B. Calibration Reports:

1. Provide a written calibration report for each measurement and control device. The calibration reports shall include, as a minimum, the following information:

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a. Date

b. Technician's name

c. Instrument designation

d. Instrument brand and model number

e. Zero and span settings or setpoint

1) Record storyboards or other level sensors shall be consistent with electronic levels.

f. Desired zero, half scale, and full scale values

g. Actual zero, half scale, and full scale values

h. Brand and model number of calibration equipment

i. Signature of technician

j. Signature of witness

C. Transmitter, Sensors, Switches and Analyzers:

1. Test and calibrate (at three points) the output signal from all analog devices for zero, half scale and full scale after installation. Switches shall be adjusted to the proper set point and shall be verified by calibration. Calibration shall be performed per the applicable requirements of ASTM and ISA. Calibration may be made by artificial movement or signal simulation when other means are not feasible.

a. Level transmitters shall be calibrated by liquid level in the basin, tank, etc.

b. Flow meters shall be calibrated by measuring known quantities of process fluids to be measured over a measured time at various constant flow rates.

c. Temperature transmitters shall be calibrated with an ASTM reference thermometer.

d. Pressure transmitters shall be calibrated with calibrated inspectors test gauges.

e. Control loops shall be calibrated in place. All instruments shall be calibrated at a minimum of zero, half scale and full scale.

D. Control Systems:

1. Controllers shall be checked to demonstrate that the control action is synchronized with final control element action and other related instrumentation as follows:

a. Controller output values and positioner output values shall be checked for proper coordination of controller output with opening direction.

b. Positioner output values and stroke shall be checked.

c. The indication on controller output gauge or meter shall agree with the final control element action.

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d. Feedback control loops shall be tuned for stable operation and optimum response to system disturbances. Loops shall maintain stable control over the minimum to maximum process range, with optimum response time, and minimum offset. Loops with critical process limits, such as temperature, shall be tuned for minimum overshoot.

e. Final control element actuators, operators or positioners shall be adjusted to provide accurate positioning without excessive movement and wear.

E. Interconnecting wiring

1. The Interconnecting wiring on electronic instruments shall be checked for continuity, short circuits, grounding and shielding as shown on approved wiring diagrams. Detrimental ground loops shall be isolated and eliminated. Excessive induced or stray voltages shall be eliminated by separating circuits, loading circuits or other practical means.

F. Alarms and Interlocks:

1. Alarm settings and interlock actions shall be checked for proper operation in the presence of the On-site Project Representative and/or the Owner. Alarms shall be checked by initiation of the alarm sensor by the associated process(es). Exceptions shall be approved by UPRR prior to project completion.

END OF SECTION

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SECTION 40 71 10 – FLOW MEASUREMENT EQUIPMENT FOR INDUSTRIAL WASTEWATER

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Device used for primary flow measuring equipment in the following facilities,

   a. Industrial wastewater treatment plants

   b. Oil-water separators systems

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions

1.03 REFERENCED STANDARDS

A. American Water Works Association (AWWA):

1. AWWA C700 - Cold-Water Meters – Displacement Type, Metal Alloy Main Case

2. AWWA C704 - Propeller-Type Meters for Waterworks Applications

B. ASME International (ASME):

1. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

2. ASME PTC 19.5 - Flow Measurement

C. ASTM International (ASTM)

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

2. ASTM A193 - Stainless Steel Anchor Bolts

3. ASTM B61 - Standard Specification for Steam or Valve Bronze Castings

4. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.

5. ASTM D695 - Compressive Properties of Rigid Plastic

6. ASTM D 790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

7. ASTM D 1941 – Standard Test Method for Open Channel Flow Measurement of Water with the Parshall Flume

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8. ASTM D 2583 – Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.

D. United States Department of Interior, Bureau of Reclamation

1. "Water Measurement Manual", Water Resources Research Laboratory

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Shop drawings indicating:

1. Minimum and maximum flow rates.

2. Critical dimensions, jointing and connections, fasteners and anchors.

3. Materials of construction.

4. Sizes, spacing, and location of structural members, connections, attachments, openings, and fasteners.

C. Discharge Tables

1. Level-to-Flow Discharge Tables, showing:

a. Flow equations.

b. Submergence transition, where published.

c. Accuracy, where published.

d. Plan view layout showing critical dimensions and primary point of measurement.

e. Discharge table source.

D. Receiving, Handling, and Storage Instructions

E. Installation Instructions

F. Operation and Maintenance Instructions

G. Product Warranty

H. Test Data

1. Independent certified test results confirming material properties.

a. Test results are to be performed on specimens representative of the resins and reinforcements submitted upon with such resins and reinforcements listed by the certifying party.

b. Data shall be no more than three (3) years old.

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I. QUALITY ASSURANCE

1. Parshall Flume:

a. The flume Manufacturer shall have products in satisfactory use in similar applications for a minimum of five years.

b. A nameplate shall be attached to the flume indicating Manufacturer's name and unique model or serial number used in reports certifying conformance to standards and "Level-to-Flow Discharge Tables".

1.05 DELIVERY, STORAGE, AND HANDLING

A. Parshall Flumes

1. Delivery

a. Inspect for damage

1) All parts should be inspected upon delivery to the site, noting any missing items or visible damage.

2) Verify that the interior flow surfaces have not been damaged or otherwise marked during transit.

3) Flanges, anchor clips, and dimensional bracing should also be inspected.

4) For smaller boxed items make sure to verify that all packaging seals are in place and that there is no visible damage to the packaging.

b. Investigate for order correctness and count

1) Once the order has been received review the packing list against what has been received. Should any items not appear to be present or the configuration of the items does not match the description on the packing list, contact Manufacturer immediately.

2) Small connection hardware (nuts, bolts, etc.) not attached to the flumes ship in individual boxes – with those contents clearly marked. Special care should be taken to secure these and any other small items that can be misplaced on a job site.

2. Handling

a. Flumes are specialty items and are fabricated to strict dimensional tolerances. While rugged and designed for a long service life, flumes must be handled with care. Flow surfaces are particularly important and in handling flumes this should always be kept in mind.

b. When cranes, hoists, and other machinery are used to lift flumes or flume sections, spreader bars and lifting straps should always be used. When performing any overhead lift, all lifting eyes must be used in conjunction

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with good rigging practices. Rigging and lifting sequences and schedules of equipment are solely the responsibility of the installing party.

c. Chains, ropes, and the like should never be used to move or position any flume as they may serrate the fiberglass laminate or compromise the protective gel coat surfaces.

3. Storage

a. Flumes not intended for immediate installation may be stored until the site is ready for their installation.

b. Flumes should only be stored in a location that is clean, level, and protected from construction traffic.

c. When shipped on pallets, flumes should be left on those pallets until such time as they are needed. Otherwise flumes should be stored upside down so that the interior flow surfaces are protected. Flumes should then be covered as an additional protection for the flow surfaces.

1.06 WARRANTY

A. The warranty period shall begin from the date of shipment.

B. Parshall Flumes:

1. Flumes shall be warranted to be free of defects in workmanship and materials for five (5) years with a completed warranty registration.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with these requirements, provide products by the following:

1. Parshall Flume:

a. Plasti-Fab, Ridgefield, Washington

b. Openchannelflow, Boise, Idaho

c. Tracom, Alpharetta, Georgia

B. Substitutions for these specifications must receive written approval from the Engineer prior to fabrication, coating and other services provided herein. Refer to Section 01 33 00 for other substitution requirements.

2.02 MANUFACTURED UNITS

A. One-piece, fiberglass reinforced plastic.

B. Gloss inside surfaces, free of irregularities.

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C. Minimum 3/16-inch wall thickness.

D. Minimum 30% E-glass laminate content by weight.

E. Isophthalic polyester resin.

F. Isophthalic gel coat:

1. All surfaces must be gel coated.

2. 15-mil cured thickness.

3. U.V. inhibitors in all gel coat formulations, regardless of application or installation location.

4. Color:

a. Interior surfaces: white gloss.

G. Pultruded fiberglass reinforced plastic bracing at top of flume (inlet and outlet), T-304 stainless steel hardware.

H. Two-inch (2") (minimum) top and end flanges.

I. Molded-in stiffening ribs, maximum 12-inch center to center spacing.

J. 15 mil Isophthalic U.V. resistant gel coat on all surfaces.

K. Dimensional bracing:

1. Removable, gray equal leg pultruded fiberglass bracing with T-304 stainless steel hardware capable of providing sufficient strength and structural support to resist the stresses of shipping and installation (cribbing of the flume is still required during installation).

a. 1-inch x 1-inch (1-3-inch Parshall flumes).

L. Anchor clips chemically bonded to the exterior of the flume to aid in securing the flume during installation and drilled for ¾-inch.

M. Physical properties:

1.	Tensile strength (ASTM D 638):	14,000 psi.
2.	Flexural strength (ASTM D 790):	22,000 psi.
3.	Flexural modulus (ASTM D 790):	1,000,000 psi.
4.	Barcol hardness (ASTM D 2583):	30.
5.	Water absorptions (ASTM D2583:	less than 0.15%

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2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Parshall Flume:

1. Performance Requirements:

a. The flume shall conform to the physical dimensions listed in Figure 19 of the U.S. Department of Interior, Water Measurement Manual, latest edition. Dimensional tolerances for 1", 2", and 3" Parshall flumes shall be plus or minus 1/16" (1.6mm) maximum in the throat, and plus or minus 1/8" (3mm) maximum elsewhere. Dimensional tolerances for all other sizes shall be plus or minus 1/8" (3mm) maximum in the throat, and plus or minus 1/4" (6mm) maximum elsewhere.

b. Size:

1) Refer to the project specific drawings for the parshall flume size.

c. Construction:

1) One-piece construction.

2) Refer to the project specific drawings to determine whether the method of installation is to be free-standing, in-floor, in manhole or other.

2.04 ACCESSORIES

A. Parshall Flume:

1. End Connections

a. End adapters

1) Refer to the project specific drawings for the configuration of the end adapters.

2. Flow / Level Measurement

a. Staff / level gauge

1) High visibility, direct read level gauge with 3/4-inch black letters / numerals on a high visibility yellow-green background.

2) Dual scale gradated in cm, 1/10-foot, and 1/100-foot increments.

3) Gauge must be molded into the flume. Surface applied gauges shall not be allowed.

b. Ultrasonic Mounting Bracket

1) Horizontally and vertically adjustable stainless-steel construction.

2) Capable of mounting ultrasonic transducers up to 1-inch NPT.

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3. Parameter Monitoring

    1) Probe holder

        a) Field removable / replaceable T-304 stainless steel probe holder (for pH, DO, conductivity, etc. probes) mounted in recessed cavity open to the flow stream and secured using a nut on the top flange of the flume.

        b) Holder to extend 1-inch below crest (floor) of the flume to aid in keeping the probe wetted.

        c) Holder shall accommodate 7/8-inch to 1 1/8-inch.

4. Sampler tube

    a. Field removable / replaceable T-304 stainless steel sampler tube secured using (2) nuts on the top flange of the flume.

    b. 3/8-inch tube to accept standard 3/8-inch suction line.

5. Modified sidewalls

    a. Refer to the project specific drawings for the extended height sidewall dimension (Ha) where flume is mounted in floors.

6. Recessed grating

    a. Refer to the project specific drawings for safety grating requirements where flume is mounted in floor.

2.05 SOURCE QUALITY CONTROL

A. Parshall Flumes:

1. Independent certified test results confirming material properties.

2. Test results are to be performed on specimens representative of the resins and reinforcements submitted upon with such resins and reinforcements listed by the certifying party.

3. Data shall be no more than three (3) years old.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Parshall Flume:

1. Verify that the flume dimensions are correct and that the site conditions are suitable for installing the flume.

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2. Flumes supplied with bolt-on end adapters or wing walls must remain sealed between the joints. Where required, apply one or two continuous beads of silicone on all seating surfaces before proceeding with the installation.

3.02 INSTALLATION

A. Parshall Flume:

1. Provide and execute Manufacturer's installation instructions for the proper free-standing, in-floor, or field installation which are to include, but not be limited to,

   a. The flat floor of the flume (the crest) should be set upstream.

   b. The crest of the flume must be installed level from front-to-back and from side-to-side (using a level on the crest – not the top – of the flume).

   c. The inlet of the flume must be set at or above the invert of the inlet channel / pipe. If set higher, a 1:4 (rise-to-run) slope ramp should be grouted from the channel / pipe to the inlet of the flume. The inlet of the flume should never be below the invert of the channel / pipe.

   d. The outlet of the flume should be set at or above (ideally) the invert of the outlet channel / pipe to help transition solids out of the flume and to minimize the chance of submergence.

   e. The internal dimensions of the flume are critical to its proper operation. The flume must be braced internally (plywood and lumber are typically used) during installation to ensure that distortion does not occur. The dimensional bracing on the top of the flume is provided to ensure dimensional accuracy. The bracing should be left on the flume until the installation has been completed. For installations where the flume is set in concrete, the bracing may be removed once the installation has been completed and verified. For installations where the flume is freestanding or otherwise not set in concrete, the bracing should be left in place.

   f. If set in-floor or in field, the flume should be weighted as well as lined and braced internally to prevent flotation and / or distortion during installation. Floor distortion is a concern on flumes with large, flat bottoms. Make sure to take the necessary steps to avoid distortion before proceeding. Flowable grout should be used to secure the flume in place. The initial lift should be slowly poured from one side of the flume so that the grout will flow under the flume to the other side, thereby helping to eliminate any void areas under the flume.

3.03 FIELD QUALITY CONTROL

A. Qualified factory representative shall provide on-site assistance, consisting of:

1. One day of installation observation.

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a. Manufacturer's Representative shall complete a "Certification of Proper Installation" and provide copies to the Owner, Engineer, Contractor and Manufacturing Facility.

b. The "Certification of Proper Installation" shall be suitable for submittal to the regulatory agency having jurisdiction.

c. Installation observation shall not alleviate installing party from installation liability.

2. Zero days of operator training.

3.04 CLEANING

A. Parshall Flume:

1. Verify that the complete installation meets the criteria above and any additional criteria supplied by the Engineer.

2. Clean the flow surfaces in accordance with the manufacturer's operation and maintenance instructions.

END OF SECTION

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SECTION 41 22 13 - JIB CRANES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installation of a jib crane, trolley and hoist. The jib crane shall have a push trolley travel, push boom swing, and an electric motor operated lifting and lowering.

1.02 GENERAL

A. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operation following instructions and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

B. General Equipment Stipulations – The General Equipment Stipulations shall apply to the equipment furnished under this section.

C. Power Supply – Power supply to the equipment will be four hundred-eighty volts (480V) sixty Hertz (60Hz) triple phase (3ph.).

D. The feeder circuit for the hoist assembly will be furnished and installed under the electrical section to the location indicated on the drawings.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Complete outline and installation drawings, together with detailed specifications and data covering materials used, parts, devices, and other accessories forming a part of the equipment furnished and the operation and maintenance manuals, shall be submitted in accordance with the submittals section.

C. Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of the hoist, and complete details and information on the power feed and control systems.

D. Provide structural loading information including; recommended foundation size, overturning moment, bolt loads and sizes, and bolt pattern / locations.

1.04 QUALITY ASSURANCE

A. Governing Standards – Equipment furnished under this section shall comply with the applicable requirements of the following:

1. Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

2. ANSI MH27.1, Specifications for Underhung Cranes and Monorail Systems

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PART 2 - PRODUCTS

2.01 MATERIALS

A. Mast Assembly – Thick-wall seamless steel tubing.

B. Boom – American Standard steel beam.

C. Bracket Fitted Type Boom:

1. Pins – High carbon steel.

2. Bearings – Permanently shielded, lifetime-lubricated, anti-friction type.

D. Mast Head Assembly Type Boom:

1. Upper Pintle Bearing – Sealed ball bearing, lifetime-lubricated.

2. Lower Bearing – Sealed roller anti-friction bearings.

E. Hoist:

1. Bearings – Anti-friction type; oil lubrication or lifetime-grease packing.

2. Gearing – Spur or helical type; fully enclosed in an oil-tight housing.

3. Wire Rope – As recommended by rope manufacturer for specified drum.

4. Mechanical Load Brake – Fully enclosed in oil-tight housing.

5. Lower Block – Safety type with guarded sheaves.

6. Lifting Hook – Forged steel; slow opening, non-fracturing with safety latch.

7. Sheave Bearings – Anti-friction or sleeve type.

F. Trolley:

1. Frame – Steel; rigid construction.

2. Wheels – Rolled, forged or cast iron steel with hardened treads.

3. Wheels Axles – High carbon steel; fixed type.

4. Bearings – Permanently shielded, lifetime-lubricated, anti-friction type.

G. Controls:

1. Pendant Control Cable – Heavy-duty type with extra-flexible stranding and neoprene jacket.

2. Power Feed Cable – Six hundred volt (600V), four (4) conductor, neoprene jacketed, heavy-duty portable cable.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

A. Service Conditions – The jib crane, hoist, and trolley will be rated for outdoor usage, and will be used intermittently to lift its rated capacity.

B. Equipment Protection – All equipment shall be delivered, stored, and handled in accordance with the General Equipment Stipulations.

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C. Acceptable Manufacturers – The jib crane, hoist and trolley, with all appurtenances, shall be manufactured by one of the following:

1. Lift-Tech International.
2. Robbins & Myers.
3. Spanco (Pharr Better Solutions).
4. Kone.
5. Abell-Howe.
6. Approved Equal.

D. Design Requirements – The jib crane and hoist shall be designed to the following criteria:

1. Foundation – sleeve mounted.
2. Overall Capacity (in tons) – 5 tons.
3. Hoisting Capacity (in tons) – 5 tons.
    a. Three (3) total hoists:
        1) Outside hoists; Two (2) total hoists, one (1) ton capacity each.
        2) Center hoist: One (1) total hoist, three (3) ton capacity.
4. Hoisting speed: 14 FPM (minimum).
5. Span: 16 FT – 0 IN.
6. Height under boom: 15 FT – 0 IN.
7. Provide rotational stops where indicated on plans.

PART 3 - EXECUTION - (NOT APPLICABLE TO THIS SPECIFICATION SECTION)

END OF SECTION

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SECTION 41 22 20 - TRAVELLING GANTRY BRIDGE CRANES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Traveling bridge crane, complete with trolley, and hoist. The crane shall have an electronically-operated bridge, an electronically-operated trolley, and an electrically-operated hoist.

1.02 GENERAL

A. Equipment and accessories furnished and installed under this contract shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are approved by the Engineer.

B. The bridge crane assembly shall consist of double girder structural members fabricated by the crane supplier and components (end wheels, wheels, bridge drive mechanism, trolley, and hoist) manufactured by Whitting, Demag, Lift-Tech International, Robbins and Myers, or Wright. All components shall be the products of a single manufacturer. Equivalent products of other manufacturers regularly engaged in the production of equipment of this type may be furnished subject to the acceptance of the Engineer. All modifications necessary to accommodate the equipment shall be subject to review and acceptance of the Engineer, and shall be made at no additional cost to the Railroad.

C. The project documents shall identify the following criteria for the Contractor to prepare their design:

1. Number of Cranes at the Project Location
2. Capacity in Tons
3. Approximate Bridge Span Distance, in Feet
4. Specific Location of Each Crane

D. Bridge Cranes shall be supported by pre-engineered building columns.

E. The Crane Manufacturer shall provide the runway beams, crane rails, support brackets, and all other appurtenances required for proper installation and operation.

F. The Crane Manufacturer shall be responsible for the coordination between the pre-engineered building manufacturer and the bridge crane supplier to ensure proper installation and operations.

G. The operations of all the bridge cranes, trolleys, and hoist shall be primarily controlled by a remote radio, digital control system. A wired pendant controller shall also be provided as a secondary controller in the event of a lost or damaged remote control unit.

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H. The bridge crane assembly shall be pre-assembled and run in the shop, then matchmarked and disassembled for shipment.

I. The Bridge Crane Manufacturer shall provide four (4) sets of O&M manuals for all of the bridge cranes and all of the remote radio control systems. The Bridge Crane Manufacturer shall also provide 3 days of on-site classes to the Railroad's personnel on the operations and maintenance of the bridge cranes and the remote radio digital control system.

J. General Equipment Stipulations – The General Equipment Stipulations shall apply to the equipment furnished under this section.

K. Governing Standards – Equipment furnished under this section shall comply with the applicable requirements of the following:

1. Occupational Safety and Health Standards of the U.S. Department of Labor, Subpart N. Materials Handling and Storage.

2. Crane Manufacturers Association of America (CMAA) Specification No. 70, Specification for Top Running and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

L. Power Supply – Power supply to the equipment shall be 480 volts, 60 Hertz, Triple Phase

M. Labels – The gantry, trolley, and hoist shall each have a conspicuous, easy to read label showing the manufacturers' name, crane serial number, and rated capacity. The rate capacity of the hoist shall also be shown on the load block.

N. Painting – Shop painting shall be provided. Paint shall be a minimum of two coat high build epoxy enamel. The crane shall be painted Universal Safety Yellow.

O. Warning Devices – The gantry crane shall be equipped with a warning horn that sounds automatically when the movement is initiated by the controller. The trolley shall be equipped with a bell which is energized by a push button on the radio controller or pendant. The crane shall also have a flashing red light located on the bottom of the crane bridge beam which is activated with the horn.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Complete outline and installation drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the submittals section.

C. Drawings shall include electrical connection diagram and schematics identifying all items requiring electrical control or power in the operation of the traveling crane assembly, and complete details and information on the power feed system.

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PART 2 - PRODUCTS

2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. The traveling gantry crane shall be a shop-assembled unit with trolley and hoist. The gantry crane assembly shall be designed for the following conditions, to be specified in the Project Documents:

1. CMAA Classification.
2. Hoisting Capacity (in tons).
3. Distance Center to Center of Runway Beams (in FT).
4. Size of ASCE Crane Rails.
5. Pounds per Yard.
6. Approximate Overall Length of Runway Beams.
7. Maximum available clearance:
    a. Beyond Centerline of Runway.
    b. Beams, each side (IN).
    c. Maximum Available Clearance Above the Top of the Runway Beam.
    d. Bottom of Runway Beam Elevation.
    e. Top of Crane Rail Elevation.
    f. Operating Floor Elevation.
8. Crane speeds at rated capacity (100 percent) of speed control function):
    a. Gantry (fpm).
    b. Trolley (fpm).
    c. Hook (fpm).
9. Required Hook Travel Elevations:
    a. Hook at highest position – Elevation.
    b. Hook at lowest position – Elevation.

2.02 GANTRY

A. The bridge shall be double leg type, rigidly supported by end trucks, and shall be designed to run on the top of the crane rail. The gantry shall be constructed to accommodate a single girder trolley and hoist.

B. Steel design and fabrication shall comply with applicable portions of the specifications of the American Institute of Steel Construction. Loadings, impact allowances, and allowable stresses shall be in accordance with the governing standards. Deflection of the main girder shall not exceed 1/800th of the span, with the maximum hoist load at any point.

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2.03 END TRUCKS

A. End trucks, each fabricated from structural steel members, shall be designed to distribute the loading equally to each wheel, shall be securely attached to the beam by welding or with fitted bolts in reamed holes, and shall be provided with heavy gusset plates to ensure rigidity and squareness. Each truck shall have heavy end plates to engage the stops on the runway beams. End trucks shall have a wheelbase of approximately 1/7th the bridge span.

B. The end trucks and wheels shall be designed to operate on the crane rails and shall clear the standard ASCE crane rail fittings, anchors and splices.

C. Wheels – Gantry wheel cranes shall be of the double flange type, made of rolled forged, or cast steel, with machined universal crowned or tapered hardened treads, designed to operate, on the specified runway. One wheel in each truck shall have integrally cut spur gear teeth, or machine-cut gears pressed on hubs to serve as drive wheels. The other wheels shall be idlers. Axles may be either rotating or fixed type. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

D. Gantry Drive Mechanism – The bridge drive shall consist of a single-speed electric motor, enclosed reduction gearing, and a cross shaft to drive one wheel of each end truck. The shaft shall be designed to withstand torsional strain and shall be supported with self-aligning, lifetime-lubricated bearings at intervals sufficient to prevent distortion of the shaft.

E. The drive motor contained a built-in adjustable mechanical brake. The bridge brake shall be solenoid operated, adjustable shoe or disc type, acting directly on the bridge drive motor shaft.

2.04 TROLLEY AND HOIST

A. The hoist shall be of the cable winding drum type, and the trolley shall be designed to run on the bottom flange of the gantry bridge.

2.05 TROLLEY

A. The trolley frame shall be rigid, shall contain the hoist, and shall be electrically driven type.

B. The trolley drive shall be a sealed worm or spur gear unit, permanently lubricated with an oil bath.

C. Wheels shall be single flanged type, made of rolled, forged, or cast steel with hardened treads. Trolley drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on hubs. Wheel gearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

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2.06 HOIST

A. The hoist shall consist of a single speed electric motor, a grooved winding drum, and gearing, all supported from the trolley. Antifriction bearings shall be used throughout. The winding drum shall have right-hand and left-hand machined grooves designed to receive the full run of hoisting cable without over-wrapping, and to provide a true vertical lift. The ration between the diameter of the drum and the diameter of the hoisting cable shall be at least 20 to 1. At least two laps of cable shall remain on the drum when the lifting hook is in the lowest position.

B. The hoist shall be provided with mechanical and electrical load brakes arranged so that the load may be raised and lowered by electric power and automatically sustained at any position of the hook when the power is cut off. The mechanical load brake shall prevent acceleration of the load when lowering and shall completely sustain the load when brought to rest, independent of the electric brake. The electric brake shall be released whenever current is flowing to the hoist motor and shall be automatically activated when the current is shut off or interrupted. The mechanical brake shall operate in oil in a sealed enclosure.

C. The hoist shall be provided with adjustable limit switches to stop the hoisting mechanism at the upper and lower limits of the hook travel.

D. The lifting tackle shall consist of a lower block and hook, necessary sheaves, and wire rope, especially for hoisting service. Rope shall be as recommended by the rope manufacturer for use on the specified drum. The lower block and hook shall be of the safety type with guarded sheaves, and a slow-opening non-fracturing forged steel hook. The hook shall be supported on a ball or roller thrust bearing for easy turning and shall include a safety latch. See Drawings for Hook Offset. The sheaves shall have anti-friction or sleeve type bearings.

E. The trolley frame shall be rigid and shall support the hoist. Trolley wheels shall be of the single flange type, of rolled, forged, or cast steel, with machined universal or crowned or tapered treads. Drive wheels shall have integral cut spur gear teeth or machine-cut gears pressed on hubs. Wheel axles shall be of the fixed type, made from high carbon steel, machined and ground to size to receive the wheel bearings. Wheel bearings shall be permanently shielded, lifetime-lubricated, anti-friction type, suitable for radial and end thrust loading. The trolley shall be provided with lug or crosshead with machined seat to receive the mounting hook of the hoist.

F. The hoisting assembly shall consist of an upper block housing the spur gearing, load chain guide, upper sheaves and equipped with a top hook for attachment directly to the trolley; a load chain equipped with a load hook; and hand chains. The top hook shall be arranged to swivel and shall be of forged steel. Antifriction bearings shall be used throughout, and the assembly shall have facilities for proper lubrication.

G. The hoist shall be equipped with a self-activating, mechanical load brake that will prevent acceleration of the load when lowering and which will sustain the maximum load at any point. Load brakes shall operate in sealed enclosures.

H. The hook shall be slow-opening, non-fracturing, forged steel, and shall be provided with a safety latch. The hook shall be mounted on anti-friction bearing to permit easy turning.

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2.07 BUMPERS AND STOPS

A. Bumpers and stops in compliance with the governing standards shall be installed on the trolley, and runway beams. The bumpers and stops shall be located so that no part of the bridge or trolley encroaches on the clearances specified or indicated on the drawings.

2.08 ELECTRICAL

A. Furnish electrical equipment including motors, motor starters, variable speed system, and wireless remote control systems, wire, and conduit. Gantry conductors may be removed for shipment. Crane wiring shall be by the crane manufacturer.

B. Electrical shall be wired in accordance with NFPA 70, NEC Article 610.

C. Furnish motors compatible with adjustable frequency, variable speed, drive system, 40 to 1 speed range, suitable for hoist, trolley, and gantry drive operations. Controls with one hundred twenty volt (120v) AC, microprocessor based, pulsed with modulation design, withstand 45 Deg. C temperatures, housed in NEMA 12 enclosure, and supplied with a 200 degrees overcurrent protection.

1. Manufacturers and Products:

   a. Electromotive, Frequency Inverter.

   b. P&H Smartorque.

   c. Or approved equal.

D. Gantry and trolley conductor voltage drops from runway supply taps shall permit the crane motors to operate within voltage tolerances of ±10 percent when building supply voltage is at ±5 percent of design voltage.

E. Festooned Flat Cable Conductors: Flexible cable, carried by heavy-duty roller, permanent lubricated roller bearings, with monorail support system that will dispense and retrieve flexible cable without twisting or tangling, and 20 percent spare conductor in each cable assembly.

F. Grounding: External in accordance with NFPA 70, NEC Article 250.

G. Pendant Controls:

1. NEMA 3R Pendant pushbutton control stations with reversing type contactors for electric hoists, trolleys and gantry.

2. Suspend control station from trolley.

3. Clearly mark function of each button.

4. Suspend station with stainless steel rope in a manner that will protect the electrical conductors against strain.

5. Control station shall be operable from one-hundred fifteen volt (115V) power supply.

6. Ground control station to hoist.

7. Provide control cable lengths of 1 FT-0 IN less than distance to nearest floor.

8. Control buttons spring-return to off when released.

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H. Radio control of hoist and trolley motions shall be from digital radio control systems as manufactured by Theimeg, 1-800-Theimeg (1-800-843-4634) easy control series with digital radio control system or equivalent subject to approval by the Railroad. The digital radio control receiver shall be mounted near the motor and be power fed from the crane control panel, furnished by the gantry crane manufacturer. The gantry crane manufacturer shall coordinate the power supply requirements with the radio controller manufacturer.

I. Power Feed System – Typically a suspended conductor is provided for powering the cranes. The Railroad (in this particular application) will consider an alternate proposal. Said alternate shall be noted in the proposal and sufficient manufacturer's information shall be provided to permit evaluation for acceptance by the railroad. The proposer shall not assume automatic acceptance by the Railroad.

J. The following specification is for a standard 3-conductor system.

1. A complete electrical power feed system for the crane assembly and runway shall be provided. The system shall consist of insulated conductors and insulated collector assemblies with copper-graphite collector shoes and shall be US Safety Trolley's "Span Guard" or "Duct-O-Bar". The conductors shall be the completely enclosed type. The current and voltage rating of the conductors shall be not less than 90 amperes continuous duty, 135 amperes intermittent duty.

2. Stationary conductors shall be installed adjacent to runway, with supports and brackets as required. Cross conductors shall be supported by angles across the top of the bridge. Collectors for hoist operation shall be installed on the hoist trolley and wired to the hoist. Conductors and collectors shall be installed in conformity with the recommendations and instructions of the system manufacturer. Reference project drawings for proposed location of conductors.

3. The feeder circuit for the crane assembly will be furnished and installed under the electrical section to the location indicated on the drawings. A suitable surface-mounted junction box with all hanger brackets and other accessories required for a complete installation shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

4. Wiring – All insulated wire shall be heat resistant and shall be insulated for 600V.

PART 3 - EXECUTION

3.01 ERECTION

A. The crane, hoist, and trolley shall be erected by workers who are regularly engaged in crane erecting and who are acceptable to the crane manufacturer. The orientation of the installation of the hoist and trolley on the crane bridge shall be directed by the Engineer.

3.02 WIRING

A. All wiring on the gantry shall be installed in rigid or intermediate metal conduit in accordance with the National Electrical Code.

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3.03 INSPECTION AND TESTING

A. After complete assembly an installation, each crane shall be tested. A manufacturer's representative shall be present during all field inspection and testing. The inspection and testing shall verify that each crane has been assembled properly and that all required adjustments have been made.

1. Acceptance Testing – Each crane shall be subject to operational and rated load testing.
2. Each crane shall raise, lower, hold in any position, and transport a test load equal to 125 percent of the rated capacity of the crane, with no detrimental effects on the crane. All motions shall be executed satisfactorily. The Contractor shall provide the test weights.
3. The following functions shall be tested:
    a. Hoisting and lowering.
    b. Trolley travel.
    c. Bridge travel.
    d. Limit switches, locking and safety devices.
4. The trip setting of hoist limit shall be determined by test with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located to trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.
5. Hoisting and lowering tests will be conducted with 0, 50, 100 and 125 percent of the nominal or rated load.
6. The rated load test shall consist of the following operations:
    a. The test load shall be lifted to a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes.
    b. The test load shall be transported by means of the trolley for the full length of the bridge.
    c. The test load shall be transported by means of the bridge the full length of the runway in one direction with the trolley as close to the extreme right-hand end of the crane as practical and in the other direction with the trolley as close to the extreme left-hand end of the crane as practical.
7. The test load shall be lowered, stopped and held with the brakes.
8. Wiring shall be given an insulation resistance test using a 500V megger.
9. Following completion of the test, each crane shall be inspected by the Contractor and the Manufacturer's Representative, in the presence of the Engineer for misalignment, breakage, and undue wear. All deficiencies shall be corrected by the Contractor in a manner acceptable to the Railroad.

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B. Test Reports – Field inspection and testing of each crane shall be documented by the Crane Manufacturer's Representative through the Contractor, noting the deficiencies and corrections and certifying that each crane is acceptable for operation. Certification of the inspection shall be submitted to the Railroad.

END OF SECTION

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SECTION 41 22 23 - HOISTS, TROLLEYS, AND MONORAILS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Hoists, trolleys, and monorails.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 00 07 00 - General Conditions.

B. Division 01 - General Requirements.

C. Section 01 61 03 - Equipment: Basic Requirements.

1.03 REFERENCED STANDARDS

A. American Bearing Manufacturers Association (ABMA).

B. American Society of Mechanical Engineers (ASME):

1. B30.11, Safety Code for Underhung Cranes and Monorail Systems.

2. B30.16, Safety Code for Overhead Hoists.

C. ASTM International (ASTM):

1. A36, Standard Specification for Carbon Structural Steel.

D. National Fire Protection Association (NFPA):

1. 70, National Electrical Code (NEC).

E. Comply with ASME B30.11 and ASME B30.16.

1.04 DEFINITIONS

A. Hook Height: The minimum acceptable distance in feet from bottom of hook in full raised position to the nearest floor surface.

B. Lift Height: The distance in feet from the bottom of the hook in full raised position to the surface of the lowest floor from which items may be hoisted.

C. Total Trolley Capacity: The ultimate load-carrying capacity of the trolley based on the ultimate strength of the material used (with a 5:1 safety factor) and the bearing life.

D. Ultimate Load-Carrying Capacity: Live load, weights of all equipment and an allowance for impact.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit under provisions of Section 01 33 00.

2. See Specification Section 01 61 03.

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3. Product technical data including:
    a. Acknowledgement that products submitted meet requirements of standards referenced.
    b. Manufacturer's installation instructions.
4. Fabrication and/or layout drawings.
    a. Track layout including supports, splices, connections, switches, and end trucks.
    b. Certifications.
5. Test reports verifying strength of inserts and rail.
6. Load test results.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 00 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

1.06 QUALITY ASSURANCE

A. Comply with ASME B30.11 and ASME B30.16.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Hoists:
    a. Yale.
    b. Acco.
    c. Robbins and Myers.
    d. Wright.
2. Trolleys:
    a. Yale.
    b. Acco.
    c. Wright.
3. Monorails:
    a. Spanmaster.
    b. Twin City Monorail.

B. Submit request for substitution in accordance with Specification Section 01 33 00.

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2.02 MANUFACTURED UNITS

A. Trolleys:

1. Motor-driven.
2. Completely compatible with hoists, cranes, and monorails specified.
3. Meet NEC standards according to classifications shown on Drawings.
4. Capable of maneuvering curves without binding or scraping the track.
5. Minimum ABMA L-10 bearing life of 5000 HRS based on 75 percent of the wheel load, excluding impact.
6. Motor Driven:
   a. Operate at a single speed as scheduled.
   b. Enclose internal gears in oil-tight housing.
   c. Design motors to operate with 460 V, 3 PH, 60 Hz power supply.
7. Plain trolleys:
   a. Frame consisting of thick rolled steel sections extending beyond wheel flanges to protect wheels.
   b. Alloy steel hardened axles, ball-bearings and pressed steel wheels.
      1) Carburized and hardened ball tread wheels.
      2) Factory lubricated requiring no additional lubrication.

B. Hoists:

1. Electric wire rope hoists:
   a. Low headroom models.
   b. Hoist frames of welded heavy-steel plate construction.
   c. Oil-tight gear casing for oil bath lubrication of gears.
   d. Construct rope drum and surrounding units to minimize abrading, crushing or jamming of the rope during usage.
   e. Drum diameter not less than 18 times the diameter of the rope used.
   f. Assure that two (2) complete wraps of rope remain on the drum after lowering the load hook through its rated lift distance, unless a lower limit device is provided, in which case provide a minimum of one (1) complete wrap.
   g. Double revving for hoists with total lift height greater than hook height.
   h. Sheave and drum grooves: Smooth and free from surface irregularities which could cause rope damage.
   i. Provide running sheaves with means for lubrication.
   j. Bearings:
      1) Antifriction type.

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2) Minimum ABMA L-10 life of 1250 HRS for Class H1, 2500 HRS for Class H2, and 5000 HRS for Class H3, based on full rated speed and mean effective load K of 0.65.

k. Mechanical load brake.

l. Lower limit switch to stop hoist when hook reaches its lower limit.

m. Motor:

1) Motor brake.

a) Internal disc magnetic type.

b) Rated for 150 percent of motor torque.

c) Delivers rapidly with 4 IN max hook drift.

2) TENV motors operable on 460 V, 3 PH, 60 Hz power.

3) Meet specified area classification.

4) Permanently lubricate and seal motor ball-bearings.

5) Provide an upper limit switch to stop the hoist motor and apply the holding brake when the hook reaches its upper limit.

n. Controls:

1) Motor starters, electric conduit, control stations, magnetic reversing contactors and low-voltage transformer, necessary for a complete and totally functional conveying system.

o. Mark the hoist with the following information:

1) Name and address of manufacturer.

2) Manufacturer's unit identification number.

3) Rated load.

4) Voltage of AC or DC power supply and phase and frequency of AC power supply.

5) Rated amperage.

2. For Class I, Division 1 or 2, Group D locations, provide spark and corrosion-resistant models with bronze hooks, stainless steel load chains, bronze or aluminum hand chain, and bronze trolley wheels.

3. Mark each hoist with the following information:

a. Name and address of manufacturer.

b. Manufacturer's unit identification number.

c. Rated load.

C. Monorails:

1. Straight track: ASTM A36 steel I beams.

2. Where track curves are required, supply straight track and curves which are standard items of monorail manufacturer.

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3. Design track to support hoist capacity plus 25 percent for impact load plus the weight of hoist and accessories without exceeding allowable working stress of track material with maximum deflection of 1/450 of span.
4. Brace track to prevent sideways movement under full load conditions.
5. Provide end stops at all track ends.
6. Assure that track splices have been designed by track supplier and are located at support points.

2.03 ACCESSORIES

A. Trolley stops designed to engage the trolley frame rather than trolley wheels.

B. Furnish chain containers for hand hoists.

C. Electrification and Controls:

1. Provide electrical power to the motor-driven hoists and trolleys using one (1) of the following methods as scheduled:
   a. Festoon tagline system:
      1) Equip with plastic wheels in areas with an NEC classification of Class I, Division 1 or 2, Group D.
      2) Include all components needed for a complete and operable system.
   b. Cable reel system:
      1) 360-degree swivel base.
      2) Full working length of cable plus 25 percent.
      3) Include all components needed for a complete and operable system.
2. Controls:
   a. Pendant pushbutton control stations with reversing type contactors for electric hoists and/or trolleys.
   b. Single station if hoist and trolley are both motor-driven.
   c. Suspend control stations from trolleys.
   d. Clearly mark function of each button.
   e. Suspend station in a manner that will protect the electrical conductors against strain.
   f. Control station: Operable from 115 V power supply.
   g. Ground control station to hoist.
   h. Provide control cable lengths of 1 FT less than distance to nearest floor.
3. Switches:
   a. Manual switches.
   b. Completely compatible with hoists, trolleys, and monorails specified.
   c. Provide switch chain to within 6 FT of floor.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Support track as shown on Drawings.

B. Arrange supports for easy removal of track for repair or replacement.

C. Align track true and level.

D. Warning Signs:

1. Affix to the hoist or the lower load block or the controls in a readable position a durable label or labels displaying the following information concerning safe operating procedures:

a. The word WARNING or other legend designed to bring the label to the attention of an operator.

b. Cautionary language against:

1) Lifting more than rated load.

2) Operating hoist when hook is not centered under hoist.

3) Operating hoist with twisted, kinked or damaged rope or chain.

4) Operating damaged or malfunctioning hoist.

5) Operating hoist with a rope that is not properly seated in its groove (if applicable).

6) Lifting people or lifting loads over people.

7) Removing or obscuring warning label.

3.02 FIELD QUALITY CONTROL

A. Test each hoist, trolley, and monorail using 110 percent rated load.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by this Specification Section.

2. Supervise pre-start-up adjustments, installation checks and all field tests.

3. Conduct initial start-up of equipment and perform operational checks.

4. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.

5. Instruct Owner's personnel for 8 HRS at jobsite on operation and maintenance of the hoist, trolley, monorail and crane equipment.

3.03 SCHEDULE

A. Hoist, trolley, and monorail systems include but are not necessarily limited to the following:

TAG	LOADING	HOIST	TROLLEY	HOOK	LIFTING	HP	OPERATIN

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NUMBER	(TONS)			HEIGHT (FT)*	HEIGHT (FT)*		G SPEED FPM
HumpAir-1	1 Ton	WR, 2 HP, 18 FPM	1/4 HP, 75 FPM			2, HP and 1/4 HP	18 FPM and 75 FPM

* Distances are to the finish floor and as indicated on the drawings..

C = Chain
HG = Hand Geared
WR = Wire Rope
NA = Not Applicable

END OF SECTION

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SECTION 41 24 40 - LOCOMOTIVE SAND SYSTEM (FOUR ARM GANTRY SYSTEM)

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers supplying and installing one (1) 50 ton sand storage silo and one (1) double leg gantry sanding crane to be used in servicing locomotives, hereinafter referred to as the System.

B. The System(s) shall be suitable for installation and operation out-of-doors at specified railroad yard described in these specifications. The System shall be provided with lubricants suitable to meet or exceed temperature extremes of the yard stated in these specifications.

C. System drive mechanisms shall be sized to operate against an average wind velocity of 11 mph and at intervals of 30 mph during straight line winds. The parking break shall be able to withstand and hold against and 80 mph wind.

1.02 REFERENCED STANDARDS

A. Crane Manufacturers Association of America (CMAA):

1. 70-00, Specifications for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes.

B. Occupational Safety and Health Administration (OSHA):

1. 29 CFR 1900, Occupational Safety and Health Standards.

C. Society for Protective Coatings – (Formally: Steel Structures Painting Council (SSPC)):

1. SP-10, Near White Blast Cleaning – At least 95% of each square inch shall be free of all visible residues.

1.03 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Shop drawings to the Engineer for approval prior to fabrication.

C. Three (3) sets of operation, maintenance and repair manuals.

D. The Contractor shall submit the following along with their submittal:

1. General drawings and details for their proposed equipment.

2. Certification that the sanding crane meets or exceeds CMAA Class D or Class F service as applicable.

3. Itemized differences between Class D and Class F as pertains to reliability and maintenance.

4. Location of an operational Class D sanding crane along with the company name, contact person, and telephone number.

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5. Calculations verifying equipment has been designed to Class D and Class F service stamped by a professional engineer in the state of manufacture.
6. Certificate of Conformance shall be issued by the equipment manufacturer stating that the equipment meets the specifications.
7. Provide information as required in the Equipment Description Table.

1.04 GUARANTEE

A. The equipment shall be guaranteed by the fabricator / supplier for one year after start-up.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. A.T. Moeller Company.
B. Whiting Corporation.
C. Approved Equal.

2.02 DESCRIPTION

A. The System shall conform to the latest CMAA No. 70 specification for electric gantry cranes Class D as it pertains to structural design and Class F as pertains to reliability and maintenance. The CMAA specification shall be considered as part of this document.
B. The operator shall ride in a "pulpit" at the end of a motorized telescoping mast with a maximum of 13 FT of vertical travel and capable of transverse movement over the distance required. The high point of the sand door shall be 16 FT-6 IN with the low point at 7 FT-9 IN above the top of the rail. Maximum speed shall be 50 fpm with a hand operated 5-step speed control for vertical and transverse directions.
C. The operator control console shall consist of weatherproof hand operated controls to permit up, down, forward, back, left and right movement control. When not under operator use, the control shall automatically assume a neutral or idle condition. Controls and interlocks shall restrict the gantry and carrier to the following:
    1. Bridge longitudinal travel in a lane 7 FT wide, located at the span mid-point, except under manual override.
    2. No bridge longitudinal travel in a lane 7 FT wide, located at the span mid-point, except under manual override.
    3. Transverse carrier travel only with the lift platform fully raised, except under manual override.
    4. The trolley will be equipped with a limit switch that will be actuated when the hopper is in position for filling, only then can the gantry crane be moved into filling position. As the gantry moves into filling position, the sliding door on the bin will be moved back permitting the sand valve to be aligned with the opening. Operator can then reach the push button on the sand hopper to activate the sand filling valve.

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5. An electrical signaling device will be finished on bin to signal operator when bin has reached the low level.

D. The bridge crane will be equipped with limit switches which will be actuated with the trips located on the gantry rail, which will decelerate crane to permit it to travel in area for filling of sand bin. These switches will be interlocked with operation of crane.

E. The carrier shall be provided with a 240 CU FT sand hopper and equipped with four (4) sand dispensing hoses and weatherproof nozzles, emergency shutoff valves, a sliding door fill opening, high and low sand level indicators, a service walk with handrails and bumpers. Sliding door shall be designed to eliminate or minimize "failure to operate" problems due to freezing rain or snow build up.

F. The trolley shall incorporate a 1-1/2 to 2 ton lifting hoist at the approximate center of the trolley on the bridge beam.

G. The operator's platform shall be equipped with a safety device to prevent the platform from dropping in the event of failure of the hoisting mechanism or cable break.

1. Operator's platform shall be equipped with a roof and removable storm closure.
2. The leg of the gantry shall be equipped with access stairs for the operator.

H. The bridge shall be supported by double legs running on ground anchored crane rail. The bridge speed shall be a maximum of 150 fpm with a five (5) step variable speed control. The bridge shall have: Three (3) 250 watt mercury vapor lights, two (2) double headed warning horns, wheels to be double flanged, a collector assembly, a service walkway with handrail the length and both sides of the beam, and an electrically operated locking device. Braking to be with a system, that is a direct acting system proportionate to the pressure applied by the operator, a foot pedal is desirable. There shall also be a parking brake with a variable timer to lock in after of each crane ail for installation by the Railroad's general contractor.

I. Each truck wheel to be provided with a flangeway sweep for removal of snow and/or sand.

J. The supplier shall provide crane rail stop, bumper and locking device anchor to installer.

K. Equipment shall be shop primed and painted with a safety yellow paint.

L. Equipment shall be provided with an OSHA compliant operators dismount the platform and access the stair attached to the gantry leg, width no to exceed clearance dimension of drive motors.

M. The supplier/fabricator shall also be responsible for:

1. Providing the electrical conductor(s), mounting brackets and weather cover (length of crane rail)
2. Providing touch-up paint for all scars due to shipping and erection.
3. Start-up personnel to check, test, start-up and commission the installation.
4. Three (3) days of training of Railroad personnel.

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5. Coordinating with structural designer and/or silo manufacturer to determine crane rail centers, crane rail weight, location, configuration support of the conductors, and all other items pertinent to the installation of system.
6. Coordinating delivery and installation with the Railroad's contractor.

2.03 POWER SUPPLY

A. The power supply shall be 460 V, 3 ph, 60 Hz. All motors shall be Totally Enclosed Fan Cooled (TEFC). The service factor of 1.15 shall not be used when determining the require horsepower. Wiring and controls shall comply with current National Electrical Code (NEC) standards.

2.04 SAND STORAGE SILO

A. The quotation shall provide the costs to furnish a 50 ton, 1,000 CU FT capacity tank. The tank shall be complete with support structure, gravity drop spout with pneumatic valve, dust eliminator, level controls, drop spout weather hood, automatic valve and level controls to be compatible with gantry controls, fabricator to also provide anchor bolt template and anchor bolts to Railroad general contractor.

B. Tank shall be of welded steel construction assembled at the factory. Support structure to be bolted construction for ease of assembly on site.

C. Tank and support structure shall be sand blasted and primer coated at the factory. Minimum surface preparation to be SSPC SP-10. Prime coat to be fish oil modified alkyd, Rust-Oleum 1069 heavy duty red primer or equal 2 to 3 mils DFT. Finish coat to be Rust-Oleum New Color Horizon Gray No. 906 2-3 mils DFT or equal.

D. Support structure and tank to be designed for the appropriate seismic zone four (4) and for 100 MPH straight line winds (with tank empty). Supplier to provide loading factors for anchor bolt sizing.

E. The tank shall be filled from the delivery truck via the use of a compressed air sand pump system. Sand fill pipe, fittings, and connections to be provided by the supplier. The gravity drop spout shall provide sand to the hopper of a sanding gantry system.

F. The storage silo shall be provided with an access ladder and fall protection device (slide bar) in accordance with OSHA.

PART 3 - EXECUTION

3.01 HOPPER FILLING OPERATION

A. When the Operator receives a signal that the sand in the crane hopper has reached the low limit, the Operator will proceed to the supply silo. The Operator will spot the crane on the limit switch in the fill position and also spot the carrier on the limit switch in the fill position. This places the hopper opening under the valve of the supply silo. With the crane and carrier properly positioned, the operator can push the button mounted at the fill location and proceed to fill the sand hopper. When the sand reaches the upper limit the operator will be signaled by a light and the valve from the silo can be closed.

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3.02 INSTALLATION AND MAINTENANCE REQUIREMENTS

A. Supplier shall include personnel required to supervise, install, erect, and start-up of the equipment provided under this contractor. The Supplier shall verify shipment and receipt of all components furnished under this contract.

B. The Supplier will provide a one year maintenance service for the provided equipment. The name, address and telephone number of the service/maintenance company shall be provided to the Railroad prior to the final payment invoice.

C. The Railroad's general contractor will:

1. Provide the foundations for the sand silo and install fabricator provided anchor bolts.
2. Provide the gantry crane rail foundation with crane rail.
3. Provide the electrification supports.
4. Install the end bumpers provided by sand gantry suppliers and bring power to the electrification conductors furnished and installed by the sand gantry supplier.

END OF SECTION

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SECTION 41 50 10 - PRE-ENGINEERED TIMBER COLUMN STRUCTURE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pre-Engineered factory- and field-fabricated Timber Column Structure.
2. Prefinished metal roofing and siding panels.
3. Prefinished metal trim items.
4. Prefinished soffits.
5. Prefinished gutters and downspouts.
6. Insulation, interior framing, and liner package.

1.02 REFERENCED STANDARDS

A. Preservative Treated Lumber:

1. American Wood Protection Association (AWPA):
   a. Commodity specification C2 (2001).
   b. Use category system: user specification for treated wood: UC4B (ground contact for fresh water).
   c. Treated item shall bear the quality mark of an independent testing agency or service certified by the AWPA to inspect preservative-treated wood.
2. Federal Specification TT-W-571-J.

B. Framing Lumber:

1. Lumber Grading Rules and Wood Species:
   a. National Design Specification for Wood Construction, current edition.
   b. Northeastern Lumber Manufacturer's Association Inc. (NELMA).
   c. Southern Pine Inspection Bureau (SPIB): Southern Pine.
   d. West Coast Lumber Inspection Bureau (WCLIB): Douglas Fir.
   e. Western Wood Products Association (WWPA): Douglas Fir and Ponderosa Pine.

C. Wood Trusses:

1. All lumber used in the design of wood trusses shall be kiln dried and graded in accordance with the current grading rules. Design stresses allowed are those listed in the current editions of the respective Lumber Association's grading rules.
2. The design of wood members shall be in accordance with the formulas published in the 2001 edition of the National Design Specification for Wood Construction.

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3. Light-metal toothed connector plates and joint design shall conform to specifications as set forth in the 2002 edition of Truss Plate Institute's Design Specification for Metal Plate Connected Wood Trusses. (TPI-2002).
    a. Connector plates shall be fabricated from ASTM A 653, Grade A, or better, 18 and 20 gauge steel sheets with a G80 or better, metallic (zinc) coating.
4. Truss members and joints shall be designed in accordance with TPI-2002. All truss designs shall be accompanied by complete and accurate shop drawings and contain the following information:
    a. Slope or depth, span and spacing of the truss.
    b. Heel bearing height.
    c. Design loading to include:
        1) Top chord live load.
        2) Top chord dead load.
        3) Bottom chord dead load.
        4) Concentrated loads and their points.
    d. Adjustments to lumber and plate design values for conditions of use.
    e. Plate type, thickness of gauge, and size.
    f. Lumber size, species and grade for each member.

1.03 SYSTEM DESCRIPTION

A. Clear Span.

B. Bay spacing of 7 FT-6 IN OC.

C. Primary Framing:
    1. Columns.
    2. Trusses.
    3. Wind Bracing.

D. Secondary Framing:
    1. Perimeter baseboards.
    2. Wall Girts.
    3. Purlins.
    4. Overhang rafters and fascia.
    5. Ancillary blocking, furring, and grounds as required.

E. Roof Covering:
    1. Prefinished ribbed metal panels.

F. Wall Covering:
    1. Prefinished ribbed metal panels.

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G. Insulation and liner package:

1. Wall insulation.
2. Ceiling insulation.
3. Air deflectors
4. Vapor retarder.
5. Wall stripping
6. Prefinished ribbed metal panels.

1.04 DESIGN REQUIREMENTS

A. Roof Design Loads:

1. Top Chord Live Load: 20 PSF.
2. Top Chord Dead Load: 4 PSF.
3. Bottom Chord Dead Load: 4 PSF.
4. Bottom Chord Point Load:
5. Unbalanced Snow Loads: Design in accordance with local building codes.

B. Wind speed:

1. Minimum 100 MPH (V3s), Exposure "C", or based on local codes, whichever is higher.

C. Roof and wall system shall be able to withstand the imposed loads with maximum allowable deflection of L/270.

D. Seismic: Designed in accordance with local building codes.

E. Assembly shall permit movement of components without buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.

F. Size and fabricate wall and roof systems to be free of distortion or defects that would be detrimental to appearance or performance.

1.05 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Provide (2) sets of the following, bearing the seal of a Professional Engineer registered in the State that the building is being constructed.

1. Complete and detailed shop and erection drawings showing size and location of each part and component, certifying that the building design meets specified roof and wind loading requirements.
2. Truss Engineering analysis and design data which includes the following:
   a. Axial forces and bending moments for each member.
   b. Basic plate design value.
   c. Design analysis of each joint showing that proper plates have been used.

C. Manufacturer's standard color chart for the Railroad to choose from.

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1.06 PROJECT RECORD REQUIREMENTS

A. Submit under provisions of Section 01 33 00.

1.07 QUALITY ASSURANCE

A. Fabricate members in accordance with standard industry practices.

1.08 QUALIFICATIONS

A. Contractor shall have a minimum of forty years documented experienced in the manufacture and erection of this type of structure.

B. Design structural components under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State that the building is being constructed.

C. Employ adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work.

D. Contractor shall be responsible for all materials, whether furnished by himself or a subcontractor, and proper storage of the same.

1.09 REGULATORY REQUIREMENTS

A. Contractor shall be responsible for compliance with all applicable building codes and/or ordinances covering the work.

B. Cooperate with regulatory agency or authority to provide data as requested.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store prefabricated components (trusses, columns, steel sheeting and other items) so that they will not be damaged or deformed.

B. Stack materials on platforms, pallets, or other structures covered with tarpaulins or other suitable weather tight ventilated covering. Handle and or subjecting parts to excessive stresses.

C. Store roofing and siding panels so that water will drain freely.

D. Do not store panels in contact with other materials which may cause staining or discoloration.

1.11 PROJECT CONDITIONS

A. Coordination:

1. Fit carpentry work to other work, scribe, and cope as required for an accurate fit. Correlate location of furring, nailers, blocking, grounds and similar supports to allow for attachment of other work.

1.12 CERTIFICATIONS

A. To be submitted for approval prior to building order:

1. Certification of sheet steel supplier stating:

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a. Minimum thickness of metallic coated steel IN INCHES.

b. Identification of all metallic coatings.

c. Coating weight range.

d. Verification that material supplied is in conformance with the applicable ASTM standard as stated in the technical specification.

2. Certification of paint supplier stating:

a. Generic chemistry of top coat.

b. Trade name of top coat.

c. Percentage of Polyvinylidene Fluoride in resin.

3. Certification of sheet steel coater stating:

a. Nominal paint film thickness IN MILS.

4. Certification of treated lumber supplier stating:

a. Preservative type.

b. Preservative retention in pounds per cubic foot of wood.

c. Depth of assay zone.

d. Treatment is in accordance with AWPA standard C2 and Federal Specification TT-W-571J.

5. Warranty:

a. Sample copy of warranty to be issued at completion of project.

b. Verification that warranty meets or exceeds the requirements stated in the technical specification.

B. FAILURE TO SUPPLY THE REQUIRED SUBMITTALS WILL RESULT IN THE BIDDER'S PROPOSAL BEING REJECTED AS NON-RESPONSIVE.

1.13 WARRANTY

A. The Building Manufacturer shall supply a warranty to the Railroad which shall provide that the Manufacturer will:

1. For a period of 50 years:

a. Absorb repair or replacement costs, including material and labor, if any preservative-treated lumber fails due to decay or insect attack.

b. Repair, or at its discretion, replace free of charge the building framework, including and roofing and / or siding panels, if directly damaged by snow loads.

2. For a period of 35 years:

a. Repaint any roofing or siding panel on which, under conditions of normal weathering, the paint has separated from the panels, if directly damaged by snow loads.

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b. Repaint any roofing or siding panels on which, under conditions of normal weathering, chalking greater than a rating of 8 (ASTM D4212 Method "A") or color change greater than five (5) units (ASTM D2244) has occurred.

3. For a period of 20 years:

   a. Repaint any roofing or siding panel on which, under conditions of normal weathering, exhibit corrosion resulting in red rust greater than 1/2 IN from any sheared edge which is clearly visible in casual observation.

4. For a period of 5 years:

   a. Repair, or at its discretion, replace free of charge the building framework, including roofing and / or siding panels, if directly damaged by wind loads, unless damage is caused by flying or falling objects.

   b. Repair any roof leaks due to defects in materials or workmanship.

5. For a period of 1 year:

   a. Repair other building parts that prove to be defective in materials or workmanship.

6. The Manufacturer shall NOT be liable for damage due deterioration caused by interior chemical vapors and / or dust, damage by flying or falling objects, or collateral damage to interior walls, ceiling, partitions, equipment, and / or contents, or cost of preparation of the site.

PART 2 - PRODUCTS

2.01 MANUFACTURERS – BUILDING SYSTEM

A. Morton Buildings Inc.
252 W. Adams St.
Morton, Illinois 61550-1804
309-263-7474

B. Morgan Buildings & Spas Inc.
2800 McCree Rd.
Garland, Texas 75041

C. Lester Building Systems, LLC
1111 2nd Avenue South
Lester Prairie, Minnesota 55354
800-826-4439

D. Cleary Building Corp.
P.O. Box 930220
Verona, Wisconsin 53953
800-373-5550

2.02 MATERIALS – FRAMING

A. Columns (Built on Concrete Foundation – see also 2.04):

   1. Factory fabricated from minimum three (3) ply No. 1 or better SYP.

   2. Provide factory installed blocking on outside face of column between nailers.

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B. Columns (Columns in ground).

C. Wood Trusses:

1. Lumber:

a. Top Chord: No. 1 or better SYP.

b. Bottom Chord: 1950 MSR or better SPF.

c. Webs: No. 1 or better SYP.

2. Trusses shall be constructed of surfaced lumber, smooth and free of all cracks, checks, and blemishes.

3. Plates: Connector plates shall be fabricated from ASTM 653, Grade A or better 18 and 20 gauge steel sheets with a G60, or better, metallic (zinc) coating.

4. Design and Fabricate trusses and connectors to withstand snow and wind loads and all dead loads.

5. Fabricate trusses in plant, using mechanical or hydraulic fixtures as required to bring members into contact. Install plates in accordance with manufacturer's instructions.

D. Baseboards

1. 2 x 8 No. 2 or better SYP with 1/2 IN x 3/4 IN notch in top.

2. Pressure treated with a wood preservative to a retention commensurate with applicable AWPA standards and kiln dried after treating to 19 percent maximum moisture content.

3. The preservative shall penetrate 100% of the sapwood.

E. Wall Girts:

1. First nailer above baseboard: 2 x 6 No. 2 or better SPF with 1/2 IN x 3/4 IN notch in bottom.

2. Balance of nailers: 2 x 4 2100f MSR or better SPF.

3. Overhang top nailer: 2 x 6 No. 2 or better SPF.

F. Base Reinforcement:

1. 7/16 IN x 32 IN OSB panels installed between the baseboard and first nailer.

G. Purlins and Truss Ties:

1. 2 IN x 4 IN No. 2 or better SPF.

H. Overhang Framing:

1. Provide factory fabricated rafter frames.

2. Provide 2 IN x 6 IN No. 2 or better SPF factory beveled fascia boards.

I. Wind Bracing:

1. 2 IN x 6 IN No. 2 or better SPF from endwall column to first truss back.

J. Framing Around Openings:

1. 2 IN x 4 IN No. 2 or better SPF around personnel doors.

2. 2 IN x 6 IN No. 2 or better SPF around overhead door openings.

K. Headers:

1. Provide built-up headers as required for a proper installation.

L. Incidental Framing:

1. 2 IN x 4 IN and or 2 IN x 6 IN No. 2 or better SPF.

M. Interior Framing:

1. 2 IN x 4 IN No. 2 or better SPF.

2.03 MATERIALS – PREFINISHED METALS

A. Roofing Panels (Fluoroflex 1000):

1. Panel substrate shall be .019 minimum thickness commercial steel sheet with a AZ55 Aluminum / Zinc (Galvalume) coating (ASTM A792).
2. The weather side of the panel shall receive a thick Polyurethane primer and a nominal one mil topcoat of 70 percent Polyvinylidene Fluoride Resin (Fluoroflex 2000).
3. The non-weather side paint system shall consist of a two coat finish with a total nominal thickness of 1/2 mil.

B. Siding Panels:

1. Panels substrate shall be .019 IN minimum thickness commercial steel sheet with a G90 (Zinc) coating (ASTM A653) or AZ55 Aluminum / Zinc (Galvalume) Coating (ASTM A792).
2. The weather side of the panel shall receive a nominal 2/10ths mil Polyurethane primer and a nominal (8/10ths mil topcoat of 70 percent Polyvinylidene Fluoride Resin (Fluoroflex 1000) to achieve a total nominal paint film thickness of one (1) mil.
3. The non-weather side paint system shall consist of a two-coat finish with a total nominal thickness of 1/2 mil.

C. Wainscot Panels:

1. Panel Substrate shall be .019 IN minimum thickness commercial steel sheet with a G90 (Zinc) coating (ASTM A653) or AZ55 Aluminum / Zinc (Galvalume) Coating (ASTM A792).
2. The weather side of the panel shall receive a nominal 2/10ths min Polyvinyldene Fluoride Resin (Fluoroflex 1000) to achieve a total nominal paint film thickness of 1 mil.
3. The non-weather side paint system shall consist of a two coat finish with a total nominal thickness of 1/2 mil.

D. Metal Trim Items:

1. Die-formed steel from the same quality material as the siding panels.

E. Interior Panels:

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1. Panel substrate shall be .019 MINIMUM thickness commercial steel sheet with a AZ50 (Galvalume) coating (ASTM A792).
2. The weather side of the panel shall receive a nominal 2/10ths mil acrylic primer and a nominal 8/10ths mil topcoat of white polyester paint to achieve a total nominal paint film thickness of 1 mil.
3. The non-weather side paint system shall consist of a two coat finish with a total nominal thickness of 1/2 mil.

F. Metal Trim Items:

1. Die-formed steel from the same quality material as the siding panels.

G. Soffits:

1. Prefinished aluminum soffit as manufactured by Alcoa Building Products.
   a. Provide solid soffit for end overhangs.
   b. Provide perforated soffit for vented side overhang.

H. Ridge Vent:

1. Prefinished aluminum Vent-A-Ridge as manufactured by Alcoa Building Products.

I. Gutters and Downspouts:

1. Provide 5 IN ogee (style "K") .030 minimum thickness 3004 H36 tempered aluminum alloy gutters on both sides of the building. Gutters shall be coated with KYNAR 5000 / HYLAR 5000 paint system with a total nominal thickness of one (1) mil on the visible side.
2. Interior paint finish shall be a nominal 1/2 mil polyester wash coat.
3. Silicone sealant and silicone rubber gaskets shall be used at laps to maintain leak protection and to relieve stress due to thermal movement.
4. Provide one (1) 3 IN x 4 IN downspout with appropriate elbows and conductor bands per 1800 SQ FT of roof area.

2.04 MATERIALS – OTHER

A. Column Sockets:

1. Fabricate socket from minimum 4 gauge hot rolled steel.
2. Factory paint socket to inhibit corrosion.

B. Socket Fasteners:

1. 1/2 IN DIA x 10 IN galvanized "J" bolts cast 8 IN into concrete foundation.
2. 1/2 IN DIA machine bolts to secure column to socket.
3. Ancillary washers and nuts.

C. Corner Bracing:

1. Provide 1-1/2 IN wide high tensile steel strapping of all unobstructed corners in an "X" configuration.

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D. Roofing and Siding Fasteners:

1. EPDM washered, painted, center drive stainless steel screws for ribbed steel panels.
2. EPDM washered, galvanized ring-shank nails for ribbed steel panels.

E. Closure Strips:

1. Closed cell foam.

F. Sealant:

1. Paintable silicone.

G. Insulation:

1. Minimum 6 IN thick, R19 fiberglass blankets in walls.
2. Minimum R30 blown fiberglass in ceiling.

H. Vapor Retarder:

1. 4 mil thick polyurethane sheets.

PART 3 - EXECUTION

3.01 ERECTION – FRAMING – GENERAL

A. Erect framing in accordance with manufacturers established construction procedures.

B. Make all components and building plumb, square, straight, and true to lines.

C. Provide adequate temporary bracing to assure structure remains plumb and square until permanent bracing is installed.

D. Alerting of structural members will not be permitted.

3.02 ERECTION – FRAMING

A. Column:

1. Attach steel column socket to the concrete foundation with 1/2 IN x 10 IN plated "J" bolts, washers, and nuts.
2. Attach the column to the column socket with four (4) 1/2 IN bolts and eight (8) twenty penny (20d) galvanized R. R. nails.

B. Baseboards:

1. Install 2 x 8 treated plank, sealed to the concrete foundation with pre-compressed Ultra-seal, using manufacturer recommended fasteners.

C. Wall Girts:

1. Install 2 x 6 notched nailer to receive OSB panel.
2. Install 2 x 4 nailers at 32 IN OC.
3. Install 2 x 6 overhang nailer at the top.

D. Trusses:

1. Set trusses in plane with the center member of the upper column using lifting methods as approved by the manufacturer.
2. When properly positioned, install two (2) 1/2 IN DIA machine bolts an manufactured recommended twenty penny (20d) ring shank nails through two of the upper column laminates and the truss heel.
3. Brace trusses as recommended by manufacturer.

E. Purlins:

1. Install 2 x 4 purlins at 24 IN OC and attach to trusses with sixty penny (60d) ring shank nails.

F. Truss Ties:

1. Install 2 x 4 truss ties at location recommended by manufacturer.
2. Truss ties shall be run from endwall to endwall.

G. Wind Bracing:

1. Install 2 x 6 angled bracing at locations recommended by manufacturer.

H. Incidental Framing:

1. Install 2 x 4 or 2 x 6 blocking as required according to building manufacturers recommendations.

I. Interior Framing:

1. Install 2 x 4 baseboard at 4 IN above grade and case in metal trims.
2. Install 2 x 4 horizontal stripping at 36 IN OC maximum in areas receiving ribbed steel panels.
3. Install 2 x 4 horizontal stripping at 16 IN OC in areas receiving gypsum board if applicable.

3.03 ERECTION – PREFINISHED METALS - GENERAL

A. Roofing Panels:

1. Install panels perpendicular to supports, aligned straight with end fascias.
2. Fasten panels to purlins with screw fasteners.

B. Siding and Wainscot Panels:

1. Install panels perpendicular to supports, aligned level and plumb.
2. Fasten panels to wall girts with screw fasteners.

C. Trim Items:

1. Install Trim items at the base, wainscot transition, corners, top of steel siding, fascias, gables, and ridge using appropriate fasteners.

D. Vent-A-Ridge:

1. Install over ridge trim using screw fasteners.
2. Ensure that a minimum of 2 IN clear throat opening is maintained.

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E. Soffits:

1. Install soffits to interlock with trim items at top of steel siding and at fascias.
2. Use solid soffit at end overhang.
3. Use a combination of solid and perforated soffits to provide balanced ventilation at side openings.

F. Gutters and Downspouts:

1. Install gutters with spikes and ferrules spaced 24 IN OC.
2. Silicone sealant and silicone rubber gaskets shall be used at laps to maintain leak prevention and to relieve stress due to thermal movement.

G. Filter Strips:

1. Provide closed cell foam filler strips at the top and bottom of the roofing panels.

H. Interior Panels:

1. Install panels perpendicular to supports, aligned level and plumb.
2. Fasten panels to wall girts with 1 IN painted screws.
3. Fasten panels to lower truss chords with 1 IN painted screws.

3.04 TOLERANCES

A. Framing Members:

1. 1/4 IN from level.
2. 1/8 IN from plumb.

B. Siding and Roofing:

1. 1/8 IN from true position.

END OF SECTION

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SECTION 41 52 20 - PREFABRICATED SALT STORAGE DOME

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Contractor furnishing all labor, materials, and equipment necessary and incidental to provide the salt storage dome for the purpose of stockpiling de-icing material to be used in the ice and snow program for the intermodal yard and automotive facility as specified herein.

2. Furnishing all plant and site labor, equipment, appliances and materials, and in performing all operations in connection with the purchase, delivery and erection of the prefabricated salt storage domes.

B. All building permits and associated fees shall be the responsibility of the Contractor.

1.02 LOCATION AND INSTALLATION

A. Prefabricated salt storage dome shall be located at the yard shown on the site drawings.

B. The Contractor shall coordinate the prefabricated salt storage dome's final footprints and exact site location and confirm that the paving on which the dome is to be constructed meets the minimum manufacturer's requirements for pads prior to installation. Footing depth shall be 42 IN minimum.

1.03 SUMMARY OF WORK

A. These specifications specify the minimum requirements of the prefabricated salt storage domes and foundation.

B. Provide a one (1) year minimum warranty for the building that includes material and labor and a roof warranty as specified later in this Section.

C. The roof slope, except for the doorway canopy, shall prevent snow and ice build-up, roof leaking, and ensure longevity of the shingles and building as a whole.

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Manufacturer's shop and erection drawings and design calculations; prepared by or under direct supervision of a Registered Professional Engineer, licensed to practice in the State that the building is being constructed, with all drawings and calculations bearing his seal.

C. Product Data: Two (2) copies of manufacturer's specifications and descriptive literature.

D. Relevant Experience: Three (3) locations, listing names of the owners, addresses, and telephone numbers where the manufacturer has completed similar work in the past two (2) years.

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E. Certification: Two (2) copies of written certification, prepared and signed by a Registered Professional Engineer licensed to practice in the State that the building is being constructed, attesting that the building design meets all required load bearing requirements, requirements of codes and authorities having jurisdiction at the project suite, and other requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. The building to be furnished shall have a storage capacity of approximately 1500 tons as provided by one of the following manufacturers or an approved equal.

1. Dome Corporation of America

   5450 East Street

   Saginaw, Michigan 48601

   Tel. (517) 777-2050

2. Bulk Storage Inc.

   2801 South Yates Ave

   Beecher, Illinois 60401

   Tel. (708) 946-9595

2.02 DESIGN CRITERIA

A. These specifications provide for a high quality bulk storage structure. As further noted in these specifications, as a minimum the building shall provide a 12 IN thick sealed concrete base wall with two faces of steel reinforcement, minimum 5/8 IN DIA panel connection bolts, #1 structural Douglas Fir plywood no structural panels members with a cross-section less than 2 x 6 (8.25 SQ IN), protective canopied entrance way with concrete wingwalls, and 25 year warranted roofing.

B. Base Wall: The base wall shall be a minimum of 12 IN thick sealed concrete wall 9 FT-0 IN above finished grade. The retaining wall shall be a reinforced concrete ring, 1 FT-0 IN thick with two mats of reinforcing steel designed to withstand the pressure of the stored material and the dome structure's dead and live loads. After curing, the inside of the retaining wall shall be coated with two (2) applications of a mixture of 50 percent mineral spirits and 50 percent linseed oil.

C. Structure: The dome structure shall be designed to withstand the minimum ground snow load and a wind load required by BOCA Building Code, latest edition. Coefficients shall be applied to the ground snow load to change it to roof snow load and further adjustments made to allow for the slope of the dome panels. Also the wind load shall be adjusted to allow for the slope of the dome panels. An entrance opening shall be provided with a width of 18 FT-0 IN and a height of approximately 18 FT-0 IN.

D. Roofing: The roofing material shall be standard asphalt roofing shingles either fiberglass or organic mat carrying a minimum manufacturer's warranty of 25 years. Rolled roofing shall be used where applicable at opening locations.

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E. Rated Capacity: The prefabricated salt storage dome shall be sufficient size to store approximately 1500 tons of de-icing salt based on weight of 80 LBS/CU FT. Storage of piled salt shall not exceed a repose angle of 32 degrees. The building shall include a built-in fan dormer for a 30 IN exhaust fan as included in the electrical specification Section and noted on the Drawings. See electrical section at end of specification for fan designation. The dome shall be designed for future conveyor loads. The conveyor shall be 24 IN wide roof supported fixed type salt loading conveyor and run from the underside of the unloading hopper to the center of the dome above the material pile. Dome design shall allow for the installation of a sidewall penetration dormer at the salt conveyor location. Provisions shall also be made for the installation of a bulkhead at the entryway to allow for full utilization of the dome's rated capacity.

F. Lumber: The outside framing members shall be SPF species or better, grade #2 or better, dried to maximum moisture content of 15 percent. The internal studs shall be 4 x 4 southern pine species or better, #2 or better, and dried to a maximum moisture content of 19 percent. All lumber shall conform to American Softwood Lumber Standard PS-20-74.

G. Plywood: The plywood shall be five (5) ply, 5 layers, Douglas fir plywood exterior and grade one structural #1. No lower grade or other species of plywood will be acceptable. All plywood shall be a minimum of 1/2 IN CDX agency rated and conform to PS-1-83.

H. Adhesive: The adhesive glue used in the fabrication of the dome's panels shall be recommended for the intended use, water resistant, mixed and applied in accordance with the manufacturer's recommendations.

I. Hardware: The hardware used to assemble the stress skin panels on site shall be a minimum 5/8 IN DIA hot dip galvanized bolts with 2-3/4 IN square washers, also hot dipped galvanized. No smaller than 5/8 IN DIA bolts will be accepted to connect the structural panels together. All nails and staples used in the manufacture of the panels shall be galvanized.

PART 3 - EXECUTION

3.01 SPECIAL PROVISIONS

A. The building furnished by the Contractor is to be erected and assembled at the site specified and as per the approved manufacturer's shop and erection drawings approved by the City in which the building is being constructed. The Contractor shall be responsible for the safe loading and unloading of the prefabricated panels. It will also be the responsibility of the Contractor to make any minor adjustments necessary in the footings and foundation to accomplish a plumb vertical building access and level horizontal foundation lines.

3.02 DESIGN AND CONSTRUCTION

A. Concrete Reinforcing:

1. General: Furnish all labor, materials, related equipment and supervision necessary for the complete reinforcement of the concrete as required by the manufacturer's drawings and specifications.

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2. Products:

    a. Reinforcing Steel: Deformed epoxy coated steel reinforcing bars conforming to ASTM A615 Grade 60. Metal shall be clean and free of loose rust, scale or coatings that will reduce bond.

    b. Anchor Bolts: Shall be unfinished ASTM A307 5/8 IN minimum diameter designation with a minimum yield strength of fy= 36 KSI. The anchor bolts shall be hot-dipped galvanized.

    c. Metal Accessories: Include all spacers, chairs, ties and other devices necessary for the proper spacing, supporting and fastening of the reinforcing steel in place.

3. Execution:

    a. Place reinforcement accurately, in position shown on the manufacturer's drawings; securely fasten and support to prevent displacement before and during pouring. Cleaning, bending and placing of reinforcement shall be done in accordance with the requirements of the American Concrete Institute codes.

B. Cast-In-Place Concrete

1. General:

    a. Furnish all labor, materials, related equipment and supervision necessary for the complete concrete work as required by the manufacturer's drawings and specifications.

    b. All concrete used for footings, foundation and pier or post supports below and above grade shall have a minimum compressive strength of 4000 PSI at twenty-eight (28) days. Mix design shall be submitted and approved by the Engineer. All concrete above grade shall have a 4 - 6 percent air entrainment.

2. Portland Cement: Supply concrete made with air-entrained portland cement ASTM C150 Type 2 cement or as approved by the Engineer.

3. Mixing Water: Mixing Water shall be clean and free from oil, acid and injurious amounts of vegetable matter, alkalis and other salts.

4. Execution:

    a. It shall be the Contractor's responsibility to check all dimensions and accuracy of the formwork and reinforcing steel prior to placing the concrete. The Contractor shall follow the normal and recommended practice for placing and protection of the concrete as outlined in the ACI.

    b. Finished surfaces of the concrete wall shall be free of voids or other surface blemishes. The outside of the foundation wall shall be ground smooth of any ridges and given a brush coat of cement paste to produce a uniform appearance. The interior of the wall shall have voids or other irregularities filled with cement paste.

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C. Framing and Sheathing:

1. Execution:

a. Provide all labor, materials and equipment necessary to complete all carpentry work and related work under this Section. All carpentry shall be installed by skilled carpenters working under proper supervision. The Work shall be carried out in a thoroughly high grade and workmanlike manner. The framework shall be assembled using 3-1/4 IN galvanized spiral nails. All joints shall be tight and present a smooth surface for gluing. The plywood sheathing shall be attached to the frame using glue. 1-3/4 IN galvanized staples shall be used to hold the plywood in place until the glue cures. The plywood shall then be beveled to suit the framework.

b. Assembly and erection of pre-fabricated panels, installation of doorway trusses, canopy and all related work must be done in accordance with the manufacturer's drawings and specifications. Adjustments may be made on site if found to be necessary and shall be carried out in a workmanlike manner conforming to good building practices.

D. Moisture Protection Asphalt Shingle Organic/Fiberglass Mat:

1. General:

a. The Contractor shall furnish all labor, materials, tools, equipment and supervision top properly install the asphalt roofing shingles to all surfaces designated for shingles on the manufacturer's drawings

2. Product:

a. The asphalt shingle shall be organic or fiberglass mat and provide a minimum manufacturer's prorated warranty as per earlier stated in the specifications. The shingles shall be of American manufacture. The shingles shall be installed with large head galvanized roofing nails as per the manufacturer's instruction.

b. Material for underlayment of shingles shall be non-perforated. The felt shall be attached directly to the plywood sheathing with large flat head galvanized roofing nails.

c. The color of shingles shall be selected from standard colors by the Owner or his or her representative.

3. Execution:

a. Surface to be covered with asphalt shingling shall be smooth and free from defects of every description, all such surfaces shall be dry and clean from dirt, rubbish and other foreign materials before roofing is started. All projecting nails shall be set flush to the roof sheathing.

b. The roofing shall be installed in strict accordance with the manufacturer's instructions in the conventional manner after the complete building has been erected. At no time should roofing felt or shingles be stored or applied on the building until all internal bracing has been installed.

c. Flashings shall be installed where called for on the approved manufacturer's drawings and shall be of aluminum non-corrosive or non-metallic material.

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d. The roofing felt shall be applied in such a manner that each panel joint is overlapped to prevent leakage and installed with large head galvanized roofing nails.

e. The roofing shingles shall be applied with large head galvanized roofing nails, the number and location of the nails to be governed by the manufacturer`s directions.

f. Roof vents and other openings in the roof shall be properly installed in such a manner to prevent leakage.

E. Finishes:

1. General: The Contractor shall furnish all materials, tools, and equipment and supervision to apply three coats of paint to all exterior exposed wood surfaces.

2. Product:

a. The paint selected shall be first quality materials as manufactured by a company list below or an approved equal:

1) Sherwin Williams.

2) Pittsburgh Paints.

3) Devoe Paint.

b. Color shall be as selected by the Owner or approved representative.

3. Surface Preparation:

a. The surface to be painted shall be sanded smooth, all dust and dirt must be removed and surfaces must be completely dry.

b. All painting shall be performed within the actual and anticipated ambient temperature ranges specified by the paint manufacturer.

4. Application:

a. The material selected shall be applied in strict compliance with the manufacturer`s specifications.

b. The painting shall consist of one coat primer and 2 finish coats.

F. Clean-up:

1. The Contractor shall be responsible for all drops and spots of paint on all other surfaces and shall leave the Work in a clean and acceptable condition.

2. All paint and debris for the working process of the painting shall be removed from of the property and be legally disposed of.

3.03 ELECTRICAL SPECIFICATIONS

A. Summary:

1. All electrical work shall be performed per applicable codes and shall be inspected and approved by the City that the building is being constructed. The power shall be brought to the dome by the Site Electrical Contractor and stubbed outside of the concrete wall to one side of the entranceway. Electrical underground conduit should be placed prior to commencement of asphalt pad construction.

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2. The electrical work shall consist of the following:

   a. The salt dome contractor shall install a 100 AMP, 240 V breaker and switch box and PVC wiring to power all electrical fixtures and equipment identified in the Contract Drawings and Specifications.

   b. The salt dome contractor shall install high-pressure sodium, corrosion resistant light fixtures with all necessary switches and wiring to fixtures and to the electrical fan. Light fixtures shall be positioned as follows on the appropriate location:

      1) Two (2) each 400 w interior fixtures.

      2) One (1) each 250 W exterior fixture mounted over the canopy of the entranceway. Exterior fixture shall have integral photocell switch.

   c. The Contractor shall supply slope drainage to conform to local and state electrical codes. All exterior conduits shall be galvanized metal. All interior conduit to be PVC schedule 40 or galvanized metal.

   d. An electrical fan shall be furnished and installed. The fan shall be corrosion resistant coated, completely enclosed motor. Gravity shutter shall be corrosion resistant coated. Fan and shutter shall be a heavy-duty industrial exhaust fan, HERESITE phenolic salt spray resistant coated with two coats. The fan shall be:

      1) Bayley Type JBP-30 IN-6U5-I, 1 HP.

      2) Single-phase electrical service.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of the prefabricated salt storage dome shall be the Contract unit price per each (EA) and shall include labor, equipment and incidentals for a complete salt dome in accordance with these Specifications and the Contract Drawings.

B. If an alternate bid is being requested, the work and costs shall be divided as noted in the Schedule of Prices.

4.02 PAYMENT

A. Payment for the prefabricated salt storage dome complete shall be by the Contract unit price per each (EA) and shall constitute full payment of labor, equipment, and incidentals necessary to install the prefabricated salt storage dome complete. The price shall include all costs for unloading and handling materials, construction of the prefabricated salt storage dome and all incidental work in accordance with the Contract Drawings and Specifications.

END OF SECTION

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SECTION 43 21 00 - PUMPING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pumping equipment.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Union Pacific Railroad (UPRR) Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Section 09 90 01 - Paint and Protective Coatings.

E. Section 43 23 52 - Positive Displacement Pump (Rotary).

F. Section 43 23 71 - Air-Operated Diaphragm Pump.

G. Section 43 25 13 - Submersible Non-Clog Pump.

H. Section 43 25 14 - Submersible Slurry Pump.

1.03 REFERENCED STANDARDS

A. Hydraulic Institute (HI): Standards for Centrifugal, Rotary and Reciprocating Pumps.

B. Building Code: International 2001 California Building Code

1.04 DEFINITIONS

A. The abbreviations are defined as follows:

1. IPS – Iron Pipe Size.
2. NPSHR – Net Positive Suction Head Required.
3. TDH – Total Differential Head.
4. TEFC – Totally Enclosed Fan Cooled.
5. VFD - Variable Frequency Drive.

B. Pump Surface Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.05 SUBMITTALS

A. Shop Drawings:

1. Submit under provisions of section 01 33 00.

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2. Product technical data including -
    a. Performance data a curves with flow (gpm), head (FT), horsepower, efficiency, HPSH requirements, submergence requirement.
    b. Pump accessory data.
    c. Bearing supports, shafting details and lubrication provisions.
    d. Solid passage information.
3. Certifications - Certified pump performance curves as described in Article 2.04.
4. Test Reports - Factory hydrostatic test.

B. Operation and Maintenance Manuals: See Section 01 33 04.

C. Miscellaneous: Certifications – Statement relative to installation and start-up per paragraph 3.2-A.4.

1.06 QUALITY ASSURANCE

A. Fully coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

B. For variable speed pumping applications, the pump manufacturer is designated to have single source responsibility for coordination of the pump and VFD drive system.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pumps - See individual pump specifications sections.
2. Mechanical Seals:
    a. Chesterton.
    b. Carlock.

B. Submit requests for substitution in accordance with Specification Section 01 33 00.

2.02 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to shut-off condition.

2.03 ACCESSORIES

A. See Section 01 61 03.

B. Each Unit:
1. Lifting eye bolts or lugs.
2. Plugged gauge cock connection at suction and discharge nozzles.

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3. Tapped and plugged openings for casing and bearing housing vents and drains.
4. Fittings for properly adding flushing lubricant.
5. Pressure relief fittings for grease lubrication.

C. Packing Seals:
1. Provide packing seal unless mechanical seal is specified in the narrow-scope pump sections.
2. Minimum of five (5) graphite impregnated synthetic packing.
3. provide minimum 1/4 IN DIA supply tap and 1/2 IN DIA minimum drain tap.
4. Provide split Teflon or bronze water ring seal.
5. Adjustable split follower cast iron or bronze gland.
6. Materials – As specified in narrow scope pump sections.

D. Seal Water Systems:
1. Pressure Reducing Sections (PRS):
a. Individual (local) PRS for each drop leg off seal water header to individual pumps.
b. See drawings for system components and arrangements.

2.04 FABRICATION

A. Pump Support:
1. Design base to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount horizontal pump, motor, and coupling on single piece drip lip type baseplate.
4. Mount vertical pumps on single piece pedestal baseplate.
5. Fabricate to withstand all operating loads transmitted from the pump and drive.

2.05 SOURCE QUALITY CONTROL

A. If specifically required in the individual pump specification sections, provide factory tests:
1. Units – Hydrostatic test at 150 percent of shutoff head for a minimum of 5 minutes.
2. Adjustable speed unit:
a. Head (FT) verses flow (gpm) pump curves:
1) Maximum, minimum and two equally spaced intermittent speeds.
2) Efficiencies along each curve.
3) Brake horsepower along each curve.

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3. Constant speed unit:
    a. Head (FT) versus flow (gpm) pump curves:
        1) Efficiencies along curve.
        2) Brake horsepower along each curve.
4. Results certified by a registered professional engineer.

B. Statically and dynamically balance each pump per HI standards.

2.06 SEISMIC DESIGN

A. Equipment (400 LBS or greater) and its anchorage to be designed to resist the total design seismic forces prescribed in the 2001 California Building Code.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Section 01 61 03.

B. Floor or Pad-Mounted Units (Non-Submersible):

1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
2. Assure no unnecessary stresses are transmitted to equipment flanges.
3. Tighten flange bolts at uniform rate and manufacturer's recommendation torque for uniform gasket compression.
4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange. Realign as necessary, install flange bolts and make equipment connection.
8. Field paint units as defined in Section 09 90 01.
9. Provide pressure gauge on discharge of all pumps and of suction of all non-submersible units.

C. Submersible Units: Comply with requirements defined in Paragraphs 3.01-B.7, 8 and 9.

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3.02 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:

1. Inspect equipment covered by these Specifications.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks.
4. Provide a written statement that manufacturer's equipment has been installed properly.
5. Instruct Owner's personnel for the specified minimum number of hours at jobsite on operation and maintenance of each of following pumping equipment.
   a. Section 43 25 13 - Submersible Non-Clog Pump, 4 HRS.
   b. Section 43 25 14 - Submersible Slurry Pump, 4 HRS.
   c. Section 43 23 52 - Positive Displacement Pump (Rotary) 4 HRS.
   d. Section 43 23 71 - Air-Operated Diaphragm Pump, 4 HRS.

END OF SECTION

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SECTION 43 23 32 - END SUCTION CENTRIFUGAL PUMP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Recovered Oil.
2. Recirculation Pump.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. UPRR Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Section 43 21 00 - Pumping Equipment.

1.03 REFERENCED STANDARDS

A. Anti-Friction Bearing Manufacturers Association (AFBMA).

B. American Iron and Steel Institute (AISI):

1. Steel Products Manual

C. ASTM International (ASTM):

1. A48 Standard Specification for Grey Iron Castings.
2. B584 Standard Specification for Copper Alloy Sand Castings for General Applications.

D. Hydraulic Institute (HI):

1. Standards for Centrifugal Rotary and Reciprocating Pumps.

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop Drawings:

1. See Section 43 21 00.

C. Operation and Maintenance Manuals:

1. See Section 01 33 04.

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PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. End Suction Centrifugal Pumps:

a. Gould.

b. Paco.

c. Or approved equal.

B. Submit requests for substitution in accordance with Specification Section 01 33 00.

2.02 MATERIALS

A. Recovered Oil Recirculation, P-207:

1. Pump casing: Cast iron, ASTM A48, Class 30.

2. Impellers: Bronze ASTM B584 (836).

3. Shaft: Carbon Steel.

4. Impeller Wear Rings: Bronze, ASTM B584 (836).

5. Shaft Sleeve: Bronze, ASTM B584 (831).

6. Baseplate: Cast Iron.

2.03 EQUIPMENT

A. Performance and Configuration Requirements:

1. Recovered Oil Recirculation,:

a. Design Condition: ## gpm. @ ## psi. TDH.

b. Pump Configuration: End Suction.

c. Maximum Pump Speed: #### rpm.

d. Nameplate Driver Horsepower: #.

e. Drive Type: Constant.

f. Drive Configuration: Direct Coupled.

B. Operating Conditions:

1. Fluid Pumped: Recovered oil from wastewater treatment process.

a. Viscosity: #### SSU.

b. Design Temperature: ## DegF.

c. Specific Gravity: 0.## - 0.##.

2. Location: Exterior/Interior

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2.04 ACCESSORIES

A. See Section 43 21 00.

B. Mechanical Seals:

1. Provide carbon rotating face, ceramic seat and EPR type O-rings.

2. Construct metal parts of Type 316 stainless steel.

C. Motor:

1. 480v, 3 Ph, 60 Hz.

2. See Section 01 61 03.

2.05 FABRICATION

A. Fabricate pump case to withstand 175 psig or 200 percent of maximum working pressure specified by pump performance, whichever is greater.

B. Furnish anti-friction type bearing rated for minimum B-10 life of 20,000 HRS at 24 HR continuous operation per AFBMA.

C. Provide grease lubrication.

D. Furnish rigid, one piece cast bearing housing with catch reservoir.

E. Provide pump case with case rings at impeller skirt. Lock ring in place with pin.

F. Statically and dynamically balance impellers per Hydraulic Institute Standards.

G. Key impeller to driven shafts and secure impeller to shaft with stainless steel locking screw.

H. See Section 43 21 00.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Section 43 21 00.

3.02 FIELD QUALITY CONTROL

A. See Section 43 21 00.

END OF SECTION

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SECTION 43 23 33 - CENTRIFUGAL PUMPS FOR PETROLEUM SERVICE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. This specification includes pumps and associated equipment used for pumping diesel fuel.
2. Equipment manufacturer shall certify that all equipment is compatible with the service and product it will handle.Example

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittal Procedures

B. Section 33 05 26 – Mechanical Identification

C. Section 43 21 00 – Pumping Equipment

1.03 REFERENCED STANDARDS

A. American National Standards Institute (ANSI)

B. American Society of Mechanical Engineers (ASME)

C. Anti-Friction Bearing Manufacturers' Association (AFBMA)

D. National Electrical Manufacturers' Association (NEMA)

E. National Fire Protection Association (NFPA)

F. National Electrical Code (NEC)

1.04 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Shop drawings and product data required by this Section include, but are not limited by, the following:

1. Shop drawings showing pump and motor layout, connections and anchorages.
2. Product data including performance curves and rated capacities of selected models, weights, furnished specialties, and accessories. Indicate pump's operating point on curves.
3. Coupling data.
4. Motor product data and efficiencies.
5. Wiring diagrams showing wiring for power, signal, and control systems and differentiating between manufacturer-installed wiring and field-installed wiring.
6. Product certificates signed by manufacturers of pumps, certifying accuracy and compliance under operating conditions.

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7. Pump pre-alignment report for new installations. As found and final report for existing installations where only the pump is replaced.
8. Manufacturer's qualification data.

C. Operational and Maintenance data for pumps including startup information and replacement parts lists.

1.05 QUALITY ASSURANCE

A. Obtain all pumps from one source and by a single manufacturer.

B. Manufacturer's Qualification: Firms regularly engaged in manufacture of equipment, of types and capacities required, whose products have been in satisfactory service for not less than 5 years.

C. Field quality control per section 43 21 00.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage. Store pumps in a dry location.

B. Protect bearings and couplings against damage from sand, grit, and foreign matter.

PART 2 - PRODUCTS

2.01 GENERAL

A. Provide pumps to meet operational requirements as shown on pump schedules and indicated on drawings or within these specifications.

2.02 MANUFACTURERS

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

1. Centrifugal Pumps:
    a. Aurora
    b. Byron Jackson
    c. Gould
    d. Ingersoll-Dresser
    e. Approved equal
2. Couplings:
    a. Omega

2.03 MATERIALS

A. CENTRIFUGAL PUMPS

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1. Pump shall be radially split case, single-stage, horizontal, end suction, centrifugal design manufactured specifically for handling petroleum products. Pumps shall be complete with pump, motor, coupling, mounting base, accessories, and all other parts and materials necessary for a complete installation.
2. Performance Characteristics:
    a. Pumps shall be suitable for operation at the fluid temperature and suction head conditions listed at any flow between 25% and 125% of design flow.
    b. Performance shall be identical for all similar pumps. Performance curves shall permit stable parallel operation of multiple pumps of the same type.
    c. Pumps shall be designed for both continuous and intermittent operation.
3. Construction:
    a. Pumps shall meet the requirements of ANSI/ASME, latest edition.

B. Pump Motors:

1. Motors will be installed in an NEC Class I, Division 2, Group D hazardous location. Sliding contacts, centrifugal, or other type switching mechanisms (including motor over current, overloading, and over temperature devices), or integral resistance devices that may be provided shall be approved for installation conditions in accordance with the NEC.
2. Motors one (1) hp and smaller shall be 120 volt, single phase, 60 Hz. Motors larger than one (1) hp shall be 480 volt, three phase, 60 Hz..
3. Shall have sufficient capacity to drive the pump through the entire operating range of the pump performance curve without exceeding nameplate data.
4. Shall have a service factor of 1.15.
5. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10% above and below rated voltage.
6. Shall be NEMA Design B squirrel-cage induction type suitable for use with across-the-line starter.
7. Insulation shall be NEMA Class F.
8. Enclosure shall be totally enclosed, fan cooled (TEFC) suitable for outdoor installation. Furnish with automatic drain/breather assembly.
9. Bearings shall be oil-lubricated ball bearings with AFBMA L10 life of 60,000 hours when running at the specified operation conditions.
10. Pump motors shall be furnished with lifting lugs on the motor casing. Motor terminal box shall be suitably sized for a 1-inch conduit entrance.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements of 43 21 00.

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B. Install pumps where indicated on the drawings and in accordance with manufacturer's recommendations. Provide all mounting hardware and accessories as required for proper operation and as recommended by the manufacturer.

C. Set and align all equipment in accordance with manufacturer's recommendations. Retighten all bolted connections after installation and alignment.

D. Check all motors and drives carefully for correct rotation and alignment before placing equipment into operation. Pump shaft shall be laser aligned prior to being placed into service.

3.02 FIELD QUALITY CONTROL

A. All testing and checkout procedures of the manufacturer shall be carried out completely.

B. Shop tests shall be conducted on all electric motor driven pumps in the manufacturer's shop.

C. Protect all equipment and surrounding areas from damage resulting from testing operations. Clean up any spills or leakage from testing.

END OF SECTION

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SECTION 43 23 52 - POSITIVE DISPLACEMENT PUMP (ROTARY)

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Positive Displacement Rotary Vane Pumps.

B. Equipment manufacturer shall certify that all equipment is compatible with the service and product it will handle.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Union Pacific Railroad (UPRR) Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 01 61 03 - Equipment: Basic Requirements.

D. Section 43 21 00 - Pumping Equipment.

E. Division 13 - Special Construction.

1.03 REFERENCED STANDARDS

A. American Bearing Manufacturing Association (ABMA).

B. American Gear Manufacturing Association (AGMA).

C. American National Standards Institute (ANSI).

D. American Petroleum Institute (API):

1. 676, Positive Displacement Pumps: Rotary.

E. ASTM International (ASTM):

1. A48, Standard Specification for Gray Iron Castings.
2. A126, Gray Iron Castings for Valve Flanges and Pipe Fittings
3. A743, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant for General Application.

F. National Electrical Code (NEC).

G. National Electrical Manufacturers Association (NEMA).

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop Drawings: Requirements in Section 43 21 00.

C. Operation and Maintenance Manuals: See Section 01 33 04.

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PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURES

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:

1. Rotary Pumps:

a. Blackmer.

b. Roper.

c. Viking.

2. Couplings

a. Omega

B. Submit requests for substitution in accordance with Specification Section 01 33 00.

2.02 MATERIALS AND LUBRICATION

A. Lubricating Oil or Journal Oil as Scheduled:

1. Equipment manufacturer shall certify that all equipment is compatible with the service and product it will handle.

2. All pumps to be provided with preliminary coupling alignment and ready for installation onto foundation.

3. Provide with flexible coupling and coupling guard.

4. Pump shall be a self-priming, constant speed unit.

5. Pumps and pump motors to be designed for outdoor application.

B. Pump Construction (Journal and Lubricating Oil Pumps):

1. All parts to have standardized dimensions for 100 percent repair part interchangeability.

2. Pump body and pressure containing parts such as heads, valve, cover: Cast iron, ASTM A48, or ductile iron.

3. Stuffing Box – Cast Iron ASTM A48.

4. Mechanical Seal:

a. ANSI Labyrinth tape ceramic and steel with self-adjusting wear compensators.

b. Single inside seal cast iron and carbon primary seals and Viton secondary seals.

5. Shaft:

a. Each drive shaft shall be fully machined or ground to size and polished. The drive shaft shall have ample size to transmit the maximum applied power at the maximum specified differential pressure and carry all applied radial loads without excessive deflection.

b. Tool steel.

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6. Bearings:
    a. Two anti-friction bearings shall be provided.
    b. Bearings shall be isolated from pump liquid.
    c. Bearings shall have and ABMA L10 Life Rating of 40,000 HRS at maximum differential pressure.
    d. Grease Lubricated.
    e. Shaft speed shall not exceed the limits specified by the bearing manufacturer.
7. Vanes – Vane material shall be Duravane with ANSI type 316 stainless steel wearplate.
8. Baseplate:
    a. Fabricated steel, common baseplate designed to support the equipment and handle the maximum torque as generated between the pump and reduction unit without base distortion.
    b. Plate shall have rounded corners with all exposed seams and contact surfaces of steel plates and shapes shall be continuously welded and ground smooth.
    c. Openings shall be provided in top of the base to facilitate grouting.
    d. An opening shall be provided, as necessary for electrical conduit to the drive unit.
9. Gear Reducer:
    a. Commercial Grade.
    b. Independently bolted to baseplate with coupling connection to driver and pump.
    c. Assembly shall feature hardened steel gears, immersed in oil, mounted on shafts supported on both ends by ball bearings and enclosed in a weatherproof housing.
10. Anchor Bolts:
    a. Anchor bolts shall be accurately located and centered in pipe sleeves having inside diameter approximately 2-1/2 times the bolt diameter and length approximately 8 times the bolt diameter.
    b. A square anchor plate with thickness of approximately 1/2 the bolt diameter and side dimensions 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto.
11. Pressure Relief Valve – Integral corrosion resistant relief valve with stainless steel spring capable of maintaining a constant discharge pressure with the full capacity of the pump being bypassed.
12. Motors:

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a. Sliding contacts, centrifugal, or other type switching mechanisms (including motor overcurrent, overloading, and overtemperature devices) or integral resistance devices that may be provided shall be approved for installation conditions in accordance with the NEC.

b. Motors 1/2 Horsepower and smaller shall be 120 Volt, Single phase, 60 Hertz. Motors larger than 1/2 Horsepower shall be 480 Volt, Three Phase, 60 Hertz.

c. Shall have sufficient capacity to drive the pump though the entire operating range of the pump performance curve without exceeding nameplate data.

d. Shall have a service factor of 1.15.

e. Motors shall be capable of delivering rated horsepower output successfully and continuously under conditions of voltage variations of 10 percent above and below the rated voltage.

f. Shall be NEMA Design B squirrel-cage induction type suitable for use with across-the-line starter.

g. Insulation shall be NEMA Class F.

h. Enclosure shall be Totally Enclosed – Fan Cooled (TEFC) suitable for outdoor installation. Furnish with automatic drain / breather assembly.

i. Bearings shall be oil-lubricated ball bearings with ABMA L10 life of 60,000 HRS when running at the specified operation conditions.

j. Pump motors shall be furnished with lifting lugs on the motor casing. Motor terminal box shall be suitably sized for a 1 IN conduit entrance.

C. Controls per Division 26.

2.03 EQUIPMENT

A. Performance and Configuration Requirements:

1. Lubricating oil and journal oil distribution pumps –

a. Suction and discharge sizes:

1) Pump shall be arranged for side suction and top discharge.

2) 150 PSI raised-face flanged connections on suction and discharge.

b. Gear Reducer: Reducer shall be capable of reducing drive motor shaft speed required to drive pump over the entire range of operating conditions.

2. Performance Schedule located at end of this Section.

a. Use the following fluid properties for equipment selection:

1) Journal Oil: Specific gravity of 0.88 and viscosity of 1000 SSU.

2) Lube Oil: Specific gravity of 0.93 and viscosity of 1000 SSU.

2.04 SOURCE QUALITY CONTROL

A. Hydrostatically test each pump body of 150 percent of rated discharge pressure. Supply documentation of test.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements of Section 43 21 00.

B. Set and align all equipment in accordance with manufacturers recommendations. Retighten all bolted connections after installation and alignment.

C. Check all motors and drives carefully for correct rotation and alignment before placing equipment into operation.

D. Provide all mounting hardware and accessories as required for proper operation and as recommended by the manufacturer.

E. Protect all mounting hardware and accessories as required for proper operation and as recommended by the manufacturer.

F. All testing and checkout procedures of the manufacturer shall be carried out completely.

G. Field install packing.

3.02 FIELD QUALITY CONTROL

A. See Section 43 21 00.

END OF SECTION

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SECTION 43 23 71 - AIR OPERATED DIAPHRAGM PUMP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air-operated diaphragm pumps.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. UPRR Contract Section.

B. Division 01 - UPRR General Conditions.

C. Division 13 - Special Construction.

D. Section 43 21 00 - Pumping Equipment.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI):

1. Steel Products Manual.

B. American National Standards Institute (ANSI).

C. American Society for Testing and Materials International (ASTM):

1. A48, Standard Specification for Gray Iron Castings.
2. A108, Standard Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
3. A276, Standard Specification for Stainless Steel Bars and Shapes.
4. A536, Standard Specification for Ductile Iron Castings.
5. A753, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application and Wrought.
6. A744, Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service.

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop Drawings:

1. Requirements in Section 43 21 00.
2. Chemical compatibility charts, provide verification that pump parts are compatible with fluid handled.
3. Air flow and pressure requirements.
4. Technical data on mufflers, lubricants and air supply appurtenances.

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C. Operation and Maintenance Manuals:

1. See Section 01 33 04.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ingersoll-Rand Aro.
2. Warren Rupp Pump Co.

B. Submit requests for substitution in accordance with Specification Section 01 33 00.

2.02 MATERIALS

A. Waste Oil Pumps:

1. Air operated non-stalling double-diaphragm type.
2. Pump body non-wetted parts: Aluminum or 316 stainless steel.
3. Pump body wetted parts: Aluminum or 316 stainless steel.
4. Ball valves: Viton.
5. Valve Seats: 316 stainless steel.
6. Diaphragms: Viton.

B. Soap Dispensing Pumps:

1. Air-operated non stalling double-diaphragm type.
2. Pump body non-wetted parts: Painted alumimum.
3. Pump body wetted parts: Kynar – Polyvinylidene Flouride (PVDF).
4. Ball (check) valve: Kynar (PVDF).
5. Valve Seats: Kynar (PVDF).
6. Diaphragms: Santoprene.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements:

1. Waste oil pumps:
   a. Waste oil specific gravity: 0.88 – 0.93.
   b. Maximum solids passage: 1/4 IN DIA.
   c. Suction and discharge size: 1-1/2 IN DIA.
   d. Self-priming up to loft suction lift.
   e. Liquid pumped: Waste oils (journal and lubricating).
   f. Non-stalling type air motor design, double-diaphragm.

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2. Soap Dispensing Pumps:
    a. Maximum solids passage: 1/4 IN DIA.
    b. Suction and discharge size: 1-1/2 IN DIA.
    c. Liquid pumped: Alkaline detergent.
        1) 3 percent sodium hydroxide.
        2) 5-7 percent mono butyl glycol (ethylene glycol monobutyl ether.)
    d. Non-stalling type air motor design, double-diaphragm.
3. Performance schedule located at end of this Section.

2.04 ACCESSORIES

A. Air Pressure Regulator / Filter Assembly"
    1. Provide air pressure regulation between 5 and 125 psig.
    2. 40 micron replaceable element with standard drain.
    3. Provide pressure gauge, 4-1/2 IN face, 0 - 160 psig.
B. Lubricator:
    1. Provide as required.
C. Muffler:
    1. Reduce exhaust to less than 80 decibels.
D. Controls:
    1. Waste oil pumps:
        a. Pushbutton control per Division 13.
        b. Mount in location approved by Owner.
    2. Soap dispensing pumps:
        a. Provide connection to soap system inside pump house and activate pump(s) upon low level setpoint signal from inside soap storage tank.
        b. Shut-off pumps at predetermined max fill point.
E. Air connection shall be flexible air hose and necessary couplers.

2.05 FABRICATION

A. Factory assemble pump complete with air valve.
B. Coat all steel and cast iron materials with a factory-applied epoxy.
C. Pump to be capable of running dry indefinitely without damage.
D. Pump and components shall be explosion proof and suitable for use in hazardous areas.

2.06 MAINENANCE MATERIALS

A. Maintenance Manuals:

1. Furnish the Owner with the following extra parts for each pump service category:

a. Two diaphragms.

b. Two valve seats.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Section 43 21 00.

B. Install flexible couplings on suction and discharge of pumps.

3.02 FIELD QUALITY CONTROL

A. See Section 43 21 00.

END OF SECTION

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SECTION 43 25 13 - SUBMERSIBLE NON-CLOG PUMP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible non-clog pumps – wet pit application.
2. Sanitary wastewater lift station pumps.
3. Industrial wastewater pump station.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Union Pacific Railroad (UPRR) Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 01 61 03 - Equipment Basic Requirements.

D. Section 43 21 00 - Pumping Equipment.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI) – Steel Products Manual.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):

1. A48, Standard Specification for Grey Iron Castings.

D. FM Global (FM).

E. Hydraulic Institute (HI):

1. Standards for Centrifugal, Rotary, and Reciprocating Pumps.

F. National Electrical Manufacturer's Association (NEMA):

1. 250 Enclosures for Electrical Equipment (1000 Volts Maximum).
2. ICS 6, Enclosures for Industrial Controls.

G. National Fire Protection Agency (NFPA):

1. 70, National Electrical Code (NEC).

H. Underwriters Laboratories, Inc. (UL):

1. 1449, Safety Transient Voltage Surge Suppressors.

1.04 SYSTEM DESCRIPTION

A. Sanitary wastewater pumps and industrial wastewater pumps.

B. Provide single source coordination responsibility through the pump manufacturer for the entire system including but not limited to the following:

1. Pumps.

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2. Motors.
3. Float switches.
4. Control panel.
5. Lift station hardware, access doors, jib cranes and winches.

1.05 SUBMITTALS

A. Submit under provisions of section 01 33 00.

B. Shop Drawings:

1. Requirements in Section 43 21 00.
2. Source quality control test reports.

C. Operation and Maintenance Manuals: See Section 01 33 04.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:

1. Submersible non-clog pumps – wet pit applications:
   a. Power-Flo.
   b. Fairbanks Morse.
   c. Gorman Rupp.
   d. Wemco.
   e. Barnes.
2. Submersible low shear.
   a. Wemco Hidrostal.
   b. Discflo.
3. Submit requirements for substitution in accordance with Specification Section 01 33 00.

2.02 MATERIALS

A. Submersible Non-Clog, Wet Pit Applications Sanitary Wastewater Lift Station Pumps:

1. Pump case – Cast iron, ASTM A48, Class 30.
2. Motor housing – Cast iron ASTM A48, Class 25 or Class 30.
3. Impeller – Cast iron ASTM A48, Class 30.
4. Shaft – Stainless steel, ANSI, Series 300 or 400.
5. Wear rings – Corrosion and wear resistant materials.

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6. O-rings – Nitrile (Buna-N).
7. Fasteners – Stainless steel.
8. Guide rails – Stainless steel.
9. Lifting cables – Stainless steel.
10. Lower ring seal – Tungsten-carbide both faces.
11. Upper ring seal – Tungsten-carbide both faces or carbon and ceramic or carbon Ni-resist.
12. Seal metal parts – Stainless steel.

B. Submersible Non-Clog, Wet Pit Applications Industrial Wastewater Pumps:
1. Pump case – Cast iron, ASTM A48, Class 30.
2. Motor housing – Cast iron, ASTM A48, Class 25 or Class 30.
3. Impeller – Cast iron, ASTM A48, Class 30.
4. Shaft – Stainless steel, ANSI, Series 300 or 400.
5. Wear rings – Corrosion and wear resistant materials.
6. O-rings – Nitrile (Buna-N).
7. Fasteners – Stainless steel.
8. Guide rails – Stainless steel.
9. Lifting cables – Stainless steel.
10. Lower ring seal – Tungsten-carbide both faces.
11. Upper ring seal – Tungsten-carbide both faces or carbon and ceramic and Ni-resist.
12. Seal metal parts – Stainless steel.

C. Submersible Low Shear, Industrial Wastewater Process Pumps:
1. Pump case – Cast iron, ASTM A48, Class 30.
2. Motor housing – Cast iron, ASTM A48, Class 25 or Class 30.
3. Impeller – Cast iron, ASTM A48, Class 30.
4. Shaft – Stainless steel, ANSI, Series 300 or 400.
5. Wear rings – Corrosion and wear resistant materials.
6. O-rings – Nitrile (Buna-N).
7. Fasteners – Stainless steel.
8. Guide rails – Stainless steel.
9. Lifting cables – Stainless steel.
10. Lower ring seal – Tungsten-carbide both faces.
11. Upper ring seal – Tungsten-carbide both faces or carbon and ceramic or carbon and Ni-resist.

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12. Seal metal parts – Stainless steel.

2.03 EQUIPMENT

A. Performance and Configuration Requirements:

1. Sanitary Wastewater Lift Station Pumps:
   a. Design condition – 100 gpm. at 47 ft. TDH.
   b. Secondary condition – 140 gpm. at 40 ft. TDH.
   c. Maximum shutoff condition – 0 gpm. at 85 ft.
   d. Pump configuration – Submersible wet pit.
   e. Maximum pump speed – 3,450 rpm.
   f. Nameplate driver horsepower – 3.8.
   g. Drive type – Constant Speed.
   h. Minimum solids passage – 2-1/2 IN.
   i. Maximum Discharge – 3.0 IN DIA.
   j. Motor requirements:
      1) Service factor – 1.15.
      2) Minimum 10 starts per hour.
   k. Ambient conditions – Wastewater maximum temperature: 104 DegF.
2. Industrial Wastewater Pumps:
   a. Design condition – 950 gpm at 56 FT TDH.
   b. Secondary condition – 650 gpm at 72 FT TDH.
   c. Maximum shutoff condition – 0 gpm at 108 FT.
   d. Pump configuration – Submersible wet pit.
   e. Maximum pump speed – 1,770 rpm.
   f. Maximum driver horsepower – 20.
   g. Drive type – Constant speed.
   h. Minimum solids passage – 3 IN.
   i. Maximum discharge – 6 IN DIA.
   j. Motor requirements:
      1) Service factor – 1.15.
      2) Minimum 10 starts per hour.
   k. Ambient Conditions:
      1) Industrial wastewater maximum temperature: 80 DegF.
      2) Industrial wastewater contains free and/or emulsified petroleum products.

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3. Industrial Wastewater Process Pumps:
    a. Design condition – 80 gpm at 33 FT TDH.
    b. Secondary condition – 100 gpm at 33 FT TDH.
    c. Maximum shutoff condition – 0 gpm at 48 FT.
    d. Pump configuration – Submersible wet pit.
    e. Maximum pump speed – 1,770 rpm.
    f. Maximum driver horsepower – 7.5.
    g. Drive type – Constant speed.
    h. Minimum solids passage – 2-1/4 IN.
    i. Maximum discharge – 3 IN IDA.
    j. Motor requirements:
        1) Service factor – 1.15.
        2) Minimum 10 starts per hour.
    k. Ambient conditions:
        1) Industrial wastewater maximum temperature – 80 DegF.
        2) Industrial wastewater contains free and/or emulsified petroleum products.

2.04 COMPONENTS

A. General:
    1. Provide pump capable of handling raw, unscreened sewage or industrial wastewater.
    2. Where watertight sealing is required, machine and fit mating surfaces with O-rings.
    3. Provide with heavy duty lift lugs or hoisting bail designed for lifting the entire pump and motor assembly.
    4. For industrial wastewater process pumps provide a low shear design pump so as to not emulsify petroleum hydrocarbons.

B. Impeller:
    1. Provide non-clog type dynamically balanced impeller in accordance with HI Standards.
    2. Provide impeller and volute wear rings as necessary to assure efficient sealing between volute and impeller.

C. Shaft:
    1. Design pump shaft of sufficient size to transmit full driver output.
    2. Use shaft which is accurately machined and constructed with sufficient materials.
    3. Design shaft for a maximum deflection of 0.002 IN measured at stuffing box.

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D. Shaft Seal:

1. Seal shaft with two independent, tandem mounted seals running in an oil filled chamber.
2. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
3. Hold interface in contact by its own spring system.

E. Bearings:

1. Support shaft on upper and lower permanently lubricated bearings with a minimum L-10 life of 50,000 HRS.

F. Motors:

1. Provide pump with FM and UL listed motor designed for area classification shown on drawings.
2. Provide motor of totally submersible design, construction with epoxy or poly-seal encapsulated windings, air-filled or dielectric oil filled, with Class F insulation and rated for continuous duty operation.
3. Motors shall be 3HP, 60 cycle, 460 Volts.
4. Assure motor is capable of running dry for extended periods without damage to motor or seal.

G. Power and Control Cables:

1. Provide power cable and control cable to pump suitable for submersible applications in wastewater and indicate same by a code or legend permanently embossed on cables.
2. For industrial wastewater power and control cable, provide cable suitable for immersion in petroleum products.
3. Size cables in accordance with applicable NEC specifications.
4. Provide 50 ft. power cable and control cable.
5. Provide each cable with a strain relief, cord grip, and explosion-proof seal installed in accordance with NEC Article 500.

H. Temperature and Moisture Monitor:

1. Furnish each phase of the motor with a temperature monitor embedded in the motor windings.
2. Arrange controls so as to shut the pump down and sound alarm should any one of the monitors detect high temperature and automatically reset once the stator temperature returns to normal.
3. Set temperature of the temperature monitors at not higher than 90 percent of insulation temperature rating.
4. Provide electrical probe as needed for detecting the presence of water in the seal chamber.
5. If water enters the probe shall energize electrical circuit to shut down pump and sound alarm circuit for external alarm.

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I. Coatings:

1. For all applications, apply polyamidoamine epoxy system to the exterior of the pump casing and motor housing that is equal to or better than that specified in Specification Section 09 90 01.
2. Protect all metallic surfaces coming into contact with sewage or industrial wastewater except stainless steel and bronze by a corrosion-resistant coating.

J. Guide Bracket, Rails, Discharge Connector:

1. Provide sliding guide bracket integral to pump unit which properly aligns the pump discharge with the discharge connection elbow for watertight seal during pumping.
2. Provide guide brackets to support guide rails.
3. Guide the entire weight of the pumping unit by guide rail(s).
4. The guide rail(s) shall not support any portion and portion of the weight of the pump.
5. Provide chains or cable of sufficient strength to lift pumps from sump.
6. Furnish guiding rail assembly and discharge flange assembly of non-sparking components.
7. Design pump to allow for removal without entering the wet well, and without removal of bolts, nuts or other fastenings.
8. Provide pump unit connecting to discharge connection with a simple downward motion without rotation.
9. Provide necessary sliding guide bracket and discharge connection which, when bolted to the floor of the sump and to the discharge line, will receive the pump discharge connecting flange without need of adjustment, fasteners, clamp, or similar devices.
10. No portion of the pump shall bear directly on the floor or the wet well.

2.05 ACCESSORIES

A. See Section 43 21 00.

B. Controls:

1. Provide sealed float-type mercury switches to control pumps and provide alarm signal as follows –
   a. Sanitary Wastewater Lift Station Pumps: 4 float switches.
   b. Industrial Wastewater Pumps: 5 float switches.
   c. Industrial Wastewater Process Pumps: 4 float switches.
2. Seal mercury tube switches in a solid polypropylene float for Sanitary Lift Station Pumps.
3. For industrial wastewater, seal mercury tube switches in material suitable for immersion in petroleum products.

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4. Provide float with large radius top at electrical cable connection to assure trouble-free operation.
5. Suspend floats on their own pole.
6. Provide floats to operate at elevation shown on drawings.
7. Design floats to be field-adjustable.
    a. For Sanitary Wastewater Lift Station Pumps, three floats are to control pumps:
        1) One for lead pump start.
        2) One for lag pump start.
        3) One for low water cutoff.
        4) An additional switch provides the signal for high level alarm.
    b. For Industrial Wastewater Pumps, three floats are to control pumps:
        1) One for pump start.
        2) One for pump stop.
        3) Two additional switches for high and low level alarm.
    c. For Industrial Wastewater Process Pumps. two floats are to control pumps:
        1) One for pump start.
        2) One for pump stop.
        3) Two additional switches for high and low level alarm.
8. Provide a intrinsically safe relay for each level control circuit to reduce the energy in the circuit to the point that no spark is created by switching.

C. Control Panel:

1. Include combination magnetic motor starter(s) with Motor Circuit Protector (MCP) type circuit breaker, NEMA full size contractor with three overload relays and control power transformer (CPT) with two fuses on the primary side and one fuse on the secondary side, for 120 VAC control circuits.
2. Furnish and install locally mounted automatic control panel at location shown on drawings and rated for area classification.
3. Include a terminal board for connection of level sensors.
4. Provide the following features:
    a. NEMA 4X stainless steel watertight enclosure with continuous hinge, neoprene gasket in cover and continuous seam weld. Include locking mechanism complete with padlock.
    b. All exposed components NEMA 4X.
    c. LEAD1 – LEAD2 – ALTERNATE selector switch for Industrial Wastewater Process Pumps and Industrial Wastewater Pumps.
    d. PUMP1 – PUMP2 – ALTERNATE selector switch for Industrial Wastewater Process Pumps.

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e. HAND-OFF-AUTOMATIC selector switches.

f. High and/or low level alarm light.

g. Pump lights – Red running light and green off lights, push-to-test type.

h. Elapsed time meters.

i. Overload reset button to reset overload relays.

j. Condensation heater

k. Moisture detector alarm light and pump shutdown.

l. 100 watt utility light outlet.

m. Rack mountable.

n. Motor over-temperature alarm light and pump shutdown.

o. Horn with silence pushbutton and reset pushbutton for described alarm conditions.

D. Access Doors and Frames (Where Shown on Drawings):

1. Furnish and install single hinged door constructed of aluminum.

2. Furnish size shown on Drawings.

3. Equip with non-sparking upper guide rail support, float bracket, and flush locking mechanism.

4. Door shall be able to remain in open position while work is being performed.

5. Securely place frame above pump(s).

6. Provide doors of skidproof design.

7. Provide doors with snap locks and removable handle.

8. Provide door hardware including latching mechanism and hinges of stainless steel materials.

E. Winch/Jib Crane:

1. Secure a manually operated, cable-type winch capable of lifting the pumps and/or trash basket.

2. Provide winch with a fabricated steel support frame (jib crane) with a minimum capacity of 1.5 times the pump weight for Sanitary Wastewater Pumps and Industrial Wastewater Pumps.

3. Provide winch and fabricated steel support frame for Industrial Wastewater Pumps:

a. Designed to lift 1.5 times pump weight or manually cleaned trash basket (500 LBS) as shown on drawings, whichever is greater, without moving winch and steel frame (jib crane) from base.

b. Designed to lift manually cleaned trash basket a minimum of 65 IN above the wet pit top when measured from the bottom of the trash basket.

c. Designed to swing 360 degree on base.

4. Fit cable end with a grab hook to properly link up with the lifting chain.
5. Designed for foundation shown on drawings.

2.06 SOURCE QUALITY CONTROL

A. Secure from the pump manufacturer the following inspections and tests on each pump before shipment from factory:
   1. Check impeller, motor rating and electrical connections for compliance with specification.
   2. Test motor and cable insulation for moisture content or insulation defects.
   3. Prior to submergence, run pump dry to establish correct rotation, and mechanical integrity.
   4. Run pump for 30 minutes submerged, a minimum of 6 FT underwater.
   5. After operational test #4, perform insulation test (#2) again.

PART 3 - EXECUTION

3.01 INSTALLATION

A. See Section 43 21 00.

B. For wet pit pumps, permanently install discharge connection elbow in wet well along with discharge piping.

C. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.02 FIELD QUALITY CONTROL

A. See Section 43 21 00.

END OF SECTION

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SECTION 43 25 14 - SUBMERSIBLE SLURRY PUMP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Submersible slurry pumps.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Union Pacific Railroad (UPRR) Contract Section.

B. Division 01 - UPRR General Conditions.

C. Section 43 21 00 - Pumping Equipment.

1.03 REFERENCED STANDARDS

A. American Iron and Steel Institute (AISI):

1. Steel Products Manual.

B. ASTM International (ASTM):

1. A48, Standard Specification for Gray Iron Castings.
2. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
3. C1018, Standard Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading).

C. National Electrical Manufacturer's Association (NEMA).

D. Underwriters Laboratories Inc. (UL).

1.04 SUBMITTALS

A. Submit under provisions of section 01 33 00.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable for submersible slurry pumps for wheel truing and drop table sump pits:

1. Galigher.
2. Hazleton.

B. Submit requests for substitution in accordance with Specification Section 01 33 00.

2.02 MATERIALS

A. Submersible Slurry Pump:

1. Pump Casing – High chrome iron and other abrasion resistant metals.

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2. Impeller – High chrome iron and other abrasion resistant metals.
3. Shaft – Carbon Steel, AISI.
4. Strainer – Cast Iron, ASTM A48, Class 35A.
5. Impeller Wear Wings ¬– High chrome iron and other abrasion resistant metals
6. Mechanical Seals:
    a. Tandem seals for added protection.
    b. Tungsten carbide or silicon carbide for leakfree seal in abrasive liquids.
7. Motor:
    a. UL Listed.
    b. NEMA T frame with rugged cast iron housing.
    c. NEMA Design R torque curve for quick starting.

2.03 EQUIPMENT

A. Performance and Configuration Requirements:
    1. Abrasive handling sump pumps:
        a. Pump configuration: Vertical.
        b. Drive type: Constant Speed.
        c. Drive Configuration: Direct Coupled.
        d. Minimum Solids Passage: 7/16 IN through strainer and 9/16 IN through pump.
    2. Performance schedule located at end of this section.

2.04 ACCESSORIES

A. See Section 43 21 00.
B. Controls:
    1. Float switch assembly:
        a. Direct acting mercury float.
        b. Provide start, high alarm and pump stop floats.
    2. Provide float mounting bracket for attachment to sump wall.
    3. Provide float levels:
        a. Pump stop at bottom of pump motor housing.
        b. Pump start at 4 FT-6 IN above sump pit floor.
        c. High alarm at 5 FT above sump pit floor.
        d. Adjust height of floats as required to avoid excessive start/stop operation of pump.
C. Chemical resistant casing.

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1. Electrical connections watertight and impact resistant.
2. Connect float wiring to starter and disconnect at MCC.

2.05 FABRICATION

A. General:
   1. Pump casing uniform and free from blowholes or other defects and designed to withstand 150 percent of shut-off head.
   2. Equipped with bolt-on strainer with solids passage as scheduled.
   3. Double suction design all metal pump for handling heavy slurries.

B. Suction and Discharge:
   1. Abrasive Handling Sump Pumps
      a. Suction: 1-1/2 IN.
      b. Discharge: 1-1/2 IN.

C. Impeller:
   1. Semi-open.
   2. Key to pump shafts with same material as shaft.
   3. Provide positive means of external axial adjustment of shaft and impeller.

D. Mechanical Seals:
   1. Tandem seals for increased protection of electrical components.
   2. Provide thermal protection and moisture detection to alert maintenance and shut pump down.

E. Bearings:
   1. Oil permanently lubricated type.

F. Connections:
   1. Provide cables in length required for proper assembly.
   2. Provide complete set of float controls.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements of Section 43 21 00.

3.02 FIELD QUALITY CONTROL

A. See Section 43 21 00.

END OF SECTION

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SECTION 46 21 19 – CONTINUOUS BELT SCREENS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Industrial wastewater treatment plant equipment for automated trash and debris removal from wastewaters.

1.02 RELATED REQUIREMENTS

A. Section 01 33 00 – Submittals and Substitutions

B. Section 01 33 04 – Operation and Maintenance Manuals

C. Section 01 61 02 - Basic Mechanical Requirements

D. Section 01 61 03 - Equipment Basic Requirements

E. Section 01 61 04 - Electrical Requirements for Mechanical Equipment

F. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

G. Section 26 09 16 – Electrical Controls and Relays (Where supplied by the continuous belt screen Manufacturer)

1.03 REFERENCED STANDARDS

A. American Bearing Manufacturers Association (ABMA)

1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings

2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings

B. American Water Works Association (AWWA):

1. AWWA 10084 – Standard Methods for the Examination of Water and Wastewater

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C. American Welding Society (AWS):

1. AWS D1.1/D1.1M – Structural Welding Code – Steel

D. ASTM International (ASTM)

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel

2. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings

3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

E. National Electrical Manufacturers Association (NEMA)

1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

2. NEMA ICS 4 - Application Guideline for Terminal Blocks

F. National Fluid Power Association (NFLPA)

1. NFLPA T2.13.1 - Recommended Practice – Hydraulic Fluid Power – Use of Fire-Resistant Fluids in Industrial Systems

G. Society of Automotive Engineers International (SAE)

1. SAE J1677 - Tests and Procedures for Carbon Steel and High Strength Low Alloy Steel Tubing

H. Society for Protective Coatings (SSPC):

1. SSPC-SP1 – Solvent Cleaning

2. SSPC-SP10/NACE No. 2 – Near White Blast Cleaning

I. Underwriters Laboratories (UL)

1. UL 98 - Standard for Safety Enclosed and Dead-Front Switches

J. U.S. Environmental Protection Agency (EPA):

1. EPA 600/4-79/020 – Methods for Chemical Analysis of Water and Wastes

1.04 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Shop Drawings shall include principal design criteria and calculated capacities, principal dimensions, all components, location of fittings and anchorage, and coatings. Shop drawings shall be provided in electronic format. One copy shall be in editable AutoCAD computer aided design format (*.dwg) and one copy shall be in portable document format (*.pdf).

C. Spare parts list.

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D. Warranty.

E. Installation, Operation and Maintenance Manuals – One electronic copy and two hard copies. A draft hardcopy manual will be shipped with the unit in order to allow for proper installation, start-up operation and training of Owner's equipment operator prior to the release of all final Installation, Operation, and Maintenance manuals.

F. Installation Contractor's Shipment Examination Report upon receipt of shipment.

G. Continuous belt screen Manufacturer's Pre-Operational Inspection and Test Report.

H. Installation Contractor's/Owners In-Service Test Report.

1.05 QUALITY ASSURANCE

A. Qualifications

1. The continuous belt screen Manufacturer shall have a minimum of five (5) years of experience in design, fabrication, startup and maintenance of continuous belt screens.

2. Manufacturer's personnel employed in the fabrication of the continuous belt screen shall include welders and weld inspectors with endorsements for the applicable AWS D1.1 welding process and positions.

3. Manufacturer's personnel employed in the preparation for, and application of, protective coatings shall be certified by NACE or other protective coating standards agency in the procedures recommended in the coatings manufacturer's instructions.

B. Certifications

1. Manufacturer shall provide certification that the continuous belt screen is compliant with this Section.

2. Manufacturer and/or Manufacturer's personnel shall hold the following current certifications,

a. AWS Welder Certification with applicable D1.1 endorsement

b. AWS Weld Inspector Certification with applicable D1.1 endorsement

c. SSPC QP-3 Certification for Shop Painting

d. NACE NII Certified Coating Applicator

e. NACE Certified Coatings Inspector – Level 2

1.06 DELIVERY, STORAGE, AND HANDLING

A. Shipping

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1. The Manufacturer shall secure components and provide protective coverings that will ensure there will be no damage to the continuous belt screen and components during handling and when securely loaded by transporter. If special handling or storage precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its enclosure(s).

2. The continuous belt screen Manufacturer shall provide transportation of the unit and components to the Owner's site.

3. The installation Contractor shall provide for unloading of the shipment and all components at the time of delivery to the site by the continuous belt screen Manufacturer and storage prior to installation. The installation Contractor will observe the condition of the shipment for defects or damage prior to unloading and report to the Engineer any damages prior to unloading and damages during unloading and installation.

B. Storage

1. The installation Contractor shall store the continuous belt screen and components in enclosures or under protective coverings to provide non-degrading protection during the period between delivery and installation. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing or high temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover. Do not store materials directly on ground.

C. Handling

1. Handle the continuous belt screen in such a manner as to ensure delivery to final location in new, sound, and undamaged condition. Take special care not to damage interior and exterior surfaces of the bars and/or screen, guides, sprockets, gears and other components critical to the sustained life-time operation equipment. The installation Contractor shall make satisfactory repairs to damaged materials at no cost to Owner.

D. Waste Management and Disposal

1. Manufacturer and transporter shall be responsible for disposal and/or recycling of all dunnage, bindings, wrappings and other materials necessary for securing the product and protecting it from degradation or degradation during shipping.

2. To the maximum extent practicable the Manufacturer shall pack components and accessories in recyclable materials for their protection during shipping. The installation Contractor shall be responsible for recycling and/or disposal of non-hazardous shipping wastes.

1.07 SITE CONDITIONS

A. Refer to the Owner's project specific drawings for the site location to be used for the configuration of the continuous belt skimmer and accessories that will prevent failure due to freezing, wind, humidity, dust or other environmental condition.

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B. Refer to the Owner's project specific drawings for site specific installation requirements, including, but not limited to depth of influent pipe, depth of influent channel, and maximum effluent water level.

1.08 SEQUENCING AND SCHEDULING

A. The installation Contractor shall be responsible for inspection of the continuous belt screen upon delivery and unloading of the product.

B. Delivery and unloading of the product shall be coordinated between the continuous belt screen Manufacturer and installation Contractor.

C. The storage location selected by the installation Contractor shall not interfere with Owner's facility operations.

1.09 WARRANTY

A. The continuous belt screen Manufacturer shall warranty the continuous belt screen, its components and accessories to be free from defects in material and workmanship for a period of one year from the date of receipt by the Owner. Limited Warranty shall include:

1. Site work, materials and labor for correction of deficiencies identified during the Pre-operational Inspection and Test, or due to material failure during the first 30 days of in-service operation, or due to failure to comply with the performance specifications. This shall not apply if failure is determined to be caused electrical, controls or other work by others.

2. One-year repair or replacement of the defective part(s).

3. Lifetime protection for structural defects.

4. 20-year protection for interior and exterior corrosion.

B. The warranty shall be submitted before delivery.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Haynes Equipment Company/Parkson, Olathe, KS.

B. Vulcan Industries, Missouri Valley, IA.

C. JWC Environmental, Santa Ana, CA.

2.02 MANUFACTURED UNITS

A. The continuous belt screen shall be the standard product of the Manufacturer with nozzle locations and accessories as noted herein, in the drawings, and as agreed to by Manufacturer and Owner. The continuous belt screen shall be constructed of type 316 stainless steel unless approved by Owner or Engineer.

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B. Frame Assembly

1. All moving components shall have protective guards or interrupt switches to protect employees from injury.

2. The frame of the unit, which is stationary, shall be constructed from type 316 stainless steel with a thickness of 3/16 inch.

3. The "A" frame unit shall be supported at the operating floor elevation by support legs constructed. The legs shall be designed to allow the unit to pivot the screen out of the channel without dewatering (e.g., for bypass purposes).

4. Guide rails shall be mounted to each side on the inside surface of the frame to direct the filter belt during its ascension out of the channel.

5. Chain/screen guides shall be provided at all locations necessary to prevent binding and excess wear of components.

6. Bottom brushes and frame to wall seals shall Viton (FKM) or approved equal that is resistant to No.2 diesel fuel, railroad locomotive engine oil and caustic detergent.

C. Filter Belt/Screen Assembly

1. Each filter element shall be a single molded component with a rake integral to its shape. The filter belt shall form a row of these rakes spaced every 4 inches, capable of lifting material of up to 3 inches in diameter out of the channel.

2. Side plates (or end plates) constructed of type 316 stainless steel or are to be mounted next to the outermost elements of each filter row and overlap to form a continuous moving sidewall for the filter belt to prevent entrance of trash.

3. The tension of the moving screen/filter belt assembly shall be completely supported by a stainless-steel link chain. All chain components shall be corrosion resistant stainless steel. Sidebars shall be type 316 stainless steel.

D. Drive Assembly

1. The drive mechanism shall be protected from the trash stream to ensure that the screen runs smoothly without jamming. The driving force is transmitted to clean, trash free components to avoid mis-tracking or binding, which could render the screen inoperable, requiring manual cleaning and realignment.

2. The drive shaft and sprockets shall be constructed from type 316 stainless steel and welded to the drive shaft.

3. The motor shall be a squirrel cage induction motor, TEFC, 230/460 volt, 3-phase, 60 Hz at 1800 rpm.

4. Overload protection shall be provided by an electrical overload device that senses motor current draw (SSAC Current Monitor or equal).

E. Rotating Brush Assembly

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1. A rotating brush shall be provided for automatic cleaning of the filter elements without need of water.

2. The rotating brush drive shaft shall be chain driven by the filter belt drive shaft and constructed of type 316 stainless-steel.

F. Discharge Chute

1. A discharge chute shall be provided integral to the machine, constructed from 14-gauge type 304 stainless steel and designed to direct the screenings to the collection equipment below.

2. The chute shall have a 1/4-inch-thick flange that shall allow it to be connected to ancillary washing, compacting, and collection equipment.

G. Lubrication

1. Lubrication fittings shall be extended from each bearing housing to be located on the respective side of the machine and accessible by operator without tools or disassembly.

H. Fasteners

1. All fasteners shall be type 18-8 stainless steel.

I. Surface Finishes

1. All stainless-steel frame and structural members will be mechanically cleaned using Dupont StarBlast or equal.

2. Carbon steel components shall be coated per System T-1 in Section 09 97 50.

J. Electrical Devices and Controls

1. No electrical devices and controls

2.03 ASSEMBLY OR FABRICATION

A. The continuous belt screen shall be factory assembled and tested prior to being shipped.

2.04 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements:

1. The following shall apply to all continuous belt screens,

a. The screen shall be capable of presenting a clean filtration surface to the influent stream at all times during continuous operation. It shall be capable of intermittent operation in order to form a mat of material to provide maximum trash removal.

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b. The screen shall provide dual filtration of all materials in order to minimize compaction of captured debris and minimize the head loss through the screen.

c. Element Size shall be 3 millimeters or less.

d. Maximum removable debris diameter shall be 3 inches or greater.

e. The screen angle shall be 75 degrees.

f. Blinding of loaded screens shall not exceed 30%.

g. Wetted elastomers shall Viton (FKM) or approved equal that is resistant to No.2 diesel fuel, railroad locomotive engine oil and caustic detergents.

2. Refer to the Owner's project specific drawings for the following site-specific performance parameters including,

a. Flow Rates

b. Inlet Depth

c. Maximum Upstream Water Level

d. Waste Diameter

2.05 SOURCE QUALITY CONTROL

A. The Engineer and/or Owner may, at their option and own expense, witness the factory test. The equipment will be shipped completely assembled other than the motor/reducer, discharge chute and support legs. It shall be capable of being set in place and field erected by the contractor with a minimum of field assembly.

2.06 MAINTENANCE MATERIALS

A. The following maintenance materials shall be provided by the continuous belt screen Manufacturer in addition to the manufactured unit and its accessories.

1. One container of one lubricant listed for each "Application" in the "Lubrication Chart" of the continuous belt screen Manufacturer's Installation, Operation and Maintenance manual.

2. Sprocket shaft bearings, 2 each.

3. Lower idler bearings, 2 each.

4. Rotating brush, 1 each.

5. Rotating brush bearing, 2 each.

6. Installation, Operation and Maintenance Manuals – 1 each electronic copy and two each hard copies. A draft hardcopy manual will be shipped with the unit in order to allow for proper installation, start-up operation and training of Owner's

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equipment operator prior to the release of all final Installation, Operation, and Maintenance manuals.

PART 3 - EXECUTION

3.01 EXAMINATION

A. If receipt and unloading of the continuous belt screen is performed by other than the installation Contractor, the installation Contractor shall inspect each component of the continuous belt screen for compliance with this Section and the Owner's project specific drawings prior to attempting installation. Redesign or modifications of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive attention for adequacy and suitability.

B. The installation Contractor shall be responsible for preparing utilities, foundation and anchorage for the continuous belt screen as provided in the drawings and continuous belt screen Manufacturer's instructions.

3.02 INSTALLATION

A. The continuous belt screen shall be installed by the installation Contractor according to the continuous belt screen Manufacturer's instructions and project specific drawings.

B. Equipment to lift and place the continuous belt screen shall be of adequate capacity to lift and lower the continuous belt screen without dragging or dropping to ensure there is no damage.

C. Anchorage for mounting the continuous belt screen shall be provided per the according to the Owner's project drawings.

3.03 FIELD QUALITY CONTROL

A. Pre-operational Inspection and Test Report

1. The continuous belt screen Manufacturer shall provide one-time installation and inspection services prior to, or including, introduction of industrial wastewater.

2. The continuous belt screen Manufacturer shall submit Manufacturer's service representative's on-site pre-operational test report. Reports of inspections, operations, adjustments, and tests performed shall be included and have determinations of acceptable or unacceptable conditions. For unacceptable items, describe corrective action taken. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in the installation will render manufacturer's warranty null and void.

B. In-Service Test

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1. After pre-operational tests of the continuous belt screen, equipment and controls have been successfully completed allow influent industrial wastewater to the continuous bar screen. The installation Contractor with Owner's instrumentation Consultant shall adjust the backup timer, level sensor and alarm setpoints to optimize unattended operation. Optimization of the operation shall be completed within (5) working days of introduction of industrial wastewater influent.

2. 1000 ml grab samples of treated wastewater shall be collected from the effluent of the continuous belt screen once per hour for a total of three grab samples. The samples shall be collected by the Owner to be sent to Owner's analytical laboratory for determination of percent passing a No.6 sieve (3.36 mm) and percent passing a No. 7 sieve (2.83 mm). The results of the laboratory test shall be used to estimate the continuous belt screen compliance with this Section and the Owner's project specific drawings. Documentation shall be provided by the Owner to the continuous belt screen Manufacturer and installation Contractor.

3. Should a second site visit be required for warranty work it shall be at the continuous belt screen Manufacturer's expense.

3.04 CLEANING

A. Prior to in-service testing, all surfaces shall be free of oils, dirt and other foreign matter present from manufacturing and installation. Where the installation Contractor has cleaned these surfaces, they shall be inspected for coating damage and shall be repaired with coatings specified herein.

3.05 DEMONSTRATION

A. Training:

1. The continuous belt screen Manufacturer shall furnish the services of an experienced factory representative for five (5) days on-site with a minimum of one trip. The trip shall be used in start-up adjustment process and to instruct the Owner's personnel on proper operation, maintenance, and repair of equipment.

END OF SECTION

SECTION 46 25 13 - DISSOLVED AIR FLOTATION SEPARATION EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Shop fabricated, aboveground, rectangular, carbon steel, dissolved air flotation separation equipment (DAF System), to be provided by the DAF system Manufacturer to the Owner or Owner's Installation Contractor for installation. In general, components of the DAF system included in this section are,

a. Rapid Mixing and Flocculation Tank with agitators and drives.

b. Dissolved Air Flotation Tank with float and sediment removal equipment, and covers,

c. Dissolved Air System with recycle pumps, air saturation and flow rate measurement.

d. Other components located between the influent to the Rapid Mixing and Flocculation Tank to the effluent of the DAF Tank that required for proper operation.

e. Stairs and platform walkway.

B. Section Does not Include:

1. Components and accessories not provided by the dissolved air flotation system manufacturer which are to be provided and installed by the Contractor for the Owner include,

a. Piping from the DAF to the recycle pump skid and from the recycle pump skid to the DAF.

b. Recycle system flow meter.

c. Chemical dosage systems.

d. Motor controls and/or variable frequency drives.

e. Instruments and controls.

f. Electrical and controls enclosures.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions

B. Section 01 33 04 – Operation and Maintenance Manuals

C. Section 01 61 02 – Basic Mechanical Requirements

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D. Section 01 61 03 – Equipment Basic Requirements

E. Section 01 61 04 – Electrical Requirements for Mechanical Equipment

F. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

G. Section 26 09 16 – Electrical Controls and Relays

H. Section 40 05 51 – Valves and Accessories

1.03 REFERENCED STANDARDS

A. American Water Works Association (AWWA):

1. AWWA 10084 – Standard Methods for the Examination of Water and Wastewater

B. American Welding Society (AWS):

1. AWS D1.1/D1.1M – Structural Welding Code – Steel

C. ASME International (ASME):

1. ASME B16.5 – Pipe Flanges and Flanged Fittings, NPS ½ Through 24 Metric/Inc Standard

D. ASTM International (ASTM):

1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel

2. ASTM E165/E165M – Standard Practice for Liquid Penetrant Examination for General Industry

E. Society for Protective Coatings (SSPC):

1. SSPC-SP1 – Solvent Cleaning

2. SSPC-SP10/NACE No. 2 – Near White Blast Cleaning

F. National Association of Corrosion Engineers (NACE):

1. NACE RP 0188-90 – Holiday Testing

G. U.S. Environmental Protection Agency (EPA):

1. EPA 600/4-79/020 – Methods for Chemical Analysis of Water and Wastes

1.04 DEFINITIONS

A. Not used.

1.05 SUBMITTALS

A. Submit as specified in Section 01 33 00.

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B. Shop Drawings shall include principal design criteria and calculated capacities, principal dimensions, all components, location of fittings and anchorage, and coatings. Shop drawings shall be provided in electronic format. One copy shall be in editable AutoCAD computer aided design format (*.dwg) and one copy shall be in portable document format (*.pdf).

1. DAF system including,

a. Rapid Mixing and Flocculation Tank including,

1) Agitators and drives

2) Influent nozzle

3) Compartment drain nozzles

4) Effluent nozzle

5) Scum removal Slotted pipe type scum removal and discharge nozzle

6) Coatings

b. Dissolved Air Flotation Tank including,

1) Float and sediment removal equipment and drives

2) Influent nozzle

3) Compartment drain nozzles

4) Dissolved air system connection nozzles

5) Effluent nozzle

6) Sampling nozzle

7) Process instrumentation connections

8) Coatings

9) Cover with openings for visual observation, instrumentation and venting

c. Dissolved Air System including,

1) Recycle pumps (2 each),

2) Water flow meter model specified by Owner

3) air saturation and flow rate measurement.

4) Bubble eliminator (educator-based systems only)

d. Other components located between the influent to the Rapid Mixing and Flocculation Tank to the effluent of the DAF Tank that are required for proper operation.

2. Accessories including,

a. Identification and instruction plates

b. Nozzle and equipment labels

c. Stairs and elevated platform walkways with handrails

d. Hardware

C. Submittals for Qualifications and Certifications including,

1. Manufacturer and/or Manufacturer's personnel certifications including,

a. AWS Welder Certification with applicable D1.1 endorsement

b. AWS Weld Inspector Certification with applicable D1.1 endorsement

c. SSPC QP-3 Certification for Shop Painting

d. NACE NII Certified Coating Applicator

e. NACE Certified Coatings Inspector – Level 2

D. Submittals for inspections, examinations, testing reports and manuals including,

1. Factory/Manufacturer's Weld Inspection Report

2. Factory/Manufacturer's Hydrostatic Test Report

3. Factory/Manufacturer's Coatings Inspection Report

4. Factory/Manufacturer's Operation and Maintenance Manual for the DAF system

5. Installation Contractor's Examination Report of the Shipment upon Receipt

6. Installation Contractor's Field Hydrostatic Test Report

7. Installation Contractor's Pre-Operational Test Report

8. Installation Contractor's/Owners In-Service Test Report

9. Operation Manual for the DAF system

1.06 QUALITY ASSURANCE

A. Qualifications

1. The DAF System Manufacturer shall have a minimum of five (5) years of current experience in design and fabrication of DAF and mixing systems.

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2. Manufacturer's personnel employed in the fabrication of the DAF system shall include welders and weld inspectors with endorsements for the applicable AWS D1.1 welding process and positions.

3. Manufacturer's personnel employed in the preparation for, and application of, protective coatings shall be certified by NACE or other protective coating standards agency in the procedures recommended in the coatings manufacturer's instructions.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping

1. The DAF system Manufacturer shall secure components and provide protective coverings that will ensure there will be no damage to the DAF system and components during handling and when securely loaded by transporter. If special handling or storage precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its enclosure(s).

2. The DAF system Manufacturer shall provide transportation of the unit and components to the Owner's site.

3. The installation Contractor shall provide for unloading of the DAF system and all components at the time of delivery to the site by the DAF system Manufacturer and storage prior to installation. The installation Contractor will observe the condition of the shipment for defects or damage prior to unloading and report to the Engineer any damages prior to unloading and damages during unloading and installation.

B. Storage

1. The installation Contractor shall store the DAF system and components in enclosures or under protective coverings sufficient to provide non-degrading protection during the period between delivery and installation. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing or high temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover. Do not store materials directly on ground.

C. Handling

1. Handle the DAF system in such a manner as to ensure delivery to final location in new, sound, and undamaged condition. Take special care not to damage interior and exterior surfaces of the DAF system components. Make satisfactory repairs to damaged materials at no cost to Owner.

D. Waste Management and Disposal

1. Manufacturer and transporter shall be responsible for disposal and/or recycling of all dunnage, bindings, wrappings, and other materials necessary for securing the product and protecting it from degradation or degradation during shipping.

2. To the maximum extent practicable the Manufacturer shall pack components and accessories in recyclable materials for their protection during shipping. The installation Contractor shall be responsible for recycling and/or disposal of non-hazardous shipping wastes.

1.08 FIELD {OR SITE} CONDITIONS

1.09 SEQUENCING AND SCHEDULING

A. The installation Contractor responsible for installation of the product shall be responsible for receipt and unloading of the product.

B. Delivery and unloading of the product shall be coordinated between the DAF system Manufacturer and installation Contractor.

C. The storage location selected by the installation Contractor shall not interfere with Owner's facility operations.

1.10 WARRANTY

A. The manufacturer shall warranty the DAF system, its components and accessories to be free from defects in material and workmanship for a period of one year from the date of receipt by the Owner. Limited Warranty shall include:

1. One-year repair or replacement of the defective part(s).

2. Lifetime protection for structural defects.

3. 30-year protection for interior and exterior corrosion.

B. The Warranty shall be submitted before delivery

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with these requirements, provide products by the following:

1. Dissolved Air Flotation Separation Equipment:

a. Environmental Treatment Systems, a subsidiary of Evoqua Water Technologies, LLC., Acworth, GA, 30101.

b. Tenco Hydro, Inc., Brookfield IL, 60513

B. Substitutions for these specifications must receive written approval from the Engineer prior to fabrication, coating and other services provided herein.

2.02 MANUFACTURED UNITS

A. Rapid Mixing Tank with Mixer: The DAF System Manufacturer shall provide a rapid mixing tank designed for two modes of operation. When used for rapid mixing the tank and impeller will be capable of rapid dispersion of cationic polyelectrolytes

(coagulants) and pH altering chemicals (acids or caustic soda). When used for flocculant dispersion the tank and mixer will minimize shear to coagulated particles while dispersing an anionic polyelectrolyte (flocculant). The system shall include a TEFC rated motor to be powered by an installation Contractor provided variable frequency drive, a mounting bracket for an optional pH probe, and mounting bracket in the influent for chemical injection piping.

The Rapid Mixing Tank may be integrally constructed as part of the Flocculation Tank, and the combined Rapid Mixing Tank and Flocculation Tank may be integrally constructed as part of the DAF Tank.

B. Flocculation Tank with Flocculator: The DAF System Manufacturer shall provide a Flocculation tank designed for the agglomeration of waste particles with flocculant into large "floc" for removal in the dissolved air flotation tank. The tank and mixer shall be designed to prevent particle shear during development of floc particles. The system shall include a TEFC rated motor to be powered by an installation Contractor provided variable frequency drive, and a mounting bracket for an optional pH probe.

   The pipe design between the Flocculation Tank effluent and DAF Tank influent shall be configured to limit shearing of floc on exit and sized to limit both turbulent shearing and floc settlement in the piping.

C. Dissolved Air Flotation Tank: The DAF System Manufacturer shall provide a DAF Tank that includes the following,

   1. Wastewater influent piping and effluent piping that uniformly distributes flow throughout the width of the tank to prevent short circuiting.

   2. Influent piping and valves from the Treated Water Recycle and Air Solubilizing System that uniformly distributes and mixes the solution with the wastewater.

   3. A motorized paddle and chain assembly for removal of floating sludge from the DAF Tank separation compartment. The assembly shall include a TEFC rated motor to be powered by an installation Contractor provided variable frequency drive. The DAF tank shall include a sump for accumulation of floating sludge skimmed by the paddle and chain assembly with sludge outlet connection and level transmitter connection.

   4. A motorized screw conveyor assembly for removal of sludge from the bottom of the DAF Tank separation compartment. The assembly shall include a TEFC rated motor to be powered by an installation Contractor provided variable frequency drive.

D. Treated Water Recycle and Air Solubilizing System: This system shall include all components necessary to provide bubble free, solubilized air in treated water that is recycled from the Effluent Compartment to the influent of the DAF Tank.

   The system shall be designed to permit the installation of an installation Contractor provided water flow meter and shall be equipped with redundant recycle pumps, pressure gauges, air flow rotameters, solenoid valves, level controls, air and water valves, and all other necessary components.

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E. Process Instrumentation Connections: Refer to the following process monitoring instruments to be provided and installed by the installation Contractor which require instrument connections provided by the DAF System Manufacturer. Instrument locations shall be proposed in the DAF System Manufacturer's shop drawings for approval by the Engineer.

1. Rapid Mixer Influent pH (Future, AIT-XXXX)

   a. Instrument Type: pH probe Endress and Hauser model Orbipac CPF8 specified on the instrumentation schedule in the project drawings.

   b. Sensor connection provided on the instrument: ¾" MNPT

   c. Sensor connection provided by DAF System Manufacturer: Minimum 1-1/2" FNPT x 6" through cover extending a minimum of 9" into the water. Mount shall provide for tool-less insertion and removal of ¾" to 1" diameter PVC probe extension tube.

2. Recycle Flow Meter (FIT-7508)

   a. Instrument Type: Flow Meter Endress and Hauser model Promag W400

   b. Sensor connection provided on the instrument: 3" flange, ANSI class 150, raised face

   c. Sensor connection provided by DAF System Manufacturer: 3" flange, ANSI class 150, raised face

3. Air Dissolving Pipe Level Switches - Whitewater Systems (LSL7512, LSH7512)

   a. Instrument Type: Tuning Fork Level Switch, Endress and Hauser model FTL 51

   b. Sensor connection provided on the instrument: 1" MNPT

   c. Sensor connection provided by DAF System Manufacturer: Two at 1" FNPT mounted on side of the Air Dissolving Pipe

4. Sludge Hopper Level Transmitter (LIT-7203) – See "Float Sludge Removal Equipment"

   a. Instrument Type: Pressure Type Endress and Hauser model Cerebar PMP71

   b. Sensor connection provided on the instrument: 1" MNPT

   c. Sensor connection provided by DAF System Manufacturer: 1" FNPT mounted on underside of sludge hopper effluent pipe

5. pH and Turbidity Controllers (AIT-7404 and AIT-7401)

   a. Sensor connection ("Monitoring Port") provided by DAF System Manufacturer: One minimum one-inch FNPT fitting mounted in the bottom

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of the DAF Effluent Compartment for water feed to the pH and Turbidity Assembly

F. Coatings: All surfaces shall be prepared for coatings per the recommendations of the coatings manufacturer, but not less than abrasive cleaning to SSPC-SP10 to the recommended profile and removal of oil per SSPC-SP1, particulate and other materials deleterious to the coating system.

Interior and exterior coatings of the Rapid Mixing Tank, Flocculation Tank, DAF Tank, platform/stairway structure, and coatings for other components and piping shall be provided by the DAF Systems Manufacturer and shall conform to the following.

1. Coatings shall be applied by the DAF System Manufacturer at the Manufacturer's shop and shall be free of damage at the time of delivery to the Owner's site.

2. The entire interior of all compartments and all interior contents of the tanks shall be coated in light grey color per Owner Specification 09 97 50 System T-2 with the exception that preparation shall also include solvent cleaning (SSPC-SP1).

3. The exterior of the tanks shall be coated in white color per Owner Specification 09 97 50 System T-1 with the exception that surface preparation shall include near white metal abrasive blast cleaning (SSPC-SP10), solvent cleaning (SSPC-SP1) and third coat/final.

4. Where carbon steel is used for platforms, they shall be coated per Owner Specification 09 97 50 System T-1 with the exception that surface preparation shall include near white metal abrasive blast cleaning (SSPC-SP10), solvent cleaning (SSPC-SP1) and third coat. Handrails shall be safety yellow in color.

2.03 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements: The DAF System

1. The DAF system shall be capable of removing suspended solids and miscible oil and grease from raw industrial wastewater with the aid of coagulation and flocculation chemical treatment, and dissolved air flotation processes.

2. The maximum allowable Total Suspended Solids (TSS) discharged from the DAF System shall not exceed 50 milligrams of TSS per liter of treated wastewater.

3. The maximum allowable Total Oil and Grease (HEM) discharged from the DAF System shall not exceed 30 milligrams of oil per liter of treated wastewater

B. Design Requirements: The DAF system shall be designed and constructed in manner which conforms to regulatory agency requirements for all Agencies Having Jurisdiction (AHJ) at the locations where the DAF system will be installed. AHJs shall include, but not be limited to, occupational safety, fire and hazardous materials safety, and public utilities.

1. Rapid Mixing

    a. Maximum water flow rate of 150 gallons per minute.

    b. Detention time not less than one (1) minute and not to exceed five (5) minutes.

    c. Mean velocity gradient between 150 s^{-1} and 700 s^{-1} with installation contractor provided variable frequency drive.

    d. Type 316 stainless steel impeller.

2. Flocculation

    a. Maximum water flow rate of 150 gallons per minute.

    b. Detention time not less than five (50 minutes and not to exceed 10 minutes.

    c. Mean velocity gradient to prevent shearing of floc is to be between 40 s^{-1} and 80 s^{-1} with installation contractor provided variable frequency drive.

    d. Maximum tip speed shall not exceed five (5) feet per second.

    e. Paddle type flocculator fabricated from Type 316 stainless steel frame and either wood, aluminum or stainless-steel paddles.

3. DAF Tank

    a. Influent Process Connection shall be evenly distributed throughout the width of the tank.

    b. Air in solution is to be injected evenly throughout the width of the tank beneath the influent at a nominal 10% air volume to water volume when the water temperature is 50 degrees.

    c. The untreated water flow rate capacity shall be 150 gallons per minute.

    d. The recycled water flow rate capacity shall be 75 gallons per minute.

    e. The hydraulic loading rate based untreated water plus recycle shall not be less than two (2) gallons per minute per square foot.

    f. The floating solids loading rate shall not be less one (1) pound per square foot.

    g. The settleable solids loading rate shall not be less than three (3) pounds per square foot.

    h. The minimum air-to-solids ration shall not be less than 0.04 pounds air per pound combined oil and suspended solids.

2.04 ACCESSORIES

A. Identification and instruction plates

1. Provide anodized aluminum identification and instruction plates and stamp necessary data listed below. Securely affix plates, in a prominent location, to DAF tank with nonferrous screws or bolts of not less than one-eight (1/8) inch in diameter.

   a. Name of Manufacturer

   b. A unique identification number associated with shop drawings

   c. Dimensions in English Units, including

      1) Manufacturer's maximum processing capacities

      2) Owner specified maximum processing capacities

   d. Design pressure in PSIG

   e. Construction Materials

   f. Year of manufacture

2. Labels having white background with black lettering shall be placed on nozzles as appropriate on the DAF system which state the following:

   a. "IW INFLUENT", includes Rapid Mixer influent nozzle and DAF Tank influent nozzle.

   b. "IW EFFLUENT" includes Flocculation Tank effluent nozzle and DAF Tank effluent nozzle.

   c. "RECYCLE EFFLUENT"

   d. "RECYCLE INFLUENT"

   e. "SLUDGE" at each sludge effluent nozzle

   f. "IW SAMPLE PORT" at each outlet designated for the collection of industrial wastewater samples.

   g. "MONITORING PORT" at each outlet designated for connection of instruments for monitoring water quality including, but not limited to, pH and turbidity monitoring.

3. Signs having White/Red Background reading "DANGER – CONFINED SPACE AUTHORIZED ENTRY ONLY – CONFINED SPACE # _____" on each tank in high visibility locations.

B. Float Sludge Removal Equipment

1. Provide an adjustable chain and paddle system for skimming of floating sludge from the water surface of the DAF Tank to an integral hopper and effluent nozzle. The effluent nozzle shall be minimum six (6) inch RF flange equipped with a one (1)" FNPT threaded fitting on the bottom of the nozzle pipe for connection of an Owner specified pressure sensing level transmitter to be provided by the installation Contractor.

2. The chain and paddle system shall include a 460 VAC, electric powered drive.

3. The pressure sensing level transmitter shall be provided by the installation Contactor.

4. The drive controller shall be provided by installation Contractor.

C. Sediment Removal Equipment

1. A sediment removal system shall be provided for the flotation compartment of the DAF Tank. The sediment removal system shall be removable and may be either chain and paddle, or screw conveyor type. A minimum 3-inch diameter, RF flange nozzle shall be provided for sediment removal.

2. The sediment removal system shall include a 460 VAC, 60 Hz, electric powered drive.

3. The drive controller shall be provided by installation Contractor.

D. Covers

1. Provide a system of covers and a low profile, four-part wire rope sling equipped with latching hooks for handling of the covers by one person utilizing a hoist. Covers shall be applied to the entire area of the top of the Rapid Mixing, Flocculation and DAF Tanks. Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

2. At a minimum provide observation hatches and instrument openings within the covers in the following areas: after influent end, mid-length over each chain with float surface visible, float paddle breach, float hopper, and effluent compartment.

3. Provide a square shape ventilation connection in the effluent cover having an 18-inch by 18-inch opening. Vent is to have one and one-half-inch (1-1/2") flange with one-half-inch (1/2") holes on approximately six-inch (6") centers for connecting exhaust conduit by others.

E. Platform

1. Provide OSHA compliant platforms configured consistent with the Owner's project drawings. Materials shall be chemically resistant to fuels, oils, acidic cleaners and caustic cleaners. The platform walkway height shall match the platform walkway height on the DAF System. Platform walkways shall be hot dip galvanized, serrated surface, raised welded metal bar grating. Stair treads shall be hot-dipped galvanized, serrated surface, raised welded metal bar grating

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as shown on the Owner's project drawings. Handrails shall be included around the perimeter of the platform. Where the distance from the platform to the top of the DAF system tanks is less than the OSHA standard, appropriate protection shall be provided between the platform and DAF system tanks. Handrails shall be coated in safety yellow color consistent with "exterior" coating specified in Paragraph 2.02.A. Ladders shall not be used for platform access.

F. Hardware

a. Bolts, stiffeners, washers, nuts, screw, pins and fittings as required shall be corrosion resistant. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating.

2.05 ASSEMBLY OR FABRICATION

A. Shop Assembly:

1. Upon completion of fabrication, the DAF system with accessories shall be completely assembled in Manufacturer's shop facility and disassemble prior to shipment to ensure efficient final assembly during installation.

2.06 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Prior to applying coatings, the DAF Manufacturer shall perform hydrostatic testing at atmospheric pressure by filling DAF with water in the shop for a minimum of four (4) hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E165/E165M. Acceptable criteria, for the hydrostatic test, is no leakage after 4 hours using a thorough visual inspection for leaks.

2. The factory test shall include assembly and operation of the recycle system and documentation that all components function according to the design requirements.

3. The factory test shall include assembly and operation of the float removal system and documentation that all components function according to the design requirements.

4. The factory test shall include assembly and operation of the sediment removal conveyor system and documentation that all components function according to the design requirements.

5. The factory test shall include assembly of tank covers and access platforms and documentation that all components are fit according to approved shop drawings.

B. Factory Acceptance Inspection:

1. Owner reserves the right to have Owner's Representative or Engineer to perform on site observation of factory tests and acceptance of results.

2.07 MAINTENANCE MATERIALS

A. Manuals

1. Prior to installation of the DAF System, the DAF System Manufacturer shall provide the Owner one hard copy and one electronic copy (*.pdf format) of the Installation, Operation and Maintenance manuals for the DAF System including equipment, valves, instruments, motors, pumps and other components purchased by the manufacturer and supplied as part of the system.

B. Replacement Parts

1. The DAF Manufacturer shall provide the following replacement parts as spares for future maintenance.

a. Supplies of coating components for repair due to damages by the installation Contractor and for Owner's maintenance of internal coatings shall be provided by the DAF Manufacturer. The supplies shall be for both the interior and exterior coating systems adequate to cover 20-square feet. Supplies shall be packed in containers sized to limit degradation in storage and shall be clearly labeled.

b. Flocculator bearings, one set

c. Float Sludge Removal System chain, one each.

d. Float Sludge Removal System paddle with end connectors, two each.

e. Float Sludge Removal System sprocket bearing, two each.

f. Screw Conveyor bearing, two each.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The Owner or Engineer shall inspect each component of DAF System for compliance with requirements. Redesign or modifications of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements. Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.02 PREPARATION

A. To expedite installation, the installation Contractor shall be responsible for preparing utilities, foundation and anchorage for the DAF systems as provided in the Owner's project drawings and DAF system Manufacturer's installation instructions prior to delivery of the DAF system.

3.03 INSTALLATION

A. The DAF system shall be installed by the installation Contractor in accordance with all pertinent federal, state and local codes.

B. Notification to the Authority Having Jurisdiction (AHJ) on the intent to install the DAF system and required documentation for permitting or registration shall be the responsibility of the Owner.

C. Equipment to unload and install the DAF system components shall be of adequate capacity to lift and move the components without dragging or dropping to ensure there are no damages. Use the DAF system Manufacturer's recommended lifting and transportation equipment.

D. The DAF system installation shall be conducted according to the manufacturer's recommendations including anchorage, assembly, adjustments and testing.

E. If not provided by the DAF system Manufacturer the installation Contractor shall seal unused openings with metal plugs if threaded or with gaskets and blind flanges if flanged. As part of the field hydrostatic test all unused sealed opening observed to leak shall be resealed and the hydrostatic test be re-run.

3.04 FIELD QUALITY CONTROL

A. Field Hydrostatic Test

1. After DAF System has been leveled and secured to foundation and components and accessories are in place the installation Contractor with the aid of the DAF System Manufacturer's representative shall hydrostatically test the system at atmospheric and operating pressure to ensure there is no leakage. The duration of the test shall be eight (8) hours beginning with sealing of leaks observed and repaired during filling with water.

B. Pre-operational Inspection and Test Report

1. The DAF System Manufacturer shall submit Manufacturer's service representative's pre-operational test report. Reports of inspections, operations, adjustments, and tests performed shall be included and have determinations of acceptable or unacceptable conditions. For unacceptable items, describe corrective action taken. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in the installation will render manufacturer's warranty null and void.

C. In-Service Test

1. After hydrostatic test and pre-operational test have been successfully completed and the DAF System connected to influent and effluent piping, allow raw wastewater to flow into the DAF System and perform startup testing according to the DAF System Manufacturer's installation, operation and maintenance manual.

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Optimization of the operation shall be completed within (5) working days of completion of the hydrostatic test. The DAF System shall be operated for a minimum of ten volume changes prior to Owner's water quality testing for removal of contaminants. Documentation of test procedures and results shall be provided by the installation Contractor to the Engineer for approval.

3.05 CLEANING

A. Prior to on-site hydrostatic and in-service testing, all surfaces shall be free of oils, dirt and other foreign matter. Where the installation Contractor has cleaned these surfaces, they shall be inspected for coating damage and shall be repaired with the coating system specified herein.

3.06 DEMONSTRATION

A. Training:

1. Provide 16 hours of the manufacturer's technical representative's on-site time equipment set up and for the training of the Owner's personnel, including travel costs.

3.07 SCHEDULES

A. Design, fabrication, and delivery of the DAF System shall be as quickly as possible but shall not exceed 12 weeks from date of Owner's review and approval of the DAF System Manufacturer's shop drawing submittals. The DAF System Manufacturer is not responsible for the duration of the Owner's review and approval.

B. Site preparation described herein shall be completed by the installation Contractor prior to delivery of the DAF System.

END OF SECTION

SECTION 46 25 14 – ABOVEGROUND PARALLEL PLATE COALESCING OIL-WATER SEPARATOR

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop fabricated, aboveground, rectangular, carbon steel, three-phase parallel plate coalescing oil-water separator with oil skimmer, integral oil holding compartment, integral sedimentation compartments, platforms, and replacement parts to be provided by the oil-water separator Manufacturer to the Owner for installation by the installation Contractor.

1.2 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 – Submittals and Substitutions

B. Section 01 33 04 – Operation and Maintenance Manuals

C. Section 09 97 50 – Tank and Pipe Coatings for Fuel and Oil Systems

D. Section 26 09 16 – Electrical Controls and Relays

1.3 REFERENCED STANDARDS

A. American Petroleum Institute (API):

1. API 421 – Monographs on Refinery Environment Control – Management of Water Discharges, Design and Operation of Oil-Water Separators

B. American Water Works Association (AWWA):

1. AWWA 10084 – Standard Methods for the Examination of Water and Wastewater

C. American Welding Society (AWS):

1. AWS D1.1/D1.1M – Structural Welding Code – Steel

D. ASME International (ASME):

1. ASME B16.5 – Pipe Flanges and Flanged Fittings, NPS ½ Through 24 Metric/Inc Standard

E. ASTM International (ASTM):

1. ASTM A36/A36M – Standard Specification for Carbon Structural Steel

2. ASTM E165/E165M – Standard Practice for Liquid Penetrant Examination for General Industry

F. Society for Protective Coatings (SSPC):

1. SSPC-SP1 – Solvent Cleaning

2. SSPC-SP10/NACE No. 2 – Near White Blast Cleaning

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G. National Association of Corrosion Engineers (NACE):

1. NACE RP 0188-90 – Holiday Testing

H. U.S. Environmental Protection Agency (EPA):

1. EPA 600/4-79/020 – Methods for Chemical Analysis of Water and Wastes

1.4 DEFINITIONS

A. Not used.

1.5 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Shop Drawings shall include principal design criteria and calculated capacities, principal dimensions, all components, location of fittings and anchorage, and coatings. Shop drawings shall be provided in electronic format. One copy shall be in editable AutoCAD computer aided design format (*.dwg) and one copy shall be in portable document format (*.pdf).

1. Oil-water separator including,

a. Influent connection

b. Separation compartment

c. Oil holding compartment

d. Sediment accumulation zones

e. Compartment drains

f. Underflow baffle and effluent weir

g. Effluent connection

h. Vent

i. Process instrumentation connections

j. Coatings

2. Accessories including,

a. Identification and instruction plates

b. Lifting mechanism

c. Inlet distribution baffle

d. Passive oil skimming pipe

e. Active oil skimming system control panel

f. Platform

g. Hardware

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C. Submittals for Qualifications and Certifications including,

1. Certification that the oil-water separator is compliant with API 421.
2. Manufacturer and/or Manufacturer's personnel certifications including,
    a. AWS Welder Certification with applicable D1.1 endorsement
    b. AWS Weld Inspector Certification with applicable D1.1 endorsement
    c. SSPC QP-3 Certification for Shop Painting
    d. NACE NII Certified Coating Applicator
    e. NACE Certified Coatings Inspector – Level 2

D. Submittals for inspections, examinations, testing reports and manuals including,

1. Factory/Manufacturer's Weld Inspection Report
2. Factory/Manufacturer's Hydrostatic Test Report
3. Factory/Manufacturer's Coatings Inspection Report
4. Factory/Manufacturer's Operation and Maintenance Manual for the active oil skimmer and control panel
5. Installation Contractor's Examination Report of the Shipment upon Receipt
6. Installation Contractor's Field Hydrostatic Test Report
7. Installation Contractor's Pre-Operational Test Report
8. Installation Contractor's/Owners In-Service Test Report
9. Operation Manual for the Oil-Water Separator
10. Operation and Maintenance Manual for the Active Oil Skimming System

1.6 QUALITY ASSURANCE

A. Qualifications

1. The oil-water separator Manufacturer shall have a minimum of five (5) years of experience in design and fabrication of API 421 compliant oil-water separators.
2. Manufacturer's personnel employed in the fabrication of the oil-water separator shall include welders and weld inspectors with endorsements for the applicable AWS D1.1 welding process and positions.
3. Manufacturer's personnel employed in the preparation for, and application of, protective coatings shall be certified by NACE or other protective coating standards agency in the procedures recommended in the coatings manufacturer's instructions.

B. Certifications

1. Manufacturer shall provide certification that the oil-water separator is compliant with API 421.
2. Manufacturer and/or Manufacturer's personnel shall hold the following current certifications,

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a. AWS Welder Certification with applicable D1.1 endorsement

b. AWS Weld Inspector Certification with applicable D1.1 endorsement

c. SSPC QP-3 Certification for Shop Painting

d. NACE NII Certified Coating Applicator

e. NACE Certified Coatings Inspector – Level 2

1.7 DELIVERY, STORAGE, AND HANDLING

A. Shipping

1. The oil-water separator Manufacturer shall secure components and provide protective coverings that will ensure there will be no damage to the oil-water separator and components during handling and when securely loaded by transporter. If special handling or storage precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its enclosure(s).

2. The oil-water separator Manufacturer shall provide transportation of the unit and components to the Owner's site.

3. The installation Contractor shall provide for unloading of the separator and all components at the time of delivery to the site by the oil-water separator Manufacturer and storage prior to installation. The installation Contractor will observe the condition of the shipment for defects or damage prior to unloading and report to the Engineer any damages prior to unloading and damages during unloading and installation.

B. Storage

1. The installation Contractor shall store the oil-water separator and components in enclosures or under protective coverings sufficient to provide non-degrading protection during the period between delivery and installation. Protect materials not suitable for outdoor storage to prevent damage during periods of inclement weather, such as subfreezing or high temperatures, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover. Do not store materials directly on ground.

C. Handling

1. Handle the oil-water separator in such a manner as to ensure delivery to final location in new, sound, and undamaged condition. Take special care not to damage interior and exterior surfaces of separator, coalescing plates, and associated supports and pipe coatings or linings. Make satisfactory repairs to damaged materials at no cost to Owner.

D. Waste Management and Disposal

1. Manufacturer and transporter shall be responsible for disposal and/or recycling of all dunnage, bindings, wrappings and other materials necessary for securing the product and protecting it from degradation or degradation during shipping.

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2. To the maximum extent practicable the Manufacturer shall pack components and accessories in recyclable materials for their protection during shipping. The installation Contractor shall be responsible for recycling and/or disposal of non-hazardous shipping wastes.

1.8 SEQUENCING AND SCHEDULING

A. The Contractor responsible for installation of the product shall be responsible for receipt and unloading of the product.

B. Delivery and unloading of the product shall be coordinated between the Manufacturer and Contractor.

C. The storage location selected by the Contractor shall not interfere with Owner's facility operations.

1.9 WARRANTY

A. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of receipt by the Owner. The warranty shall be limited to repair or replacement of the defective part(s). Limited Warranty: Lifetime protection for structural defects. Warranty shall provide 30-year protection for interior and exterior corrosion. The 30-year warranty shall be submitted before delivery.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with these requirements, provide products by the following:

1. Parallel Plate Coalescing Oil-Water Separator:

a. Mercer International Inc., Mendham, NJ, USA, (973) 543-9000.

B. Substitutions for these specifications must receive written approval from the Engineer prior to fabrication, coating and other services provided herein.

2.2 MANUFACTURED UNIT

A. Oil-Water Separator

1. The oil/water separator shall be the standard product of the Manufacturer with nozzle locations and accessories as noted herein, in the drawings, and as agreed to by Manufacturer and Owner. The oil-water separation tank and skimmed oil holding compartment shall be constructed of ASTM A36/A36M grade carbon steel sheeting having 3/16-inch minimum thickness and ASTM A36/A36M grade carbon steel structural support frame. Welds shall be in accordance with AWS D1.1/D1.1M to provide liquid tight oil-water separation compartments and skimmed oil holding compartment that will not warp or deform under load. Welders, coatings applicators and inspectors shall be qualified and certified in according to Part 1.06 of this specification. Welds shall be ground sufficiently smooth and weld spatter completely removed to permit full contact of protective coatings.

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2. Influent Connection

    a. Influent connections shall be one ANSI 150# raised face slip-on flange at nominal eight inches pipe diameter with a distinct inlet chamber for equalizing flow turbulence.

3. Separation Compartment

    a. The separation compartment shall consist of an equalization zone and coalescing zone. The equalization zone shall provide a minimum of 45 minutes detention of flow to allow the dispersion of flow, removal of higher buoyancy oils, and removal larger diameter solids prior to entry into the coalescing zone. The coalescing zone shall be equipped with a parallel plate type coalescer.

4. Oil Holding Compartment

    a. Provide an oil holding compartment for accumulation of oil skimmed by both the passive and active oil skimming systems. The oil holding compartment shall be integral to the oil-water separator and equipped with access manways for cleaning, 2-inch (2") raised face slip-on ANSI 150# flange outlet, and instrumentation ports described herein.

5. Sediment Accumulation Zones

    a. The separator shall be fabricated with hopper bottoms in all compartments except the effluent compartment. The hopper sides shall be sloped within a range of five degrees (5o) of the same inclination as the plate pack. Each compartment shall be equipped with a minimum 2-inch diameter, raised face slip-on ANSI 150# flanged sludge removal/drain port placed at the bottom of the hopper. All sediment removal ports shall be accessible from the same side of the oil-water separator.

6. Compartment Drains

    a. Provide means for emptying compartments for maintenance. Sediment removal ports may be utilized as compartment drains.

7. Underflow Baffle and Effluent Weir

    a. Provide a full width underflow baffle between the separation compartment and effluent weir to retain floating oil in the separation compartment. The bottom of the underflow baffle shall provide for the design water flow while retaining the maximum amount of oil possible in the separation compartment.

    b. Provide an adjustable height, standard width effluent weir, with or without end contractions to work in conjunction with the underflow baffle to retain floating oil in the separation compartment, and to be used as a primary flow measurement device.

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8. Effluent Connection

    a. The effluent connection shall be one ANSI 150# raised face slip-on flange at nominal eight inches pipe diameter mounted on facing sidewall of the effluent compartment when viewed from the effluent end of the oil-water separator. The height of the connection shall be placed to permit standard connection to downstream piping.

9. Vent

    a. Provide a four-inch (4") raised face slip-on ANSI 150# flange at influent end of the separation compartment for connection of ventilation duct. The side of the tank on which the vent shall be proposed by the oil-water separator Manufacturer based the location of walkways, platform supports and other potential obstructions to access.

10. Process Instrumentation Connections

    a. Refer to the following process monitoring instruments to be provided and installed by the installation Contractor which require instrument connections provided by the oil-water separator Manufacturer. Instrument locations shall be proposed in the oil-water separator Manufacturer's shop drawings for approval by the Engineer.

        1) Separation Compartment Level Transmitter and Oil Interface (LT-6201A&B)

            a) Instrument Type: Multiple reed switch Electrolab model 2100

            b) Sensor connection provided on the instrument: 2" MNPT hub sensor grip for stainless steel square tube sensor

            c) Sensor connection provided by oil-water separator Manufacturer: Minimum 3" FNPT mounted in cover bracket at top of the separation compartment wall that extends into the separation compartment with opening center at six-inches (6") from interior of tank wall

            d) Bushing for mounting 2" hub sensor grip in bracket to be provided by installation Contractor

        2) Oil Holding Compartment Level Transmitter (LT-6211)

            a) Instrument Type: Pressure Type Endress and Hauser model Cerebar PMP71

            b) Sensor connection provided on the instrument: 1" MNPT

            c) Sensor connection provided by oil-water separator Manufacturer: 1" FNPT mounted on side of oil holding compartment

        3) Oil Holding Compartment Level Switches (LSL-6211, LSH-6211, and LSHH-6211)

            a) Instrument Type: Tuning Fork Level Switch, Endress and Hauser model FTL 51

            b) Sensor connection provided on the instrument: 1" MNPT

c) Sensor connection provided by oil-water separator Manufacturer: Three at 1" FNPT mounted on side of oil holding compartment

11. All surfaces shall be prepared for coatings per the recommendations of the coatings manufacturer, but not less than abrasive cleaning to SSPC-SP10 to the recommended profile and removal of oil per SSPC-SP1, particulate and other materials deleterious to the coating system.

    Interior and exterior coatings of the oil-water separator and coatings for applicable components of the platform shall be provided by the oil-water separator Manufacturer and shall conform to the following.

    a. Coatings shall be applied by the oil-water separator Manufacturer at the Manufacturer's shop and shall be free of damage at the time of delivery to the Owner's site.

    b. The interior of all compartments and all interior contents of the oil-water separator shall be coated in light grey color per Owner Specification 09 90 01 System T-2 with the exception that preparation shall also include solvent cleaning (SSPC-SP1).

    c. The exterior of the oil-water separator shall be coated in white color per Owner Specification 09 90 01 System T-1 with the exception that surface preparation shall include near white metal abrasive blast cleaning (SSPC-SP10), solvent cleaning (SSPC-SP1) and third coat/final.

    d. Where carbon steel is used for platforms, they shall be coated per Owner Specification 09 90 01 System T-1 with the exception that surface preparation shall include near white metal abrasive blast cleaning (SSPC-SP10), solvent cleaning (SSPC-SP1) and third coat. Handrails shall be safety yellow in color.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements: The primary coalescer within the oil/water separator shall strictly adhere to the following performance criteria:

1. Maximum Operating Flow: 150 gpm
2. Factor of safety for design: 200%
3. Design Flow: 300 gpm
4. Maximum specific gravity of Oil: 0.90
5. Maximum insoluble oil loading rate: 200,000 ppm (20%)
6. Maximum Specific Gravity of Sediment: 0.90
7. Maximum diameter of sediment or non-settleable debris: one-half inch (1/2")
8. Minimum diameter of sediment: 0.0041 inches
9. Maximum fluid velocity through plate area: 2.0 ft./min.
10. Maximum Reynold's number: 350.
11. Minimum rise rate not to exceed: 0.55 in./min.

12. Minimum detention time in plate area: 2.0 min.

13. Minimum oil droplet capture capability within the primary coalescer shall be 60 microns at 0.90 specific gravity, 70 deg. Fahrenheit.

14. Nozzle and accessory locations according to the general arrangement drawing.

2.4 ACCESSORIES

A. Identification and instruction plates

1. Provide anodized aluminum identification and instruction plates and stamp necessary data listed below. Securely affix plates, in a prominent location, to separator with nonferrous screws or bolts of not less than 1/8 inch in diameter.

a. Name of Manufacturer

b. A unique identification number associated with shop drawings

c. Dimensions in English Units, including

1) API 421 processing rate in gallons per minute

2) Owner specified maximum processing rate in gallons per minute

d. Design pressure in PSIG

e. Construction Materials

f. Year of manufacture

2. Labels shall be placed on nozzles on the separator which states the following:

a. "INLET"

b. "OUTLET"

c. "RETURN"

d. "USED OIL" at skimmed oil holding compartment pump connections

e. "SLUDGE" at each sludge/drain connection

f. White/Red Background reading "DANGER – CONFINED SPACE AUTHORIZED ENTRY ONLY – CONFINED SPACE #_____" at each skimmed oil holding compartment manway and high visibility location for separation tank.

B. Lifting Mechanism

1. The oil-water separator shall be fabricated with lifting lugs/supports for unloading on delivery and installation. The lifting lug/support system shall carry the total dry weight of the separator and attendant appurtenances. Lifting instructions shall be prominently displayed on a corrosion resistant plate located on the outside of the separator.

C. Inlet Distribution Baffle

1. Provide an easily removable two-stage inlet distribution baffle (304L stainless steel), designed for efficient flow equalization. The baffle design shall conform to recommendations in API publication 421, 1st Edition, Feb. 1990, section

2.2.3.3.2. The baffle shall be easily removable without draining down or

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entering the vessel.

D. Parallel Plate Coalescer

1. The coalescer shall be flat parallel-plate design assembled in "plate pack" configuration for installation and removal as a single component. Laminar flow shall be maintained through the coalescer at the maximum design flowrate.
2. The removable plate pack shall be fabricated to ensure there is no bypass of wastewater flow or leakage around the plates. Replaceable diesel fuel and corrosion resistant elastomeric seals may be utilized to prevent leakage around the plate packs.
3. The plate pack shall be equipped with a low-profile lifting bracket which minimizes the overall height of the plate pack. The plate pack shall be able to be removed in part, or in whole, vertically without any obstructions or requiring non-vertical movement. If segmented, each coalescer plate pack shall be equipped with hoisting rings or lifting connection and guides.
4. The plates shall be Manufacturer's standard grade aluminum spaced no less than three quarters of an inch vertically on crossflow (non-counter current) The plate dimensions (entry view) shall not exceed 24 inches. At no point shall solids or oils have to travel more than 24 inches to exit any plate gap. Plate spacing shall have a uniform right angle plate gap of three-quarters inches (3/4"). Configuration of the plates shall not promote solids buildup on the plates.
5. All coalescer plate shall be easily removable in the field, allowing field adjustment capability of plates, permitting custom modifications of the unit's performance. Minimum field plate gap capability shall be five-sixteenths inches (5/16").
6. The oil-water separator shall be capable of increased capacity in the future by substituting longer coalesce plates for the ones supplied with the unit.

E. Oil Removal System

1. Passive Oil Skimming Pipe
   a. Provide an adjustable oil skimming pipe in the separation compartment with discharge into the skimmed oil holding compartment. The oil skimming pipe shall be sized to skim at a rate to meet or exceed the skimmed oil pump transfer rate of 50 gpm.
2. Active Oil Skimming System
   a. Provide a 120/230 VAC electric powered oleophilic tube type oil skimmer system with debris screen, water decanter, and local control panel. The control panel shall be rated NEMA 4X, 14 GA Type 304 or 316 stainless steel and capable of application of Control of Hazardous Energy/ Lock-Out/Tag-Out device. Mounting for the control panel shall be provided by the installation Contractor.

F. Covers

1. Provide a system of covers and a low profile, four-part wire rope sling equipped with latching hooks for handling by one person utilizing a hoist. Covers shall be applied to the entire area of the top of the oil-water separator. At a minimum

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provide observation hatches or instrument openings within the covers in the following areas: active oil skimmer pulley and decanter, plate pack effluent, passive oil skimmer, oil storage compartment (if accessible), and effluent compartment. Parts subject to wear or requiring adjustment, inspection, cleaning or repair shall be accessible and capable of convenient removal when required.

G. Platform

1. Provide OSHA compliant platforms configured consistent with the drawings. Materials shall be chemically resistant to fuels, oils, acidic cleaners and caustic cleaners. The platform walkway height shall match the existing walkway height. Handrails shall be included around the perimeter of the platform. Where the distance from the platform to the top of the oil-water separator is less than the OSHA standard, appropriate protection shall be provided between the platform and oil-water separator. Handrails shall be removable and coated in safety yellow color consistent with "exterior" coating specified in Paragraph 2.02.A. Ladders shall not be used for platform access.

H. Hardware

1. Bolts, stiffeners, washers, nuts, screw, pins and fittings as required shall be corrosion resistant. Provide materials that are inherently corrosion resistant and not merely treated with a corrosion-resistant coating.

2.5 FABRICATION

A. Shop Assembly:

1. Upon completion of fabrication, the oil-water separator with accessories shall be completely assembled in Manufacturer's shop facility and disassemble prior to shipment to ensure efficient final assembly during installation.

2.6 SOURCE QUALITY CONTROL

A. Factory Tests

1. Prior to applying coatings, the oil-water separator Manufacturer shall perform hydrostatic testing at atmospheric pressure by filling separator with water in the shop for a minimum of four (4) hours. Testing shall be conducted after all seams have been cleaned and all welds have been inspected in accordance with ASTM E165/E165M. Acceptable criteria, for the hydrostatic test, is no leakage after 4 hours using a thorough visual inspection for leaks.

2.7 MAINTENANCE MATERIALS

A. Replacement Parts

1. The oil-water separator Manufacturer shall provide the following replacement parts as spares for future maintenance.

a. One each oleophilic oil skimmer tube matching oleophilic oil skimmer tube provided with the active oil skimmer.

b. Supplies of coating components for repair due to damages by the installation Contractor and for Owner's maintenance of internal coatings shall be provided by the oil-water separator Manufacturer. The supplies shall be for both the interior and exterior coating systems adequate to cover 20-square

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feet. Supplies shall be packed in containers sized to limit degradation in storage and shall be clearly labeled.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Owner or Engineer shall inspect each component of separator for compliance with requirements. Redesign or modifications of equipment to comply with specified requirements, or necessary redesign or modification following failure to meet specified requirements, shall receive attention for adequacy and suitability. This element of inspection shall encompass visual examinations and dimensional measurements. Noncompliance with specified requirements, or presence of one or more defects preventing or lessening maximum efficiency of separator operation, shall constitute cause for rejection.

3.2 PREPARATION

A. As specified in the drawings at locations where the oil-water separator is a replacement or within an existing facility, the installation Contractor shall be responsible for demolition of structures, equipment and utilities that will not be reused for the installation of the new oil-water separator or provided to the Owner for salvage.

B. To expedite installation, installation Contractor shall be responsible for preparing utilities, foundation and anchorage for the oil-water separator as provided in the drawings prior to delivery of the oil-water separator.

3.3 INSTALLATION

A. The separator shall be installed by the installation Contractor in accordance with all pertinent federal, state and local codes.

B. Notification to the Authority Having Jurisdiction (AHJ) on the intent to install the oil-water separator and required documentation for permitting or registering the oil-water separator shall be the responsibility of the Owner.

C. Equipment to lift the tank shall be of adequate capacity to lift and lower the tank without dragging or dropping to ensure there is no damage to the tank or the coating. Lift separator as required without parallel plate packs in place onto level foundation using lifting mechanism provided. Level separator and bolt to supports to prevent hydrostatic uplift and ensure unit stability. Use the oil-water separator Manufacturer supplied lifting mechanisms for lifting and placing the plate packs without damage. Avoid abrupt contact between the plate packs and the separator walls and plate pack supports to avoid damage. The oil-water separator system installation shall be conducted in accordance with manufacturer's recommendations.

D. Anchor separator to the foundation according to the oil-water separator Manufacturer's instructions.

E. If not provided by the oil-water separator Manufacturer the installation Contractor shall seal unused openings with metal plugs if threaded or with blind flanges if flanged. As part of the field hydrostatic test all unused sealed opening observed to leak shall be resealed and the hydrostatic test be re-run.

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3.4 FIELD QUALITY CONTROL

A. Field Hydrostatic Test

1. After separator has been leveled and secured to foundation and parallel plate packs are in place, level effluent overflow weir at elevation specified by manufacturer and hydrostatically test unit at atmospheric or operational pressure to ensure there is no leakage. The duration of the test shall be eight (8) hours beginning with sealing of leaks observed and repaired during filling with water.

B. Pre-operational Investigation and Test Report

1. The oil-water separator Manufacturer shall submit Manufacturer's service representative's pre-operational test report. Reports of inspections, operations, adjustments, and tests performed shall be included and have determinations of acceptable or unacceptable conditions. For unacceptable items, describe corrective action taken. Include detailed descriptions of points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. Include the manufacturer's certificate that equipment conforms to specified requirements and is ready for permanent operation and that nothing in the installation will render manufacturer's warranty null and void.

C. In-Service Test

1. After hydrostatic test and pre-operational test have been successfully completed and the unit has been properly connected to influent and effluent piping, allow influent oil-in-water mixture to flow into the separator filled with water. Adjust and level the passive oil skimmer to optimize unattended oil skimming and minimize water entrainment. Optimization of the operation shall be completed within (5) working days of completion of the hydrostatic test. The oil-water separator shall be operated for a minimum of ten separation compartment volume changes prior to testing for removal of contaminants. Documentation of test procedures and results shall be provided by the installation Contractor to the Engineer for approval.

D. Analytical Methods

1. Treated wastewater samples of the influent and effluent shall be collected by the Owner as part of the in-service test and shall be analyzed by the Owner's approved laboratory. Copies of results shall be provided to the installation Contractor for resubmittal with other testing documentation. Sample collection, preservation and testing methods for shall be in accordance with the current AWWA 10084, APHA standard methods for the examination of water and wastewater, EPA 600/4-79/020, EPA Methods for Chemical Analysis of Water and Wastes, or those substitute methods approved by the authority having jurisdiction or the Owner.

3.5 CLEANING

A. Prior to hydrostatic and in-service testing, all surfaces shall be free of oils, dirt and other foreign matter. Where the installation Contractor has cleaned these surfaces, they shall be inspected for coating damage shall be repaired with coating specified in 2.02.A.

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3.6 DEMONSTRATION

A. Training

1. Manufacturer shall furnish the services of an experienced factory representative for five (5) days on-site with a minimum of one trip. The trip shall be used in start-up adjustment process and to instruct the Owner's personnel on proper operation, maintenance, and repair of equipment.

3.7 SCHEDULES

A. Design, fabrication and delivery of the oil-water separator shall be as quickly as possible but shall not exceed 12 weeks from date of Owner's acceptance of the oil-water separator Manufacturer's quotation or proposal and shall include the oil-water separator Manufacturer's submittals and Owner's review and approval. The oil-water separator Manufacturer is not responsible for the duration of the Owner's review and approval.

B. Site preparation described herein shall be completed by the installation Contractor prior to delivery of the oil-water separator.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Not used

4.2 PAYMENT

A. Not used

END OF SECTION

SECTION 46 33 10 – INDUSTRIAL WASTEWATER CHEMICAL FEED SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Chemical feed systems associated with the treatment of industrial wastewater.

1.02 RELATED REQUIREMENTS (SECTIONS)

A. Section 01 33 00 Submittals and Substitutions

B. Section 01 33 04 Operation and Maintenance Manuals

C. Section 01 61 02 Basic Mechanical Requirements

D. Section 01 61 03 Equipment Basic Requirements

E. Section 01 61 04 Electrical Requirements for Mechanical Equipment

F. Section 40 05 03 Piping Material and Methods

G. Section 40 05 51 Valves and Accessories

1.03 REFERENCED STANDARDS

A. American Water Works Association (AWWA)

1. AWWA B408 – (2018) Liquid Polyaluminum

B. ASME International (ASME)

1. ASME B16.1 - (2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250

2. ASME 16.5 – (2017) Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard

3. ASME B16.11 – (2016) Forged Fittings, Socket-Welding and Threaded

C. ASTM International (ASTM)

1. ASTM D1785 – (2015; E 2018) Standard Specification for Poly Vinyl Chloride (PVC), Plastic Pipe, Schedules 40,80, and 120

2. ASTM F441/F441M – (2013; E 2013) Standard Specification for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80

D. Hydraulic Institute (HI)

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1. HI 9.1-9.5 – (2000) Pumps – General Guidelines for Types, Applications, Definitions, Sound Measurements, and Documentation

2. HI ANSI/HI 7.1-7.5 – (2017) Controlled-Volume Metering Pumps American National Standard for Nomenclature, Definitions, Application, and Operator – B115

E. National Electrical Manufacturers Association (NEMA)

1. NEMA 250 – (2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

2. NEMA ICS 1 – (2000; R 2015) Standard for Industrial Control and Systems: General Requirements

3. NEMA ICS 2 – (2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V.

F. National Fire Protection Association (NFPA)

1. NFPA 70 – (2020) National Electric Code

G. Underwriters Laboratories (UL)

1. UL 50 – (2015) UL Standard for Safety Enclosures for Electrical Equipment

1.04 DEFINITIONS

1.05 SUBMITTALS

A. Submit as specified in Section 01 33 00.

B. Submit manufacturer's performance charts, and pump curves. List of materials, list of equipment, including a complete list of parts and supplies and source of supply. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

C. Submit information for the following

1. Pumps

2. Piping and tubing

3. Valves

4. Control Equipment

5. Electrical Enclosures

D. Shop Drawings

1. Detail fabrication and installation for each chemical feed system.

E. Coordination Drawings

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1. Detail major elements, components and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

    a. Planned equipment layout

    b. Mounting or anchorage

    c. Clearances around equipment.

    d. Equipment and accessory service connections and support details.

F. Manuals

1. Provide O&M manuals for each piece of equipment provided as part of each chemical feed system. Provide 1 copy of each manual in digital and print form.

1.06 QUALITY ASSURANCE

A. Equipment furnished under this Section shall be supplied by a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least five years. Demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers named herein if "or approved equal" is specified.

B. The components and equipment shall be suitable for the chemicals specified as follows:

1. ISC 503PTM: Wastewater Coagulant

2. ISC 256: Wastewater Flocculant, Anionic polyacrylamide

3. ISC DF-10: Silicone Antifoam/Defoamer

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect material and equipment delivered and placed in storage from the weather, excessive humidity and excessive temperature variation, dirt, dust, or other contaminants.

1.08 WARRANTY

A. The manufacturer shall warrant the equipment package for a period of one (1) year from the date of start-up by a manufacturer's representative.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Provide a chemical feed system consisting of a chemical supply storage tank from which the chemical solution is pumped through piping or tubing, as appropriate, to

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the point of application. Include with each chemical feed system controlled volume pumps, tanks, mixers, gauges, calibration columns, back pressure regulators, strainers, pressure relief valves, corporation stop, sight glasses, flow metering devices, check valves, and hand valves as required.

B. Each chemical feed system shall be sourced as a packaged unit from a single vendor.

C. The chemical feed system shall be frame or skid mounted, pre-assembled, piped, wired and tested at the manufacturer prior to installation.

2.02 MANUFACTURERS

A. Provide materials and equipment which are the standard products of a manufacturer regularly engaged in the manufacture of the products and that essentially duplicate items that have been in satisfactory use for at least 5 years prior to bid opening. Equipment must be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site. Submit Service Organization Certificates outlining their location, contact information and qualifications.

B. Approved Manufacturers

1. UGSI Chemical Feed Solutions

2.03 MATERIALS

A. Chemical storage totes and drums and associated chemical shall be supplied by the Owner.

B. Controlled Volume Pumps

1. Provide controlled volume pumps as defined by HI ANSI/HI 7.1-7.5. Each pump must be capable of delivering chemical solution at any rate from the minimum flow rate to the maximum flow rate and be capable of continuous operation at rated capacity. Accuracy must be plus or minus 2 percent over a 100 to 1 range from the required maximum capacity to the minimum pumping rate. Net positive suction head required cannot exceed 90 percent of the net positive suction head available, as installed. Provide in a configuration as simple as practicable to provide equipment isolation, bypass and reliable service and to be readily accessible for inspection, cleaning, adjustment, repairs, and replacements.

2. Each pump shall be a complete assembly including: Valve to provide a priming port, backpressure, anti-siphon, and pressure relief functions. The setting of the pressure relief valve shall be above the system operating pressure.

3. Pumps shall have 4-20mA variable speed input.

4. Pumps shall be capable of manual speed adjustment.

5. Electric Drives for Controlled Volume Pumps

a. Provide with and drive the metering pumps by alternating current electric motor drives.

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b. Electric motor must be of sufficient capacity to operate the chemical metering equipment under all operating conditions without exceeding their rated nameplate current or power, or their specified temperature limits. Provide motors having starting characteristics and ruggedness necessary under the actual conditions of operations or clean-up procedures used in the areas where they are located. Alternating current motors with power rating of 1/3 hp or less must be 115 volts, single-phase, 60-Hz service; motors with power rating in excess of 1/3 hp must be 460 volts, three-phase, 60-Hz service. Electrical features of direct current motors, including the ratings of the motors, must be compatible with the capabilities and ratings of the rectifier controllers with which they are used.

C. Acid Feed Systems

1. Reserved for future use.

D. Primary Coagulant Feed Systems

1. Provide a Coagulant feed system. The feed system shall be an integrated equipment package to automatically meter, dilute, activate and feed solution into the water stream.

2. Supply as a package unit sourced from one vendor.

3. Supply an identical spare pump as part of the packaged system.

4. The system shall be designed to prevent siphoning of chemical into the flow stream or wastewater from entering the chemical feed system.

5. Chemical injection shall be through a corporation stop. The materials of construction of the corporation stop shall be rated for the chemical and pressure ratings of the system.

6. Requirements

a. Controlled Volume Chemical Pump

b. Mix chamber with impeller for dilution of chemical prior to injection

c. Dilution water rotameter and control valve

d. Dilution water solenoid valve

e. Dilution water check valve

f. Neat chemical check valve

g. Differential pressure switch

h. Pressure relief valve and piping

i. Calibration cylinder

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j. System pressure gauge

k. Skid Mounted Electrical Control Panel

1) NEMA 4X Enclosure

2) Relay Logic Controls

3) Switch for On-Off-Remote

4) Indicator light for Run

5) Remote start contact

6) Output contacts for run, loss of dilution water and chemical leak.

7) Pump flow rate display

8) Pump stroke rate display

7. Refer to the equipment schedule for performance requirements.

E. Flocculant Feed Systems

1. Provide a Flocculant feed system. The feed system shall be an integrated equipment package to automatically meter, dilute, activate and feed solution into the water stream.

2. Supply as a package unit sourced from one vendor.

3. Supply an identical spare pump as part of the packaged system.

4. The system shall be designed to prevent siphoning of chemical into the flow stream or wastewater from entering the chemical feed system.

5. Chemical injection shall be through a corporation stop. The materials of construction of the corporation stop shall be rated for the chemical and pressure ratings of the system.

6. Requirements

a. Controlled Volume Chemical Pump

b. Mix chamber for dilution of chemical prior to injection

c. Dilution water rotameter and control valve

d. Dilution water solenoid valve

e. Dilution water check valve

f. Neat chemical check valve

g. Differential pressure switch

h. Pressure relief valve and piping

i. Calibration cylinder

j. System pressure gauge

k. Skid Mounted Electrical Control Panel

1) NEMA 4X Enclosure

2) Relay Logic Controls

3) Switch for On-Off-Remote

4) Indicator light for Run

5) Remote start contact

6) Output contacts for run, loss of dilution water and chemical leak.

7) Pump flow rate display

8) Pump stroke rate display

7. Refer to the equipment schedule for performance requirements.

F. Foam Control Feed Systems

1. Provide a foam control feed system. The feed system shall be an integrated equipment package to automatically meter, and feed solution into the water stream.

2. Supply as a package unit sourced from one vendor.

3. Supply an identical spare pump as part of the packaged system.

4. The system shall be designed to prevent siphoning of chemical into the flow stream or wastewater from entering the chemical feed system.

5. Chemical injection shall be through a corporation stop. The materials of construction of the corporation stop shall be rated for the chemical and pressure ratings of the system.

6. Requirements

a. Controlled Volume Chemical Pump

b. Differential pressure switch

c. Pressure relief valve and piping

d. Calibration cylinder

e. System pressure gauge

f. Skid Mounted Electrical Control Panel

1) NEMA 4X Enclosure

2) Relay Logic Controls

3) Switch for On-Off-Remote

4) Indicator light for Run

5) Remote start contact

6) Output contacts for run and chemical leak

7) Pump flow rate display

8) Pump stroke display

7. Refer to the equipment schedule for performance requirements.

G. Controls

1. Provide the chemical metering equipment with the appurtenances and accessories, as required, for flow capacity adjustment. Provide manual range adjustment on all systems.

a. Automatic Control: Provide automatic control with the capability to vary feed rate based on signals from a flow, or pH meter or controller.

b. Flow meter and Controller: Provide flow meter and controller capable of varying the chemical dosage in proportion to the measured flow with the dosage per flow unit manually adjustable.

c. pH Probe: Provide pH probe and locate the pH probe where indicated. Supply probe capable of varying the chemical feed rate in response to the deviation from set point.

d. Semiautomatic Control: Provide semiautomatic control with the capability to automatically start and stop the chemical metering equipments. The pump start and stop must respond to flow switch or pump operation or timer status. Install flow switch for semiautomatic operation in the pipe line upstream of chemical injectors.

e. Manual Control: Provide nonautomatic control with the capability for starting or stopping the chemical metering equipment and adjustment of the solution feed rate by the operator.

H. Calibration Columns/Standpipes

1. Provide chemical metering equipment with a calibration standpipe for measuring pump output. The standpipe must allow convenient observation of the change of fluid level for at least 1/2 minute at full stroke and maximum speed settings, and of Schedule 80, clear PVC pipe conforming to ASTM D1785 with Schedule 80

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fittings equipped with a flanged connection to the pump manifold and an end cap fitted with a PVC vacuum breaker and ball valve for air venting. The standpipe must have a clear, observable length of at least 12 inches and be permanently calibrated in gallons and fractions thereof, to allow reading of the fluid contents with an accuracy of 1 percent.

I. Valves for Chemical Feed Systems

1. Metering Pump Valves

a. Equip the metering pump with adjustable internal vacuum and pressure relief valve, hydraulic oil refill valve, and automatic air bleed valve. The relief valve must be adjustable over the full pressure range of the pump and preset at the factory.

2. Suction and Discharge Valves

a. Fit suction and discharge valve cartridges with ball checks that open to full pipe diameter.

3. Back Pressure Valve

a. Install back pressure regulating valve on the pump discharge and factory adjust to crack open at the indicated pressure. Provide spring opposed diaphragms with loading pressures adjustable by means of a screw in the top works.

4. Pressure Gauges

a. Provide diaphragm type gauges with Bourdon tube and diaphragm compartments filled completely with oil, and made of materials suitable for the application. Install diaphragm seals at each gauge connection to isolate gauges from corrosion, sludge or other hazards of the process fluid. Provide seal material that is compatible with the oil in the gauge and the process fluid.

5. Injectors

a. Introduce injectors for chemical solution into the pipeline mains by means of a suitable diffuser tube inserted through a corporation cock. Construct the device for introducing the solution into a pressure main in such a way that accidental breakage of discharge hose or tubing does not cause water to escape from the pipeline, and allows disassembling of the unit without leakage.

6. Piping

a. The piping systems shall be suitable for the services specified and intended. Each piping system shall be coordinated to function as a unit. Flanges, valves, fittings and appurtenances shall have a pressure rating no less than that required for the system in which they are installed.

b. Chemical Solution Piping

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1) Incorporate provisions to allow solution piping to be conveniently and safely bled of trapped air and minimize infiltration of air bubbles.

2) Piping Smaller than 1-1/2 inch Diameter

a) Chemical solution piping smaller than 2 inch diameter must be PVC pipe conforming to ASTM D1785 or CPVC pipe conforming to ASTM F441/F441M, or polyethylene tubing. Provide plastic fittings for plastic pipe with threaded joints. Make joints for polyethylene tubing using a clamp-type mechanical coupling.

7. Electrical Work

a. Provide electric motor-driven equipment complete with motor, motor starter, and controls. Implement hazard classifications in accordance with NFPA 70.

b. Motor Starters

1) Provide motor starters complete with thermal overload protection and other appurtenances necessary for the motor control specified.

c. Control and Protective Devices

1) Provide manual or automatic control and protective or signal devices required for the operation and any control wiring required for controls and devices. Provide motor controls conforming to NEMA ICS 1 or NEMA ICS 2. Prewire equipment to the maximum practicable extent. Control cabinets must conform to the requirements of UL 50, NEMA 250, Type 4.

8. Equipment Appurtenances

a. Provide galvanized steel, cadmium plated or Type 316 stainless steel bolts, nuts, anchors, washers and all other types of supports necessary for the installation of the equipment.

2.04 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance Requirements:

1. Capacity and features of the chemical feed systems and accessories must be suitable for 24-hour full load service in ambient, non-freezing conditions.

2. Select and fabricate the pumps in accordance with HI ANSI/HI 7.1-7.5 and HI 9.1-9.5 except as modified.

2.05 MAINTENANCE MATERIALS {OR EXTRA STOCK}

A. Each chemical feed system shall be supplied with an identical spare controlled volume pump.

B. Supply each peristaltic pump with 1 extra set of pump hoses.

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C. Supply 1 additional pH probe on installations requiring a pH probe.

PART 3 - EXECUTION

3.01 EXAMINATION

A. After becoming familiar with details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.02 PREPARATION

A. Chemicals are owner provided and site dependent. Verify with the owner the chemicals that will be used in the chemical feed systems prior ordering equipment.

3.03 INSTALLATION

A. Submit detail drawings containing complete piping, wiring, schematic, flow diagrams, and any other details required to demonstrate that the system has been coordinated and properly functions as a unit. On the drawings show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearances for installation, maintenance and operation.

B. Chemical Feeding Equipment

1. Install controlled volume pumps, equipment, and appurtenances to provide a complete and integrated system in accordance with the instruction of the manufacturer and under the direct supervision of the manufacturer's representative.

3.04 FIELD QUALITY CONTROL

A. Field Tests:

1. After installation of each controlled volume pump, carry out operating tests as specified below to assure that the chemical metering installation operates properly. If any deficiencies are revealed during any tests, correct such deficiencies and reconduct the tests. Submit reports of all tests in booklet form prior to final acceptance of the installation. Show all field tests performed to adjust each component and all field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Indicate in each test report the final position of controls.

2. Controlled Volume Pumps – Operational Tests

a. Test pumps to demonstrate that the pumps are capable of operating without vibration or leakage. Perform testing at the pump's maximum flow rate and at half the flow rate. Demonstrate testing while controlled and operated in all feasible modes with the pumps operated singly and in unison. Plot the response of each pump on curves for the various operating pressures encountered and the results compare to the curves shown on the manufacturer's published pump data

3. Controlled Volume Pumps – Time, Volume and Pumping Pressure Tests

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a. Test pumps by filling the calibrated column/standpipe or a portable calibrated standpipe furnished by the Contractor with chemical and measuring the outage, with all other equipment valved off. Record the time, volume and pumping pressures.

4. Flow Tests

a. Test pumps to demonstrate zero gpm flow at a zero stroke or speed setting. Failure to meet this test is cause for rejection. Test pumps through full range of required performance. Submit test results to prove pump functions within specified system parameters.

B. Chemical Waste

1. Neutralize chemicals wasted during testing procedures to achieve a pH value between 6.5 and 9.5 and a chlorine concentration of not more than 1 percent (10,000 mg/L). Route all chemicals wasted during testing procedures as directed by the Owner to the sanitary sewer or through the treatment process at a rate that the process can assimilate without upset.

3.05 DEMONSTRATION

A. Training:

1. Provide training for a total period of 8 hours of normal working time and start after the system is functionally complete but prior to final acceptance tests. Cover all of the items contained in the Operating and Maintenance Instructions during field training.

2. Training shall be provided by of a manufacturer's representative who is certified by manufacturer in the installation, adjustment, and operation of the equipment specified. The representative must supervise the installation, adjustment, and testing of the equipment.

B. Operating Instructions

1. Submit complete copies of operating instructions outlining the step-by-step procedures required for system startup, operation and shutdown. Include in the instructions the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Also include in the instructions as-built drawings of the piping layout, equipment layout, simplified wiring and control diagrams of the system as installed, and flow diagrams.

2. Supply copies of the instructions in print and digital pdf format.

C. Maintenance Instructions

1. Submit complete copies of maintenance instructions listing routine maintenance procedures, possible breakdowns and repairs, and trouble-shooting guides.

2. Supply copies of the instructions in print and digital pdf format.

END OF SECTION

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