MAY 2026
PROJECT NO. 225096-001

CITY OF PENDLETON

TECHNICAL SPECIFICATIONS

WWTRRF 2025 IMPROVEMENTS

Operational Buildings

Volume 2

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TECHNICAL SPECIFICATIONS

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TABLE OF CONTENTS

VOLUME 1

TECHNICAL SPECIFICATIONS

DIVISION 07 – THERMAL & MOISTURE PROTECTION

DIVISION 08 – OPENINGS

DIVISION 09 – FINISHES

DIVISION 10 – SPECIALTIES

DIVISION 13 – SPECIAL CONSTRUCTION

VOLUME 2

TECHNICAL SPECIFICATIONS

DIVISION 22 – PLUMBING

DIVISION 23 – HVAC

APPENDICES

VOLUME 3

DRAWINGS (BOUND SEPARATELY)

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SECTION 22 00 00 - PLUMBING, GENERAL

1. GENERAL

1.1 WORK INCLUDED

A. Furnish all labor, material and equipment as required for the installation of all plumbing, fixtures and related accessories.

B. Piping, apparatus and equipment are shown on the Project Plans at approximate locations only. Change locations to suit the job conditions, as directed by the Engineer, or rearranged as required for built-in fixtures or equipment. Install all parts of the system to avoid obstructions, preserve headroom (8 feet 0 inches minimum), and to keep openings and passageways clear. Install a commercial water hammer arrester in the water supply system.

C. No holes are to be made in any structural member without the Engineer's written consent. Where pipes pass through any structural member, or where notching, boring or cutting of structure, if necessary, the Contractor shall proceed as directed by the Engineer.

1.2 REFERENCE STANDARDS

A. Comply with all local and state plumbing codes.

B. All applicable code laws and regulations governing or relating to any portion of this work are hereby incorporated into and made a part of these specifications.

1.3 SUBMITTALS

A. Submit Shop Drawings in accordance with Section 01 33 00 – Submittal Procedures.

B. Where cutting of concrete, masonry, or wood or work by other trades is required, furnish information for all openings, recess and chases for plumbing.

C. Submit water system and DWV system isometrics including pipe sizes, fittings, and interconnections. Isometrics may be hand drawn or computer generated and represent a diagrammatic layout of the systems in accordance with the local and state plumbing code.

2. PRODUCTS

2.1 GENERAL

A. All fittings, fixtures and piping are to be lead free, per NSF 61 and NSF 372.

B. All pipes are to be properly graded, according to the applicable plumbing code, and securely supported with pipe brackets and insulating strips to prevent transmission of noise through pipes.

C. Provide drain valves at low points of water systems, and any other piping and connections to obtain a complete and workable system. Such systems shall be provided with shutoff and drain valves at low points, with continuous grade down to drainage points to enable evacuation of the piping back to a safe location.

D. All hot and cold-water piping is to be insulated, except for short, exposed fixture connections. Provide ½" preformed polyethylene insulation with vapor barrier.

E. Plumbing piping, fixtures, specialties, and equipment shall be installed as recommended by the manufacturer for the intended usage.

F. Floor sinks shall be provided for all equipment drains. No equipment drains shall discharge to floor slabs.

2.2 DOMESTIC PIPING

A. For Process Piping refer to Division 40 for more information.

B. Pressurized Systems (Above-ground): All above-ground domestic pipe and fittings, in accordance with the Drawings, shall be one of the following:

1. Type L, hard drawn copper tube with wrought copper fittings and lead-free solder joints.

2. PEX tubing with crimp type (1-1/4" or smaller) or expansion joints (1-1/2" or larger).

a. PEX shall be supported every 32 inches using Sioux Straps or approved equal.

b. Protect PEX tubing with foam wrap at slab penetrations or when near concrete.

c. Provide nail plates at wall stud penetrations.

d. Contractor shall provide to the Owner: PEX crimping tools, expansion tools, or similar, for all pipe sizes installed and utilized on the project.

C. Pressurized Systems (Below-ground): All below ground domestic pipe and fittings in accordance with the Drawings, shall be one of the following:

1. Water service piping shall be polyethylene (PE) NSF 61 and NSF 14 certified. It shall be rated for 200 psi and manufactured in accordance with ASTM D3035 and AWWA C901. Fittings shall be brass mechanical pack joint type per ASTM B584 and NSF 61, equipped with compression-type connections, internal gripping rings and sealing gaskets. All fittings shall be rated for 200 psi and manufactured by Ford Meter Box, A.Y. McDonald, or approved equal.

a. Inside buildings, only one connection is allowed prior to transitioning to an approved material.

2. PEX tubing, reference Part 2.2 B.2 above.

D. Pressurized Hydronic Systems: Unless otherwise specified or indicated, all hydronic piping shall be as follows:

1. Schedule 80, Chlorinated Polyvinyl chloride (CPVC) pipe with solvent weld fittings anchored in molded schedule 40 PVC fittings with spigot ends. Pipe shall be rated for not less than 160 degrees Fahrenheit. Pipe shall be NSF approved.

2. Pipe shall be fully insulated and jacketed in PVC pipe. Fittings shall be insulated. If pipe is below ground, insulation and jacket shall be approved for buried applications.

3. Expansion Joints

a. Expansion joints shall have 12" of travel and shall be provided and installed every 60 feet at minimum. For buried expansion joints, provide a four-foot section of 6" PVC pipe as a carrier pipe. Install with Fernco caps and drill to size of CPVC pipe penetration.

b. Expansion joints shall be internal slip with gaskets. Bellow type expansion joints are not allowed.

c. Install expansion joints with 50% insertion to allow for positive or negative movement after installation.

d. Expansion joints shall be Spears or approved equal.

4. Pipe and fittings shall be Temp-asure or approved equal.

E. Drain, Waste & Vent Systems : Unless otherwise specified or indicated, all drain, waste and vent piping and associated fittings shall be as indicated below:

1. Schedule 40 cellular core PVC (ASTM F 891), PVC socket fittings (ASTM D2665) with solvent cemented joints and purple primer.

F. Pipe Materials shall be as specified in respective specifications.

G. Vent piping passing through the roof shall be flashed. Flashing shall be per roofing manufacturer's requirements for metal roof systems.

2.3 DOMESTIC FITTINGS

A. All fittings shall be as specified in related pipe specification sections and plans.

B. Nipples: Material shall be same as pipe except that when unthreaded part is less than 1-1/2 inches long, use extra strong pipe for nipple. Use of close nipples is not approved.

C. Unions: For pipe 2-1/2 inches and smaller, use screwed type, unless otherwise indicated. Over 2-1/2 inches use flange type unions.

D. Water Hammer Arrester: A commercial water hammer arrester shall be installed in the water system at an indoor location protected from freezing. The water hammer shall be ASSE 1010-2004 certified and shall be the same pipe size as the pipe it is installed in or 1". The water hammer arrestor shall be effective when installed at any angle. The commercial water hammer arrester shall be Sioux Chief Hydra-Rester or approved equal.

E. Water Supply Stops: Provide 1/2-inch solid bronze, chrome plated with wheel, globe or angle pattern handle, where appropriate. Applications include sinks, lavatories, toilets, etc. Approved models include Oatey 1/4 -turn stop valve or approved equal. Joints shall be compression type.

F. Cleanouts: Cleanouts are to be provided as shown on the Project Plans. Underground or concealed cleanouts are to be brought to floor level or grade, to accessible locations with access covers and frames. Clean outs shall have a minimum diameter of 3-inches. Stack cleanouts shall be installed at the base of each stack. Cleanouts material shall match the material to which they serve and include a removable plastic plug. Wall cleanouts shall have a flush plug and be covered with a chrome plate.

G. Access Covers And Frames: All inaccessible valves, controls, trap primers, cleanouts, etc., are to be made accessible by means of access doors in ceilings, walls, or floors. Access covers and frames for valves, cleanouts, etc., shall not be smaller than 8-inch by 8-inch, as manufactured by Zurn; Josam; WADE; J.R. Smith, or nickel-bronze, with hinged cover. The floor access covers in unfinished concrete floors, not exposed to chemicals, may be of galvanized cast iron, as manufactured by Alhambra Foundry Company Model A-2015; Neenah Foundry Co., No. R-6660, or equal.

H. Hydronic air release valve: hydronic air release valves are to be provided at high points or where shown on the project plans. Air release valves are to be installed in an accessible location and ¾". Air release valves shall be rated for the same operating temperature and pressure as the pipe they are installed in. Manufacturers shall be Watts, Bell & Gossett, or equal.

2.4 VALVES

A. Water shut off valves shall be the ball type, except on fixture supply piping where globe valves shall be used. Valve material shall be compatible with pipe material.

B. The Contractor shall provide shutoff valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system. Shut off valves shall be placed on all hot and cold water connections to equipment, fixtures, bathroom groups, and prior to chases.

C. Valves shall open by turning counterclockwise and shall have suitable handwheels or nuts as required.

D. Provide a temperature and pressure relief valve for each water heater. Provide pressure relief valves at other locations where indicated. Relief valves shall be equipped with manual test levers. The Contractor shall provide piping to convey relief valve discharge to the nearest floor drain, the building exterior, or elsewhere if approved by the Engineer.

2.5 TRAP PRIMERS:

A. Trap primer sizes and locations shall be as shown on the Project Plans.

B. Where required by code, floor drains and floor sinks connected to the sanitary sewer shall be protected by trap primers connected to the water supply to the nearest plumbing fixture. One half-inch copper tubes shall run from the primers to the traps. Trap primers shall be mounted in accessible locations. Furnish and install the trap seals and primers, as manufactured by Zurn (Model Z-1022; WADE; Josam (Model 88250), or J.R. Smith (Model 2699); or equal.

2.6 PROTECTIVE COATINGS

A. All ferrous metal, except finished, galvanized and machine surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 90 00 – Painting and Coating. Prime colors shall be compatible with finish coats to be applied in the field.

B. Self-contained units such as wall-mounted hose racks shall be supplied with factory applied finish coats of baked enamel.

C. Field painting shall comply with Section 09 90 00 – Painting and Coating.

3. EXECUTION

3.1 GENERAL

A. Obtain all required plumbing permits for the project. Coordinate testing and inspection with the local Authority Having Jurisdiction.

B. Install all piping, fixtures, equipment, and accessories in accordance with the local adopted plumbing code, rules, and regulations of the State and local municipality, whichever represents the more stringent standard.

C. The plans do not attempt to show exact details of all piping, and no extra payment will be allowed for obstruction by work of other trades or local obstructions to the work under this contract which require offsets where diagrams have been made to show piping connection. These diagrams must not be used for obtaining material quantities. Changes in location of equipment or piping, advisable in the opinion of the Contractor, will be submitted to the Engineer for approval before proceeding with the work. Verify all measurements and dimensions at the site. Adjust all equipment and leave it in a condition satisfactory to the Engineer.

D. Pipe sizes shown on the Plans are inside dimension of piping installed unless noted otherwise. Provide all piping which passes through walls, floors, or ceilings with standard weight pipe sleeves. Provide all pipes which pass through finished walls with chrome-plated canopy flanges. Pipe sleeves installed in water-holding basins are to have a 1/4-inch steel seep ring, 4 inches larger in diameter than the OD of the sleeve. Continuously weld ring to sleeve. Make joint between pipe and sleeve watertight with non-shrink lightweight grout as shown in the plans. Dry pack sleeves in existing work in place and provide a finished appearance.

3.2 WORKMANSHIP AND MATERIALS

A. All work shall in strict accordance with the current adopted local and State Plumbing Codes and any other Authorities Having Jurisdiction. The Contractor shall have the required certifications and be thoroughly familiar with the local codes prior to bidding.

B. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and erection of piping and placing of equipment. The Contractor shall remove all stains and repair all damage before final acceptance of the Work.

C. If the Engineer finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the Contractor has furnished proof that said items conform to the Specifications. Adequacy and extent of such proof will be determined by the Engineer.

3.3 OPENINGS

A. The Contractor shall provide all necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the buildings. Openings shall be as indicated or as required to provide passage for the plumbing work.

3.4 WATER SUPPLY DISTRIBUTION

A. Hot and Cold-Water Supply: Provide a distribution system from water service to fixtures as indicated in plans. Connect to fixtures and equipment requiring hot and cold water, including mains, risers, branches, gate, ball and check valves, and other specified parts under fixtures herein. When water service is greater than 80 psig, provide an approved lead-free pressure reducing valve. Provide backflow preventers as indicated in the project plans. Where indicated in the plans, install individual mixing valves at single spigot lavatories and sinks, setting them to provide a 105°F water supply. Refer to the project plans for more information.

B. Drain Water Supply Piping: Where indicated on the plans, grade horizontal piping at uniform slope of 1/4-inch in ten feet minimum, into low points for the purpose of emptying piping of water when needed. Where constant pitch cannot be maintained for long runs, establish intermediate low point and rise to new level. Grade branches to drain to main. At bottom of rise, at low points, provide 3/4-inch brass hose bib valves.

3.5 DRAINAGE SYSTEM

A. Provide building drainage system complete with cleanouts; building cleanout; soil, waste and vent stacks, extended through roof and flashed; branch piping and fixture traps; fixture connections, floor drains, and all requiring soil, waste, drain, and vent facilities.

B. Drainage Specialties: Floor drains for toilet and other like areas in waterproof floors for trap; cast iron, adjustable chrome plated brass strainer, double drainage flange with weep holes, flashing clamp device.

C. Traps: Provide traps for fixtures and other equipment requiring connections to drainage system, except where trap is an integral part of unit design. Refer to the project plumbing fixtures schedules in the plans for trap type, size, and finishes for more information. Set traps as close as possible to fixtures and equipment. Tail pieces for buried traps shall be no longer than 2-ft.

D. Building Cleanout: Set building cleanout flush with the finish grade in the location shown on the Plans.

E. Floor Drains: Provide drains complete with deep seal P-traps where required. Install so that the double drainage flange is cast into the floor concrete.

F. Cleanout, Access Covers: Provide cleanouts where indicated and if not indicated, in following locations: at junction of building drain with building sewer, at points of change in direction in horizontal drains greater than 135°, at intervals of 50 feet in long horizontal runs; at the base of soil and waste stacks, and branch drains more than 5-ft from the building drain.

G. Roof Stack Terminal: Provide flashing for stacks passing through roofs according to roof manufacturer's requirements.

H. For Threaded Pipe: Provide cast iron recessed pipe coupling with double threads to connect stack to its extension with a recessed portion to extend over flashing which will serve as counter flashing or rain guard; from recessed coupling enclosed in chimney, carry stack extension to heights above as directed. Paint extensions above on prime and one finished coat asphalt paint outside and at least 12 inches down from top inside page.

3.6 PIPING INSTALLATION

A. Arrange, install piping approximately as indicated, straight, plumb and as directed as possible; form right angles or parallel lines with building walls. Pipes close to wall partitions, ceilings; offset only where necessary to follow walls as directed. Locate groups of pipes parallel to each other; space at distance to permit applying full insulation and to permit for service valves.

B. Routing: Install horizontal piping as high as possible without sags or humps. Grade water piping as specified under Water Supply Distribution. Grade drainage piping in uniform slope of 1/4-inch per foot minimum; where this is possible, maintain slopes as directed, but in no case less than 1/8-inch per foot.

C. Fittings: Where changes in pipe size occur, use only reducing fittings. For drainage piping changes in direction, use long sweep, where possible, otherwise short sweep 1/4 bends, or combination Y and 1/8 bends, also Y's or combination with other bends; use sanitary T branches only for horizontal branches discharging into stacks.

D. Unions: Provide unions, screwed or flanged, where required and in following locations if not indicated: In long runs of piping in water supply or other services, except drainage at intervals to permit convenient disassembling for alteration, repair; In bypasses around equipment; Connection to hot water heaters, pumps, or other equipment requiring disconnection for replacement. Locate between shut-off and equipment.

E. Valve: Locate valves for easy access and operation; where concealed, provide access doors. Do not locate valves with stems below horizontal. All valves and appurtenances used in connection with the gas and vacuum shall be of a type designed and approved for use with fuel gas.

F. Concealed Piping: Where so indicated or specified, conceal piping in building construction or underground. Install such piping with minimal delay to work of other trades and allow ample time for tests and approvals; do not cover before approval is obtained. Keep fixture branches concealed to points above floor close to fixtures; expose only as much as necessary for final connection.

G. Pipes Over Electrical Equipment: Avoid locating water and drain piping over electrical equipment; where this is unavoidable, obtain permission to do so; provide drip pan under such pipes.

H. Protect Open Piping: Keep piping free from scale and dirt; protect open pipe end wherever work is excavated over during construction, to prevent foreign bodies entering and lodging there; use temporary cap plugs, burlap or other approved material for protection.

3.7 FIXTURE INSTALLATION

A. Connect all fixtures shown on the Project Plans to piping as needed to make a complete installation. Provide p-trap and tubing to wall as required. All plumbing faucets, handles, exposed piping, fixtures, and trim shall be brass with chrome-plated finish. Equip all sinks or lavatories mounted in counter with deck rims in satin finished aluminum material on all sinks.

3.8 ACCEPTABLE TESTS

A. Test all piping provided under this Section. Water or DWV systems shall be tested with water or air as noted below. All piping shall be tested prior to being buried, backfilled, or concealed behind walls. Where piping is laid below or within concrete, maintain test pressure during concrete pour. All tests shall be held for a minimum of 15 minutes and be witnessed by the Authority Having Jurisdiction. Where air tests fail to meet the duration specified, each joint shall be covered with a soap solution or leak detector fluid to identify the source of the leak. Leaks shall be repaired, and the system shall be retested until a successful test has been obtained and approved by the local Authority. Clean piping after completion of soap test. Test shall be as follows:

1. Pressure Lines:

a. By Air: Cap or plug system outlets and test with air to 100 psig.

b. By Water: Cap or plug system outlets, use source water at working pressure to fill the system.

c. Duration: The piping system shall withstand the test pressure without showing evidence of leakage for a period of no less than 15 minutes.

d. PVC Plastic pipe shall not be tested with air, except when permitted by manufacturer’s instructions.

2. Drain Lines: Test all drain lines either as an entire system or by sections.

a. By Water: close all system openings, except highest one in the test section, and fill the system with water. Provide sufficient overlapping of sections so that every joint and connection will be subjected to a static head of at least 10 feet. Allow water to stand for 2 hours before beginning inspection. Repair all leaks which occur and repeat the test until a satisfactory result is obtained.

b. By Air: close all system openings using test caps and plugs. Fill the drain system with air until reaching 5 psig. The test shall be held for 15 minutes and be witnessed by the Authority Having Jurisdiction for approval. Any leaks identified shall be repaired and the test shall be repeated until successful test results are obtained.

END OF SECTION 22 00 00

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SECTION 22 30 00 - PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Contractor shall furnish and install all plumbing fixtures and equipment as outlined in the plumbing schedule and drawings, complete with all plumbing fixtures, specialties, and water, and/or electric connections and hook-ups for a complete and operable installation as specified herein and in accordance with the requirements of the Contract Documents.

1.2 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 00 – Submittals.

B. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

PART 2 - PRODUCTS

2.1 GENERAL

A. All plumbing piping, fixtures, specialties, equipment, etc., shall be new, first-quality products manufactured for the intended usage. Materials, capacities, features, finishes, and manufacturers shall be as specified herein and shall be compatible with elements of the work to which they relate or connect.

B. All exposed brass, faucets, wastes, traps, etc., are to be chrome-plated. Provide each fixture with individual stops and anchor firmly to the building wall or floor. Unless otherwise specified, all fixtures are to be by Crane Co.; Kohler; American Standard; Zurn; Mifab; Lasco Bathware; and Briggs/Sayco/ProFlo or equal.

2.2 FLOOR SINKS

A. Provide cast iron floor sinks and equipment drains as shown on plans. No equipment drains shall discharge to floor slabs.

B. Manufacturers:

1. Zurn

2. Jay R. Smith

3. Sioux Chief

4. Or approved equal.

C. Equipment drains are to be as shown on the Project Plans.

2.3 PREMANUFACTURED TRENCH DRAINS

A. Provide premanufactured trench drains as shown on the plans. Trench drains shall be premanufactured HDPE or FRP.

B. Channels shall be pre-sloped and interconnecting.

1. Trench drain width shall be 6”.

C. Fittings:

1. Provide and install end caps as needed.

2. Bottom outlet.

3. Channel Sections: mechanically locking connections.

D. Grating

1. Class C traffic rated at minimum.

2. Corrosion resistant ie. Stainless steel or coated Ductile Iron.

3. Install with acid resistant epoxy coated finish.

4. Grating shall include a locking type mechanism.

E. Mounting

1. Drains shall be provided with manufacture’s carrier system. Other mounting methods not approved by the manufacturer shall be prohibited.

2. Top of grate shall be set to the elevation indicated in the plans.

3. Cast concrete in place only after all trench channels, piping and interconnected sections have been installed and tested.

F. Catch Basins

1. Provide catch basins were indicated in the plans.

2. Catch basins shall be precast polymer and provided by the same manufacturer that provides the trench drain.

G. Manufacturers:

1. Zurn

2. MIFAB

3. Or approved equal.

2.4 HOSE BIBBS AND HYDRANTS:

A. Hose bibbs and hydrants: When located in exposed locations subject to freezing, hose bibbs and hydrants shall be the non-freeze type. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless-steel warning signs reading "DO NOT DRINK" in clearly legible letters, permanently attached at the hose bibb. The sizes shall be as shown on the Project Plans.

B. Vacuum Breaker: As indicated on the plans, hose bibbs shall be provided with manufacturer provided vacuum breakers. If not available from the manufacturer then as furnished by Grainger, Crane Co., American Standard, or equal.

C. Manufacturer or approved equal:

1. Woodford Mfg.

2. Grainger.

3. Or approved equal.

2.5 WATER COOLERS

A. Standards: Lead-free, ADA- compliant. Conforms to NSF/ANSI 61 and UL 399.

B. Construction:

1. Wall Mounted

2. Stainless steel with contoured basin that eliminates standing water.

3. Install with manufacturer’s cane apron.

4. Install with compatible surface mounting plate.

C. Bubbler:

1. Single or Double Bubbler as shown on the Drawings.

2. Laminar flow design with flexible safety guard. Constant flow shall be achievable between water pressures of 20 and 100 psi.

D. Activated by pre-assembled push-bar or push-buttons.

E. Filter: Install with manufacturer’s standard filter.

1) NSF 42 and 53 certified for lead, cyst, particulate, taste, and odor reduction.

2) Filter is rated for minimum 3,000 gallons.

3) Filter monitor: Visible LED Filter Status Indicator for when filter change is necessary.

F. Required Accessories:

1. Water cooler:

a. Compressor: Hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication.

b. Condenser: Fan-cooled, copper tube with aluminum fins. Provide permanently lubricated fan.

c. Cooling Unit: Combination tube-tank type. Continuous copper tubing that is fully insulated with EPS foam that meets UL requirements for self-extinguishing material.

d. Refrigerant Control: Refrigerant is controlled by an accurately calibrated capillary tube.

e. Temperature Control: easily accessible enclosed adjustable thermostat is factory preset.

f. Conform to requirements in ASHRAE 18.

2. Bottle filler:

a. Activated by electronic front sensor.

G. Manufacturers:

1. Elkay

2. Or approved equal.

2.6 EMERGENCY EYE-WASHES & SHOWERS:

A. Combination Eye-wash and Drench Shower

1. The emergency eye wash and shower shall be a combination eye-wash and shower safety station with two spray type outlet heads to deliver a flood of water for rinsing eyes with a minimum 10” diameter shower head.

a. Drench Shower

1) The shower head shall be ABS plastic or stainless steel.

2) The shower valve shall be a chrome plated brass stay-open ball valve with Teflon seals. The valve shall be furnished with a stainless-steel actuating arm and pull rod.

3) The unit shall regulate the shower flow to 20 gpm.

b. Eye Wash

1) The eye wash shall have two spray heads. Each head shall have a 'flip top" dust cover, internal flow control, and filter to remove impurities from the water.

2) The eye wash valve shall be a chrome plated brass stay-open ball valve with Teflon seals.

3) The eye wash bowl shall be a minimum 11" diameter and stainless steel.

4) The unit shall regulate the eyewash flow to 0.4 GPM.

B. Manufacturers:

1. Haws

2. Guardian

3. Or approved equal.

2.7 SHOWER

A. Showers and associated components shall be ADA compliant.

B. Stall: one piece, sized according to plans.

1. Install with manufacturer's standard ADA seat and grab bars.

C. Shower Valve

1. Inlet size: ½" hot and cold supply.

2. Valve shall be single handle with chrome finish.

3. Valve shall include internal thermostatic mixing valve.

4. Shower Valve shall be Moen Adler or approved equal.

D. Shower Drain

1. Outlet size: 2" drain and 2" vent.

2. Strainer: round with SST finish.

3. Shower drain shall be Sioux Chief or approved equal.

E. Install with manufacturer-approved curtain rod.

F. Manufacturers:

1. Aquatic

2. MAAX

3. Or approved equal.

2.8 WATER CLOSETS (WC)

A. Compliance: WC's shall be ADA compliant and situated in an ADA compliant stall and installed to ADA standards.

B. Water Closets shall be tank type with a manual flush lever.

C. Construction: White china porcelain, with an open front seat.

D. Connection: WC's shall be capable of being anchored to a closet flange. Closet rings or gaskets shall be of an approved type and such connection shall be warrantied from failure for a minimum of 1 year. Closet flanges shall be securely fastened to the subfloor with non-corrosive bolts or anchors.

1. WC's shall be supplied with an UPC approved water fill valve with an air gap fitting.

E. Manufacturers:

1. American Standard

2. Or approved equal.

2.9 URINAL

A. Install in compliance with ADA standards.

B. Construction: white china porcelain, vandal-resistant where applicable.

C. Connection: Urinals shall be capable of being anchored to a urinal flange. Urinal rings or gaskets shall be of an approved type and such connection shall be warrantied from failure for a minimum of 1 year. Urinal flanges shall be securely fastened with non-corrosive bolts or anchors.

D. Strainer: stainless steel beehive grate.

E. Flushometer: mounted on fixture. Supply with approved type vacuum breaker.

1. Flush volume is not to exceed 1 gpf (3.8 LPF).

F. Manufacturer:

1. Zurn

2. American Standard

3. Or approved equal.

2.10 SINKS & LAVATORIES

A. All sinks and lavatories shall be lead-free and ADA- compliant and conform to NSF/ANSI 61 and UL 399.

B. Lavatory

1. Description: wall hung, with single hole for faucet.

2. Insulation:

a. The insulation shall be easily removable, bacteria resistant, molded to piping and fixture configurations, closed cell vinyl assembles.

b. Handicapped persons protection:

1) Shall conform to the wheelchair accessibility requirements of ADA and other governing authorities.

2) Handicapped persons protection shall be Lav Guard as manufactured by Truebro, Inc., Pro-Wrap as manufactured by McGuire, Inc., or approved equal.

3. Fasteners shall be corrosion resistant and reusable.

4. Manufacturers:

a. American Standard

b. Or approved equal.

C. Kitchen Sink

1. Description – Stainless steel finish, single basin with three holes for faucet.

2. Dimensions: 25”x22”

3. Provide with 3” stainless steel strainer.

4. Faucet: centerset style with gooseneck spout.

a. Chrome finish.

b. Valves: Quarter-turn with wristblade handle.

D. Mop Sink

1. Basin Construction: Precast concrete with black and white marble chips. Drain shall be cast brass with stainless steel strainer cast integral and shall provide for a caulked connection not less than 1-inch deep to 3-inch pipe.

a. Dimensions: 24-inch x 24-inch x 12-inch high, corner floor service sink with drop front.

2. Service sink faucet: stainless steel or cast brass construction with vacuum breaker, adjustable top brace, 3/4-inch hose thread on spout with bucket hook and inlets on 8-inch centers, chrome finish.

3. Provide the following accessories:

a. Hose and wall hook;

b. Stainless steel mop hanger;

c. 20 gauge, stainless steel splash panels/wall guards.

4. Manufacturers:

a. Fiat

b. Or approved equal.

E. Utility Sink

1. Description: freestanding catch basin and faucet.
2. Dimensions
a. Sink Bowl: 18” width x 16” depth.
b. Legs: 20” minimum.
3. Finish: stainless steel.
4. Drain: bottom outlet with deep-seal p-trap.
a. Size and connect to drain as recommended by manufacturer.
5. Hot and cold connections: 3/8”
6. The utility sink shall be Trinity model THA-0303 or approved equal.

2.11 THERMOSTATIC MIXING VALVE

A. Large Type Thermostatic mixing valve; Emergency Drench Shower

1. Inlet check wall support with 1 " inlets and 1 1/4" outlet (25mm X 32mm) with adjustable high temperature limit stop.

2. 1 GPM (3.71 L/min) minimum flow capacity and 125 psi max operating pressure.

3. Color-coded dial thermometer (0 to 140°F, -10 to 60°C) with inlet manifold piping and locking temperature regulators. Set to 75 Deg F.

4. Must be factory assembled and tested.

5. Manufacturer or approved equal:

a. Leonard Model TM-850-LF

B. Point of Use Thermostatic Mixing valve

1. Purpose: under sink applications.

2. 3/8” inlets and 3/8” outlet with adjustable mixed outlet and integral check valves to prevent cross flow.

3. Provide with wall supports.

4. 0.25 GPM (0.95 L/min) minimum flow capacity and 125 psi max operating pressure.

5. Dial thermometer (80 to 120°F) with locking adjustment cap. Set to 105 Deg F.

6. Must be factory assembled and tested.

7. Manufacturer or approved equal:

   a. Leonard Model 170-LF

2.12 BACKFLOW PREVENTERS

A. Reduced Pressure Zone (RPZ) Backflow Preventer

1. A Reduced Pressure Zone assembly shall be installed at each potential health hazard location to prevent backflow due to backpressure. The assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Seats and seat discs shall be replaceable in both check modules and the relief valve. There shall be no threads or screws in the waterway exposed to line fluids. Service of all internal components shall be through a single access bronze cover secured with stainless steel bolts. The assembly shall also include two resilient seated isolation valves, four resilient seated test cocks, and an air gap drain fitting.

2. Assembly Requirements:

   a. USC

   b. ASSE Std. 1013

   c. AWWA Std. C511

   d. CSA B64.4.

3. Accessories:

   a. Single access cover and modular check construction.

   b. Top entry to all internals.

   c. Captured springs.

   d. Internal relief valve.

e. Replaceable seats.

f. Bronze body construction for durability (1⁄4" – 2") - Size per plans.

g. Ball valve test cocks — screwdriver slotted (1⁄4" – 2").

h. Compact, space saving design.

i. No special tools shall be required for servicing.

j. Sensor on the relief valve for flood detection (1⁄2" – 2").

4. Manufacturers or approved equal:

a. Watts Series 009

5. Route drain to an approved location.

2.13 WATER HEATERS

A. Electric Tank Type Water Heaters

1. Electric water heaters shall be furnished as shown, complete with electric, cold water, and hot water connections; 3/4–inch drain valve piped to drain; ¾-inch (min) temperature and pressure relief valve piped to floor sink or drain; and aquastat. The tank shall be of welded steel construction for a working pressure of not less than 150 psi, glass-lined, with magnesium anode, minimum R-16 fiber glass insulation, built-in heat traps, enameled steel jacket, and feet.

2. Heater Specification: Electric water heaters shall meet the following requirements:

Item	Units	Value
Identification Number		WH-STG-11
Location		Storage Building (Structure G)
Tank Capacity	Gallon	80
Site Elevation	feet	1,100
Heater Input	kW	13.5
Electrical	Volts/Phase/Hz	208/3/60

3. Electric water heaters shall be one of the following listed products, or equal:

a. Bradford White

b. Rheem

4. Accessories:

a. Electrical Disconnect

b. Water Heater Pan

c. Temperature Pressure Relief Valve and drain. Route drain to an approved location.

d. Seismic Strap

B. Gas Tank Type Water Heaters

1. Gas water heaters shall be furnished as shown, complete with gas, cold water, and hot water connections; 3/4–inch drain valve piped to drain; ¾-inch (min) temperature and pressure relief valve piped to floor sink or drain; and aquastat. The tank shall be of welded steel construction for a working pressure of not less than 150 psi, glass-lined, with magnesium anode, minimum R-16 fiber glass insulation, built-in heat traps, enameled steel jacket, and feet.

2. Gas line: provide drip leg, gas cock, flex connection, and regulator prior to connection to gas water heater. Adjust regulator to manufacturer's recommendations.

3. Heater Specification: Gas water heaters shall meet the following requirements:

Item	Units	Value
Identification Number		WH-ADM-71
Location		New Admin Building (Structure F)
Tank Capacity	Gallon	75
Site Elevation	feet	1,100
Heater Input	Btu/hr	76,000

4. Heater: stainless steel or titanium construction. Include internal flame arrestor and resettable thermal switch.

5. Flue vent: size according to manufacturer's requirements. Provide flue vent cap.

6. Gas water heaters shall be one of the following listed products, or equal:

a. Bradford White

b. Rheem

c. National Steel Const. Co.

d. A.O. Smith

e. State Industries Inc.

7. Accessories

   a. Electrical Disconnect

   b. Water Heater Pan

   c. Temperature Pressure Relief Valve and drain. Route drain to an approved location.

   d. Seismic Strap

C. Expansion Tanks

1. Provide diaphragm-type expansion tanks with welded steel, rated for 125-psi working pressure and 200 degrees F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. The diaphragm shall be securely sealed into tank to separate air charge from system water to maintain required expansion capacity. The air charge fittings shall include a stainless schrader valve with EPDM seats.

   a. Acceptable manufacturers include:

      1) Amtrol, Inc.

      2) Armstrong Pumps, Inc.

      3) Bell & Gossett

D. Hot Water Recirculation Pump

1. Operating conditions: The hot water recirculation pump shall be suitable for long term operation under the following conditions:

No.	Items	
1	Location	New Admin Building (Structure F)
2	Duty	Intermittent
3	Drive	Constant Speed
4	Ambient environment	Indoors
5	Ambient temperature; degrees F	32 to 100
6	Fluid service	Hot Water
7	Fluid temperature, degrees F	60-150
8	Fluid pH range	6 to 8
9	Fluid specific gravity	1.0
10	Project site elevation, ft. a.s.l	1100

2. Performance Requirements

No.	Items	Unit	
1	Maximum Operating Pressure	psi	100
2	Design flow	gpm	3
3	Design flow pump head (TDH)	ft	4

3. Construction: Construction of hot water recirculation pumps shall conform to the following requirements:

No.	Items	
1	Pump casing	Stainless Steel
2	Impeller	Composite
3	Mounting Method	Mounted to shelf
4	Pump Connection	½" Flange Kit to NPT

4. Drive: Electric motor, suitable for 120-volt, 1-phase, 60 Hz AC power supply, with armored cable and plug, in accordance with Section 40 05 93 – Common Motor Requirements for Process Equipment.

5. Control: Provide with timer assembly. Field set the timer to operate in 15 minute cycles, 24 hours per day.

6. Manufacturers or Approved Equal:

   a. Grundfos;

   b. Goulds;

   c. Watts.

PART 3 - EXECUTION

3.1 GENERAL

A. Install and secure all plumbing equipment as recommended by manufacturer unless directed otherwise.

B. Coordinate roughing-in locations prior to installation.

3.2 WATER HEATER INSTALLATION

A. The Contractor shall install water heaters in accordance with manufacturer's printed instructions.

B. The work hereunder shall be coordinated with plumbing piping and related electrical work to achieve operating system and shall conform to all applicable codes.

C. The Contractor shall provide steel pipe support for tanks, independent of building structural framing members.

D. Tank shall be cleaned and flushed prior to delivery to site. All openings shall be sealed until pipe connections are made.

E. The Contractor shall provide and install floor restraints and a cable that conform with Seismic Zone 3 requirements.

3.3 EXPANSION TANK INSTALLATION

A. Install expansion according to manufacturer's written instructions. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system and project requirements.

END OF SECTION 22 30 00

SECTION 23 00 00 - GENERAL HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Work consists of, but is not necessarily limited to, the furnishing of all labor, equipment, appliances and materials and the performance of all operations in connection with the installation of all mechanical Heating, Ventilation, and Air Conditioning (HVAC) work described by these Contract Documents. All Work shall be completed in strict accordance with Specifications, Drawings and applicable codes, including incidental materials necessary and required for their completion.

B. Intent of Drawings: Drawings, plans and schematics, and diagrams indicate general location and arrangement of piping systems.

1. The HVAC Contractor is responsible for installation of satisfactory and complete work in accordance with the intent of Drawings and Specifications. Provide, at no extra cost, incidental items required for completion of work even though not specifically mentioned or indicated in Specifications or on Drawings.

2. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision. Do not proceed with installation in area of question until conflict has been fully resolved.

C. Interferences: Project design took into account potential interferences between trades (e.g. mechanical ductwork with piping or with electrical light fixtures), however, not every interference can be eliminated. It shall be the responsibility of the Bidder and potential Contractor to field verify all mechanical piping and duct routing, making allowances for existing and new beams, pipes, ducts, hangers, and other obstructions. The cost associated with interferences shall be at no additional expense to Owner.

D. Discrepancies: Prior to submitting Bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification. The more stringent provisions shall take precedence where Codes, Specifications and Drawings differ with one another. The Contractor shall bid the more expensive requirement, unless an Addendum prior to bid addresses the discrepancy.

E. Prior Approvals: The Engineer shall receive all proposed substitutions at least 10 days prior to Bid. Approval requests received after 3 p.m. on the 10th day will be rejected. Supply technical data and dimensional Drawings showing that substitutes are equivalent to the specified product.

F. HVAC Contractor shall pay for all permits, inspections, reviews and fees in connection with this work.

G. HVAC Contractor shall provide training to the Owner.

1.2 DEFINITIONS

A. "PROVIDE" - Furnished and installed complete.

B. "OR APPROVED EQUAL" – Items may be deemed equal as approved by submitting a quote to the Engineer, 10 days prior to Bid.

C. Intent of Drawings: Drawings, plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1.3 REFERENCE STANDARDS

A. HVAC Contractor shall conform to the latest edition or the edition adopted by the Local Governing Authority, State and National Codes and Ordinances, the State Fire Marshal, and utility company regulations.

B. All materials shall conform to applicable standards.

1.4 SUBMITTALS

A. Submit HVAC material and equipment submittals and shop drawings in accordance with Section 01 33 00 - Submittals.

B. Complete shop drawings and manufacturers' literature submittal shall conform to the following:

1. Indicate the type, make, manufacturer's name, supplier and trade designation of materials and equipment proposed.

2. The submittal shall include outline dimensions sufficiently accurate and complete to permit layout and coordination of pipe and duct connections, foundation, and setting of anchor bolts and base plates, procurement and setting of embedded items, etc. Drawings shall show clearances required for interferences to be avoided. Electrical connections, number of conductors and other pertinent electrical power data shall also be shown.

3. Shop drawings or submittals that cover substitutions or alternates not previously approved will not be acceptable.

1.5 QUALITY CONTROL

A. Warranty: This Contractor shall warrant and guarantee the following:

1. That all HVAC work executed under these Contract Documents will be free from defects of materials and workmanship for a period of one year from the date of final acceptance of this work.

2. The Contractor agrees to, at the Contractor's own expense, repair and replace all such defective materials and work and all other work damaged thereby which becomes defective during the term of warranty. Agreement does not include damages done by Owner.

B. Workmanship: Work shall be accomplished by workmen skilled in particular trade, in conformance with best practices and accepted standards. Work shall contribute to efficiency of operation, accessibility, maintenance and appearance. No part of installation shall interfere with operation of any other system or part of building. Non-satisfactory work shall be corrected at no additional expense to Owner.

1.6 SUBSTANTIAL COMPLETION

A. At substantial completion of Project, the Contractor shall be ready to demonstrate compliance with the list of items below. If this is not possible, the Contractor shall inform the General Contractor and Engineer no less than one week prior to substantial completion site visit.

1. Provide documentation that HVAC has been tested and balanced.

2. Demonstrate that labeling of all mechanical and ducting systems are 100 percent complete in accordance with the Specifications.

1.7 RECORD DOCUMENTS

A. Provide two (2) full size sets (Mechanical and HVAC drawings), one for Engineer, one for Owner. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes and terminal units requiring periodic maintenance or repair.

2. Main and branches of piping systems, with valves and control devices located and numbered, and with items requiring maintenance located. Indicate actual inverts and horizontal locations of underground piping.

3. Equipment locations (exposed and concealed) dimensioned from prominent building lines.

4. Addendum items, change order items and all changes made to drawings from bidding phase through to project completion.

1.8 OPERATIONS & MAINTENANCE MANUALS

A. In accordance with Section 01 78 23 - Operation and Maintenance Manuals, prepare three (3) copies of Operating and Maintenance manuals for the mechanical systems and equipment as described below. Partial or separate data will be returned for completion.

1. Manuals shall be assembled in three ring binders. All information shall be arranged in sections, with each section having a heavy paper divider with a protruding tab clearly labeled. Sections shall be arranged in the same order that the equipment is listed in the Specifications.

2. Include a cover page which lists project name, date and Contractor’s name, address and telephone number.

3. Include index sheet for each specification section indicating equipment, with supplier and supplier's telephone number.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION NOT USED

END OF SECTION 23 00 00

SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes testing, adjusting and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow and waterflow within distribution systems, including submains, branches and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of the activities and procedures specified in this Section.

1.2 DEFINITIONS

A. "ADJUST" - To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. "BALANCE" - To proportion flows within the distribution system, including submains, branches and terminals, according to design quantities.

C. "DRAFT" - A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. "PROCEDURE" - An approach to and execution of a sequence of work operations to yield repeatable results.

E. "REPORT FORMS" - Test data sheets for recording test data in logical order.

F. "STATIC HEAD" - The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. "SUCTION HEAD" - The height of fluid surface above the centerline of the pump on the suction side.

H. "SYSTEM EFFECT" - A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. “SYSTEM EFFECT FACTORS” - Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. “TERMINAL” A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. “TEST” - A procedure to determine quantitative performance of a system or equipment.

L. “TESTING, ADJUSTING, AND BALANCING AGENT” - The entity responsible for performing and repor1ing the testing, adjusting and balancing procedures.

M. “AABC” - Associated Air Balance Council.

N. “AMCA” - Air Movement and Control Association.

O. “NEBB” - National Environmental Balancing Bureau.

P. “SMACNA” - Sheet Metal and Air Conditioning Contractors' National Association.

1.3 SUBMITTALS

A. Certified Testing, Adjusting and Balancing Reports: Submit two (2) copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting and balancing Agent.

1.4 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting and Balancing Reports: Certify the testing, adjusting and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting and balancing reports.

2. Certify that the testing, adjusting and balancing team complied with the approved testing, adjusting and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting and Balancing Reports: Use standard forms from AABC's "National Standards for Testing, Adjusting and Balancing."

D. Testing, Adjusting and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems."

E. Instrumentation Type, Quantity and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six (6) months or more frequently if required by the instrument manufacturer.

1.5 PROJECT CONDITIONS

A. Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting and balancing period. Cooperate with the Owner during testing, adjusting and balancing operations to minimize conflicts with the Owner's operations.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

D. Contractor is responsible for returning to site and testing all hydronic equipment once hydronic upgrades that are part of other projects are completed.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine approved submittal data of HVAC systems and equipment.

B. Examine equipment performance data including fan and pump curves. Relate performance data to project conditions and requirements including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10 or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting and commissioning specified in individual Specification Sections have been performed.

D. Examine system and equipment test reports.

E. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings and manual volume dampers, are properly installed and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

F. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

G. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight and equipment with functioning controls is ready for operation.

H. Examine strainers for clean screens and proper perforations.

I. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature system components to verify the following:

1. Dampers, valves and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller setpoints are set at design values. Observe and record system reactions to changes in conditions. Record default setpoints if different from design values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to design values.

M. Report deficiencies discovered before and during performance of testing, adjusting and balancing procedures.

3.2 PREPARATION

A. Prepare a testing, adjusting and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.

2. Hydronic systems are filled, clean and free of air.

3. Automatic temperature-control systems are operational.

4. Equipment and duct access doors are securely closed.

5. Balance, smoke and fire dampers are open.

6. Isolating and balancing valves are open and control valves are operational.

7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

8. Windows and doors can be closed so design conditions for system operations can be met.

3.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section.

B. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems" and this Section.

C. Cut insulation, ducts, pipes and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this project.

D. Mark equipment settings with paint or other suitable, permanent identification material including damper-control positions, valve indicators, fan-speed-control levers and similar controls and devices to show final settings.

3.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross check the summation of required outlet volumes with required fan volumes.

B. Determine the best locations in main and branch ducts for accurate duct, airflow measurements.

C. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

D. Locate start-stop and disconnect switches, electrical interlocks and motor starters.

E. Verify that motor starters are equipped with properly sized thermal protection.

F. Check dampers for proper position to achieve desired airflow path.

G. Check for airflow blockages.

H. Check condensate drains for proper connections and functioning.

I. Check for proper sealing of air-handling unit components.

3.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return- and exhaust-air systems. These additional procedures are specified in other articles in this Section.

B. 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 as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.

    b. Measure static pressure directly at the fan outlet or through the flexible connection.

    c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

    d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.

5. Adjust fan speed higher or lower than design with the approval of the Architect. Make required adjustments to pulley sizes, motor sizes and electrical connections to accommodate fan-speed changes.

6. 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.

C. 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.

a. Where sufficient space in sub mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

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

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

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.

3.6 FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.

2. Check expansion tank liquid level.

3. Check makeup-water-station pressure gauge for adequate pressure for highest vent.

4. Check flow-control valves for specified sequence of operation and set at design flow.

5. Set system controls so automatic valves are wide open to heat exchangers.

6. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

7. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 HYDRONIC SYSTEMS' BALANCING PROCEDURES

A. Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gauge heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.

2. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge valve until design water flow is achieved.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.

4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than design flow.

E. Adjust balancing stations to within specified tolerances of design flow rate as follows:

1. Determine the balancing station with the highest percentage over design flow.

2. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.

3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads and systems' pressures and temperatures including outdoor-air temperature.

3.8 MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer, model and serial numbers.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating if high-efficiency motor.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

3.9 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

3.10 BOILERS

A. Measure entering- and leaving-water temperatures and water flow.

3.11 HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each coil:

1. Entering- and leaving-water temperatures.

2. Water flow rate.

3. Water pressure drop.

4. Dry-bulb temperatures of entering and leaving air.

5. Airflow.

6. Air pressure drop.

3.12 TEMPERATURE TESTING

A. During testing, adjusting and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

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

3.14 TOLERANCES

A. Set HVAC system airflow and waterflow rates within the following tolerances:

1. Supply, Return and Exhaust Fans: Plus 5 to plus 10 percent.

2. Air Outlets and Inlets: 0 to plus 10 percent.

3. Heating-Waterflow Rate: 0 to plus 10 percent.

3.15 FINAL REPORT

A. General: Typewritten or computer printout in letter-quality font on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.

2. Fan curves.

3. Manufacturers' test data.

4. Field test reports prepared by system and equipment installers.

5. Other information relative to equipment performance, but do not include approved shop drawings and product data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.

2. Name and address of testing, adjusting and balancing Agent.

3. Project name.

4. Project location.

5. Architect's name and address.

6. Engineer's name and address.

7. Contractor's name and address.

8. Report date.

9. Signature of testing, adjusting and balancing Agent who certifies the report.

10. Summary of contents including the following:

    a. Design versus final performance.

    b. Notable characteristics of systems.

    c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.

12. Data for terminal units including manufacturer, type size and fittings.

13. Notes to explain why certain final data in the body of reports vary from design values.

14. Test conditions for fans and pump performance forms including the following:

    a. Settings for outside-, return- and exhaust-air dampers.

    b. Conditions of filters.

    c. Cooling coil, wet- and dry-bulb conditions.

d. Face and bypass damper settings at coils.

e. Fan drive settings including settings and percentage of maximum pitch diameter.

f. Other system operating conditions that affect performance.

E. Air-Handling Unit Test Reports: For air-handling units with coils include the following:

1. Unit Data: Include the following:

a. Unit identification.

b. Location.

c. Make and type.

d. Model number and unit size.

e. Manufacturer's serial number.

f. Sheave make, size in inches and bore.

g. Sheave dimensions, center-to-center and amount of adjustments in inches.

h. Number of belts, make and size.

i. Number of filters, type and size.

2. Motor Data: Include the following:

a. Make and frame type and size.

b. Horsepower and rpm.

c. Volts, phase and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches and bore.

f. Sheave dimensions, center-to-center and amount of adjustments in inches.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Filter static-pressure differential in inches wg.

f. Preheat coil static-pressure differential in inches wg.

g. Cooling coil static-pressure differential in inches wg.

h. Heating coil static-pressure differential in inches wg.

i. Outside airflow in cfm.

j. Return airflow in cfm.

k. Outside-air damper position.

l. Return-air damper position.

m. Airflow rate in cfm.

n. Average face velocity in fpm.

o. Air pressure drop in inches wg.

p. Outside-air, wet- and dry-bulb temperatures in deg F.

q. Return-air, wet- and dry-bulb temperatures in deg F.

r. Entering-air, wet- and dry-bulb temperatures in deg F.

s. Leaving-air, wet- and dry-bulb temperatures in deg F.

t. Water flow rate in gpm.

u. Water pressure differential in feet of head or psig.

v. Entering-water temperature in deg F.

w. Leaving-water temperature in deg F.

F. Fan Test Reports: For supply, return and exhaust fans include the following:

1. Fan Data: Include the following:

a. System identification.

b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Sheave make, size in inches and bore.

g. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Motor Data: Include the following:

a. Make and frame type and size.

b. Horsepower and rpm.

c. Volts, phase and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches and bore.

f. Sheave dimensions, center-to-center and amount of adjustments in inches.

g. Number of belts, make and size.

3. Test Data: Include design and actual values for the following:

a. Total airflow rate in cfm.

b. Total system static pressure in inches wg.

c. Fan rpm.

d. Discharge static pressure in inches wg.

e. Suction static pressure in inches wg.

G. Round, Flat-Oval and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data: Include the following:

a. System and air-handling unit number.

b. Location and zone.

c. Traverse air temperature in deg F.

d. Duct static pressure in inches wg.

e. Duct size in inches.

f. Duct area in sq. ft.

g. Design airflow rate in cfm.

h. Design velocity in fpm.

i. Actual airflow rate in cfm.

j. Actual average velocity in fpm.

k. Barometric pressure in psig.

H. Air- Terminal-Device Reports: For terminal units include the following:

1. Unit Data: Include the following:

a. System and air-handling unit identification.

b. Location and zone.

c. Test apparatus used.

d. Area served.

e. Air-terminal-device make.

f. Air-terminal-device number from system diagram.

g. Air-terminal-device type and model number.

h. Air-terminal-device size.

i. Air-terminal-device effective area in sq. ft.

2. Test Data: Include design and actual values for the following:

a. Airflow rate in cfm.

b. Air velocity in fpm.

c. Preliminary airflow rate as needed in cfm.

d. Preliminary velocity as needed in fpm.

e. Final airflow rate in cfm.

f. Final velocity in fpm.

g. Space temperature in deg F.

I. Instrument Calibration Reports: For instrument calibration include the following:

1. Report Data: Include the following:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.16 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units, condenser fans and motorized dampers, exhaust fans and motorized dampers that are not supplied with factory-wired controls.

B. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, adjustment and other apparatus and accessories to control mechanical systems.

C. Furnish and provide programming and control equipment as required to satisfy sequences of operation as described on the Drawings.

1.2 REFERENCE STANDARDS

A. NFPA 70, Article 100

B. NFPA 90A Installation of Air Conditioning and Ventilation Systems

C. AMCA 500D

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device in accordance with Section 01 33 00 – Submittal Procedures. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials and installation and startup instructions for each type of product indicated.

B. Each control device labeled with setting or adjustable range of control.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

1. Schematic flow diagrams showing fans, coils, dampers, valves and control devices.

2. Wiring Diagrams: Power, signal and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

3. Written description of sequence of operation.

4. Schedule of dampers including size, leakage and flow characteristics.

5. Schedule of valves including leakage and flow characteristics.

D. Maintenance Data: Include the following for systems to include in maintenance manuals specified in Section 01 78 23 – Operation and Maintenance Data.

1. Maintenance instructions and lists of spare parts for each type of control device.

2. Interconnection wiring diagrams with identified and numbered system components and devices.

3. Inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.

4. Calibration records and list of setpoints.

E. Project Record Documents: Record actual locations of control components including control units, thermostats and sensors. Revise shop drawings to reflect actual installation and operating sequences.

1.4 QUALITY CONTROL

A. Installer Qualifications: An experienced installer who is a certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature control systems similar to those indicated for this project and with a record of successful in-service performance.

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

D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems”

1.5 COORDINATION

A. Coordinate with the Mechanical contractor for actual mechanical equipment being supplied to the project site. Low voltage actuators for outside air damper operation are required to be interlocked with ducted condenser air conditioning units and laboratory fume hood exhaust fan.

B. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

C. Coordinate supply of conditioned electrical circuits for control units.

D. Coordinate equipment with Division 26 to achieve compatibility with starter coils and annunciation devices.

PART 2 - PRODUCTS

2.1 THERMOSTATS

A. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

B. Room thermostat accessories include the following:

1. Insulating Bases: For thermostats located on exterior walls.

C. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

D. Manufacturers, or Equal:

1. Chromalox, Inc.
2. Honeywell, Inc.; Home & Building Control
3. Johnson Controls, Inc.; Controls Group
4. Texas Instruments, Inc.; Commercial Sensors & Controls

2.2 FAN CONTROL PANEL

A. The Contractor shall provide Fan Control Panels as part of the HVAC package.

B. Fan Control Panels shall be designed and certified by a UL 508a listed shop.

C. Fan Control Panel design shall include all components necessary to meet the intent of the HVAC Sequence of Operation, FCP design details, and Control Strategy as outlined in the Project Plans.

D. Fan Control Panels designs shall be submitted for approval prior to construction.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that conditioned power supply is available to control units and operator workstation.

B. Verify that duct-, pipe- and equipment-mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate all 60-inches above the floor.

C. Install labels and nameplates to identify control components.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes and cabinets according to Division 26.

B. Install building wire and cable according to Division 26.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

2. Install exposed cable in raceway.

3. Install concealed cable in raceway.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

3.4 CONNECTIONS

A. Ground all equipment per Division 26 requirements.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 4868.

3.5 CONTROL SEQUENCES

A. Refer to Drawings.

END OF SECTION 23 09 00

SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes metal ducts for air supply, return air, exhaust and air-distribution systems in pressure classes from minus 2 to plus 2 inches wg. Furnish fabricated ductwork, including liner, sealant, pre-insulated jacketing and duct hangers for a complete and operable system.

1. Unless otherwise specified, all ductwork shall be constructed of galvanized steel.

B. The duct system design, as indicated, has been used to select size and type of air-moving and distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by the design engineer. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.2 REFERENCE STANDARDS

A.	NUSIG	National Uniform Seismic Installation Guidelines
B.	NFPA 90A	Installation of Air Conditioning and Ventilating System
C.	NFPA 90B	Installation of Warm Air Heating and Air Conditioning Systems
D.	SMACNA	HVAC Duct Construction Standards – Metal and Flexible
E.	SMACNA	Seismic Restraint Manual: Guidelines for Mechanical Systems
F.	AWS D1.1	Structural Welding Code Steel, for hangers and supports
G.	AWS D9.1	Sheet Metal Welding Code, for duct joint and seam welding
H.	NAIMA AH116	Fibrous Glass Duct Construction Standards
I.	ASTM B 209 (ASTM B 209M)	
J.	ASTM A 653/A 653M	
K.	ASTM C 916	
L.	ASTM C 1071	

1.3 SUBMITTALS

A. Product Data: Submit product information in accordance with Section 01 30 00 – Submittals. At a minimum, include information for the following items:

1. Sheet metal materials

2. Duct liner

3. Sealant materials

4. Pre-Insulated Duct Jacketing

1.4 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code Steel, for hangers and supports and AWS D9.1, Sheet Metal Welding Code, for duct joint and seam welding.

PART 2 - PRODUCTS

2.1 GENERAL

A. All duct installed shall be galvanized steel as indicated above.

B. Comply with SMACNA's "HVAC Duct Construction Standards-Metal and Flexible" for acceptable materials, material thicknesses and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations and other imperfections.

C. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:

1. Supply Ducts: 2-inch wg.

2. Return Ducts (Negative Pressure): 1-inch wg.

3. Exhaust Ducts (Negative Pressure): 1-inch wg.

2.2 SHEET METAL MATERIALS

A. Provide ducts constructed of the following materials as indicated above and on the Drawings:

1. Galvanized Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

2. Reinforcement Shapes and Plates: Reinforcement where installed on sheet metal ducts.

3. Tie Rods: Galvanized steel, 1/48 minimum diameter for lengths 368 or less; 3/88 minimum diameter for lengths longer than 368.

B. Fabrication: Fabricate ducts, elbows, transitions, offsets, branch connections and other construction according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.

2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards-Metal and Flexible."

2.3 DUCT LINER

A. All ducts shall have duct liner.

B. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124 and insulation requirements specified.

C. Materials: Provide liner with material conforming to ASTM C 1071. All surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

1. Thickness: 1 inch.

2. Thermal Conductivity (k-Value): 0.26 at 75-degree F mean temperature.

3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

4. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

5. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

a. Tensile Strength: Indefinitely sustain a 50-lb tensile dead-load test perpendicular to duct wall.

b. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8" into airstream.

c. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

D. Application of Liner in Rectangular Ducts: Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing. Butt transverse joints together without gaps and coat joint with adhesive.

1. Fold and compress liner in comers of rectangular ducts or cut and fit to ensure butted- edge overlapping.

2. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

3. Secure liner with mechanical fasteners 4-inches from comers and at intervals not exceeding 128 transversely, at 3-inches from transverse joints and at intervals not exceeding 18-inches longitudinally.

4. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or 2” profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.

   b. Intervals of lined duct preceding unlined duct.

5. Terminate inner ducts with buildouts attached to dampers, turning vane assemblies or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets or welds.

E. Manufacturers, or Equal:

1. CertainTeed Corp.; Insulation Group.

2. Johns Manville International, Inc.

3. Knauf Fiber Glass GmbH.

4. Owens Corning.

2.4 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term “sealant” is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics. All sealants shall comply with requirements of Section 07 92 00 – Joint Sealants.

B. Joint and Seam Tape: Provide 2-inch wide glass fiber reinforced fabric.

C. Water-Based Joint and Seam Sealant: Flexible adhesive sealant, resistant to UV light when cured, UL 723 listed and complying with NFPA requirements for Class 1 ducts.

D. Solvent-Based Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

E. Flanged Joint Mastic: One part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use “0”.

F. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners or SMACNA-approved attachment structural-steel fasteners appropriate for construction materials to which hangers are attached.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4-inch thick.

2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4-inch thick.

B. Duct Attachments: Screws, blind rivets or self-tapping metal screws; compatible with duct materials.

C. Trapeze Supports: Provide aluminum steel support materials and ensure materials are electrolytically separated from ducts.

2.6 DRYER EXHAUST DUCTWORK

A. Snap lock, round galvanized sheet metal with taped, slip-fit joints. Minimum 26 gage. Eliminate edges and sheet metal screws that could catch lint. Use duct tape or pop-rivets on all seams and joints.

B. Install flexible connections of fire-resistant material with spiral inner liner wire, stainless steel clamps between unit and exhaust duct.

C. Roof discharge cap shall have baffled outlet, without bird screen similar to Penn Pul-Air.

2.7 SCREENS

A. Furnish and install screen on all duct, fan, etc., openings which lead to or are outdoors. Screens shall be No. 16 gage, galvanized steel 1/2" mesh bolted into removable galvanized steel frame.

2.8 WEATHER HOODS

A. Furnish and install weather hoods on all exterior duct penetrations.

B. Weather hoods shall match the size of the duct penetration.

C. Weather hood configuration shall be one of the following:

1. Supply duct – 90 degrees downturned

2. Exhaust duct – 45 degrees downward

D. Mount weather hoods to exterior wall according to manufacturer’s recommendations.

2.9 PLENUMS AND BLANK-OFF PLATES

A. Provide plenums at air handling units, fan coil units and other equipment where return air or outside air ducts are shown to connect. Provide full or partial blank-off plates on return air openings as necessary for properly balancing of system supply air, outside air and return air flows or to cover openings where air transfer is not desired.

B. Construct plenums with same duct material as indicated above or on the plans. Gages and bracing shall conform to SMACNA recommendations for ductwork of like size. Openings for fans, access doors, etc., shall be framed with galvanized steel angles.

C. Where access doors are shown, provide hinged doors as outlined in section 23 33 00 – Duct Accessories.

2.10 DUCT WRAP INSULATION

A. Provide thermal and acoustical insulation for *all* interior conditioned-air ductwork.

B. Insulation Materials:

1. Highly resilient, lightweight, blanket-type thermal insulation made with inorganic fiberglass bonded technology.

2. Insulation shall not contain asbestos, lead, mercury, or mercury compounds.

3. Insulation that comes in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

4. Insulation is to be mold resistant in accordance with ASTM C1138.

C. Insulation Characteristics:

1. Factory Applied Facing – Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing; Foil-scrim-kraft (FSK).

2. Minimum Insulation rating – R-12 @ 25% compression

3. Insulation Thickness: minimum 1” unless otherwise defined in the Project Plans.

4. Density – 0.75-1 pound per cubic foot (PCF)

D. Joints

1. Butt joints together tightly and connect with 3” wide Pressure sensitive tape. Where vapor retarder is required, close joints with pressure-sensitive tape or glass fabric and mastic.

2. Use of bonding adhesive is prohibited.

E. Certifications:

1. ASTM C1290

2. ASTM C553

3. ASTM C1136

4. NFPA 90A

5. UL/ULC Classified

F. Manufacturer or Approved Equal

1. Knauf Insulation- Atmosphere®

2. John Manville – Microlite®

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Install ducts with hangers and braces designed to withstand seismic force required by applicable building codes without damage to equipment. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Hangers shall be installed such that equipment hangs level.

B. Coordinate ductwork layout with suspended ceiling, fire rated walls and ceilings, lighting layouts, fire protection piping layout, structural components, and plumbing system.

C. Drawings indicate the net inside dimension of ductwork. No allowance for interior acoustic duct liner thickness has been made. The metal duct dimension will need to be increased to keep the net inside dimension when insulation lining is required.

D. Seal all joints and seams on ductwork.

E. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards- Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous glass ducts. Provide duct accessories of materials suited to duct materials.

F. Install turning vanes in all square and rectangular elbows.

G. Install backdraft dampers on exhaust fans or ducts nearest to outside and where indicated.

H. Install fire, smoke and fire/smoke dampers with fusible links, according to manufacturer's UL approved written instructions.

I. Roof mounted equipment curbs shall be constructed such that equipment is level.

J. Flexible ducts shall be limited to a maximum of 5 feet long.

K. Install ducts with fewest possible joints.

L. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

M. Install ducts close to walls, overhead construction, columns and other structural and permanent enclosure elements of building.

N. Protect duct interiors from the elements and foreign materials until building is enclosed.

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA's HVAC Duct Construction Standards-Metal and Flexible for duct pressure class indicated.

1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.

3.3 HANGING AND SUPPORTING

A. Support horizontal ducts within 24-inch of each elbow and within 48-inch of each branch intersection.

B. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

C. Install concrete inserts before placing concrete.

D. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4-inch thick.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 33 00 - Duct Accessories.

B. Comply with SMACNA's “HVAC Duct Construction Standards - Metal and Flexible” for branch, outlet and inlet and terminal unit connections.

3.5 INSULATION INSTALLATION

A. Preparation

1. Install over clean, dry sheet metal ducts.

2. All sheet metal joints and seams must be sealed to prevent air leakage from the duct.

B. Application

1. Apply per Manufacturer’s recommendations.

3.6 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

END OF SECTION 23 31 13

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SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes manual volume dampers, motorized control dampers, turning vanes, duct-mounted access doors, flexible ducts, flexible connectors, and duct accessory hardware.

1.2 REFERENCE STANDARDS

A. NFPA 90A “Installation of Air Conditioning and Ventilating System”

B. NFPA 90B "Installation of Warm Air Heating and Air Conditioning Systems”

C. SMACNA's "HVAC Duct Construction Standards - Metal and Flexible”

1.3 SUBMITTALS

A. Shop Drawings: Submit detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location and size of each field connection detail in accordance with Section 01 33 00 – Submittal Procedures. At a minimum, submit information for the following:

1. Manual Volume Dampers.
2. Motorized Control Dampers.
3. Turning Vanes.
4. Duct-Mounted Access Doors.
5. Flexible Ducts.
6. Flexible Connectors.
7. Special Fittings.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. All sheet metal shall be compatible with ductwork and shall be constructed of materials specified in Section 23 31 13 – Metal Ducts. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses and duct construction methods, unless otherwise indicated.

2.2 MANUAL VOLUME DAMPERS

A. Provide factory fabricated dampers with required hardware and accessories. Stiffen all damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

B. Standard Volume Dampers: Provide dampers with multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. Provide dampers fabricated of materials called out on the drawings; where no material is called out on the drawings, use aluminum dampers on aluminum and stainless steel ducts, use galvanized dampers on galvanized steel ducts.

1. Aluminum Frames: Hat-shaped, 0.10 thick aluminum sheet channels, frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Aluminum Blades: 0.10 thick aluminum sheet.
3. Extruded-Aluminum Blades: 0.050 thick extruded aluminum.
4. Blade Axles: Nonferrous.
5. Bearings: Molded synthetic.
6. Tie Bars and Brackets: Galvanized Steel.
7. Steel Frames: Hat-shaped, galvanized stainless sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
8. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.

C. Manufacturers, or Equal.

1. Greenheck
2. Air Balance, Inc.
3. American Warming and Ventilating.
4. Flexmaster U.S.A., Inc.
5. McGill AirFlow Corporation.
6. Louvers & Dampers.
7. Nailor Industries Inc.

8. Ruskin Company.

9. Vent Products Company, Inc.

2.3 MOTORIZED CONTROL DAMPERS

A. Provide AMCA-rated, opposed-blade design; minimum of 16 gauge thick galvanized-steel frames with holes for duct mounting; minimum of 14 gauge thick galvanized-steel damper blades with maximum blade width of 6-inches.

1. Blades to ½-inch diameter zinc-plated axles using zinc-plated hardware with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring stainless steel blade bearings and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 degrees to plus 200 degrees F.

3. Provide closed-cell neoprene edging.

4. Provide motorized control dampers for service with air conditioning unit condenser fans with 9 volt electric actuator.

B. Manufacturers, or Equal.

1. Greenheck

2. Air Balance, Inc.

3. American Warming and Ventilating.

4. Louvers & Dampers.

5. McGill AirFlow Corporation

6. Metalaire, Inc.

7. Nailor Industries, Inc.

8. Ruskin Company.

9. Vent Products Company, Inc.

2.4 TURNING VANES

A. Fabricate to comply with SMACNA's “HVAC Duct Construction Standards-Metal and Flexible” for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch wide, single-vane curved blades of galvanized sheet steel set per SMACNA, support with bars perpendicular to blades set 2-inches o.c. and set into vane runners suitable for duct mounting.

C. Manufactures, or Equal.

1. Ductmate Industries, Inc.

2. Duro Dyne Corp.

3. Metalaire, Inc.

2.5 DUCT-MOUNTED ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double-wall duct mounting and rectangular fabricated of aluminum with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-inch by 1-inch butt or piano hinge and cam latches.

C. Frame: Aluminum with bend-over tabs and foam gaskets.

D. For all access doors less than 12-inch square, secure with two sash locks.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Insulation: 1-inch thick fibrous-glass or polystyrene-foam board.

G. Manufacturers, or Equal.

1. Greenheck.

2. American Warming and Ventilating.

3. Ductmate Industries, Inc.

4. Flexmaster U.S.A., Inc.

5. Louvers & Dampers.

6. McGill AirFlow Corporation.

7. Nailor Industries Inc.

8. Ventfabrics, Inc.

2.6 FLEXIBLE DUCTS

A. General Description: Flame-retarded or noncombustible materials, coatings and adhesives in compliance with UL 181, Class 1.

B. Fabricate flexible ducts in accordance with SMACNA's "HVAC Duct Construction Standards – Metal and Flexible."

C. Minimum Rated Velocity: 5,000 FPM

D. Operating Temperature: -20°F to 250°F

E. Minimum Rated Operating Pressure:

1. Positive Pressure: 10” WG.

2. Negative Pressure: ½” WG.

F. Insulation: 1-inch thick fibrous-glass.

G. Flexible duct length: 5 ft maximum.

2.7 FLEXIBLE CONNECTORS

A. General Description: Flame-retarded or noncombustible fabrics, coatings and adhesives complying with UL 181, Class 1.

B. Metal-Edged Connectors: Factory fabricated with a strip of fabric 3 ½-inch wide attached to two strips of 2 ¾-inch wide, 0.032-inch thick aluminum sheets. Select metal compatible with ducts.

C. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weather-proof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd.

2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.

3. Service Temperature: Minus 50 degrees F to plus 250 degrees F.

D. Manufactures, or Equal.

1. Ductmate Industries, Inc.

2. Duro Dyne Corp.

3. Ventfabrics, Inc.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's “HVAC Duct Construction Standards-Metal and Flexible” for metal ducts.

B. Provide duct accessories of materials suited to duct materials; for example use aluminum accessories in aluminum ducts. Use galvanized steel accessories in galvanized steel ducts unless noted.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; install dampers in a way that avoids damage or erosion of duct liner.

E. Provide balancing dampers at points on supply, return and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Install duct access doors to allow for inspecting, adjusting and maintaining accessories and terminal units as follows:

1. Downstream from volume dampers, turning vanes and equipment.

2. On sides of ducts where adequate clearance is available.

G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

H. Connect diffusers or light troffer boots to low-pressure ducts directly.

I. Adjust duct accessories for proper settings.

END OF SECTION 23 33 00

SECTION 23 34 23 – HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes requirements for Exhaust and Propeller Fans.

1.2 REFERENCE STANDARDS

A.	AMCA 99	
B.	AMCA 204	Balance Quality and Vibration Levels for Fans
C.	AMCA 210	Laboratory Methods of Testing Fans for Rating
D.	AMCA 211	Certified Ratings Program Manual for Fan Air Performance
E.	AMCA 300	Reverberant Room Method for Sound Testing of Fans
F.	AMCA 301	Methods for Calculating Fan Sound Ratings from Laboratory Test Data
G.	NFPA 70, Article 100	
H.	UL 705	
I.	AMCA Compliance	
J.	NEMA Compliance	

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties and accessories for each type of product indicated in equipment schedules in accordance with Section 01 33 00 – Submittal Procedures. At a minimum, include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material gauges and finishes including color charts.
5. Dampers including housings, linkages and operators.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

1. Wiring Diagrams: Provide information defining power signal and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which the power ventilators will be attached.

2. Method of attaching power ventilators to building structure.

D. Maintenance Data: Provide technical manuals in accordance with Section 01 78 23 – Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Performance ratings: conform to AMCA Standard 211, Certified Ratings Program Manual for Fan Air Performance.

B. All electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

C. All wiring shall be in accordance with the National Electrical Code (NEC).

D. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

E. All motors and electrical accessories shall comply with NEMA standards.

F. All power ventilators shall comply with UL 705.

G. Fans shall be manufactured in an ISO 9001 certified facility.

1.5 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

B. The wireless controller shall be shipped inside the carton with the unit and able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.6 WARRANTY

A. The units shall have a manufacturer’s parts and defects warranty for a period one (1) year from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

PART 2 - PRODUCTS

2.1 GENERAL

A. Sound-Power Level Ratings: Comply with AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data. Factory test fans according to AMCA 300 - Reverberant Room Method for Sound Testing of Fans. All fans shall be labeled with AMCA - Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation and efficiency by factory tests and ratings according to AMCA 210, Laboratory Methods of Testing Fans for Rating.

2.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations. See Drawings for listed project elevation.

B. Operating Limits: Classify according to AMCA 99.

2.3 CENTRIFUGAL EXHAUST FANS

A. Description: Provide direct-driven centrifugal exhaust fans consisting of housing, wheel, fan shaft, bearings, and complete with motor and disconnect switch, drive assembly, and accessories.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades. Wheel shall be balanced in accordance with AMCA 204, Balance Quality and Vibration Levels for Fans.

C. Belt-Driven Drive Assembly: Resiliently mounted to housing with the following features:

1. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.

2. Shaft Bearings: Permanently-lubricated, permanently-sealed, self-aligning ball bearings.

3. Pulleys: Cast-iron adjustable-pitch motor pulley.

4. Drives shall be sized for 150 percent of the installed motor horsepower.

D. Accessories: Provide the following accessories with each fan:

1. Disconnect Switch: Non-fusible type with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2. Birdscreens: Removable, ½-inch mesh, aluminum or brass wire.

3. UL listed construction.

E. Manufacturers, or Equal:

1. Greenheck Fan Corp.

2. Cook, Loren Company

2.4 BATHROOM EXHAUST FAN

A. Description: provide complete direct drive bathroom exhaust fans consisting of fan, housing, bearings, grille and enclosure, motor, and accessories.

B. Exhaust fans shall be ceiling mounted and equipped with a ceiling grille.

C. Exhaust fans shall be powered by the light switch (when light turns on, fan turns on).

D. Provide transition fittings as required to connect to exhaust ductwork.

E. Accessories: Provide the following accessories with each fan:

1. Discharge weatherhood on building exterior.

2. UL listed construction.

F. Manufacturers, or Equal:

1. Greenheck Fan Corp.

2. Cook, Loren Company

2.5 MOTORS

A. Comply with requirements in Division 40 05 93 – Common Motor Requirements for Process Equipment.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

3.2 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of electrical services to verify actual locations of connections before installation.

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

3.3 COORDINATION

A. Coordinate size and location of structural support members.

B. Coordinate installation of roof curbs, equipment supports and roof penetrations.

3.4 INSTALLATION

A. Install power ventilators level and plumb.

B. Support suspended units from structure using threaded steel rods.

1. Restrain support units with vibration and seismic control devices as required by the manufacturer and local code.

C. Arrange installation of units to provide access space around equipment for service and maintenance.

D. Label units.

3.5 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section - 23 33 00 – Air Duct Accessories.

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Electrical: comply with applicable requirements in Division 26 sections for power wiring, switches, and motor controls.

D. Ground equipment as recommended by the manufacturer.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 4866.

3.6 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify shipping, blocking and bracing are removed.

2. Verity unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify proper thermal-overload protection is installed in motors, starters and disconnect switches.

3. Verify cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts and install belt guards.

5. Verify lubrication for bearings and other moving parts.

6. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

7. Disable automatic temperature-control operators.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.

2. Measure and record motor voltage and amperage.

C. Manually operate dampers from fully-closed to fully-open position and record fan performance.

D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units and retest. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. For ducted systems, balance airflow per the Testing and Balancing specifications. Refer to Section 23 00 00 – General HVAC Requirements for testing, adjusting and balancing procedures.

E. Shut unit down and reconnect automatic temperature-control operators.

F. Replace fan and motor pulleys as required to achieve design airflow.

G. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.7 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.8 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt and construction debris and repair damaged finishes.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owners maintenance personnel to adjust, operate and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment and schedules.

2. Review data in maintenance manuals provided under Section 01 78 23 – Operation and Maintenance Data.

3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

3.10 O&M

A. Provide O&M manuals to the Owner.

END OF SECTION 23 34 23

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SECTION 23 34 39.13 – HIGH VOLUME, LOW-SPEED PROPELLER CEILING FANS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes requirements for High Volume Low Speed Propeller Ceiling Fans.

1.2 REFERENCE STANDARDS

A. NFPA 70, Article 100

B. UL 507

C. CSA 22.2 No. 113

D. NEMA Compliance

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties and accessories for each type of product indicated in equipment schedules in accordance with Section 01 33 00 - Submittals. At a minimum, include the following:

1. Motor ratings and electrical characteristics, plus motor and electrical accessories.

B. Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.

1. Wiring Diagrams: Provide information defining power signal and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: Provide technical manuals in accordance with Section 01 78 23 - Operation and Maintenance Data.

D. Warranty Data

1.4 QUALITY ASSURANCE

A. All electrical components, devices and accessories shall be 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. All motors and electrical accessories shall comply with NEMA standards.

C. Fans shall be UL listed.

PART 2 - PRODUCTS

2.1 GENERAL

A. Ceiling fans shall be suitable for industrial settings.

2.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base air ratings on actual site elevations. See Drawings for listed project elevation.

2.3 PROPELLER FANS

A. Description: Belt-driven or direct-driven propeller fans consisting of fan airfoils, hub, housing, orifice ring, motor, drive assembly and accessories.

B. Housing: Aluminum sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly. Fully sealed drive enclosure resists corrosion and reduced heat buildup for longer life.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable cast-aluminum airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Onboard VFD & Platform: Housed in an ABS/PVC based enclosure with built-in heatsink.

F. Mounting: Steel mounting hardware to be capable of being mounted to I-beams, bar joists, solid beams or purlins. Contractor to coordinate mounting hardware with Project Drawings.

G. Safety: Double safety cable system, airfoil retainer, hub safety clips, Grade 8 hardware, fire relay, guy wires and airfoil restraint system.

H. Airfoils: Eight 8-ft aluminum airfoils mill finish and shall be field balanced.

I. Power Requirements: Shall meet the power requirements as indicated in the HVAC schedules.

J. Manufacturers, or Approved Equal

1. Delta T LLC dba Big Ass Fans.

2. Greenheck Fan Corp

3. Captive Aire

2.4 MOTORS

A. Controls: Shall be provided by the fan manufacturer, UV resistant, IP55 rated, password protected, powered by fan drive and with a touchscreen interface.

B. Comply with requirements in Section 40 05 93 – Process Equipment.

C. Provide disconnect switch for fan motor.

D. Provide access panel for fan motor.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

3.2 COORDINATION

A. Coordinate size and location of structural support members.

B. Coordinate installation of roof curbs, equipment supports and roof penetrations.

3.3 INSTALLATION

A. Install ceiling fans level and plumb.

B. Support suspended units as recommended by the manufacturer.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in other Divisions.

E. Balance airfoils according to manufacturer recommendations.

3.4 CONNECTIONS

A. Equipment shall be properly grounded and bonded.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 4866.

3.5 FIELD QUALITY CONTROL

A. Equipment Startup Checks:

1. Verify shipping, blocking and bracing are removed.

2. Verity unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify proper thermal-overload protection is installed in motors, starters and disconnect switches.

3. Verify cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts and install belt guards.

5. Verify lubrication for bearings and other moving parts.

6. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

B. Starting Procedures:

1. Energize motor and adjust fan to indicated rpm.

2. Measure and record motor voltage and amperage.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units and retest.

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

E. Shut unit down and reconnect automatic temperature-control operators.

F. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.6 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt and construction debris and repair damaged finishes.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate and maintain power ventilators.

1. Train Owner’s maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment and schedules.

2. Review data in maintenance manuals provided under Section 01 78 23 - Operation and Maintenance Data.

3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

END OF SECTION 23 34 39.13

SECTION 23 37 00 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide ceiling and wall-mounted diffusers, registers and grilles as indicated on the drawings and per the requirements of this specification.

1.2 REFERENCE STANDARDS

A. ASHRAE 70 Method of Testing for Rating the Performance of Air Outlets and Inlets

1.3 SUBMITTALS

A. Provide product data for each product in accordance with Section 01 33 00 – Submittals. At a minimum, the following information shall be provided:

1. Data Sheet: Indicate materials of construction, finish and mounting details and performance data including throw and drop, static-pressure drop and noise ratings.

2. For each diffuser, register and grille provided indicate Drawing designation, room location, quantity, model number, size and accessories furnished.

1.4 QUALITY CONTROL

1. Verification of Performance: Rate diffusers, registers and grilles according to ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.

PART 2 - PRODUCTS

2.1 DIFFUSERS, REGISTERS AND GRILLES

A. Provide as scheduled on the drawings.

B. Manufacturers: Price, Titus, Tuttle and Bailey, Krueger, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, registers and grilles level and plumb.

B. Install diffusers, registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors and fire dampers.

C. Provide transition fittings as required to connect diffusers, registers, and grilles to ductwork.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers and grilles to air patterns indicated or as directed before starting air balancing.

END OF SECTION 23 37 00

SECTION 23 54 00 - FURNACES

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes the following:

1. Furnaces and accessories complete with controls.

2. Direct-expansion cooling coils with refrigerant piping.

1.2 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Submittals.

B. Product Data: For each furnace. Include rated capacities of selected models, shipping, installed and operating weights, furnished specialties and accessories. Include plan and elevation views of units, minimum clearances and data on ratings and capacities.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal and control wiring.

D. Operation and Maintenance Data: For each furnace to include in emergency, operation and maintenance manuals. Include the following:

1. Furnaces and accessories complete with controls.

2. Direct-expansion cooling coils with refrigerant piping.

E. Coordination Drawings: Floor plans and other details, drawn to scale, from which the following items are shown and coordinated with each other, based on input from installers of the structural members to which furnace units will be installed.

F. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (NEC).

C. Product Options: Drawings indicate size, profiles and dimensional requirements of furnaces and are based on the specific system indicated.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

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

1.4 DELIVERY, STORAGE, AND HANDLING

A. Furnace shall be stored and handled according to the manufacturer’s recommendations.

B. The controller shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace the following components of furnaces that fail in materials or workmanship within specified warranty period:

1. Control circuit board.

B. Warranty Period: 5 years from date of Substantial Completion. If during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

PART 2 - PRODUCTS

2.1 GAS FIRED FURNACES

A. Furnaces shall be factory assembled, wired, and tested, in compliance with NFPA 54, National Fuel Gas Code.

1. AHRI Approval: Designed and certified by and bearing label of Air-Conditioning, Heating, and Refrigeration Institute (AHRI).

2. Type of Gas: Designed and built to burn natural gas with characteristics same as those of gas available at the project site.

B. Venting and Exhaust: Installer shall provide all air intake and exhaust flue piping, fittings, and weather caps as required for a complete system. Locate penetrations and termination types per plans and HVAC details.

C. Heat Exchanger: stainless steel.

D. Burners: stainless steel.

E. Manufacturers:

1. Trane
2. Mitsubishi
3. Daikin
4. Amana Heating and Cooling.
5. Armstrong Air Conditioning Inc.
6. Bryant Heating & Cooling Systems; Carrier; Div. of United Technologies Corp.
7. Carrier; Div. of United Technologies Corp.

F. Description: Factory assembled, wired and tested.

G. Cabinet: Steel with glass-fiber interior insulation downstream from cooling coil.

1. Duct Liner: Fiberglass, minimum 1/2" thick, complying with ASTM C 1071 and having a coated surface exposed to airstream complying with NFPA 90A, NFPA 90B, SMACNA's "Fibrous Glass Duct Construction Standards," and NAIMA's "Fibrous Glass Duct Liner Standard."

   a. Fire-Hazard Classification: Maximum flame-spread Index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.

   b. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.

H. Finish of External Casings and Cabinets: Factory painted, manufacturer's standard color.

I. Fan: Centrifugal, factory balanced, resilient mounted, direct drive. Fans to be made of cast or extruded aluminum. Factory to set blade pitch angle.

J. Fan Motors: Energy-efficient type. Open drip-proof with internal thermal protection. Motors must be multitapped, multispeed, with internal thermal protection and permanent lubrication.

K. Summer Fan Switch: Connected to permit independent on-off switch of unit fan.

L. Provide condensate pump as recommended by manufacturer.

2.2 CONTROLS

A. Furnace Controls; Include components required for satisfactory operation of furnaces and auxiliary equipment in all seasons.

B. Furnaces shall be compatible with a third-party thermostat as specified on the Plans.

C. Reference control strategy on MH-001 in the project drawings.

D. Control Transformer: 24-V AC output, factory installed and wired in furnace.

E. Cooling Relay: To start condensing unit.

F. Blower Fan Control: Fan on-automatic.

G. Power wiring is specified in Division 26. Signal and control wiring are specified in Division 26.

2.3 AIR FILTERS AND CLEANERS

A. Filters are to comply with NFPA 90A.

B. Filters shall be removable and replaceable.

C. Filters: 1" thick, disposable, fiberglass type in sheet metal frame.

2.4 COOLING FEATURES

A. Evaporator Coil: Copper tubes mechanically expanded into flat aluminum fins to reduce buildup. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Match remote condensing with type, capacity, pressure-drop ratings, restricted distributor or expansion valve. Include condensate drain pan with accessible drain outlet.

B. Evaporator Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.

C. Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen and sealed. Insulate suction line with minimum 3/8" thick, flexible elastomeric tubular insulation complying with ASTM C 534. Flared or sweat ends compatible with coil and condensing unit connections. Standard line lengths as required.

2.5 CONDENSER UNIT

A. The unit shall meet the intent of the design conditions listed on the equipment schedule, RE: project drawings schedules.

B. Fan: Furnish with a multispeed AC fan motor. The fan shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

C. Evaporator Coil: Copper tubes mechanically expanded into flat aluminum fins to reduce buildup. Match size with condenser unit.

D. Condensate Drain: Include with pan and accessible drain outlet. Route condensate drain to an approved location.

E. Refrigerant line: comply with guidelines in other Specifications.

F. Refrigerant: In compliance with EPA guidelines and the 2020 AIM Act.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of condensate drainage piping systems, gas piping systems, and electrical services to verify actual locations of connections before installation.

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

3.2 FURNACE INSTALLATION

A. Suspended Units: Suspend from structure using threaded rods, spring hangers and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

1. Install furnace with vibration and seismic control devices as required by the manufacturer and local mechanical codes.

B. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

1. Anchor furnace to substrate to resist seismic acceleration and vibration as required by manufacturer and code.

C. Controls: Install thermostats at mounting height equal to light switches.

D. Control Wiring: Install control wiring as specified in Division 26.

E. Arrange installation of unit to provide access space around equipment for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to equipment to allow service and maintenance. Connect to equipment as recommended by the manufacturer.

C. Connect ducts according to Specification 23 31 13 – Metal Ducts.

D. Ground equipment according to Division 26.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 STARTUP SERVICE

A. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

3. Perform cleaning and adjusting specified in this Section.

4. Install clean filters.

B. Starting procedures include the following:

1. Energize motor; verify proper operation of motor, drive system and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully-closed to fully-open position and record fan performance.

4. Test cooling and heating temperatures and verify they meet manufacturer specifications.

5. Balance ducted airflow systems per the Testing and Balancing specifications.

3.5 ADJUSTING

A. Adjust initial temperature and humidity setpoints.

B. Set controls and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features including shutters, dampers and relays to provide optimum heating performance and system efficiency.

3.6 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets and coils entering air face.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.7 O&M

A. Provide O&M manuals to the Owner.

END OF SECTION 23 54 00

SECTION 23 72 00 - AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide Air-to-Air Energy Recovery Units that comply with ASHRAE 84, “Method of Testing Air-to-Air Heat Exchangers,” UL 1812 “Ducted Heat Recovery Ventilators,” and AHRI standard 1060, “Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.”

B. Units shall be listed and labeled by UL and comply with applicable NEMA and NFPA standards.

1.2 REFERENCE STANDARDS

A. ASHRAE 84 Method of Testing Air-to-Air Heat Exchangers

B. AMCA 210 Laboratory Methods of Testing Fans for Rating

C. UL 1812 Ducted Heat Recovery Ventilators

D. AHRI Standard 1060 Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment

1.3 SUBMITTALS

A. Product Data: Product Data and Shop Drawings shall be submitted in accordance with Section 01 33 00 – Submittal Procedures. Include rated capacities, shipping, installed and operating weights, furnished specialties and accessories. Shop drawing information shall also include the following:

1. Wiring Diagrams: Power, signal and control wiring. Differentiate between manufacturer- installed and field-installed wiring.

2. Field Quality-Control Test Reports.

3. Details of anchorages, mounting and attachments to structure and to supported equipment.

1.4 QUALITY ASSURANCE

A. Warranty: The manufacturer shall provide a 1-year parts replacement warranty as specified in Section 23 00 00 – General HVAC Requirements.

B. In compliance with ASHRAE Standard 62.1, the energy recovery unit must be rated for less than 10 percent cross leakage at the design static pressure differential.

PART 2 - PRODUCTS

2.1 MATERIALS OF CONSTRUCTION

A. Construct unit suitable for installation in the attic, as detailed below:

1. Base: Welded structural steel channel with integral lifting lugs.

2. Mount base to bottom truss chords using approved methods from the truss manufacturer.

3. Access Doors: Double wall insulated doors with stainless steel piano hinges and two compression latches. Supply and exhaust air streams shall not be covered by a single door. Provide doors for access to filters, fans, electrical equipment, heat exchangers and any area requiring access for routine maintenance.

4. Energy recovery unit shall have standard duct connections factory mounted to the unit.

B. Heat exchangers (HX): Constructed as follows:

1. Cross flow flat plate heat exchanger type:

a. Construction: Galvanized steel framing with corrugated fiber membrane, with entire heat transfer surface visible for inspection and cleaning without disassembly of the heat exchanger.

b. Drain Pans: Locate under entire heat exchanger. Terminate drain pan connections through the side of the unit.

1) Route drain to an approved location.

2.2 BLOWERS AND MOTORS

A. All fans shall have pillow block bearings with minimum L-50 200,000 hour rating and meet the following requirements:

1. Blowers: direct drive plenum type. Motor and blower shall be assembled onto a galvanized steel platform.

a. Performance shall be factory tested for flow rate, pressure, power, air density, rotation speed, and efficiency, in accordance with AMCA 210.

2. Motors: NEMA frame and 1.15-service factor, mounted on adjustable base. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 85% of motor horsepower. All motors shall comply with ANSI/NEMA MG 1 efficiency requirements.

3. Drives: Adjustable for 10 hp motors and smaller, fixed for 15 hp motors and larger. All drives shall be minimum 2-groove with 2 belts and minimum 1.2 service factor.

4. Accessories:

a. Provide belt guards.

2.3 DAMPERS

A. Motorized, low leakage type with galvanized steel frame, formed galvanized steel blades, vinyl edge seals, metal jamb seals, and stainless steel bearings. Gravity dampers shall have aluminum frame, aluminum blades, extruded vinyl edge seals, and stainless steel bearings. Provide the following types of dampers in the location indicated:

1. Exhaust: Gravity damper.

2.4 FILTERS

A. Filter rack shall be internal to the unit and factory installed.

B. 2” MERV 8 disposable pleated filters shall be provided in the intake and exhaust streams.

C. Provide dirty filter sensor.

2.5 ELECTRICAL

A. Wire units according to NEC. All major electrical components shall be UL listed. Factory wire unit for single point power connection. Enclose all power wiring in liquid tight conduit.

1. Provide fused disconnect, fan motor starters/protectors, contactors, control transformer, control circuit fusing, service switch, and terminal block.

2. Provide NEMA 3R electrical/control panel.

3. Factory test wiring and controls before shipment.

2.6 CONTROL & SEQUENCE OF OPERATION

A. Energy Recovery Unit shall be running at a constant speed while the air handler is on.

B. Provide control wiring from air handler to energy recovery unit.

2.7 MANUFACTURERS OR EQUAL

A. Greenheck

B. Daikin

C. Captive Aire

D. Innovent

E. Valent

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install unit per Manufacturer’s written instructions.

3.2 EXAMINATION

A. Examine areas to receive energy recovery equipment for compliance with requirements for installation tolerances, clearances and other conditions affecting performance.

B. Examine roughing-in, electrical connections, and ductwork connections to verify actual locations before installing energy recovery equipment.

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

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping, ductwork, and electrical connections after complete installation. Report results in writing.

B. Equipment Startup Checks:

1. Verify shipping, blocking and bracing are removed.

2. Verity unit is secure on mountings and supporting devices and connections to ducts and electrical components are complete. Verify proper thermal-overload protection is installed in motors, starters and disconnect switches.

3. Verify cleaning and adjusting are complete.

4. Disconnect fan drive from motor, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts and install belt guards.

5. Verify lubrication for bearings and other moving parts.

6. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.

C. Starting Procedures:

1. Energize motors and adjust fans to indicated rpm.

2. Measure and record motor voltage and amperage.

D. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units and retest.

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

F. Shut unit down and reconnect automatic temperature-control operators.

G. Refer to Section 23 05 93 – Testing Adjusting and Balancing for HVAC for testing, adjusting and balancing procedures.

H. Replace fan and motor pulleys as required to achieve design airflow.

I. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.5 CLEANING

A. On completion of installation, internally clean fans according to manufacturer's written instructions. Remove foreign material and construction debris. Vacuum fan wheel and cabinet.

B. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owners maintenance personnel to adjust, operate and maintain power ventilators.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing and maintaining equipment and schedules.

2. Review data in maintenance manuals provided under Section 01 78 23 – Operation and Maintenance Data.

3. Schedule training with Owner, through Engineer, with at least seven days' advance notice.

END OF SECTION 23 72 00

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SECTION 23 81 26 – DUCTLESS SPLIT AIR CONDITIONING UNITS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes ceiling mounted ductless air conditioning units with heat pump, outdoor unit and accessories.

1.2 SUBMITTALS

A. Product Data: Product Data and Shop Drawings shall be submitted in accordance with Section 01 33 00 – Submittal Procedures. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which fan-coil units will be attached.
2. Method of attaching hangers to building structure.

1.3 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute’s (ARI) Standard 210 and bear the ARI Certification label.

D. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001, which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

E. A dry air holding charge shall be provided in the indoor section.

F. The outdoor unit shall be pre-charged with an approved refrigerant for 70 feet (20 meters) of refrigerant tubing.

G. System efficiency shall meet or exceed 13.0 SEER.

1.4 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer's recommendations.

B. The wireless controller shall be able to withstand 105°F storage temperatures and 95% relative humidity without adverse effect.

1.5 WARRANTY

A. The units shall have a manufacturer's parts and defects warranty for a period one (1) year from date of installation. The compressor shall have a warranty of 6 years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

1.6 PERFORMANCE

A. Each system shall perform in accordance to the ratings shown on the drawings. Cooling performance shall be based on 80°F DB, 67°F WB for the indoor unit, and 95°F DB, 75°F WB for the outdoor unit. Heating performance shall be based on 70°F DB, 60°F WB for the indoor unit, and 47°F DB, 15°F WB for the outdoor unit.

PART 2 - PRODUCTS

2.1 INDOOR UNIT

A. The indoor unit shall meet the intent of the design conditions listed on the equipment schedule. Reference the HVAC schedule in the project drawings.

B. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.

C. Unit Cabinet: The casing shall be steel with enamel paint. Cabinet shall be designed for suspension mounting and horizontal operation. The rear cabinet panel shall have provisions for a field-installed filtered outside air intake connection.

D. Fan: The evaporator fan shall have three high performance, double inlet, forward curve sirocco fans driven by a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall a minimum of four (4) speeds: Low, M1, M2, and Hi.

E. Vane

1. There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall provide a choice of five (5) vertical airflow patterns selected by remote control: 100% horizontal flow, 80% horizontal flow (plus 20% downward airflow), 60% horizontal airflow (plus 40% downward airflow), 40% horizontal airflow (plus 60% downward airflow), and swing. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped.

2. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

F. Filter: Return air shall be filtered by means of an easily removable washable filter.

G. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

H. Electrical: The electrical power of the unit shall be 208 volts, 1 phase, 60 hertz. The system shall be capable of satisfactory operation within voltage limits of 198 volts to 215 volts. The power to the indoor unit shall be supplied from a separate circuit from the outdoor unit.

I. Control

1. The mini split shall be temperature controlled by an external thermostat. The Contractor shall provide necessary adapters and interfaces to connect the external thermostat to the mini split.

2. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices. The control system between the outdoor unit and indoor unit shall be supplied from the outdoor unit.

3. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

4. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.

5. The indoor unit shall be controlled by either a wireless remote or a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD).

6. The controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

7. Normal operation of the controller shall provide individual system control in which the controller and indoor unit are installed in the same room.

8. The control voltage from the wired controller to the indoor unit shall be 12 volts, DC. The control signal between the indoor and outdoor unit shall be pulse signal 24 volts DC. Up to two wired controllers shall be able to be used to control one unit.

9. Control system shall control the continued operation of the air sweep louvers, as well as provide On/Off and mode switching. The controller shall have the capability to provide sequential starting with up to fifty seconds delay.

2.2 OUTDOOR UNIT

A. General

1. The outdoor unit shall meet the intent of the design conditions listed on the equipment schedule, RE: project drawings schedules.

2. The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions.

3. The outdoor unit shall be capable of operating at 0°F (-18°C) ambient temperature without additional low ambient controls; provide wind baffle.

4. System shall have a maximum refrigerant tubing length of 165 feet between indoor and outdoor units without the need for line size changes, traps or additional oil.

5. Heat pump cabinets shall be installed six (6) inches above the equipment pad.

B. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection.

C. Fan: Furnish with an AC fan motor. The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and dispelling it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.

D. Coil: The L-shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

E. Compressor: The compressor for shall be a scroll compressor with variable speed technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical: The electrical power of the unit shall be 208 volts, 1 phase, 60 hertz. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

2.3 SCHEDULE

A. Refer to Project Drawings for AC Mini-Split Unit Schedules.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

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

3.2 INSTALLATION

A. Install ductless split air conditioning indoor and outdoor units with vibration and seismic-control devices as required by the manufacturer and local mechanical codes.

B. Arrange installation of units to provide access space around equipment for service and maintenance.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect piping split AC units mounted using approved method ie. socket weld for condensate drain and compression or brazing for copper piping, as recommended by the manufacturer.

D. Connect condensate drain pans using PVC tubing. Extend to nearest equipment or floor drain or other approved location.

E. Refrigerant Piping: Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

F. Duct installation (when required per project plans) and connection requirements are specified in other Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches and motor controls.

H. Ground equipment according to Division 26 Section "Grounding and Bonding." Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 4868.

3.4 STARTUP SERVICE

A. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters and disconnect switches.

3. Perform cleaning and adjusting specified in this Section.

4. Install clean filters.

B. Starting procedures include the following:

1. Energize motor; verify proper operation of motor, drive system and fan wheel. Adjust fan to .indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Manually operate dampers from fully-closed to fully-open position and record fan performance.

4. Test cooling and heating temperatures and verify they meet manufacturer specifications.

5. For ducted systems, balance airflow per the Testing and Balancing specifications.

3.5 CLEANING

A. Clean condenser units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air-handling and air-distribution systems, clean filter housings and install new filters.

3.6 O&M

A. Provide O&M manuals to the Owner.

END OF SECTION 23 81 26

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SECTION 23 82 39.10 – ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes industrial Electric Unit Heaters with electric-resistance coils.

1.2 REFERENCE STANDARDS

A. Label all electrical components, devices and accessories in accordance with NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. UL 2021

1.3 SUBMITTALS

A. Product Data: Product Data and Shop Drawings shall be submitted in accordance with Section 01 33 00 – Submittal Procedures. Include rated capacities, shipping, installed and operating weights, furnished specialties and accessories. Shop drawing information shall also include the following:

1. Wiring Diagrams: Power, signal and control wiring. Differentiate between manufacturer- installed and field-installed wiring.

2. Field Quality-Control Test Reports.

3. Details of anchorages, mounting and attachments to structure and to supported equipment.

B. Operation and Maintenance Data: Provide technical manuals for unit heaters that include emergency, operation and maintenance information in accordance with Section 01 78 23– Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations: Obtain electric unit heaters through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles and dimensional requirements of electric unit heaters and are based on the specific system indicated. Products submitted for approval "As-Equal", will be evaluated during construction against this section and the project plans for general project compliance. It is the responsibility of the Contractor to ensure that products used during bid meet the general requirements of these specifications. Substitutions and "as-equal" products will not be evaluated during bid phase.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace unit heater that fails in materials or workmanship within specified warranty period. The warranty period shall be for five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Casing:

1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Cabinet: Removable panels for maintenance access to controls.

3. Cabinet Finish: Manufacturer's standard powder coat finish applied to factory-assembled and -tested galvanized steel unit heater before shipping.

4. Discharge Louver: Adjustable outlet grille with 45° angled louvers.

C. Electrical-Resistance Heating Elements:

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection. Fan: Aluminum propeller directly connected to motor.

E. Motor: High performance permanently lubricated, total enclosed, multi-speed with integral thermal-overload protection.

F. Reference the MH-600 sheets in the Project Drawings for required heating capacities.

2.2 CONTROLS

A. Provide a wall-mounted thermostat, low-voltage relay with transformer kit unless otherwise indicated on the Project Plans. Thermostat may be provided either separately or as with the Unit heater.

B. Refer to Sequence of Operations on MH-001 of the project plans, MH-601 for Control Device Schedule and Section 23 09 00 - Instrumentation and Control of HVAC for thermostat requirements.

2.3 ACCESSORIES

A. Provide either ceiling or wall mounting hardware as indicated on the plans.

B. Provide thermostat, see above for more details.

2.4 MANUFACTURERS, OR EQUAL

1. Reznor
2. Markel
3. Modine Manufacturer Company.
4. Sterling Radiator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances, clearances and other conditions affecting performance.

B. Examine roughing-in and electrical connections to verify actual locations before unit heater installation.

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

3.2 INSTALLATION

A. Install unit heaters level and plumb.

B. Install unit heaters to comply with NFPA 90A.

C. Suspend propeller Wall-mounted units: Mount unit heaters from structure with factory supplied mounting brackets according to manufacturer recommendation. Mounting brackets should match the finish of the Unit Heater.

D. Where required install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other control sensors with the Project Plans before installation.

3.3 CONNECTIONS

A. Factory wire motors and controls for a single field connection with disconnect switch, unless otherwise indicated in the Project Plans.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Installation requirements are specified in Division 26. Drawings indicate general arrangement of wiring, connections and location.

D. Ground equipment as directed in Division 26.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing.

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safeties.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt and debris. Repair damaged finish to match original finish.

B. After installing units, clean unit heaters internally according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain unit heaters.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

2. Review data in maintenance manuals. Refer to Section 01 77 00 - Closeout Procedures.

3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 23 82 39

SECTION 23 82 39.20 – HYDRONIC UNIT HEATERS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. This Section includes industrial hydronic unit heaters.

B. Reference Specification 22 00 00 – Plumbing General, for hydronic piping information.

1.2 REFERENCE STANDARDS

A. Label all electrical components, devices and accessories in accordance with NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. UL 2021

1.3 SUBMITTALS

A. Product Data: Product Data and Shop Drawings shall be submitted in accordance with Section 01 33 00 – Submittal Procedures. Include rated capacities, shipping, installed and operating weights, furnished specialties and accessories. Shop drawing information shall also include the following:

1. Wiring Diagrams: Power, signal and control wiring. Differentiate between manufacturer- installed and field-installed wiring.

2. Field Quality-Control Test Reports.

3. Details of anchorages, mounting and attachments to structure and to supported equipment.

B. Operation and Maintenance Data: Provide technical manuals for unit heaters that include emergency, operation and maintenance information in accordance with Section 01 78 23– Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

B. Source Limitations: Obtain hydronic unit heaters through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles and dimensional requirements of hydronic unit heaters and are based on the specific system indicated. Products submitted for approval “As-Equal”, will be evaluated during construction against this section and the project plans for general project compliance. It is the responsibility of the Contractor to ensure that products used during bid meet the general requirements of these specifications. Substitutions and “as-equal” products will not be evaluated during bid phase.

D. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace unit heater that fails in materials or workmanship within specified warranty period. The warranty period shall be for five years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. Casing:

1. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2. Cabinet: Removable panels for maintenance access to controls.

3. Cabinet Finish: Manufacturer's standard powder coat finish applied to factory-assembled and -tested galvanized steel unit heater before shipping.

4. Discharge Louver: Adjustable outlet grille with 45° angled louvers.

C. Water Coil Heating Elements:

1. Material: heavy wall drawn seamless copper tubing with brazed connections.

2. Provide aluminum fins with drawn collars.

3. Water coils shall be capable of withstanding constant long-term pressure of 150 PSI at 350°F under maximum load conditions.

D. Motor: High performance permanently lubricated, totally enclosed, with integral thermal-overload protection.

E. Fan: Aluminum blade hub type, balanced from the factory. Provide with OSHA approved fan guard.

F. Reference the MH-600 sheets in the Project Drawings for required heating capacities.

2.2 CONTROLS

A. Provide a wall-mounted thermostat, low-voltage relay with transformer kit unless otherwise indicated on the Project Plans. Thermostat may be provided either separately or as with the Unit heater.

B. Refer to Sequence of Operations on MH-001 of the project plans, MH-601 for Control Device Schedule and Section 23 09 00 - Instrumentation and Control of HVAC for thermostat requirements.

2.3 ACCESSORIES

A. Provide either ceiling or wall mounting hardware as indicated on the plans.

B. Provide thermostat, see above for more details.

2.4 MANUFACTURERS, OR EQUAL

1. Trane
2. Reznor
3. Modine Manufacturer Company.
4. Sterling Radiator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances, clearances and other conditions affecting performance.

B. Examine roughing-in and electrical connections to verify actual locations before unit heater installation.

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

3.2 INSTALLATION

A. Install unit heaters level and plumb.

B. Install unit heaters to comply with NFPA 90A.

C. Suspend propeller Wall-mounted units: Mount unit heaters from structure with factory supplied mounting brackets according to manufacturer recommendation. Mounting brackets should match the finish of the Unit Heater.

D. Where required install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other control sensors with the Project Plans before installation.

3.3 CONNECTIONS

A. Factory wire motors and controls for a single field connection with disconnect switch, unless otherwise indicated in the Project Plans.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Install hydronic supply and return water lines as recommended by the manufacturer.

D. Installation requirements are specified in Division 26. Drawings indicate general arrangement of wiring, connections and location.

E. Ground equipment as directed in Division 26.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing.

1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.

3. Test and adjust controls and safeties.

4. Pressure test hydronic systems as recommended by the manufacturer.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 CLEANING

A. After installing units, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt and debris. Repair damaged finish to match original finish.

B. After installing units, clean unit heaters internally according to manufacturer's written instructions.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain unit heaters.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.

2. Review data in maintenance manuals. Refer to Section 01 77 00 - Closeout Procedures.

3. Schedule training with Owner, through Architect, with at least seven days advance notice.

END OF SECTION 23 82 39.20

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SECTION 26 05 00 – ELECTRICAL, GENERAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to all of Division 26 Specifications. This Specification section applies to all Division 26 Specifications and Electrical Drawings.

B. Division 26 contractor shall review all other division specifications and drawings for additional requirements.

1.2 QUALITY ASSURANCE

A. Comply with latest NEC, NFPA, UBC, UFC, UL and applicable Local and State Codes. Also comply with Utility Company regulations and industry standards and these Drawings.

B. Work shall be done by only trained, licensed and experienced workmen familiar with the requirements.

C. All microprocessor based equipment and software with equipment shall utilize 4 digits for the year part of all dates. A two digit date shall be an option for printing at Owner's preference.

D. Hazardous Location Rating of Equipment: Equipment manufacturer shall reference the hazardous-area classification drawing in the Contract Documents and provide equipment in compliance with the defined NEC- classification requirements. It will be the manufacturer's sole responsibility to submit equipment in compliance with the Contract Documents, NFPA 820, and NEC requirements.

1.3 EXTENT OF DRAWINGS / SPECIFICATION

A. Drawings indicate intent and general layout of electrical systems for the Project. Drawings are partly diagrammatic and do not indicate all fittings and accessories which may be required. Provide such fittings and accessories as required to form a complete and operating system in general conformance with Specifications and Drawings.

1.4 PRIOR APPROVALS

A. Unless directed otherwise by Division 1, all products submitted for prior approval shall be received by the Engineer 10 business days prior to Bid. Supply technical data, photometrics and dimensional Drawings showing that substitutes are equal to product specified. Faxed prior approvals will not be accepted.

1.5 DISCREPANCIES

A. Prior to submitting Bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification. The more stringent provisions shall take precedence where codes, Specifications and Drawings differ with one another. The Contractor shall Bid the more expensive requirement, unless discrepancy is addressed by Addendum prior to Bid.

1.6 TEMPORARY LIGHTING/POWER

A. Provide temporary electrical power and lighting for all trades that require service during the course of this Project. Provide temporary service and distribution as required. Provide temporary power for all electrical equipment that will need to be installed due to the phased construction of this project. Comply with the NEC and OSHA requirements. Energy Costs by General Contractor.

1.7 SHOP DRAWING SUBMITTALS

A. General: Follow the procedures specified in Section 01 33 00 – Submittal Procedures. Submit for final and official approval through the General Contractor.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots, and openings in building structure during progress of construction to allow for electrical installations.

C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning prior to closing in the building.

E. Coordinate connecting electrical service to components furnished under other Sections.

F. Coordinate connecting electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Coordinate requirements for access panels and doors where electrical items requiring access are concealed by finished surfaces.

1.9 SUBSTANTIAL COMPLETION

A. At Substantial Completion of Project, be ready to demonstrate the following list of items below. If this is not possible, inform the General Contractor and Engineer no less than 1 week prior to Engineer’s visitation of the site for Substantial Completion.

B. Demonstrate the operation and test of the emergency lighting system.

C. Demonstrate the main service ground, bonding to neutral and resistance readings obtained at time of installation. This will involve having some covers removed from the main panels at the time of the Engineer's visitation.

D. All electrical systems and items specified shall be installed and operational.

E. Demonstrate exterior lighting controls.

F. Demonstrate the operation of all emergency power systems including generators, uninterruptible power supplies and inverter systems.

1.10 RECORD DOCUMENTS

A. Prepare Record Documents in accordance with the requirements in Section 01 77 00 – Closeout Procedures. In addition to the requirements specified in Division 1, indicate the following installed conditions:

B. Actual location of all electrical service gear/feeders, panel/motor/special equipment feeders, all major underground or underslab conduits, all conduit stubs for future use, any change in branch circuitry from Drawings, key junction boxes and pull boxes not indicated on Drawings, any control locations or indicator lights not shown on Drawings.

C. Addendum items, Change Order items and all changes made to Drawings from Bidding phase through to Project completion.

D. Actual equipment and materials installed. Where manufacturer and catalog number are indicated on Drawings, generally or in fixture or equipment schedules, change to reflect actual products installed.

E. Change service panel and branch panel breaker locations and schedules to reflect actual installed conditions.

1.11 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Section 01 77 00 – Closeout Procedures. In addition to the requirements specified in Division 1 assemble O & M Manuals as follows:

1. Compile Operating and Maintenance Manuals for the electrical systems and equipment. The manuals shall be provided to the Engineer for approval complete and at one time, prior to requesting final payment. Partial or separate data will be returned for completion.

2. Manuals shall be assembled in three-ring binders. Binders shall be 3 inch thick or less and have slip sleeve jacket on binder side and front. More than one binder shall be used for each set of data if required to prevent overfilling of one binder. All information shall be arranged in Sections and each Section shall have a blank buff colored, heavy paper divider with a protruding tab clearly labeled. Sections shall be arranged in the same order that the equipment is listed in the Specification and each Specification section shall have a separate tab. Shop Drawings which are larger than 8-1/2-inch by 11 inch shall be individually folded so they are 8-1/2-inch by 11 inch or less and inserted behind the appropriate tab.

3. Tabs shall be labeled and arranged as follows:

   a. Index: Furnish under the first tab an index of Sections listing name of Section and Specification numbers.

   b. Equipment Manufacturers: Furnish under the second tab a complete typed list of equipment suppliers and manufacturers representative including type of equipment, name, address and phone number. The company listed here should be the one which could furnish replacement parts and offer technical information about the equipment.

   c. Product Literature: Each tab, starting with the third shall contain the name of a Specification Section. Behind each tab shall be the previously submitted and approved Shop Drawing, factory published operation and maintenance instructions and parts lists. Also include description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions. Servicing instructions and lubrication charts and schedules.

4. Upon completion and approval of the booklets, one copy shall be given to the Architect, and two to the Owner. Using the booklet, the Electrical Contractor shall explain in detail and instruct the Owner's operating personnel in the correct operation and maintenance of the equipment.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

A. Channel and angle support systems, hangers, anchors, sleeves, brackets, fabricated items, and fasteners are designed to provide secure support from the building structure for electrical components.

1. Material: Steel, except as otherwise indicated, protected from corrosion with zinc coating or with treatment of equivalent corrosion resistance using approved alternative finish or inherent material characteristics.

2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel, except as otherwise indicated.

B. Steel channel supports have 9/16-inch diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Fittings and accessories mate and match with channels and are from the same manufacturer.

C. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps or "click"- type hangers.

D. Sheet-Metal Sleeves: 0.0276-inch or heavier galvanized sheet steel, round tube, closed with welded longitudinal joint.

E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable iron casting with hot-dip galvanized finish.

G. Expansion Anchors: Carbon-steel wedge or sleeve type.

H. Toggle Bolts: All-steel springhead type.

I. Powder-Driven Threaded Studs: Heat-treated steel.

2.2 CONCRETE EQUIPMENT BASES

A. Forms and Reinforcing Materials: As specified in Section 03 30 00 – Cast-In-Place Concrete.

B. Concrete: 3000 psi, 28-day compressive strength as specified in Section 03 33 00 – Cast-In-Place Concrete.

2.3 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.

2. Legend: Indicates voltage.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

E. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.

1. Not less than 6 inches wide by 4 mils thick.

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend indicating type of underground line.

F. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

2.4 NAMEPLATES

A. Engraved Plastic Nameplates: Engraving stock, melamine plastic laminate, minimum 1/16-inch thick for signs up to 20 sq. in. and 1/8-inch thick for larger sizes.

1. Engraved legend with white letters on black face.

2. Punched or drilled for mechanical fasteners.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16-inch.

2. Tensile Strength: 50 lb minimum.

3. Temperature Range: Minus 40 to plus 185 deg F.

4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.

2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.

3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.

4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION REQUIREMENTS

A. Install components and equipment to provide the maximum possible headroom where mounting heights or other location criteria are not indicated.

B. Install items level, plumb, and parallel and perpendicular to other building systems and components, except where otherwise indicated.

C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

D. Give right of way to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING METHODS

A. Damp Locations and Outdoors: Hot-dip galvanized materials, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Conform to manufacturer's recommendations for selecting supports.

E. Strength of Supports: Adequate to carry all present and future loads, times a safety factor of at least 4; 200 lb minimum design load.

3.3 GENERAL INSTALLATION OF MATERIALS

A. Install wires according to manufacturer's written instructions and NECA's "Standard of Installation."

B. Conductor Splices: Keep to the minimum and comply with the following:

1. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

2. Use splice and tap connectors that are compatible with conductor material.

C. Connect outlets and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

D. Install devices to securely and permanently fasten and support electrical components.

E. Raceway Supports: Comply with NFPA 70 and the following requirements:

1. Conform to manufacturer's recommendations for selecting and installing supports.

2. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

3. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

4. Spare Capacity: Size supports for multiple conduits so capacity can be increased by a 25 percent minimum in the future.

5. Support individual horizontal raceways with separate, malleable iron pipe hangers or clamps.

6. Hanger Rods: 1/4-inch diameter or larger threaded steel, except as otherwise indicated.

7. Spring Steel Fasteners: Specifically designed for supporting single conduits or tubing. May be used in lieu of malleable iron hangers for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to channel and slotted angle supports in accordance with NEC.

8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports, with no weight load on raceway terminals.

F. Vertical Conductor Supports: Install simultaneously with conductors.

G. Miscellaneous Supports: Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices except where components are mounted directly to structural features of adequate strength.

H. Sleeves: Install for cable and raceway penetrations of concrete slabs and walls, except where core-drilled holes are used. Install for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

I. Fastening: Unless otherwise indicated, securely fasten electrical items and their supporting hardware to the building structure. Perform fastening according to the following:

1. Fasten by means of wood screws or screw-type nails on wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or solid masonry; and by machine screws, welded threaded studs, or spring-tension clamps on steel.

2. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts, machine screws, or wood screws.

3. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or any other items.

4. In partitions of light steel construction use sheet-metal screws.

5. Drill holes in concrete beams so holes more than 1-1/2 inches deep do not cut main reinforcing bars.

6. Drill holes in concrete so holes more than 3/4-inch deep do not cut main reinforcing bars.

7. Fill and seal holes drilled in concrete and not used.

8. Select fasteners so the load applied to any fastener does not exceed 25 percent of the proof-test load.

J. Install concrete pads and bases where indicated.

K. Install utility-metering equipment according to utility company's written requirements. Provide grounding and empty conduits as required by company.

3.4 LABEL INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.

2. Prime surfaces using type of primer specified for surface.

3. Apply one intermediate and one finish coat of enamel.

F. Color Identification of Junction boxes: Identify with spray paint. Apply colors as follows:

1. Emergency lighting and power: Orange.

2. Mechanical/Electrical Supervisory System: Blue

3. Security System: Yellow.

G. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.

H. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Permanent black marker indicating panel and circuit designation.

2. Concealed Boxes: Permanent black marker indicating panel and circuit designation.

I. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

J. Color-Coding of Secondary Phase Conductors: Use the following colors for service, feeder and branch-circuit phase conductors:

1. 208/120-V Conductors:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

d. Neutral: White.

e. Ground: Green.

2. 480/277-V Conductors:

a. Phase A: Brown.

b. Phase B: Orange

c. Phase C: Yellow.

d. Neutral: Gray.

e. Ground: Green.

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:

a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1 inch wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.

K. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.

2. Tag Fasteners: Nylon cable ties.

3. Band Fasteners: Integral ears.

L. Apply identification to conductors as follows:

1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.

2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.

3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

M. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

N. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with 1/2-inch high lettering on 1-1/2 inch high label; where two lines of text are required, use labels 2 inches high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards, electrical cabinets, and enclosures.

2. Access doors and panels for concealed electrical items.
3. Electrical switchgear and switchboards.
4. Emergency system boxes and enclosures.
5. Disconnect switches.
6. Enclosed circuit breakers.
7. Motor starters.
8. Push-button stations.
9. Power transfer equipment.
10. Contactors.
11. Remote-controlled switches.
12. Control devices.
13. Transformers.
14. Battery racks.
15. Power-generating units.

O. For panelboards, provide framed type circuit schedules with identification of items controlled by each breaker. Indicate room numbers of items controlled or room name where appropriate for Owners convenience. Final schedules shall be typed or printed for clarity. Hand written schedules are not acceptable. Schedules shall be posted inside each panel door mounted in transparent card holder upon project completion.

END OF SECTION 26 05 00

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes wires, cables and connectors for power, lighting, signal, control and related systems rated 600 V and less.

1.2 SUBMITTALS

A. Furnish in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers complying with the Quality Assurance requirements are acceptable.

2.2 WIRES AND CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.

B. Power Conductors: Provide solid conductors for power and lighting circuits No. 10 AWG and smaller. Provide stranded conductors for sizes No. 8 AWG and larger.

C. Control Conductors: Provide stranded conductors.

D. Conductor Material: Copper for all wires and cables. Aluminum conductors are not acceptable.

E. Insulation: Provide THHN/THWN insulation for all conductors size 500 kcmil and larger, and No. 8 AWG and smaller. For all other sizes provide THW, THHN/THWN or XHHW insulation as appropriate for the locations where installed. Type THHN insulation may be used for branch circuit and feeder sizes for 100 amp under. Adjust conduit size.

F. Color coding for phase identification in accordance with Section 26 05 00 –Electrical, General.

G. VFD Cables: Provide VFD cable for all VFD applications.

1. Cable shall contain all phase conductors plus ground.

2. Contain a braided shield with 85% coverage and foil shield with 100% coverage.

3. Insulation to be XLPE.

4. For retrofit applications where conduit fill is limited, modifications to the above

5. For retrofit applications where conduit fill is limited, modifications to the above requirements to reduce cable size may be required. Submit product for review and approval by Engineer.

2.3 CONNECTORS FOR CONDUCTORS

A. Provide UL-listed factory-fabricated, solderless metal connectors of sizes, ampacity ratings, materials, types and classes for applications and for services indicated. Use connectors with temperature ratings equal to or greater than those of the wires upon which used.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Use the following wiring methods as indicated:

1. Wire: Install all wire in raceway, minimum size for light and power circuits shall be #12 AWG. Minimum size for control wire shall be 14 AWG.

3.2 INSTALLATION OF WIRES AND CABLES

A. General: Install electrical cables, wires, and connectors in compliance with NEC.

B. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant, where necessary.

C. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced. No joints or taps permitted in service or feeder circuits.

D. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

E. Install VFD cables per VFD manufacturer requirements. VFD cable shielding must be connected at both the drive and the motor ends unless the drive manufacturer provided different guidelines. The shielding must be connected at a 360° contact.

3.3 FIELD QUALITY CONTROL

A. Prior to energizing, test wires and cables for electrical continuity and for short-circuits.

END OF SECTION 26 05 19

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 QUALITY ASSURANCE

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

1. Comply with UL 467.

B. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

C. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Section 26 05 19 – Low-Voltage Conductors and Cables.

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.

2. Assembly of Stranded Conductors: ASTM B 8.

H. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4-inch in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16-inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4 inch in diameter by 120 inches in length.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

E. Ground Rod Clamps at Test Wells: Use bolted pressure clamps with at least two bolts.

F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.

D. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

E. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

F. Water Heater: Bond conductor to heater units, piping, connected equipment, and components.

G. Signal and Communication Systems: Provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

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

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

3.3 INSTALLATION

A. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor by cadweld process to reinforce steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

B. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 6 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

H. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

3.5 FIELD QUALITY CONTROL

A. Test ground resistance of entire system and at each building/structure where electrical equipment is installed.

B. Where maximum allowable ground resistance of 5 ohms is exceeded, install additional grounding mats or ground rods until ground resistance is equal to or below maximum allowable ground resistance.

C. Terminate ground and shield for VFD cables per VFD manufacturer requirements. VFD cable shielding must be connected at both the drive and the motor ends unless the drive manufacturer provided different guidelines. The shielding must be connected at a 360° contact. Provide and install cable claps or metal fittings as required for proper connection.

END OF SECTION 26 05 26

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SECTION 26 05 29 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers complying with the Quality Assurance requirements are acceptable.

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

C. Manufacturers: Subject to compliance with requirements, provide products by the following or equal:

1. Thomas & Betts.
2. Power-Strut.
3. Unistrut.
4. Cooper B-Line.
5. Robroy.
6. Aickinstrut.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic. Products for use outdoors shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.

2. Toggle Bolts: All steel springhead type.

3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

C. U-Channel Systems: 16 gauge steel channels, with 9/16-inch diameter holes, at a minimum of 8 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

2.4 FABRICATED SUPPORTING DEVICES

A. Pipe Sleeves: Provide pipe sleeves of one of the following:

1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:

a. 3 inch and smaller: 20 gauge.

b. 4-inch to 6-inch: 16 gauge.

c. Over 6-inch: 14 gauge.

2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.

3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.

2. Strength of each support shall be adequate to carry the load plus a minimum of 200 lbs safety allowance.

3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

4. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For

hanger rods with spring steel fasteners, use 1/4-inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

5. Space supports for raceways in accordance with NEC.

6. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

D. In open overhead spaces, support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

E. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with "Fire Resistant Joint Sealers" requirement of Section 07 92 00 – Joint Sealants.

F. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. All device boxes in sheetrock walls will be tight before, during and after installation of sheetrock.

G. Cutting and Patching: Obtain Engineer's approval before cutting and patching on structural members of building surfaces.

END OF SECTION 26 05 29

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SECTION 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes raceways for electrical wiring. Types of raceways in this Section include only the following:

1. Electrical metallic tubing (EMT).
2. Flexible metal conduit.
3. Intermediate metal conduit.
4. Liquidtight flexible metal conduit.
5. Rigid metal conduit.
6. Rigid nonmetallic conduit.
7. Wiremold.
8. Wireway.

1.2 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers complying with the Quality Assurance requirements are acceptable.

2.2 METAL CONDUIT AND TUBING

A. Rigid Metal Conduit (RMC): ANSI C80.1.

B. Intermediate Metal Conduit (IMC): UL 1242.

C. Electrical Metallic Tubing (EMT) and Fittings: ANSI C80.3.

D. Flexible Metal Conduit: UL 1, zinc-coated steel.

E. Liquidtight Flexible Metal Conduit and Fittings: UL 360. Fittings shall be specifically approved for use with this raceway.

F. PVC Coated Metal Conduit:

1. Use PVC Coated Rigid Metal Conduit and fittings in all wet and hazardous areas.

   a. PCS:

      1) The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the equipment for Type GRC.

      2) Coated conduit NEMA Standard RN-1

      3) The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.

   b. Factory-bonded PVC jacket:

      1) The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.

      2) Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.

      3) PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.

      4) The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:

         I. Confirm bond with certified test results.

   c. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:

      1) Nominal thickness of 0.002 inch

      2) Conduits having areas with thin or no coating are not acceptable

      3) All threads shall be coated with urethane.

   d. The PVC exterior and urethane interior coating applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).

   e. PCS conduit bodies and fittings:

      1) Malleable iron

      2) The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.

3) The PVC coating on the outside of conduit bodies shall be 0.040 inch thick and have a series of ribs to protect the coating from tool damage during installation

4) 0.002-inch interior urethane coating.

5) Utilize the PVC coating as an integral part of the gasket design.

6) Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.

7) A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.

I. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.

II. The sleeve shall provide a vapor- and moisture-resistant seal at every connection.

f. Interlocking design formed from continues metal strip for integrity and flexibility

g. Manufactured in accordance with:

1) UL-1

2.3 NONMETALLIC CONDUIT AND DUCTS

A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 80 PVC.

B. PVC Conduit and Tubing Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

C. Liquidtight Flexible Nonmetallic Conduit and Fittings: UL 1660. Fittings shall be specifically approved for use with this raceway.

D. Conduit, Tubing, and Duct Accessories: Types, sizes, and materials complying with manufacturer's published product information. Mate and match accessories with raceway.

E. Electrical Nonmetallic Tubing (ENT): Is not allowed.

2.4 CONDUIT BODIES

A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements.

B. Provide matching gasketed covers secured with corrosion-resistant screws.

C. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.

2.5 WIREWAYS

A. General: Electrical wireways shall be of types, sizes, and number of channels as indicated. Fittings and accessories including but not limited to couplings, offsets, elbows, expansion joints, adapters, hold-down straps, and end caps shall match and mate with wireway as required for complete system.

B. Where features are not indicated, select to fulfill wiring requirements and comply with applicable provisions of NEC.

2.6 SURFACE RACEWAYS

A. General: Sizes and channels as indicated. Provide fittings that match and mate with race-way.

B. Surface Metal Raceway: Construct of galvanized steel with snap-on covers, with 1/8-inch mounting screw knockouts in base approximately 8 inches o.c. Finish with manufacturer's standard prime coating suitable for painting. Provide raceways of types suitable for each application required.

C. PVC coated rigid shall be provided in the areas that have process equipment, moisture or susceptible to moisture. Conditioned areas such as electrical room, office and restroom where conduit is concealed in the wall. EMT is acceptable.

PART 3 - EXECUTION

3.1 WIRING METHOD

A. Outdoors: Use the following wiring methods:

1. Exposed: PVC coated rigid metal conduit, elbows to be PVC coated RMC.

2. Concealed: Rigid metal conduit, elbows to be PVC coated RMC.

3. Underground: Rigid nonmetallic conduit (sched 80), elbows to be PVC coated RMC.

4. Indoors or Outdoors: Connection to vibrating equipment including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment in moist or humid location or corrosive atmosphere, or where subject to water spray or dripping oil, grease, or water: liquid tight flexible metal conduit.

B. Indoors: Use the following wiring methods:

1. Connection to Vibrating Equipment: Including transformers and hydraulic, pneumatic or electric solenoid or motor-operated equipment: flexible metal conduit.

2. Exposed: Electrical metallic tubing, rigid metal conduit.

3. Concealed: Electrical metallic tubing. AC/MC cable NOT ALLOWED.

4. Underslab: Sch 80 PVC, elbows to be PVC coated RMC.

C. Hazardous Locations

1. As required by the NEC

3.2 INSTALLATION

A. General: Install electrical raceways in accordance with requirements of NEC, and as follows:

B. Conceal Conduit and EMT, unless indicated otherwise, within finished walls, ceilings, and floors. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install raceways level and square and at proper elevations.

C. Elevation of Raceway: Where possible, install horizontal raceway runs above water and steam piping.

D. Complete installation of electrical raceways before starting installation of conductors within raceways.

E. Provide supports for raceways as specified in Specification Section 26 05 00 – Electrical, General.

F. Prevent foreign matter from entering raceways by using temporary closure protection.

G. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

H. Make bends and offsets so the inside diameter is not effectively reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

I. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location. For rigid metal conduit and intermediate steel conduit, use threaded rigid steel conduit fittings except as otherwise indicated. EMT set screw connectors and couplers are to be steel.

J. Run concealed raceways with a minimum of bends in the shortest practical distance considering the type of building construction and obstructions except as otherwise indicated. This does not apply to conduits in crawl spaces.

K. Raceways embedded in slabs: Not allowed without engineering approval.

L. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.

M. Run exposed, parallel, or banked raceways together.

N. Join raceways with fittings designed and approved for the purpose and make joints tight. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

O. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.

P. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

Q. Install pull wires in empty raceways. Use monofilament plastic line having not less than 200 lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire.

R. Communication and Signal System Raceways 2 Inch Trade Size and Smaller: In addition to the above requirements, install raceways 2 inch and smaller trade size in maximum lengths at 150 feet and with a maximum of two, 90 deg bends or equivalent. Install pull or junction boxes where necessary to comply with these requirements.

S. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible metal conduit may be used 6 inches above the floor. Where equipment connections are not made under this contract, install screwdriver operated threaded flush plugs flush with floor.

T. Flexible Connections: Use short length (maximum of 6 ft.) of flexible conduit for recessed and semi-recessed lighting fixtures, for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet locations. Install separate ground conductor across flexible connections.

U. Surface Metal Raceway: Install a separate green ground conductor in raceway from the junction box supplying the raceway to receptacle or fixture ground terminals.

V. Raceway Installed Above Accessible Ceilings: Raceway located above accessible ceilings shall be a minimum of 24 inches above finished ceiling or mounted direct to structure, whichever is less.

3.3 ADJUSTING AND CLEANING

A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris.

END OF SECTION 26 05 33

SECTION 26 05 33.16 – CABINETS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes cabinets, boxes, and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:

1. Outlet and device boxes.

2. Pull and junction boxes.

3. Cabinets.

PART 2 - PRODUCTS

2.1 CABINETS, BOXES, AND FITTINGS, GENERAL

A. Electrical Cabinets, Boxes, and Fittings: Of indicated types, sizes, and NEMA enclosure classes. Where not indicated, provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

B. Provide conduit entrance boxes for large motors connections when parallel conduits are required for proper motor assembly, reference specification 40 05 93 – Common Motor Requirements for Process Equipment.

2.2 MATERIALS AND FINISHES

A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.

B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.

C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.

D. Exterior Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.

E. Painted Interior Finish: Where indicated, white baked enamel.

F. Fittings for Boxes, Cabinets, and Enclosures: Conform to UL 514B. Zinc plated steel for conduit hubs, bushings, box connectors and couplers. Set screw type. Use insulated throat connectors.

2.3 METAL OUTLET, DEVICE, AND SMALL WIRING BOXES

A. General: Conform to UL 514A, "Metallic Outlet Boxes, Electrical," and UL 514B, "Fittings for Conduit and Outlet Boxes." Boxes shall be of type, shape, size, and depth to suit each location and application. Minimum size 4 inch square x 2-1/8 inch deep.

B. Steel Boxes: Conform to NEMA OS 1, "Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports." Boxes shall be sheet steel with stamped knockouts, threaded screw holes and accessories suitable for each location including mounting brackets and straps, cable clamps, exterior rings and fixture studs.

2.4 PULL AND JUNCTION BOXES

A. General: Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed or bolted on covers of material same as box and shall be of size and shape to suit application.

B. Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing.

C. Hot-Dipped Galvanized Steel Boxes: Sheet steel with welded seams. Where necessary to provide a rigid assembly, construct with internal structural steel bracing. Hot-dip galvanized after fabrication. Cover shall be gasketed.

2.5 CABINETS

A. Comply with UL 50, "Electrical Cabinets and Boxes."

B. Construction: Sheet steel, NEMA 12 class except as otherwise indicated. Cabinet shall consist of a box and a front consisting of a one piece frame and a hinged door. Arrange door to close against a rabbet placed all around the inside edge of the frame, with a uniformly close fit between door and frame. Provide concealed fasteners, not over 24 inches apart, to hold fronts to cabinet boxes and provide for adjustment. Provide flush or concealed door hinges not over 24 inches apart and not over 6 inches from top and bottom of door. For flush cabinets, make the front approximately 3/4-inch larger than the box all around. For surface mounted cabinets make front same height and width as box.

C. Doors: Double doors for cabinets wider than 24 inches. Telephone cabinets wider than 48-inches may have sliding or removable doors.

D. Locks: Combination spring catch and key lock, with all locks for cabinets of the same system keyed alike. Locks may be omitted on signal, power, and lighting cabinets located within wire closets and mechanical/electrical rooms. Locks shall be of a type to permit doors to latch closed without locking.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.

B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.

C. Support and fasten items securely in accordance with Section 26 05 29 – Support Devices.

D. Sizes shall be adequate to meet NEC volume requirements, but in no case smaller than sizes indicated.

E. Remove sharp edges where they may come in contact with wiring or personnel.

3.2 INSTALLATION OF OUTLET BOXES

A. Gasketed Boxes: At the following locations use cast metal, threaded hub type boxes with gasketed weatherproof covers:

1. Exterior locations.

2. Where surface mounted on unfinished walls, columns or pilasters. (Cover gaskets may be omitted in dry locations).

3. Where exposed to moisture laden atmosphere.

4. Where indicated.

B. Mounting: Mount outlet boxes for switches and receptacles with the long axis vertical or as indicated. Three or more gang boxes shall be mounted with the long axis horizontal. Locate box covers or device plates so they will not span different types of building finishes either vertically or horizontally. Locate boxes for switches near doors on the side opposite the hinges and close to door trim, even though electrical floor plans may show them on hinge side.

C. Ceiling Outlets: For fixtures, where wiring is concealed, use outlet boxes 4 inches square by 2-1/8 inches deep minimum.

D. Cover Plates for Surface Boxes: Use plates sized to box front without overlap.

E. Protect outlet boxes to prevent entrance of plaster, and debris. Thoroughly clean foreign material from boxes before conductors are installed.

F. Concrete Boxes: Use extra deep boxes to permit side conduit entrance without interfering with reinforcing, but do not use such boxes with over 6 inch depth.

G. Do not install boxes back-to-back.

H. Provide hazardous location rated boxes where required.

3.3 INSTALLATION OF PULL AND JUNCTION BOXES

A. Mount pull boxes in inaccessible ceilings with the covers flush with the finished ceiling.

B. Size: Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.4 INSTALLATION OF CABINETS AND HINGED DOOR ENCLOSURES

A. Mount with fronts straight and plumb.

B. Install with tops 78 inches above floor.

C. Set cabinets in finished spaces flush with walls.

3.5 GROUNDING

A. Electrically ground metallic cabinets, boxes, and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the cabinet, box or enclosure.

3.6 CLEANING AND FINISH REPAIR

A. Upon completion of installation, inspect components. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, abrasions and weld marks.

B. Galvanized Finish: Repair damage using a zinc-rich paint recommended by the tray manufacturer.

C. Painted Finish: Repair damage using matching corrosion inhibiting touch-up coating.

END OF SECTION 26 05 33.16

SECTION 26 05 73 – POWER SYSTEM STUDIES

PART 1 - GENERAL

1.1 SCOPE

A. Section includes:

1. Short circuit fault analysis study.

2. Protective device coordination study.

3. Arc-flash hazard study.

B. The Contractor shall furnish short-circuit and protective device coordination studies which shall be prepared by a Registered Professional Engineer. The analysis shall be performed and submitted in two phases for initial and final studies.

C. The Contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.5 and Informative Annex D. The analysis shall be performed and submitted in two phases for initial and final studies.

D. The Contractor shall furnish power system model and project library files used for the creation of the studies in electronic format. The model and project library files shall be submitted in two phases as part of initial and final studies.

E. It is the Contractor's responsibility for scheduling and coordinating the work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of the Contractor's Work.

F. The Contractor shall coordinate with the Owner to schedule and attend Electrical System Study meetings as defined in Part 3.

G. Scope of studies shall encompass all proposed components of electrical distribution system and any directly affected existing distribution components. Additionally, if existing equipment is not arc flash labeled up to the current NFPA 70E standards then this equipment shall be included in the scope of this study. (Note: edit depending on owner/customer needs, may want entire system modeled/evaluated if not done in the past)

H. After completion of the studies, as part of commissioning the Contractor shall coordinate the setting and testing of all protective devices with adjustable settings based on the recommendations from the protective device coordination study.

I. After completion of the studies, as part of commissioning the Contractor shall coordinate the installation of the arc flash hazard labels by a qualified electrician or the firm performing the studies.

1.2 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems (Red Book).

2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).

3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis (Brown Book).

4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings (Gray Book).

5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems (Blue Book).

6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations, latest edition

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures

3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories

5. ANSI C37.5 – Methods for Determining the RMS Value of a Sinusoidal Current Wave and Normal-Frequency Recovery Voltage, and for Simplified Calculation of Fault Currents

C. The National Fire Protection Association (NFPA)

1. NFPA 70 - National Electrical Code, edition followed by local jurisdiction

2. NFPA 70E – Standard for Electrical Safety in the Workplace, latest edition

1.3 SUBMITTALS FOR REVIEW/APPROVAL

A. Furnish submittals as specified in Section 01 33 00 – Submittal Procedures and 26 05 00 – Electrical, General.

B. The initial short-circuit, protective device coordination, and arc flash studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. The initial submittal shall also include a version of the preliminary model and project library files for review. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.4 SUBMITTALS FOR CONSTRUCTION

A. Submit qualification information for the firm and individual(s) specified in part 1.5 herein.

B. Submit letter or email correspondence from utility with available short circuit current value at the main service switchboard. As a minimum, the utility shall include the following for the facility: service voltage and configuration, main service maximum allowable short circuit current, service transformer kVA and impedance, 3-phase and phase to ground X/R ratios, and service conductor size, number, and length.

C. The final results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. No more than five (5) bound copies of the complete final report shall be submitted. For large system studies, submittals requiring more than five (5) copies of the report will be provided without the section containing the computer printout of the short-circuit input and output data. An additional copy of the final report, model file, and project library file shall be provided in a zip file for download.

D. The report shall include the following sections:

1. Section 1 – Executive Summary

2. Section 2 – Short-Circuit and Protective Device Evaluation Study

    2.1 Short-Circuit Analysis Objectives

    2.2 System Modeling

    2.3 Modeling Assumptions

    2.4 Short-Circuit Results

    2.5 Equipment, Material, and Protective Device Evaluation

3. Section 3 – Protective Device Coordination Study

3.1 Study Description and Protection Philosophy

3.2 Codes and Standards

3.3 Coordination Objectives

3.4 Coordination Results

3.5 Coordination Recommendations

3.6 Time-Current Characteristic Plots

4. Section 4 – Recommended Protective Device Settings

5. Section 5 – Arc Flash Hazard Study

5.1 Study Description

5.2 Analysis Procedure

5.3 Arc-Flash Analysis Results

5.4 Arc-Flash Analysis Recommendations

6. Section 6 – Appendices

6.1 Power System Study Single line diagrams

6.2 Reference Drawing Single line diagrams

6.3 Short-Circuit Input Data Report

6.4 Short-Circuit Analysis Results Reports

6.5 Protective Device Settings Report

6.6 Arc-Flash Analysis Results Reports

6.7 Arc Flash Hazard Labels

6.8 At discretion of firm/Engineer performing study any other appendices needed to capture request information in report data section 2.6 herein.

1.5 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies. The firm and individual(s) performing the specified studies shall be experienced in the application of computer software used for power system studies and shall have performed studies of similar magnitude on electrical systems using similar equipment and devices. The Registered Professional Electrical Engineer shall be a full-time employee of the Engineering Services Organization.

PART 2 - PRODUCT

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by Registered Professional Engineer. The coordination study shall begin with the utility company's feeder protective device and include all electrical protective devices down to and include the largest feeder circuit breaker and motor starter in the 480V motor control centers and power distribution panelboards. The study shall also include variable frequency drives, harmonic filters, power factor correction equipment, transformers and protective devices associated with variable frequency drives, emergency and standby generators associated paralleling equipment and distribution switchgear.

B. The Contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.5 and Informative Annex D.

C. The short-circuit fault, protective device coordination, and arc flash hazard analysis shall be performed and submitted in two phases:

1. Initial results report and modeling analysis:

a. Based on the Contract Documents and Electric Utility information.

b. The initial report shall indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study, provide preliminary breaker settings, and preliminary arc flash results.

c. Provide a list of assumptions used in the initial study.

d. Provide modeling data inputs and single line diagrams. Equipment in the model shall be tagged according to the contract and record drawings.

2. Final results report and modeling analysis:

a. The final results shall modify the initial report as follows:

1) Utilize the actual equipment provided on the project.

2) Utilize conductor lengths based on installation.

3) Must incorporate comments from Owner and Engineer for the project.

2.2 DATA COLLECTION

A. Contractor shall furnish all field data as required by the power system studies. Contractor shall verify existing distribution system equipment and protective device models and settings with assistance of a qualified electrician as needed. Contractor shall provide conductor lengths based on installation for new equipment. Contractor shall coordinate a site visit with Engineer performing the study if deemed necessary for accurate completion of the model. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing. (note: more detail might be needed depending on level of data collection)

B. Source combination may include present and future utility supplies, motors, and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner or Contractor. Any relevant record drawings for modeling shall be provided by Owner or Contractor.

D. Include fault contribution of existing motors in the study, with motors < 50 hp grouped together. Motors < 50HP shall not be grouped together if associated buses need arc flash labels. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standards 141, latest edition.

B. Transformer design impedances and standard X/R ratios shall be used when test values are not available.

C. Provide the following:

1. Calculation methods and assumptions

2. Selected base per unit quantities

3. One-line diagram of the system being evaluated with available fault at each bus, and interrupting rating of devices noted. Bus interrupt ratings shall be based on the lowest rated piece of equipment connected directly to each bus.

4. Source impedance data, including electric utility system and motor fault contribution characteristics

5. Typical calculations

6. Tabulations of calculated quantities

7. Results, conclusions, and recommendations

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point

2. Incoming switchgear

3. Low voltage switchgear

4. Motor control centers

5. Standby generators and automatic transfer switches

6. Branch circuit panelboards

7. 3-phase control panels

8. VFD cabinets

9. 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.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings

2. Adequacy of switchgear, motor control centers, and panelboard bus bracing to withstand short-circuit stresses

3. Adequacy of transformer windings to withstand short-circuit stresses

4. Cable and busway sizes for ability to withstand short-circuit heating

5. Notify Owner in writing, of existing, circuit protective devices improperly rated for the calculated available fault current

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves shall be graphically displayed on log-log scale paper.

B. Include on each curve sheet a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.

D. Identify device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the curve sheets, where applicable:

1. Electric utility's protective device
2. Low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
3. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
4. Transformer full-load current, magnetizing inrush current, and ANSI transformer withstand parameters
5. Conductor damage curves
6. Ground fault protective devices, as applicable
7. Pertinent motor starting characteristics and motor damage points
8. Pertinent generator short-circuit decrement curve and generator damage point
9. Other system load protective devices for the largest branch circuit and the largest feeder circuit breaker in each motor control center

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Select each primary protective device required for a delta-wye connected transformer so that the characteristics or operating band is within the transformer parameters which includes a parameter equivalent to 58% of the ANSI withstand point to afford protection for secondary line-to-ground faults.

H. Separate low voltage power circuit breakers from each other and the associated primary protective device by a 16% current margin for coordination and protection in the event of secondary line-to-line faults.

I. Engineer shall provide settings file printouts for all multifunction relays supplied under this contract including all ANSI protective relay functions and associated logic and control. Metering, communication, and control logic settings not associated with ANSI protective functions are not required.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2012, Informative Annex D.

B. 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. Alternative methods shall be presented in the proposal.

C. The arc flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where Work could be performed on energized parts.

D. The Arc-Flash Hazard Analysis shall include all 480V locations and significant locations in 240V and 208V systems fed from transformers equal to or greater than 30 kVA.

E. Safe working distances shall be specified for calculated fault locations based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm^2.

F. The Arc Flash Hazard analysis shall include calculations for maximum and minimum contributions of fault current magnitude. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume a minimum motor load. Conversely, the maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.

G. Arc flash computation shall include both line and load side of main breaker calculations, where necessary. Main breakers shall be excluded as the protective device for buses when the main breaker is not considered isolated from the bus within a given enclosure.

H. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584 section B.1.2.

2.6 REPORT DATA

A. Input Data:

1. Utility three-phase and line-to-ground available contribution with associated X/R ratios

2. Short-circuit reactance of rotating machines with associated X/R ratios

3. Cable type, construction, size, number per phase, length, impedance and conduit type

4. Bus duct type, size, length, and impedance

5. Transformer primary & secondary voltages, winding configurations, kVA rating, impedance, and X/R ratio
6. Reactor inductance and continuous ampere rating
7. Aerial line type, construction, conductor spacing, size, number per phase, and length

B. Short-Circuit Data:

1. Source fault impedance and generator contributions
2. X to R ratios
3. Asymmetry factors
4. Motor contributions
5. Short circuit kVA
6. Symmetrical and asymmetrical fault currents

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
    a. Current transformer ratio.
    b. Current setting.
    c. Time setting.
    d. Instantaneous setting.
    e. Specialty non-overcurrent device settings.
    f. Recommendations on improved relaying systems, if applicable.
2. Circuit Breakers:
    a. Adjustable pickups and time delays (long time, short time, ground).
    b. Adjustable time-current characteristic.
    c. Adjustable instantaneous pickup.
    d. Recommendations on improved trip systems, if applicable.

D. Incident energy and arc flash boundary calculations.

1. Arcing fault magnitude
2. Device clearing time
3. Duration of arc
4. Arc flash boundary

5. Working distance

6. Incident energy

7. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 ELECTRICAL SYSTEM STUDY MEETINGS

A. The individual conducting the short circuit analysis, protective device coordination, and the arc-flash hazard studies shall meet with the Owner and Engineer three (3) times.

B. The purpose of the three meetings is as follows:

1. Initial meeting:

   a. Meet with the Owner and Engineer to discuss the scope of the studies.

   b. Discuss the Owner’s operational requirements for both normal operation and maintenance.

2. Preliminary results meeting:

   a. This meeting will be held after the studies have been completed, reviewed, and accepted by the Engineer.

   b. The purpose of this meeting is to inform the Owner of the results of the study and impacts on normal operation and maintenance including:

      1) Protective device coordination problems and recommended solutions.

      2) Explanation of the arc-flash study results and its potential impact on operations.

      3) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.

3. Final meeting:

   a. Discuss changes to the reports based on the previous meeting.

   b. Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.

   c. Deliver the final electrical system studies report.

C. The meetings will be at the Owner’s facility:

1. Provide a minimum of three weeks' notice to the Owner and Engineer in advance of the projected meeting date.

2. Submit a draft of the meeting agenda when each meeting is requested.

D. Meeting materials:

1. Prepare and provide the following materials:

a. Meeting agenda. Include at a minimum the scope of the meeting, estimated time length for the meeting and meeting goals.

b. Six copies of the project one-line diagrams for the initial meeting.

c. Six copies of the studies of the submitted study.

E. By virtue of the fact that this is a professional study the Owner reserves the right to modify the requirements of the study to comply with its operational requirements. The protective device coordination study and the arc-flash study shall be modified based on the results of the meetings with the Owner.

3.2 FIELD ADJUSTMENT

A. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments to be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Owner in writing of any required major equipment modifications.

D. Following completion of all studies, acceptance testing and startup by the field engineering service division of the equipment manufacturer, a two-year warranty shall be provided on all components manufactured by the engineering service parent manufacturing company.

3.3 ARC FLASH WARNING LABELS

A. The vendor shall provide a 4 in. x 6 in. thermal transfer type label of high adhesion polyester for each work location analyzed. UV resistant label material shall be used for equipment located outdoors.

B. The label shall have an orange header with the wording, "WARNING, SHOCK & ARC FLASH HAZARD", and shall include the following information:

1. Bus or Equipment designation

2. Nominal voltage

3. Arc flash boundary

4. Incident energy

5. Working distance

6. Shock Boundaries, shock hazard, and shock glove classification

7. List of recommended personal protective equipment based on NFPA 70E table 130.5(G)

8. Protective Device Designation

9. Engineering report issue date

C. Labels shall be machine printed, with no field markings

D. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboards and disconnects, 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 flash label shall be provided

E. Labels shall be field installed by a qualified electrician or the firm or individual(s) who performed the study under the Startup and Acceptance Testing contract portion.

3.4 ARC FLASH TRAINING

A. The firm or individual(s) who performed the study shall train personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). Maintenance procedures in accordance with the requirements of NFPA 70E, Standard For Electrical Safety Requirements For Employee Workplaces, shall be provided in the equipment manuals. The training shall be certified for continuing education units (CEUs) by the International Association for Continuing Education Training (IACET).

END OF SECTION 26 05 73

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SECTION 26 08 00 – FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Responsibilities for testing the electrical installation.
2. Routine tests during installation.
3. Adjusting and calibration.
4. Acceptance tests.
5. Demonstration of electrical equipment.
6. Commissioning and plant start-up.

B. Related sections:

1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.
3. The following sections are related to the Work described in this Section. This list of related sections is provided for convenience only and is not intended to excuse or otherwise diminish the duty of the Contractor to see that the completed Work complies accurately with the Contract Documents.
   a. Section 01 33 00 – Submittal Procedures
   b. Section 26 05 00 – Electrical, General
   c. Section 26 05 26 – Grounding and Bonding for Electrical Systems

C. Copyright information:

1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc (NETA). See NETA publication ATS for details.

1.2 REFERENCES

A. As specified in Section 26 05 00 – Electrical, General.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):

1. D 877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.

2. D 923 - Standard Practices for Sampling Electrical Insulating Liquids.

3. D 971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.

4. D 1298 - Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.

5. D 1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).

6. D 1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.

7. D 1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.

8. D 3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

D. Institute of Electrical and Electronics Engineers (IEEE):

1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.

2. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

3. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage.

4. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

5. C57.13 - IEEE Standard Requirements for Instrument Transformers.

6. C57.13.1 - IEEE Guide for Field Testing of Relaying Current Transformers.

7. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.

8. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

E. Insulated Cable Engineer’s Association (ICEA).

F. InterNational Electrical Testing Association (NETA).

1. ATS-2009 Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

G. International Electrotechnical Commission (IEC).

H. Manufacturer’s testing recommendations and instruction manuals.

I. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code (NEC).

2. 110 - Standard for Emergency and Standby Power Systems.

J. National Institute of Standards and Technology (NIST).

K. Specification sections for the electrical equipment being tested.

L. Shop drawings.

1.3 DEFINITIONS

A. As specified in Section 26 05 00 – Electrical, General.

B. Specific definitions:

1. Testing laboratory: The organization performing acceptance tests.

1.4 SYSTEM DESCRIPTION

A. Testing of all electrical equipment installed under this Contract in accordance with the manufacturer’s requirements and as specified in this Section.

B. Conduct all tests in the presence of the Engineer or the Engineer’s representative:

1. The Engineer will witness all visual, mechanical and electrical tests and inspections.

C. The testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications. The results of the tests shall determine the suitability for continued reliable operation.

D. Responsibilities:

1. Contractor responsibilities:

a. Ensure that all resources are made available for testing, and that all testing requirements are met.

2. Electrical subcontractor responsibilities:

a. Perform routine tests during installation.

b. Demonstrate operation of electrical equipment.

c. Commission the electrical installation.

d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including but not limited to:

1) Providing electrical power as required.

2) Operating of electrical equipment in conjunction with testing of other equipment.

3) Activating and shutting down electrical circuits.

4) Making and recording electrical measurements.

5) Replacing blown fuses.

6) Installing temporary jumpers.

3. Testing laboratory responsibilities:

a. Perform all acceptance tests as defined in this Section.

b. Provide all required equipment, materials, labor, and technical support during acceptance tests.

E. Upon completion of testing or calibration, attach a label to all serviced devices:

1. The label shall indicate the date serviced and the company that performed the service.

1.5 SUBMITTALS

A. Furnish submittals as specified in Sections 01 33 00 – Submittal Procedures and 26 05 00 – Electrical, General.

B. LAN cable test form:

1. LAN cable test reports:

a. Submit 3 copies of test reports showing the results of all tests specified in this Section:

1) Test type.

2) Test location.

3) Test date.

4) Cable number.

5) Cable length.

6) Certification that the cable meets or exceeds the specified standard.

b. Furnish hard copy and electronic copy for all traces.

C. Test report:

1. Include the following:

a. Summary of Project.

b. Description of equipment tested.

c. Description of tests performed.

d. Test results.

e. Conclusions and recommendations.

f. Completed test forms.

g. List of test equipment used and calibration dates.

h. LAN cable test reports.

D. Testing laboratory qualifications:

1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:

a. This statement will be used to determine whether the laboratory is acceptable, and shall include:

1) Corporate history and references.

2) Resume of individual performing test.

3) Equipment list and test calibration data.

E. Division of responsibilities:

1. Submit a list identifying who is responsible for performing each portion of the testing.

F. Manufacturers' testing procedures:

1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer.

1.6 QUALITY ASSURANCE

A. As specified in Section 26 05 00 – Electrical, General.

B. Testing laboratory qualifications:

1. The testing laboratory may be qualified testing personnel from the electrical subcontractor’s staff or an independent testing company.

2. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.7 DELIVERY, STORAGE, AND PROTECTION NOT USED

1.8 PROJECT OR SITE CONDITIONS

A. As specified in Section 26 05 00 – Electrical, General.

1.9 SEQUENCING

A. Perform testing in the following sequence:

1. Perform routine tests as the equipment is installed including:

a. Insulation resistance tests.

b. Continuity tests.

c. Rotational tests.

2. Adjusting and preliminary calibration.

3. Acceptance tests.

4. Demonstration.

5. Commissioning and plant start-up.

1.10 SCHEDULING NOT USED

1.11 WARRANTY

A. As specified in Section 26 05 00 – Electrical, General.

1.12 SYSTEM START-UP NOT USED

1.13 OWNER'S INSTRUCTIONS NOT USED

1.14 COMMISSIONING

A. Commissioning and plant start-up, as described in the Specifications, shall not begin until acceptance testing is complete, and operation has been demonstrated to the satisfaction of the Engineer.

B. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable:

1. Simulation of process parameters will be considered only upon receipt of a written request by the Contractor.

C. Record all motor currents during normal operation.

D. Record the indications of all power meters every half-hour during commissioning.

1.15 MAINTENANCE NOT USED

PART 2 - PRODUCTS

2.1 MANUFACTURERS NOT USED

2.2 EXISTING PRODUCTS NOT USED

2.3 MATERIALS NOT USED

2.4 MANUFACTURED UNITS NOT USED

2.5 EQUIPMENT NOT USED

2.6 COMPONENTS NOT USED

2.7 ACCESSORIES NOT USED

2.8 MIXES NOT USED

2.9 FABRICATION NOT USED

2.10 FINISHES NOT USED

2.11 SOURCE QUALITY CONTROL

A. General:

1. Test instrument calibration:

a. Utilize a testing laboratory with a calibration program which maintains all applicable test instrumentation within rated accuracy.

b. The accuracy shall be traceable to the NIST in an unbroken chain.

c. Calibrate instruments in accordance with the following frequency schedule:

1) Field instruments: 6 months maximum.

2) Laboratory instruments: 12 months maximum.

3) Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.

d. Dated calibration labels shall be visible on all test equipment.

e. Maintain an up-to-date instrument calibration record for each test instrument:

1) The records shall show the date and results of each calibration or test.

f. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

PART 3 - EXECUTION

3.1 EXAMINATION NOT USED

3.2 PREPARATION

A. Do not begin testing until the following conditions have been met:

1. All instruments required are available and in proper operating condition.

2. All required dispensable materials such as solvents, rags, and brushes are available.

3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment are available or scheduled.

4. All instruction books, calibration curves, or other printed material to cover the electrical devices are available.

5. Data sheets to record all test results are available.

3.3 INSTALLATION NOT USED

3.4 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION NOT USED

3.5 REPAIR/RESTORATION NOT USED

3.6 RE-INSTALLATION NOT USED

3.7 FIELD QUALITY CONTROL

A. Dry type transformers:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify that resilient mounts are free and that any shipping brackets have been removed.

e. Inspect equipment for cleanliness.

f. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

3) Thermographic survey.

g. Verify that as-left tap connections are as specified.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground:

1) Apply voltage in accordance with manufacturer's published data.

Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Calculate dielectric absorption ration or polarization index.

d. Perform turns ratio tests at all tap positions.

e. Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.

3. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Tap connections are left as found unless otherwise specified.

e. Minimum insulation resistance values of transformer insulation shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

2) Investigate insulation values less than the allowable minimum.

f. The dielectric absorption ratio or polarization index shall not be less than 1.0.

g. Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.

h. Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

B. Cables, 600 volts and less:

1. Visual and mechanical inspection:

a. Compare cable data with that indicated on the Drawings and specified in the Specifications.

b. Inspect exposed sections of cables for physical damage and correct connection as indicated on the Drawings.

c. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

3) Thermographic survey.

d. Inspect compression-applied connectors for correct cable match and indentation.

e. Inspect for correct identification and arrangements.

f. Inspect jacket insulation and condition.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter.

b. Perform insulation-resistance tests on each conductor with respect to ground and adjacent conductors:

1) Applied voltage shall be:

500 VDC for 300-volt rated cable.

1,000 VDC for 600-volt rated cable.

2) Test duration shall be 1 minute.

c. Perform continuity tests to ensure correct cable connection.

d. Verify uniform resistance of parallel conductors.

3. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Insulation resistance values shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

2) Investigate values of insulation resistance less than the allowable minimum.

e. Cables shall exhibit continuity.

f. Investigate deviations in resistance between parallel conductors.

C. Low voltage molded case and insulated case circuit breakers:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage and alignment.

d. Verify the unit is clean.

e. Operate circuit breaker to ensure smooth operation.

f. Inspect bolted electrical connections for high resistance by one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

3) Thermographic survey.

g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.

h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

b. Perform insulation resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:

1) Apply voltage in accordance with manufacturer’s published data.

2) Refer to NETA ATS tables in the absence of manufacturer’s published data.

c. Perform a contact/pole-resistance test.

d. Determine long-time pickup and delay by primary current injection.

e. Determine short-time pickup and delay by primary current injection.

f. Determine ground-fault pickup and delay by primary current injection.

g. Determine instantaneous pickup value by primary current injection.

h. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer’s published data.

i. Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, antipump function and trip unit battery condition:

1) Reset all trip logs and indicators.

j. Verify operation of charging mechanism.

3. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

   1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Insulation resistance values shall be in accordance with manufacturer's published data:

   1) Refer to NETA ATS tables in the absence of manufacturer's published data.

   2) Investigate values of insulation resistance less than the allowable minimum.

e. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:

   1) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

f. Insulation resistance values of control wiring shall not be less than 2 megohms.

g. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:

   1) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.

h. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

i. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.

j. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:

   1) Refer to NETA ATS tables in the absence of manufacturer's published data.

k. Pickup values and trip characteristics shall be within manufacturer's published tolerances.

l. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer’s published data:

1) Refer to NETA ATS tables in the absence of manufacturer’s published data.

m. Breaker open, close, trip, trip-free, antipump, and auxiliary features shall function as designed.

n. The charging mechanism shall operate in accordance with manufacturer’s published data.

D. Grounding systems:

1. Visual and mechanical inspection:

a. Inspect ground system for compliance with that indicated on the Drawings, specified in Specifications, and in the National Electrical Code.

b. Inspect physical and mechanical condition.

c. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:

Refer to manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.

d. Inspect anchorage.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

b. Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.

c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, the system neutral and any derived neutral points.

3. Test values:

a. Grounding system electrical and mechanical connections shall be free of corrosion.

b. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

d. The resistance between the main grounding electrode and ground shall be as specified in Section 26 05 26 – Grounding and Bonding for Electrical Systems. Investigate point-to-point resistance values that exceed 0.5 ohm.

E. Rotating machinery:

1. Visual and mechanical inspection:

a. Compare equipment nameplate information with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.

e. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

Thermographic survey.

f. Perform special tests such as gap spacing and machine alignment if applicable.

g. Verify correct application of appropriate lubrication and lubrication systems.

h. Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

b. Perform insulation resistance test in accordance with IEEE 43:

1) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio.

2) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.

c. Perform dc dielectric withstand voltage tests on machines rated at 2,300 volts and greater in accordance with IEEE 95.

d. Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.

e. Perform insulation resistance test on insulated bearings in accordance with manufacturer's published data.

f. Test surge protection devices as specified in this Section.

g. Test motor starter as specified in this Section.

h. Perform resistance tests on resistance temperature detector (RTD) circuits.

i. Verify operation of motor space heater.

j. Perform a rotation test to ensure correct shaft rotation.

k. Measure running current and evaluate relative to load conditions and nameplate full-load amperes.

3. Test values:

a. Inspection:

1) Air baffles shall be clean and installed in accordance with the manufacturer's published data.

2) Filter media shall be clean and installed in accordance with the manufacturer's published data.

3) Cooling fans shall operate.

4) Slip ring alignment shall be within manufacturer's published tolerances.

5) Brush alignment shall be within manufacturer's published tolerances.

6) Brush rigging shall be within manufacturer's published tolerances.

b. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

c. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

d. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

e. Air-gap spacing and machine alignment shall be in accordance with manufacturer's published data.

f. The dielectric absorption ratio or polarization index shall not be less than 1.0. The recommended minimum insulation ($IR_{1\ min}$) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:

1) IR1 min equals 100 megohms for dc armature and ac windings with form-wound coils above 1 kilovolt.

2) IR1 min equals 5 megohms for machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.

Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.

g. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

h. Investigate phase-to-phase stator resistance values that deviate by more than 10 percent.

i. Power factor or dissipation factor values shall be compared to manufacturer's published data:

1) In the absence of manufacturer’s published data compare values of similar machines.

j. Tip-up values shall indicate no significant increase in power factor.

k. If no evidence of distress, insulation failure or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.

l. Bearing insulation resistance measurements shall be within manufacturer’s published tolerances:

1) In the absence of manufacturer’s published data compare values of similar machines.

m. Test results of surge protection devices shall be as specified in this Section.

n. Test results of motor starter equipment shall be as specified in this Section.

o. RTD circuits shall conform to the design intent and machine protection device manufacturer’s published data.

p. Heaters shall be operational.

q. Vibration amplitudes shall not exceed values in NETA ATS tables:

1) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.

r. Machine rotation should match required rotation of connected load.

s. Running phase-to-phase voltages should be within 1.0 percent. Running currents shall be balanced and proportional to load condition and nameplate data.

F. Motor starters, low voltage:

1. Visual and mechanical inspection:

a. Compare equipment nameplate information with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify the unit is clean.

e. Inspect contactors:

1) Verify mechanical operation.

2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

f. Motor-running protection:

1) Verify overload element rating is correct for its application.

2) If motor running protection is provided by fuses, verify correct fuse rating.

g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

3) Thermographic survey.

h. Lubrication requirements:

1) Verify appropriate lubrication on moving current-carrying parts.

2) Verify appropriate lubrication on moving and sliding surfaces.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low resistance ohmmeter.

b. Perform insulation resistance tests for 1 minute on each pole, phase-to-phase and phase to ground with the starter closed, and across each open pole for 1 minute:

1) Test voltage shall be in accordance with manufacturer's published data.

2) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 VDC for 300-volt rated cable and 1,000 VDC for 600-volt rated cable. Apply the test voltage for 1 minute:

1) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

d. Test motor protection devices in accordance with manufacturer's published data.

e. Test circuit breakers as specified in this Section.

f. Perform operational tests by initiating control devices.

3. Test values:

a. Compare bolted connection resistance values to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Insulation resistance values shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

2) Investigate values of insulation resistance less than the allowable minimum.

e. Insulation resistance values of control wiring shall not be less than 2 megohms.

f. Motor protection parameters shall be in accordance with manufacturer's published data.

g. Circuit breaker test results shall as specified in this Section.

h. Control devices shall perform in accordance with system design requirements.

G. Motor control centers, low voltage:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding and required clearances.

d. Inspect equipment for cleanliness.

e. Verify that circuit breaker/fuse sizes and types correspond to the approved submittals and coordination study.

f. Verify that current and voltage transformer ratios correspond to that indicated on the Drawings.

g. Inspect bolted electrical connections for high resistance using one of the following methods:

  1) Use of low resistance ohmmeter.

  2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

  Refer to manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.

  3) Thermographic survey.

h. Mechanical and electrical interlocks:

  1) Attempt closure on locked-open devices.

  2) Attempt to open locked-closed devices.

  3) Make/attempt key-exchanges in all positions.

i. Lubrication requirements:

  1) Verify appropriate lubrication on moving current-carrying parts.

  2) Verify appropriate lubrication on moving and sliding surfaces.

j. Inspect insulators for evidence of physical damage or contaminated surfaces.

k. Verify correct barrier and shutter installation and operation.

l. Exercise all active components.

m. Inspect all indicating devices for correct operation.

n. Verify that filters are in place and/or vents are clear.

o. Perform visual and mechanical inspection of instrument transformers as specified in this Section.

p. Inspect control power transformers:

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary fuse/circuit breaker ratings match the submittal drawings.

q. Perform visual and mechanical inspection of circuit breakers as specified in this Section.

r. Perform visual and mechanical inspection of starters as specified in this Section.

s. Perform visual and mechanical inspection of dry-type transformers as specified in this Section.

t. Perform visual and mechanical inspection of variable frequency drives as specified in this Section.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter if applicable.

b. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for 1 minute:

1) Perform test in accordance with NETA ATS tables.

c. Perform an dielectric withstand test on each bus section, each phase to ground with phases not under test grounded, in accordance with manufacturer's published data or NETA ATS tables. Apply the test voltage for 1 minute.

d. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 VDC for 300-volt rated cable and 1,000 VDC for 600-volt rated cable. Apply the test voltage for 1 minute:

1) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

e. Perform ground-resistance tests:

1) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.

f. Determine the accuracy of all meters.

g. Control power transformers:

1) Perform insulation resistance tests, winding-to-winding and winding-to-ground:

Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.

2) Perform secondary wiring integrity test:

Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:

(1) Verify correct potential at all devices.

3) Verify correct secondary voltage by energizing primary winding with system voltage:

Measure secondary voltage with the secondary wiring disconnected.

h. Verify operation of space heaters.

i. Perform electrical tests of circuit breakers as specified in this Section.

j. Perform electrical tests of starters as specified in this Section.

k. Perform electrical tests of dry-type transformers as specified in this Section.

l. Perform electrical tests of variable frequency drives as specified in this Section.

3. Test values:

a. Compare bus connection resistances to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Compare bus connection resistances to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values for bus and control power transformers shall be in accordance with manufacturer's published data:

Refer to NETA ATS tables in the absence of manufacturer's published data.

Investigate insulation values less than the allowable minimum.

Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.

e. Bus insulation shall withstand the overpotential test voltage applied.

f. Insulation-resistance values for control wiring shall not be less than 2.0 megohms.

g. Instrument transformer test values shall be as specified in this Section.

h. Investigate grounding system resistance values that exceed 0.5 ohm.

i. Meter accuracy shall be in accordance with manufacturer's published data.

j. Control power transformers:

1) Insulation resistance values of control power transformers shall be in accordance with manufacturer's published data:

Refer to NETA ATS tables in the absence of manufacturer's published data.

Investigate insulation values less than the allowable minimum.

Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.

2) Secondary wiring shall be in accordance with that indicated on the Drawings and specified in the Specifications.

3) Secondary voltage shall be in accordance with that indicated on the Drawings.

k. Heaters shall be operational.

l. Test values for circuit breakers shall be as specified in this Section.

m. Test values for starters shall be as specified in this Section.

n. Test values for dry-type transformers shall as specified in this Section.

o. Test values for variable frequency drives shall be as specified in this Section.

H. Variable frequency drive systems:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, and grounding.

d. Verify the unit is clean.

e. Ensure vent path openings are free from debris and that heat transfer surfaces are clean.

f. Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.

g. Motor running protection:

1) Verify drive overcurrent setpoints are correct for their application.

2) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.

3) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.

h. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

Refer to manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.

3) Thermographic survey.

i. Verify correct fuse sizing in accordance with manufacturer’s published data.

j. Perform visual and mechanical inspection of input circuit breaker as specified in this Section.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with low-resistance ohmmeter.

b. Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.

c. Perform insulation-resistance tests on control wiring with respect to ground. Applied potential shall be 500 VDC for 300-volt rated cable and 1,000 VDC for 600-volt rated cable. Apply the test voltage for 1 minute:

1) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.

d. Test for the following parameters in accordance with relay calibration procedures specified in this Section or as recommended by the manufacturer:

1) Input phase loss protection.

2) Input overvoltage protection.

3) Output phase rotation.

4) Overtemperature protection.

5) Direct current overvoltage protection.

6) Overfrequency protection.

7) Drive overload protection.

8) Fault alarm outputs.

e. Perform continuity tests on bonding conductors as specified in this Section.

f. Perform start-up of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.

g. Perform operational tests by initiating control devices:

1) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.

2) Verify operation of drive from remote start/stop and speed control signals.

h. Perform electrical tests of input circuit breaker as specified in this Section.

3. Test values:

a. Compare bolted connection resistances to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer’s published data:

1) Refer to NETA ATS tables in the absence of manufacturer’s published data.

c. Results of the thermographic survey shall be in accordance with NETA ATS requirements.

d. Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer’s published time-current curve.

e. Test values for input circuit breaker shall be as specified in this Section.

f. Insulation-resistance values for control wiring shall not be less than 2.0 megohms.

g. Relay calibration results shall be as specified in this Section.

h. Continuity of bonding conductors shall be as specified in this Section.

i. Control devices shall perform in accordance with system requirements.

j. Operational tests shall conform to system design requirements.

I. Surge arresters, low-voltage:

1. Visual and mechanical inspection:

a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

b. Inspect physical and mechanical condition.

c. Inspect anchorage, alignment, grounding, and clearances.

d. Verify the arresters are clean.

e. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use of low resistance ohmmeter.

2) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:

Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.

f. Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

g. Verify that stroke counter is correctly mounted and electrically connected, if applicable.

h. Record stroke counter reading.

2. Electrical tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.

b. Perform an insulation-resistance test on each arrester, phase terminal-to-ground:

1) Apply voltage in accordance with manufacturers published data.

2) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Test grounding connection as specified in this Section.

3. Test values:

a. Compare bolted connection resistances to values of similar connections:

1) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

b. Bolt-torque levels shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

c. Insulation resistance values shall be in accordance with manufacturer's published data:

1) Refer to NETA ATS tables in the absence of manufacturer's published data.

2) Investigate insulation values less than the allowable minimum.

d. Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

J. Fiber-optic cables:

1. Visual and mechanical inspection:

a. Compare cable, connector, and splice data with that indicated on the Drawings and specified in the Specifications:

b. Inspect cable and connections for physical and mechanical damage.

c. Verify that all connectors and splices are correctly installed.

2. Electrical tests:

a. Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):

1) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.

2) Adjust OTDR pulse width settings to a maximum setting of 1/1000th of the cable length or 10 nanoseconds.

b. Perform connector and splice integrity test using an optical time domain reflectometer.

c. Perform cable attenuation loss measurement with an optical power loss test set:

1) Perform attenuation tests with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum.

2) Test multimode fibers at 850 nanometer and 1,300 nanometer.

3) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.

d. Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:

1) At the conclusion of all outdoor splices at one location, and before they are enclosed and sealed, all splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. The splices shall be tested for integrity as well as attenuation.

e. Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an Optical Loss Test Set:

1) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer and 1,300 nanometer for multimode fibers.

2) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

3. Test values:

a. Cable and connections shall not have been subjected to physical or mechanical damage.

b. Connectors and splices shall be installed in accordance with industry standards.

c. The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.

d. Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.

e. Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

K. LAN cable testing:

1. Visual and mechanical inspections:

a. Compare cable type and connections with that indicated on the Drawings and specified in the Specifications.

b. Inspect cable and connectors for physical and mechanical damage.

c. Verify that all connectors are correctly installed.

2. Pre-testing:

a. Test individual cables before installation:

1) Before physical placement of the cable, test each cable while on the spool with a LAN certification test device.

2) Before the cable is installed, verify that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.

3) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of all traces, before placement of the cable.

4) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.

3. Electrical tests:

a. Perform cable end-to-end testing on all installed cables after installation of connectors from both ends of the cable.

b. Test shall include cable system performance tests and confirm the absence of wiring errors.

4. Test results:

a. Cables shall meet or exceed TIA standards for a Category 5e or Category 6 installation, as applicable.

5. Test equipment:

a. LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:

1) Near end cross talk.

2) Attenuation.

3) Equal level far end cross talk.

4) Return loss.

5) Ambient noise.

6) Effective cable length.

7) Propagation delay.

8) Continuity/loop resistance.

b. LAN certification test equipment shall be able to store and produce plots of the test results.

c. Acceptable manufacturers: The following or equal:

1) Agilent Technologies, WireScope 350.

L. Capacitors and reactors, capacitors:

1. Visual and mechanical inspection:

   a. Compare equipment nameplate data with that indicated on the Drawings and specified in the Specifications.

   b. Inspect physical and mechanical condition.

   c. Inspect anchorage, alignment, grounding, and clearances.

   d. Verify the unit is clean.

   e. Verify that capacitors are electrically connected in their specified configuration.

   f. Inspect bolted electrical connections for high resistance using one of the following methods:

      1) Use of low-resistance ohmmeter.

      2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method:

         Refer to manufacturer's instructions for proper foot-pound levels NETA ATS tables.

      3) Perform thermographic survey.

2. Electrical tests:

   a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable.

   b. Perform insulation-resistance tests from phase terminal(s) to case for one minute.

      1) Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, refer to NETA ATS tables.

   c. Measure the capacitance of all terminal combinations.

   d. Measure resistance of the internal discharge resistors.

3. Test values:

   a. Test values - visual and mechanical:

      1) Compare bolted connection resistance values to values of similar connections.

Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels shall be in accordance with manufacturer's published data:

Refer to NETA ATS tables in the absence of manufacturer’s data.

3) Results of the thermographic survey shall be in accordance with NETA ATS requirements.

b. Test values - electrical:

1) Compare bolted connection resistance values to values of similar connections:

Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values shall be in accordance with manufacturer's published data:

Refer to NETA ATS tables in the absence of manufacturer's published data.

Values of insulation resistance less than NETA ATS tables or manufacturer's recommendations should be investigated.

3) Investigate capacitance values differing from manufacturer's published data.

4) Investigate discharge resistor values differing from manufacturer's published data. In accordance with NFPA 70 NEC, Article 460, residual voltage of a capacitor shall be reduced to 50 volts in the following time intervals after being disconnected from the source of supply:

Rated Voltage	Discharge Time
Less than or equal to 600 volts	1 minute
Greater than 600 volts	5 minutes

3.8 ADJUSTING

A. Adjust limit switches and level switches to their operating points before testing.

B. Set pressure switches, flow switches, and timing relays to anticipated values before testing:

1. Final settings shall be as dictated by operating results during testing.

3.9 CLEANING

A. As specified in Section 26 05 00 –Electrical, General.

B. After the acceptance tests have been completed, dispose of all testing expendables, vacuum all cabinets, and sweep clean all surrounding areas.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 26 05 00 – Electrical, General.

B. Subsystem demonstration:

1. Subsystem, as used in this Section, means individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, blowers, lighting control systems and other electrically operated or controlled equipment.

2. Before demonstrating any subsystem:

    a. Demonstrate proper operation of all alarm and status contacts.

    b. Adjust and calibrate all process and control devices as accurately as possible.

3. Operate each subsystem in its manual mode:

    a. Demonstrate compliance with all Contract requirements.

4. After each subsystem has operated successfully in its manual mode, perform automatic and remote operation demonstrations:

    a. Verify that all features are fully operational and meet all Contract requirements.

    b. Demonstrate all operating modes and sequences, including proper start and stop sequence of pumps, proper operation of valves and proper speed control.

3.11 PROTECTION

A. As specified in Section 26 05 00 – Electrical, General.

3.12 SCHEDULES

A. At least 30 days before commencement of the acceptance tests, submit the manufacturer’s complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for all equipment to be tested.

END OF SECTION 26 08 00

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SECTION 26 22 00 – LOW VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

2. Control and signal transformers.

1.3 SUBMITTALS

A. Product Data Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Wiring and connection diagrams.

C. Source quality-control test reports.

D. Output Settings Reports: Record of tap adjustments specified in Part 3.

1.4 QUALITY ASSURANCE

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

B. Comply with IEEE C 57.12.91.

C. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified Section 26 05 00 – Electrical, General.

B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Siemens.

2. GE Electrical Distribution & Control.

3. Square D/Group Schneider NA.

B. Substitutions: Refer to specification 01 25 13 – Product Substitution Procedures.

Other manufacturers may be submitted for approval by an engineer, provided they meet all performance and certification requirements.

2.2 MATERIALS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Copper.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NEMA ST 20, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

D. Enclosure: Ventilated, raintight, NEMA 250, Type 3R required.

E. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "Indoor Corrosion Protection."

1. Finish Color: Gray.

F. Outdoor Transformer Enclosure Finish: Comply with NEMA 250 for "Outdoor Corrosion Protection."

1. Finish Color: Gray.

G. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

H. Taps for Transformers Smaller Than 3 kVA: None.

I. Taps for Transformers 7.5 to 24 kVA: Two 5 percent taps below rated voltage.

J. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

K. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.

2. Include special terminal for grounding the shield.

3. Shield Effectiveness:

a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.

b. Common-Mode Noise Attenuation: Minus 120 dBA minimum at 0.5 to 1.5 kHz; minus 65 dBA minimum at 1.5 to 100 kHz.

c. Normal-Mode Noise Attenuation: Minus 52 dBA minimum at 1.5 to 10 kHz.

L. Wall Brackets: Manufacturer's standard brackets.

M. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

2.4 CONTROL AND SIGNAL TRANSFORMERS

A. Description: Self-cooled, two-winding dry type, rated for continuous duty, complying with NEMA ST 1, and listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls and floors for suitable mounting conditions where transformers will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.

1. Brace wall-mounting transformers as specified in Section 26 05 00 – General

B. Install floor-mounting transformers level on concrete bases. Construct concrete bases of dimensions not less than 4 inches larger in both directions than supported unit and 4 inches high.

1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Section 26 05 00 – General, Electrical.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 05 26 – Grounding and Bonding.

B. Connect wiring according to Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 26 22 00

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SECTION 26 24 16 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:

1. Branch-circuit panelboards.

2. Distribution panelboards.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a. Enclosure types and details for types other than NEMA 250, Type 1.

b. Bus configuration, current, and voltage ratings.

c. Short-circuit current rating of panelboards and overcurrent protective devices.

d. UL listing.

e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing. Scheduling shall be typewritten indicating loads served by each breaker.

D. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.4 QUALITY ASSURANCE

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

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.6 EXTRA MATERIALS

A. Keys: Six spares of each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:

a. General Electric Co.; Electrical Distribution & Control Div.

b. Siemens Energy & Automation, Inc.

c. Square D Co.

d. Or engineer approved equal.

2.2 FABRICATION AND FEATURES

A. Enclosures: Flush or Surface mounted cabinets as indicated. NEMA PB 1, Type 1, to meet environmental conditions at installed location.

1. Outdoor Locations: NEMA 250, Type 3R.

2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

B. Front: Secured to box with piano hinged door in door trim. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.

C. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.

D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.

E. Bus: Copper.

F. Main and Neutral Lugs: Compression type suitable for use with conductor material.

G. Equipment Ground Bus: Copper only Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

H. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.

I. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

J. Gutter Barrier: Arrange to isolate individual panel sections.

K. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.

L. Feed-through Lugs: Compression type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals, unless otherwise stated. Series rating not allowed.

2.4 LOAD CENTERS - NOT ALLOWED.

2.5 BRANCH-CIRCUIT PANELBOARDS

A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.6 DISTRIBUTION PANELBOARDS

A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike.

B. Main Overcurrent Protective Devices: Circuit breaker.

C. Branch overcurrent protective devices shall be one of the following:

1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.

C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

E. Install filler plates in unused spaces.

F. Provision for Future Circuits at Flush Panelboards: Stub three 3/4-inch (19 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 3/4-inch (19 mm) empty conduits into raised floor space or below slab not on grade.

G. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Section 26 05 00 – Electrical, General.

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, section 7.5 for switches and section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

B. Balancing loads between phases such that difference is below 20 percent.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

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SECTION 26 27 26 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

A. Product Data: For each product specified.

B. Shop Drawings: Legends for receptacles and switch plates.

C. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

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

B. Comply with NEMA WD 1.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Receptacles for provided by others Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Wiring Devices:

   a. Cooper Wiring Devices

   b. Hubbell, Inc.; Wiring Devices Div.

   c. Leviton Manufacturing Co., Inc.

   d. Pass & Seymour/Legrand; Wiring Devices Div.

2. Wiring Devices for Hazardous (Classified) Locations:

   a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.

   b. Killark Electric Manufacturing Co.

   c. Pyle-National, Inc.; an Amphenol Co.

3. Multioutlet Assemblies:

   a. Hubbell, Inc.: Wiring Devices Div.

   b. Wiremold.

B. Substitutions: Refer to specification 01 25 13 – Product Substitution Procedures.

Other manufacturers may be submitted for approval by an engineer, provided they meet all performance and certification requirements.

2.2 RECEPTACLES

A. Straight-Blade and Locking Receptacles: Industrial grade Leviton 5362 or equal.

B. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle. Do not connect downstream receptacles to load side of GFCI. Design units for installation in a 2-3/4-inch-deep outlet box without an adapter.

C. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap.

1. Devices: Listed and labeled as isolated-ground receptacles.

2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.

D. TVSS Receptacles: Duplex type, NEMA WD 6, Configuration 5-20R, with integral TVSS in line to ground, line to neutral, and neutral to ground.

1. TVSS Components: Multiple metal-oxide varistors; rated a nominal clamp level of 500 transient-suppression voltage and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.

2. Active TVSS Indication: Light visible in face of device to indicate device as "active" or "no longer active."

3. Identification: Distinctive marking on face of device denotes TVSS-type unit.

E. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

2.4 SWITCHES

A. Toggle Switches: Commercial-duty, quiet type.

1. Single Pole Switch: 20 A, 120/277-V AC. Leviton CSB 120 or approved equal.

2. 3-Way Switch: 20A 120/277-V AC: Leviton CSB 320 or approved equal.

2.5 WALL PLATES

A. Single and combination types match corresponding wiring devices. Provide the following wall plate types:

1. Finished Spaces: Nylon/Lexan - White (Emergency receptacle and switch plates shall be red in color and be engraved with the label “Emergency” and be labeled with the panel circuit number).

2. Unfinished spaces: Galvanized steel (Emergency receptacle and switch plates shall be red in color and be engraved with the label “Emergency” and be labeled with the panel circuit number).

3. Exterior non-continuous use: Die cast aluminum or impact resistant thermoplastic with spring loaded flip cover and weather-resistant gasket.

4. Exterior continuous use: Die cast aluminum or impact resistant thermoplastic with 3-1/2” deep “in-use” flip cover and weather-resistant gasket.

2.6 MULTIOUTLET ASSEMBLIES

A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

B. Raceway Material: Metal, with manufacturer's standard finish.

C. Wire: No. 12 AWG.

2.7 FINISHES

A. Color: White, unless otherwise indicated or required by Code.

2.8 RAISED COVERS, SURFACE MOUNTED

A. Single and double cover types to match the corresponding wiring device.

1. Interior spaces only.

2. Cover to be mounted to a 4 square device box.

3. Finish to be galvanized steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install devices and assemblies plumb and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

F. Protect devices and assemblies during painting.

G. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Section 26 05 00 – Electrical, General.

3.3 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.

D. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Check TVSS receptacle indicating lights for normal indication.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

END OF SECTION 26 27 26

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SECTION 26 28 00 - OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes overcurrent protective devices (OCPDs) rated 600 V and below and switching devices commonly used with them.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 specification sections.

B. Product data for fuses, fusible switches, circuit breakers, and OCPD accessories specified in this Section, including descriptive data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cartridge Fuses:
   a. Bussmann Div., Cooper Industries, Inc.
   b. Gould Inc.
   c. Littelfuse Inc.
2. Fusible Switches:
   a. General Electric Co.
   b. Square D Co.
   c. Siemens
   d. Eaton
3. Molded-Case Circuit Breakers:
   a. General Electric Co.
   b. Square D Co.
   c. Siemens

d. Eaton

4. Combination Circuit Breaker and Ground Fault Circuit Interrupters:

a. General Electric Co.

b. Square D Co.

c. Siemens

d. Eaton

5. Molded-Case Circuit Breakers With Solid-State Trip Devices:

a. General Electric Co.

b. Square D Co.

c. Siemens

d. Eaton

2.2 OVERCURRENT PROTECTIVE DEVICES (OCPD'S), GENERAL

A. General: Provide OCPD's in indicated types, as integral components of panelboards, switchboards, and also as individually enclosed and mounted single units.

B. Enclosures: NEMA 250 "Enclosures for Electrical Equipment (1,000 Volts Maximum)."

2.3 CARTRIDGE FUSES

A. General: NEMA Standard FU1, "Low-Voltage Cartridge Fuses." Unless indicated otherwise, provide nonrenewable cartridge fuses of indicated types, classes, and current ratings that have voltage ratings consistent with the circuits on which used.

B. Class RK1 and RK5 Dual Element Time-Delay Fuses: UL 198E, "Class R Fuses."

2.4 FUSIBLE SWITCHES

A. General: UL 98 "Enclosed and Dead Front Switches" and NEMA KS 1 "Enclosed Switches," quick-make, quick-break heavy-duty units.

B. Rating: Load-breaking capacity in excess of the normal horsepower rating for the switch.

C. Withstand Capability: In excess of the let-through current permitted by its fuse when subject to faults up to 100,000 RMS symmetrical amperes.

D. Operation: By means of external handle.

E. Interlock: Prevents access to switch interior except when in "off" position.

F. Fuse Clips: Rejection type.

G. Padlocking Provisions: For 2 padlocks, whether open or closed.

H. Enclosure for Independent Mounting: NEMA Type 1 enclosure except as otherwise indicated or required to suit environment where located.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. General: UL 489, "Molded Case Circuit Breakers and Circuit Breaker Enclosures," and NEMA AB 1, "Molded Case Circuit Breakers."

B. Construction: Bolt-in type, except breakers 225-ampere frame size and larger may be plug-in type if held in place by positive locking device requiring mechanical release for removal.

C. Characteristics: Indicated frame size, trip rating, number of poles, and a short-circuit interrupting capacity rating of 10,000 amperes symmetrical, unless a greater rating as indicated.

D. Tripping Device: Quick-make, quick-break toggle mechanism with inverse-time delay and instantaneous overcurrent trip protection for each pole.

E. Adjustable Instantaneous Trip Devices: Factory adjusted to low-trip-setting current values.

F. Enclosure for Independent Mounting: NEMA Type 1 enclosure, except as otherwise indicated or required to suit environment where located.

G. Combination Circuit Breakers and Ground Fault Circuit Interrupters: UL 943 "Ground Fault Circuit Interrupters," arranged for sensing and tripping for ground fault current in addition to overcurrent and short-circuit current. Provide features as follows:

1. Match features and module size of panelboard breakers and provide clear identification of ground fault trip function.

2. Trip Setting for Ground Fault: 30 milliamperes.

2.6 OCPD ACCESSORIES

A. Shunt-Trip Devices for Circuit Breakers: Where indicated, arrange to trip breaker from an external source of power through a control switch or relay contacts.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Independently Mounted OCPD's: Locate as indicated and install in accordance with manufacturer's written installation instructions.

B. OCPD's in distribution equipment shall be factory installed.

3.2 CONNECTIONS

A. Check connectors, terminals, bus joints, and mountings for tightness. Tighten field-connected connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

3.3 GROUNDING

A. Provide equipment grounding connections for individually mounted OCPD units as indicated and as required by NEC. Tighten connectors to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.

3.4 FIELD QUALITY CONTROL

A. Visual and mechanical inspection: Include the following inspections and related work.

1. Overcurrent-Protective-Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system arrangement and parameters. Where discrepancies are found, test organization shall recommend final protective device ratings and settings. Use accepted revised ratings or settings to make the final system adjustments.

2. Inspect for defects and physical damage, NRTL labeling, and nameplate compliance with current single line diagram.

3. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer's instruction manual.

4. Check tightness of electrical connections of OCPD's with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.

5. Clean OCPD's using manufacturer's approved methods and materials.

B. Retest: Correct deficiencies identified by tests and observations and provide retesting of OCPD's. Verify by the system tests that specified requirements are met.

3.5 CLEANING

A. Upon completion of installation, inspect OCPD's. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION 26 28 00

SECTION 26 51 19 – LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, LED light engines, LED drives, lamps, ballasts, emergency lighting units, and accessories.

1.3 SUBMITTALS

A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.
2. LED drivers.
3. LED light engine.
4. Fluorescent and high-intensity-discharge ballasts.
5. Types of lamps.

B. Product Certificates: Signed by manufacturers of lighting fixtures certifying that products comply with requirements.

C. Dimming Driver Compatibility Certificates: Signed by manufacturer of dimmable drivers certifying that they are compatible with dimming systems and equipment with which they are used.

D. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

B. Comply with NFPA 70.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

B. Exterior Building Lights: Coordinate exterior conduit penetrations for connections to the back of building mounted fixtures. Coordinate locations and install back boxes as required during construction of walls, framing and other related construction.

1.6 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation:

1. Light Fixtures: As indicated on Drawing fixture schedule.

2. LED Drivers: Compatible with LED light engine.

3. LED Light Engine: Per manufacturer on Drawing fixture schedule.

B. Substitutions: Refer to specification 01 25 13 – Product Substitution Procedures.

C. Other manufacturers may be submitted for approval by an engineer, provided they meet all performance and certification requirements.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during maintenance and relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.

2. Lens Thickness: 0.125-inch minimum, unless greater thickness is indicated.

2.3 LED DRIVERS

A. General Requirements: Unless otherwise indicated, features include the following:

1. Shall be electronic type, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47, Part 15.

2. Total Harmonic Distortion Rating: Less than 20 percent at all input voltages.

3. Sound Rating: A.

4. Minimum efficiency of 85%.

B. LED Drivers: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Dimmable drivers shall be 0-10V type.

2. Dimmable drivers shall be capable of dimming without LED flicker or strobing across their full dimming range.

C. LED Drivers for Low-Temperature Environments: As follows:

1. Temperatures 0 Deg F and Above: Electronic or electromagnetic type rated for 0 deg F starting temperature.

2. Temperatures Minus 20 Deg F and Above: Electromagnetic type designed for use with high-output lamps.

2.4 EXIT SIGNS

A. General Requirements: Comply with UL 924 and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.5 EMERGENCY LED SUPPLY UNITS

A. Internal Type: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.

1. Test Switch and Light-Emitting Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Test switch shall illuminate LEDs for minimum of 3 minutes when pushed momentarily.

2. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum 5-year nominal life.

3. Charger: Fully automatic, solid-state, constant-current type.

4. Operation: Relay automatically energizes LEDs from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects LEDs, and battery is automatically recharged and floated on charger.

5. Lumen output: Minimum 700 lumens (LED), Minimum 1350 lumens (T8 minimum lamps), Minimum 750 lumens (compact fluorescent 4-pin lamps).

B. External Type: Self-contained, modular, battery-inverter unit. Comply with UL 924.

1. Test Switch and Light-Emitting Diode Indicator Light: Visible and accessible without entering ceiling space. Test switch shall illuminate LEDs or lamps for minimum of 3 minutes when pushed momentarily.

2. Battery: Sealed, maintenance-free, nickel-cadmium type with minimum 10-year nominal life.

3. Charger: Fully automatic, solid-state, constant-current type.

4. Operation: Relay automatically energizes LEDs or lamp from unit when normal supply circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects LEDs or lamp, and battery is automatically recharged and floated on charger.

5. Housing: NEMA 250, Class 1 enclosure.

6. Self-diagnostics.

2.6 LED LIGHT ENGINES

A. LED Color Temperature: 3500 K, unless otherwise indicated.

B. CCT tolerances are to be kept within a 3-step MacAdam ellipse and are to maintain a Min CRI of 80.

C. Lumen Maintenance/Rated Life: The LED light engine and driver system shall have a rated life of L70 > 60,000 hours at an ambient temperature of 25 deg C, based on manufacturers test data per IES LM 80 and TM 21.

2.7 FIXTURE SUPPORT COMPONENTS

A. Comply with Section 26 05 00 – Electrical, General for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.8 FINISHES

A. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer’s written instructions and approved Shop Drawings. Support fixtures according to requirements of Section 26 05 00 - Electrical, General.

B. Support for Recessed and Semi-recessed Grid-type Fixtures:

1. Pendant-hung lighting fixtures shall be supported directly from the structure above using No. 9-gauge wire or an approved alternate support without using the ceiling suspension system for direct support.

2. Lighting fixtures weighing less than 56 pounds shall have, in addition to the requirements outlined above, two No. 12 gauge hangers connected from the fixture housing to the structure above. These wires may be slack.

3. Lighting fixtures weighing 56 pound or more shall be supported directly from the structure above by approved hangers.

C. Support for Suspended Fixtures: Brace pendants and rods over 48 inches long to limit swinging. Support stem-mounted, single-unit, suspended fixtures with twin-stem hangers. For continuous rows, use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of chassis, including one at each end.

D. Surface-mounted lighting fixtures shall be attached to the ceiling system with positive clamping devices that completely surround the supporting members. Safety wires shall be attached between the clamping device and the adjacent ceiling hanger or to the structure above. In no case shall the fixture exceed the design carrying capacity of the supporting members.

E. Exterior-mounted lighting fixtures shall be mounted according to the manufacturer’s instructions. Conduit shall be concealed within walls or installed within the building and then penetrate to exterior fixture. Surface mounted conduit on exterior of the building is not acceptable. All penetrations are to be sealed.

3.2 CONNECTIONS

A. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 467, UL 486A, and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Tests: As follows:

1. Verify normal operation of each fixture after installation.

2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.

3. Verify normal transfer to battery source and retransfer to normal.

C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

D. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust amiable fixtures to provide required light intensities.

END OF SECTION 26 51 19

SECTION 28 46 20 - FIRE ALARM SYSTEM

[NOTE: Ensure to coordinate with local agencies/authorities before proceeding.]

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section includes fire alarm equipment. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, auxiliary control devices, annunciators, power supplies, and writing as required for a complete and operational system.

B. The fire alarm system shall comply with requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

C. The new fire alarm system to be the following or approved equal.

1. Fire Alarm Panel selection shall be coordinated with the Fire Protection Contractor (FPC) and be capable of providing the required alarms and communications required per the AHJ. All coordination shall be performed by the Fire Alarm Contractor (FAC).

D. Fire alarm system and design shall be design-build and shall comply to all required codes and local jurisdiction requirements.

E. The system and its components shall be Underwriters Laboratories, Inc., listed under the appropriate UL testing standard as listed herein for fire alarm applications, and shall be installed in compliance with the UL listing.

1.2 SCOPE

A. Basic Performance

1. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style D).

2. A single ground or open on any initiating device circuit or notification appliance circuit shall not cause system malfunction, loss of operating power, or the ability to report an alarm.

B. The Fire Alarm System shall include, but not limited to the following:

1. Engineering & Submittals

2. Fire Permit

3. AHJ Inspection & Coordination

4. Wiring and conduit inside the fire sprinkler room.

5. Programming

6. Testing and documentation of final system configuration

7. 1-year parts and labor warranty following approval by the AHJ.

8. Fire Alarm Panel as specified above, capable of meeting the system requirements.

9. Communications equipment and setup, per AHJ requirements.

10. Photo detector smoke detect

11. Audio/visual alarming equipment

12. And all other system components required by the AHJ to create a complete and operable system.

1.3 SUBMITTALS

A. Manufacturer’s Equipment: All references to manufacturer's or supplier's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function, and quality. Equivalent equipment (compatible UL listed) from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

B. Shop Drawings: Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and all applicable calculations.

C. Manuals: Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets (with model numbers to be used indicated).

D. Certifications: Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation is an authorized representative of the major equipment manufacturer.

E. Fire alarm contractor is responsible for submittal to Authority Having Jurisdiction (AHJ). Contractor is responsible to obtain approval for fire alarm system design in compliance with current versions of NFPA 72,101 and UFC from the AHJ.

F. Testing Report: Provide written confirmation letter with compiled testing data completed per section 3.2.

G. Final Inspection Report: Provide final inspection report with a summary of the demonstration activities and acknowledgement that the systems function properly.

1.4 GUARANTY

A. All work performed, and all material and equipment furnished, under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance.

1.5 POST-CONTRACT MAINTENANCE

A. Complete maintenance and repair service for the fire alarm system shall be available from a factory-trained, authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.

1.6 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification.

1. National Fire Protection Association (NFPA) - USA:

a. No. 72 National Fire Alarm Code Current Version

b. No. 101 Life Safety Code Current Version

2. Underwriters Laboratories Inc. (UL) - USA:

a. No. 268 Smoke Detectors for Fire Protective Signaling Systems

b. No. 864 Control Units for Fire Protective Signaling Systems

c. No. 464 Audible Signaling Appliances

d. No. 1971 Visual Signaling Appliances

e. No. 38 Manually Actuated Signaling Boxes

3. Local and State Building Codes.

B. All requirements of the AHJ.

1.7 APPROVALS

A. Each system must have proper listing and/or approval from the following nationally recognized agencies.

1. UL Underwriters Laboratories Inc

2. FM Factory Mutual

3. MEA Material Equipment Acceptance (NYC)

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and components shall be new, and the manufacturer's current model.

B. All equipment and components shall be installed in strict compliance with manufacturer’s recommendations.

C. All equipment shall be attached to walls and ceiling/floor assemblies, and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 CONDUIT AND WIRE

A. Conduit

1. Conduit shall be in accordance with the National Electrical Code (NEC), and local and state requirements.

2. Conduit fill shall not exceed 40% of interior cross-sectional area where three or more cables are contained within a single conduit.

3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box, or raceway containing these conductors, as per NEC Article 760-29.

B. Wire

1. All fire alarm system wiring shall be new.

2. Wiring shall be in accordance with local, state, and national codes (e.g., NEC Article 760). Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits, and 14 AWG (1.63 mm) for notification device circuits.

3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling (fire alarm) system.

C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

D. The control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes, with a lock-on device. This circuit shall be labeled at the main power distribution panel as fire alarm system. Control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

2.3 FIRE ALARM CONTROL PANEL (FACP)

A. Fire Alarm Panel Make Honeywell Model ES-1000x 954-PT or approved equal.

B. System Display: The system display shall indicate the status of the following system parameters:

1. AC Power: Green LED

2. System Alarm: Red LED

3. Supervisory: Yellow LED

4. System Trouble: Yellow LED

5. Circuit Trouble: Yellow LED

6. Alarm Silenced: Yellow LED

7. Power Trouble: Yellow LED

2.4 BATTERIES

A. The fire alarm contractor shall verify that the batteries have sufficient capacity to power the fire alarm system for not less than 24 hours, plus 5 minutes of alarm upon a normal AC power failure.

B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks, refilling, spills, and leakage shall not be required.

2.5 SYSTEM COMPONENTS

A. Programmable Electronic Sounders:

1. Electronic sounders shall operate on 24 VDC nominal.

2. Electronic sounders shall be field programmable without the use of special tools, to provide slow whoop, continuous, or interrupted tones with an output sound level of at least 90 dBA measured at 10 feet from the device.

3. Shall be flush- or surface-mounted as show on plans.

B. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-code, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.

2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.

3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet, front or side.

4. Manual stations shall be constructed of high-impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters ½ inch in size or larger.

5. Stations shall be suitable for semi-flush mounting on standard single gang box, and shall be installed not less than 42 inches, or more than 48 inches, above the finished floor.

C. Conventional Photoelectric Area Smoke Detectors

1. Photoelectric smoke detectors shall be a 24 VDC, two-wire, ceiling-mounted, light-scattering type using an LED light source.

2. Each detector shall contain a remote LED output and a built-in test switch.

3. Detector shall be provided on a twist-lock base.

4. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.

5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360°.

These LEDs shall flash every 10 seconds, indicating that power is applied to the detector.

6. The detector shall not go into alarm when exposed to air velocities of up to 3,000 feet per minute.

7. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.

8. All field wire connections shall be made to the base through the use of a clamping plate and screw.

D. Conventional Ionization Type Area Smoke Detectors

1. Ionization type smoke detectors shall be a two-wire, 24 VDC-type using a dual unipolar chamber.

2. Each detector shall contain a remote LED output and a built-in test switch.

3. Detector shall be provided on a twist-lock base.

4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.

5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360°, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.

6. The detector shall not alarm when exposed to air velocities of up to 1,200 feet per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.

7. All field wire connections shall be made to the base through the use of a clamping plate and screw.

E. Duct Smoke Detectors

1. Duct smoke detectors shall be a 24 VDC-type with visual alarm and power indicators, and a reset switch. Each detector shall be installed upon the composite supply/return air ducts(s), with properly sized air sampling tubes.

F. Supervisory Switches

1. Supervisory switches shall be 24 VDC-type, tamper-resistant screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local, and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

C. All fire detection and alarm system devices, control panels, and remote annunciators shall be flush-mounted when located in finished areas, and may be surface-mounted when located in unfinished areas.

D. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall perform the tests in Section 3.2 TESTS.

3.2 TESTS

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

2. Close each supervisory contact and verify proper supervisory alarm at the FACP.

3. Open initiating device circuits and verify that the trouble signal actuates.

4. Open and short notification appliance circuits and verify that trouble signal actuates.

5. Ground device circuits and verify response of trouble signals.

6. Open release circuits and verify response of trouble signals.

7. Check presence and audibility of tone at all alarm notification devices.

8. Check installation, supervision, and operation of smoke detectors.

9. When any defects are detected, make repairs or install replacement components, and repeat the tests as required.

10. Each initiating device circuit shall be tested for its alarm-reporting capability by operating all of the connected initiating devices.

11. Conduct tests from the FACP to verify trouble indications for common mode failures, such as alternating current power failure.

3.3 FINAL INSPECTION

A. At the final inspection, a factory-trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.4 INSTRUCTION

A. Provide instruction as required to the building personnel. "Hands-on" demonstrations of the operation of all system components and the entire system shall be provided.

END OF SECTION 28 46 20

SECTION 31 00 00 - EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all labor, materials, and equipment as required for all excavation, grading, providing borrow materials, hauling, placing, compacting, and testing earthwork materials to construct the site to the grades shown on the plans.

B. Prior to commencement of any earthwork, the Contractor shall review the geotechnical reports. The geotechnical report is on file at the office of the Engineer for information only and the Contractor is responsible for making any interpretations there from.

C. Submit to the Engineer's Field Representative load tickets on all materials delivered to the site.

1.2 REFERENCE STANDARDS

A. Oregon Standard Specifications for Construction, 2024 Edition

B. ODOT Highway Design Manual (HDM), 2025 Edition

C. ODOT Standard Drawings, current edition

D.	ASTM C 29	Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
E.	ASTM D 136	Sieve Analysis of Fine and Coarse Aggregates
F.		
G.	ASTM D 698	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregated Mixtures, Using 5.5-lb Rammer and 12-inch Drop
H.	ASTM D 1556	Density of Soil by the Sand-Cone Method
I.	ASTM D 1557	Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures, Using 10 lb. Rammer and 10 inch Drop
J.	ASTM D 1633	Test Method for Compressive Strength of Molded Soil-Cement Cylinders
K.	ASTM D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregate
L.	ASTM D 2487	Classification of Soils for Engineering Purposes
M.	ASTM D 2901	Test Method for Cement Control of Freshly-Mixed Soil Cement

N. ASTM D 2922 Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

O. ASTM D 4254 Test Methods for Minimum Index Density of Soils and Calculative of Relative Density

P. ASTM D6913/D6913M Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis (for coarse-grained soils)

Q. ASTM D7928 Standard Test Method for Particle-Size Distribution of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis (for fine fractions)

R. OSHA - 1926.650-651 and other applicable sections.

S. Where conflicts occur between ODOT standards and the Contract Documents, the Contract Documents shall govern.

1.3 SUBMITTALS

A. The Contractor shall submit test results of all materials proposed to be used in work in accordance with the requirements of Section 01 33 00 - Submittal Procedures.

B. Submit sieve analysis, moisture density relationship test for both ASTM D698 and D1557, and sand equivalency. The sieve analysis and moisture density relationship tests must have been completed within 12 calendar months from the date of submittal.

1.4 DEFINITIONS

A. Backfill or Fill: (a) Material used to replace material removed during construction or (b) The act of replacing or placing material during construction.

B. Backfill Operation or Fill Operation: The method and the activity required to fill surface depressions and excavations, or to construct fills to required grades.

C. Common Fill: Fill or borrow materials which are naturally occurring and not meeting a specific gradation or classification.

D. Structural Fill: The act of placing common or imported fill material under controlled operation to a certain density.

1.5 GEOTECHNICAL INVESTIGATION / TRCHNICAL DATA

A. A geotechnical investigation and report that were completed for the overall site are available to the Contractor. Contractor may not rely upon or make any claim against Owner or Engineer with respect to:

1. The completeness of such report and investigation for Contractor's purposes, including but not limited to, any aspects of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, and safety precautions and programs incidental there to.

2. Other data, interpretations, opinions, and information contained in such report or shown or indicated in the report.

3. Any Contractor interpretation of or conclusion drawn from the geotechnical investigation and report or any such other data, interpretations, opinions, or information.

PART 2 - PRODUCTS

2.1 SUITABLE FILL AND BACKFILL MATERIAL REQUIREMENTS

A. The following types of suitable materials are defined (see Execution for the location where the materials are approved for use or where identified in other specifications and drawings):

1. Common Fill: Fill or borrow materials which are naturally occurring, not meeting a specific gradation or classification, are not Unsuitable Materials, and can be placed in a controlled operation to a certain density.

    a. During or after the wet season, typically winter and spring (or in periods of precipitation), the near-surface fine-grained soils are moisture-sensitive and may cause difficulties with compaction and workability, and may result in low productivity.

    b. During dry summer and fall months, the near-surface fine-grained soils may require additional grading effort (discing, mixing, or other means) to attain proper moisture content.

2. Aggregate Base (Crushed Aggregate Base, Drain Rock or Base Rock): Material meeting Aggregate Base and Shoulders requirements as specified in the current edition of the 2025 Oregon Standard Specifications for Construction, Part 00600 – Bases, Section 00641 Aggregate Subbase, Base and Shoulders, sub section 00640.10 Materials. Project shall utilize aggregate composition the satisfying ¾"-0 requires within the standard details.

3. Trench Zone Backfill (Class A or B): Material meeting Trench Backfill requirements as specified in the current edition of the 2025 Oregon Standard Specifications for Construction, Part 00400 – Drainage and Sewers, Section 00405 Trench Excavation, Bedding and Backfill, sub section 00405.14 Trench Backfill

4. Crushed Stone Backfill (Bedding Material): Material meeting Pipe Zone Material as specified in the current edition of the 2025 Oregon Standard Specifications for Construction, Part 00400 – Drainage and Sewers, Section 00405 Trench Excavation, Bedding and Backfill, sub section 00405.13 Pipe Zone Material

5.

2.2 UNSUITABLE MATERIALS

A. Unsuitable material include the materials listed below:

1. Soils which, when classified under ASTM D 2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System), fall in the classification of Pt, OH, CH, MH, or OL.

2. Native soils with rocks greater than 6 inches in diameter.

3. Soils which cannot be compacted sufficiently to achieve the density specified for the intended use.

4. Materials that contain hazardous or designated waste materials including petroleum hydrocarbons, pesticides, heavy metals, and any material which may be classified as hazardous or toxic according to applicable regulations.

5. Soils that contain greater concentrations of chloride or sulfate irons, or have a soil resistively or pH less than the existing on-site soils.

PART 3 - EXECUTION

3.1 PREPARATION

A. Notify Engineer prior to starting any grading operations.

B. Identify required lines, levels, contours and datum.

C. Identify and flag surface and aerial utilities, known underground utilities locations.

D. Maintain and protect existing utilities which pass through the work area.

3.2 SITE CONTROL

A. Unfavorable Weather: Do not place, spread, or roll any fill material during unfavorable weather conditions. Do not resume operations until moisture content of material is satisfactory.

B. Flooding: Provide berms or channels to prevent flooding or saturation of subgrade. Promptly remove all water collecting in depressions.

C. Softened Subgrade: Where soil has been softened or eroded by flooding or placement during unfavorable weather, remove all damaged areas and recompact as specified for fill.

D. Dust Control: Use all means necessary to control dust on and near the work and on and near all off-site borrow areas as specified in Section 01 50 00 – Temporary Facilities and Controls. Thoroughly moisten all surfaces as required to prevent dust from being a nuisance to the public, neighbors, residents, properties, and concurrent performance of other work on the site.

E. Noise Control: Use equipment that is equipped with adequate noise attenuation devices.

3.3 OFF-SITE IMPACTS

A. Comply with all traffic and hauling requirements of the State and County.

B. Provide all signing, flagmen, or other special traffic control required to provide for the safety of the public.

C. Use only vehicles approved for highway use and comply with all load requirements.

D. Provide wheel cleaning as required to minimize the tracking of materials onto public roadways.

3.4 PROTECTION

A. Protect trees and other features to remain as a portion of the final landscaping or project.

B. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from equipment and vehicular traffic.

C. Protect above and below grade utilities which are to remain.

D. Notify Engineer of unexpected subsurface conditions and discontinue affected work in the area until notified to resume work.

E. Protect bottom of excavations and soil adjacent to and beneath foundation from frost.

F. Grade excavation top perimeter to prevent surface water runoff into excavation.

3.5 EXCAVATION

A. Excavate all cut areas to the grades shown on the plans.

B. Excavate all areas that have excessive moisture content and cannot be compacted to the required densities.

C. Correct unauthorized excavation at no cost to the Owner.

D. Excavate or scarify and aerate soils with excessive moisture content, and allow to dry.

3.6 SUBGRADE PREPARATION

A. Excavate to subgrade elevation.

B. In the presence of a materials testing company, thoroughly proofroll with a loaded tandem-axle dump truck with a minimum weight of 20 tons, or 40-ton static roller.

C. Areas where soft or disturbed conditions are identified, excavate, remove and dispose of unsuitable soft spot material. If the material is suitable except for excessive moisture content, scarify and dry the material to the acceptable moisture content, or replace with Engineer approved materials, and recompact to the density of the material to place over the area. Soft sport repair shall be incidental to the Work. No special payment will be made for soft spot repair.

D. The Contractor’s materials testing company to submit a subgrade inspection report noting the means and methods used to proofroll the subgrade and any corrections or repairs made.

3.7 PREPARATION OF FOUNDATION

A. See requirements as shown in the Drawings of the excavation sections

3.8 IMPORTED STRUCTURAL FILL

A. Compact Aggregate Subbase and Base, and common fill material to at least 95% of the maximum dry density as determined in accordance with ASTM D1557. Maximum loose lift thickness shall not exceed 8 inches.

B. Granular material with more than 30% by weight retained on the 3/4-inch sieve shall be compacted to a minimum 75 percent of maximum index density as determined by ASTM D4253 and D4254. Compact drain rock material with four passes of a walk-behind vibratory plate compactor in 8-inch maximum lift thicknesses.

3.9 DISPOSAL OF WASTE SOIL

Excess or waste-excavated soils may be disposed of on-site at a location chosen by the Owner. Contractor shall request disposal location from Engineer and Owner before disposing of any waste material. Waste material to be spread evenly, not left in stockpiles

3.10 QUALITY CONTROL

A. Material & Compaction Testing: All soils testing of samples submitted by the Contractor will be done by an independent testing laboratory mutually agreed upon by Contractor and Owner and at the Contractor’s expense. If tests indicate work does not meet specific compaction requirements, remove work, replace, and retest at the Contractor’s expense.

1. Qualifications of testing company

a. Basic requirements of ASTM E 329, “Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials as Used in Construction” and ASTM D 3666, “Standard Specification for Minimum Requirements for Agency Testing and Inspecting Bituminous Paving Materials”, as applicable.

b. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

2. Frequency of Compaction Tests

   a. Curbs and sidewalks: In horizontal plane, test at start with subsequent tests a maximum of every 250 feet. At landscape islands test each island at one location. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change. Perform a minimum of two (2) tests at finished grade.

   b. Parking and vehicle areas, roadways: In horizontal plane, test each backfill area with subsequent test for every 2,500 square feet of backfill surface area. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change.

   c. Concrete slabs for buildings, patios, concrete plaza, and entry slabs: In horizontal plane, test each backfill area with subsequent test for every 1,000 square feet of backfill surface area. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change.

   d. Linear foundations and footings: In horizontal plane, test at start with subsequent tests a maximum of every 100 feet, and where elevation changes between adjacent footings. At every horizontal location, obtain one test at subgrade. Perform subsequent tests every 12 inches of compacted depth and at top of backfill or when materials or procedures change. Perform a minimum of two (2) tests at finished grade.

3.11 TOLERANCES

A. Finished grade of graded areas shall meet the following requirements:

   1. In paved areas including roadways, sidewalks, parking lots, etc., plus or minus 0.10 feet from the grade shown on the plans.

   2. Building pads, plus or minus 0.05 feet from the grade shown on the plans.

   3. In landscaped areas or similar areas, plus or minus two (2) inches.

   4. Differential grades between walking surfaces shall not exceed 1/4-inch.

   5. Landscape finish grade adjacent to concrete walks shall be minus 1-inch from walking surface elevation.

END OF SECTION 31 00 00

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SECTION 31 05 19.13 - GEOTEXTILES FOR EARTHWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and install geotextiles as specified herein and as indicated on the drawings.

1.2 SUBMITTALS

A. Certificates: Submit geotextile manufacturer's certified test results showing that the geotextiles meet the requirements of these specifications.

B. Submit manufacturer's installation instructions and maintain copy at the jobsite.

PART 2 - PRODUCTS

2.1 GENERAL

A. Geotextiles shall be composed only of long chain polymeric (at least 85% polyolefins, polyesters or polyamides) filaments or yarns oriented into a stable network that retains its relative structure (including selvages) during handling, placement, and design service life.

2.2 DRAINAGE GEOTEXTILE

A. Drainage Geotextile fabric shall be filter fabric meeting requirements as specified in the current edition of the 2025 Oregon Standard Specifications for Construction, Part 00300 – Roadwork, Section 00331 Subgrade Stabilization, Sub section 00331.10 Materials. Product shall be installed in accordance with Part 0300 – Roadwork, Section 00350 Geosynthetic Installation, Sub Section 00350.41 Geotextile Installation Requirements

PART 3 - EXECUTION

3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect geotextiles against damage and excessive sunlight during shipment and storage.

3.2 EXAMINATIONS

A. Verify that surfaces upon which the geotextile is to be installed are graded to a smooth, uniform condition free of obstructions, depressions, and debris.

3.3 GENERAL PLACEMENT REQUIREMENTS

A. Spread geotextile immediately ahead of the covering operation. Do not drag the geotextile on the ground or mishandle in any way. Place the geotextile loosely and without wrinkles so that placement of the overlying material will not tear the geotextile.

B. Place the cover material on the geotextile in such a manner that a minimum of 12 inches of material will be between the equipment tires or tracks and the geotextile at all times.

C. Cover the geotextile with the specified cover material as soon as possible. Geotextiles which have not been ultraviolet stabilized shall not remain uncovered for longer than 7 days. Ultraviolet stabilized materials shall not remain exposed for longer than 30 days.

3.4 PLACEMENT IN SOFT GROUND

A. Where geotextiles will be placed over soft ground, construction vehicles shall not drive directly on the geotextile material. End-dumping the cover material directly on the geotextile will not be permitted. Under no circumstances shall cover material be dropped on unprotected geotextile from a height greater than 3 ft. above the surface of the geotextile.

B. Limit compaction of the first lift above the geotextile over soft ground to operation of placing and spreading equipment only. No sheep foot type equipment will be allowed on the first lift. Subsequent lifts will be closely observed during compaction. If any foundation failures occur during compaction operations, lightweight compaction equipment shall be used. Use pegs, pins, or the manufacturer’s recommended methods as needed to hold the geotextile in place until the specified cover material is placed. Seams that have separated will require the removal of fill and the required overlap reestablished. Repair at no cost to the Owner.

3.5 REPAIRS

A. Should the geotextile be torn, punctured or the overlaps joints disturbed, as evidenced by visible geotextile damage, subgrade pumping, intrusion, or pad or roadbed distortion, remove the backfill around the damaged or displaced area and repair or replace the damaged geotextile at no cost to the Owner.

B. The repair shall consist of a patch of the same type of geotextile placed over the ruptured area. The patch shall overlap the existing geotextiles a minimum of 2 feet from the edge of the rupture.

3.6 JOINT OVERLAP

A. Drainage Application: Overlap the geotextile a minimum of 12 inches at all joints. In trenches less than 12 in. wide, overlap shall be the width of the trench. In channels or areas where water will flow the overlap shall be from the bottom of the slope to the top to prevent water from flowing under the overlap.

END OF SECTION 31 05 19.13

SECTION 31 11 00 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide removal of trees, stumps, shrubs, grass and other vegetation within the construction limits to permit construction of the new facilities.

B. Protect the adjoining properties from damage during clearing and grubbing operations.

1.2 REFERENCE STANDARDS

A. Oregon Standard Specifications for Construction, 2024 Edition

B. ODOT Highway Design Manual (HDM), 2025 Edition

C. ODOT Standard Drawings, current edition

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 CLEARING AND GRUBBING

A. Clearing and grubbing shall extend to no more than 3 feet outside of the construction limits. The clearing and grubbing operation shall be conducted in a manner which will not damage any vegetation outside of the clearing and grubbing limits. All brush, roots, and other debris within the grubbing limits shall be removed to a depth of 6". Completely remove stumps and other debris protruding through the subgrade surface. The Contractor shall chop all brush and debris resulting from the Clearing and Grubbing operation and haul to a disposal site located by the Contractor off-site. Burning of debris on-site will not be allowed.

B. While conducting clearing and grubbing, protect all trees, shrubs, vegetative growth, and fencing that are not designated for removal.

3.2 STRIPPING

A. Areas within the limits of the project shall be stripped to remove topsoil containing organic material before construction begins over such areas. The topsoil shall not be used in construction of onsite fills or trench backfills. The topsoil shall be hauled to a disposal site located by the Contractor off-site.

END OF SECTION 31 11 00

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SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide, install, and remove material and equipment necessary for removing water during excavation, backfill, and compaction for earthwork, structures, and piping. Dewater all utility trenches and structural excavations such that Work is performed in dry conditions. Maintain removal of water until backfilling is complete. Dewatering of trenches and other excavations is considered incidental to the construction of the Work.

B. Maintain groundwater levels at a minimum of 2 feet below the proposed construction excavations.

1.2 SUBMITTALS

A. Submit for approval a site-specific dewatering plan, sealed by a professional engineer, based on the location and configuration of site improvements. Evaluate the site conditions, potential dewatering options, and considerations relative to the dewatering design and equipment, and construction approach. Discharge into the wastewater treatment system is not permitted. Include the following minimum components in the plan:

1. Detailed shop drawings showing the locations of all excavations, shoring, and temporary dewatering equipment.
2. Detailed shop drawings showing the installation of temporary dewatering equipment.
3. Pumping and piping capacity.
4. Location of discharge and permit to discharge to any offsite facilities or irrigation system.
5. Sediment control devices.
6. Redundant pumps.
7. Power source and routing.

1.3 PERMITTING

A. The dewatering plan shall be in accordance with all industry standard best management practices and Oregon DEQ requirements and shall be developed using sound engineering techniques.

B. Dewatering activities shall protect stormwater quality and be done in a manner that mitigates sediment and pollutant migration.

PART 2 - PRODUCTS NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Contractor is responsible for all necessary equipment to implement and maintain the dewatering operations throughout the construction process. This includes but is not limited to:

1. Providing temporary power as necessary
2. Pumping equipment
3. Competent workmen for the operation of the pumping equipment
4. Temporary piping
5. Sedimentation basins
6. Standby/redundant equipment

END OF SECTION 31 23 19

SECTION 31 23 33 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide all excavation of trenches, bedding, and backfilling work for construction of piping following the latest edition of the 2025 Oregon Standard Specifications for Construction

B. Excavation of trenches shall include all material excavated or removed regardless of type, character, composition or condition of the material.

1.2 SUBMITTALS

A. Submit samples, in accordance with Section 01 33 00 – Submittal Procedures, of all materials proposed to be used in work. Sample sizes shall be determined by the testing laboratory.

1.3 DEFINITIONS

A. Pipe Zone: That portion of the vertical trench cross-section lying between a plane below the bottom surface of the pipe and a plane 6 inches above the top of the pipe.

B. Trench Zone: The portion of the vertical trench cross-section lying between the Pipe Zone and a point 18 inches below the finished grade.

C. Final Backfill: The portion of the vertical trench cross-section within 18 inches of finished grade.

D. Pipe Bedding: Material placed below the pipe and in the Pipe Zone.

E. Springline: The center axis of the pipe.

F. Trench Backfill: Material placed from the top of the Pipe Zone to finished grade.

G. Trench Foundation Material: Material placed below the Pipe Bedding.

PART 2 - PRODUCTS

2.1 PIPE BEDDING MATERIAL

A. Pipe bedding shall consist of crushed stone backfill (Bedding Material) material per Section 31 00 00 – Earthwork, 2.1 Suitable Fill and Backfill Material Requirements.

2.2 TRENCH BACKFILL MATERIAL

A. Excavated trench material may be used as follows:

1. Excavated trench material shall be free from cinders, ashes, refuse, organic and frozen material, boulders with any dimension exceeding 8 inches, or other unsuitable material per Section 31 00 00 - Earthwork.

2. Material with excessive or deficient moisture content will not be considered as unsuitable if the moisture content can be adjusted to a level that allows obtaining compaction.

3. Imported backfill material shall conform to imported Trench Zone Backfill Class A or B) per Section 31 00 00 – Earthwork, 2.1 Suitable Fill and Backfill Material Requirements

2.3 FOUNDATION STABILIZATION

A. Trench foundation material shall consist of foundation stabilization backfill material per Section 31 00 00 – Earthwork,3.7 Preparation of Foundation

2.4 IDENTIFICATION TAPE AND LOCATING WIRE

A. Locating wire shall be No. 12 AWG insulated cooper locating wire with 1/64” PVC insulation.

B. Identification tape shall be 3-inches wide, 4 mil polyethylene vinyl. Tape text and color shall meet the following requirements

Pipe Contents	Text	Color
Potable Water	“CAUTION – WATER LINE BURIED BELOW”	Blue
Pressure Sewer	“CAUTION – SEWER LINE BURIED BELOW”	Green
Reclaimed Water	“CAUTION – RECLAIMED WATER LINE BURIED BELOW”	Purple
Pressure Irrigation	“CAUTION – IRRIGATION LINE BURIED BELOW”	Purple
Gas	“CAUTION – GAS LINE BURIED BELOW”	Yellow
Telephone	“CAUTION – PIPE LINE BURIED BELOW”	Yellow
Cable TV	“CAUTION – PIPE LINE BURIED BELOW”	Yellow
Electric	“CAUTION – ELECTRICAL LINE BURIED BELOW”	Red

PART 3 - EXECUTION

3.1 EXISTING UTILITIES:

A. The Contractor shall be fully responsible for any and all damage to existing or constructed utilities, and shall repair damages in accordance with utility owner’s requirements at no additional cost to the Owner. It shall be the Contractor’s responsibility to coordinate and notify all affected utility owners. Call 811 Dig-Line before commencing construction.

1. Parallel Utility Support: Work associated with parallel utility support and utility crossings shall be incidental to the work unless a specific bid items is provided for parallel utility support.

2. Utility Crossing Support: All utilities that interfere with the construction of the trenching and pipe installation shall be temporarily supported in accordance with the utility owner's requirements. Work associated with utility crossings support shall be incidental to the work unless a specific bid items is provided for utility crossing support.

3. All crossing utilities shown on the plans and marked by Dig-Line shall be vertical and horizontally located, in a non-destructive manner, prior to construction to verify pipe elevation, materials, and diameter. This information shall be provided to the Engineer for evaluation of conflicts prior to construction. All potholes shall be backfilled immediately after obtaining information.

3.2 TRENCH EXCAVATION

A. Trenches shall be excavated to lines and grades shown on the drawings, with a minimum width at the top or crown of the pipe not to exceed the outside diameter of the pipe plus 2'. In the event the Contractor should over excavate in width or depth without the Engineer's approval, they shall provide pipe bedding for the full length of the over excavation. No special payment will be made for work caused by over excavation.

B. Trench shall be kept free from water at all times to facilitate fine grading, proper laying and joining of pipe, and prevention of damage to completed joints.

C. If the trench bottom is disturbed during excavation, compact trench bottom to 95% maximum density of the standard proctor, ASTM D698.

D. The Contractor shall conduct trench operations in such a manner as to provide adequate safety precautions for workmen, adjacent property, or the public at all times by use of adequate sheeting, shoring, or bracing to sustain stability of the trench floor and walls. The Contractor shall furnish, place, and maintain such shoring as may be required to support sides of the trench. Costs of shoring and bracing shall be considered incidental to trench excavation and backfill.

3.3 PIPE BEDDING

A. Place bedding in layers no thicker than 6 inches. Allow for bedding depth around pipe bells. Place bedding at least 4 inches below the pipe and 6 inches above the pipe.

B. Shovel slice and tamp to ensure that the bedding material is firmly placed.

C. Following placement of pipe, place additional bedding material up to the springline of the pipe. Shovel slice and tamp to ensure that the bedding material fills in and supports the pipe haunch area.

D. In 6 inch lifts, place additional bedding layers from the pipe springline to 6 inches above the pipe.

3.4 TRENCH BACKFILL

A. All backfill material shall be placed in layers not to exceed 8-inch maximum loose lift thickness for native material and 12-inch maximum loose lift thickness for imported aggregate backfill.

B. The entire trench shall be compacted to 95% maximum density of the standard proctor as determined by ASTM D-698.

C. Trenches under buildings and structures shall be compacted, the entire depth, to 95% maximum density of the modified proctor determined by ASTM D1557.

3.5 IDENTIFICATION TAPE AND LOCATING WIRE PLACEMENT

A. Unless indicated otherwise, attach locating wire to the crown of all buried pipelines using electrical tape, except gravity irrigation, sanitary sewer, or storm sewer mains having visible manholes or clean-out structures at all angle points. Provide 12 inches of slack wire above ground at each location of valve or wire box.

B. Unless indicated otherwise, identification tape shall be placed above all buried pipelines, 18" - 24" above the crown of the pipe, except gravity irrigation, sanitary sewer, or storm sewer mains having visible manholes or clean-out structures at all angle points.

C. Unless indicated otherwise, identification tape shall be placed above all buried pipelines that are installed with locating wire. Identification tape shall be placed 18" - 24" above the crown of the pipe.

3.6 QUALITY CONTROL

A. Material & Compaction Testing: All soils testing of samples submitted by the Contractor will be done by a testing laboratory mutually agreed upon by Contractor and Owner and at the Contractor's expense. If tests indicate work does not meet specific compaction requirements, remove work, replace, and retest at the Contractor's expense.

1. Qualifications of testing company

    a. Basic requirements of ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials as Used in Construction" and ASTM D 3666, "Standard Specification for Minimum Requirements for Agency Testing and Inspecting Bituminous Paving Materials", as applicable.

    b. Calibrate testing equipment at reasonable intervals by devices of accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants.

2. Frequency of Compaction Tests

    a. Test section shall be a test at 2-feet above top of pipe and every 1-foot lift thereafter and at the top of the trench backfill.

b. Two (2) test sections, at different locations for every trench less than 300 feet in length, but not less than once per day.

c. One (1) test section per every 300 feet of additional trench and at locations where materials or construction procedures change, but not less than once per day.

3.7 CLEANUP

A. Surplus excavated material or stripped material not salvaged as topsoil and excavated material not meeting the requirements for backfill shall become waste. All waste material shall be disposed of by the Contractor.

END OF SECTION 31 23 33

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SECTION 32 12 16 – ASPHALT PAVING

1.1 WORK INCLUDED

A. This work consists of constructing minor hot mixed asphalt concrete (MHMAC) pavement to the lines, grades, thicknesses, and cross sections shown or established. Provide MHMAC in accordance with the 2025 Oregon Standard Specifications for Construction, Section 00744 – Minor Hot Mixed Asphalt Concrete (MHMAC) Pavement, as modified herein.

1.2 REFERENCE STANDARDS

A. 2025 Oregon Standard Specifications for Construction, Oregon Department of Transportation, (ODOT).

1.3 SUBMITTALS

A. Submit the proposed job mix formula and supporting data to the Engineer for review at least 10 calendar days before anticipated use.

1.4 QUALITY CONTROL

A. The mixture will be accepted by visual inspection by the Engineer. If the mixture is considered suspect, the Engineer may verify that the mixture is within tolerances and limits of 00744.14. When requested, obtain samples according to appropriate procedures in the Oregon Department of Transportation, Construction Manual, Manual of Field Test Procedures (MFTP) under the observation of the Engineer at a frequency established by the Engineer. The Engineer will test for gradation, asphalt content, moisture, and recycled asphalt paving (RAP) content (if applicable) according to procedures specified in 00744.14 and the MFTP. Take corrective action when testing shows that MHMAC is not within the tolerances and limits of ODOT Section 00744.14.

PART 2 - PRODUCTS

2.1 MINOR HOT MIXED ASPHALT CONCRETE (MHMAC)

A. Asphalt Cement – Use PG 64-22.

B. Broadband Limits – 1/2" Dense.

C. Job Mix Formula – Level 2.

2.2 EQUIPMENT

A. Equipment in accordance with ODOT Section 00744.24.

PART 3 - - EXECUTION

3.1 CONSTRUCTION

A. Construction in accordance with ODOT Section 00744.

END OF SECTION 32 12 16

SECTION 32 13 13 - CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish all labor, materials, and equipment required for concrete work including forming, reinforcing steel, anchor bolts and site concrete.

B. Anchor bolt templates to be supplied by light pole manufacturer.

1.2 JOB CONDITIONS

A. In hot and cold weather, comply with the requirements of ACI 305 and 306.

B. Do not place concrete on frozen ground. Unless adequate protection is provided, do not place concrete during rain, sleet, or snow.

C. Do not allow rain water to increase mixing water or damage surface finish.

D. When temperature of surrounding air is expected to be below 40°F, during placing, or within 24 hours thereafter, do not allow concrete temperature to drop below 55°F, for sections less than twelve inches (12”) in any dimension, or 55°F, for any other sections.

1. Keep the temperature of concrete, when placed, under 80°F, to preclude loss of slump, flash set, or cold joints.

2. When temperature of steel is greater than 120°F, spray steel forms and reinforcement with water just prior to placing concrete. Do not allow any water to pond in forms.

1.3 SUBMITTALS

A. Submit mix design to be used for each class of concrete.

B. Submit location of materials source, admixtures to be used, and other related data.

C. Submit test reports showing suitability of aggregates used in concrete mixes.

D. Indicate sizes, spacing, locations of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

E. Control joint placement plan.

F. The Contractor shall pay any material testing expenses associated with material submittals.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: Use Portland cement conforming to the requirements of ASTM C 150 Type II for low alkali cement.

B. General Admixtures: Admixtures, other than air-entraining agents, may be used when the type and amount to be used are approved. Calcium chloride will not be allowed as an admixture.

C. Air-Entraining Agents: Use air-entraining agents conforming to the requirements of ASTM C 260. Air entraining admixtures shall be added to the mixing water.

D. Water Reducing Agents: Water reducing admixtures may be used to increase workability of the concrete when approved by the Engineer. Use water reducing admixtures conforming to ASTM C 494.

E. Water: Use potable water for mixing concrete.

F. Coarse Aggregate: Use coarse aggregate that consists of gravel, crushed slag, crushed stone or other approved inert materials, composed of hard, strong and durable particles, free of injurious coatings, and conforming to the requirements of ASTM C 33, except as modified herein.

1. Use only aggregates that include deleterious substances not exceeding the following:

	Percent (by weight)
Soft Fragments	0.20
Coal and Lignite	0.30
Clay Lumps	.30
Other Deleterious Substances	2.0
Minus 200 Material	1.75

2. Use coarse aggregate meeting the following gradations when tested in accordance to the requirements of ASTM C 136.

	Percent Passing (by weight)				
Course Aggregate Size	1"	3/4”	3/8"	No. 4	No. 8
3/4” to No. 4	100	90-100	20-55	1-10	0-5

G. Fine Aggregate: Use aggregate of natural sand or other approved inert materials composed of hard, strong, and durable particles conforming to the requirements of ASTM C 33 except as modified herein.

1. Use only aggregates that include deleterious substances not exceeding the following:

	Percent (by weight)
Clay Lumps	.50
Coal and Lignite	.30
Other Deleterious Substances	2.00
Minus 200 Material	1.75

2. Moisture content of fine aggregate shall not exceed 8 percent.

3. Use fine aggregate that is uniformly graded from coarse to fine within the following gradation, when tested in accordance to the requirements of ASTM C 136.

Sieve Size	Percent Passing (by weight)
3/8"	100
No. 4	95 100
No. 8	80 100
No. 16	50 85
No. 30	25 60
No. 50	10 30
No. 100	2 10

H. Patch Mortar: Make patching mortar using portland cement and sand to form a workable mortar suitable for filling defects in concrete surfaces.

1. Mortar: 1 part portland cement to 2 parts sand by damp loose volume.

2. Mix white and gray portland cement as required to match surrounding concrete.

3. Keep mixing water to a minimum.

4. Mix patching mortar in advance and allow to stand with frequent manipulation, without addition of water, until it has reached stiffest placeable consistency.

I. Curing Compounds: Use curing compounds that meet the requirements of ASTM C 309.

J. Sealer: Use Conspec Silane 40 or approved equal.

K. Joint Sealant: Use Sikaflex 1c SL or approved equal. Use Sonolastic Polysulfide Sealant or approved equal for submerged in water applications. Color to match that of concrete.

2.2 REINFORCING STEEL AND WELDED WIRE MESH

A. Reinforcement Steel: ASTM A 615 Grade 60

B. Welded Wire Fabric: 12x12 W5.4/5.4

2.3 FORMING MATERIALS

A. Smooth Forms: Faced with material which will produce smooth, hard, uniform texture on concrete.

B. Form accessories that are to be partially or wholly embedded in concrete are to be a commercially manufactured type:

1. Use form ties constructed so that ends or end fasteners can be removed without causing appreciable spalling of concrete faces.

C. Form Release Agent: Colorless material which will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

D. Contraction Joint Material: Wood strips; maximum possible length.

E. Dobie Blocks: Commercial grade blocks to support horizontal reinforcement.

2.4 READY MIX CONCRETE

A. Furnish commercial ready mix shall have the following properties:

Construction Type	Minimum Compressive Strength	Minimum Cement Content	Maximum Water / Cement Ratio	Air Entrainment Percentage	Maximum Slump
Light Pole, Sign, Fence Foundations	3,000 psi	560 LB/CY	0.49	6.5 ±1.5	4 ±1
Curbs, Gutters	4,000 psi	560 LB/CY	0.44	6.5 ±1.5	2.5 ±1
Concrete Pavement	4,000 psi	560 LB/CY	0.44	6.5 ±1.5	4 ±1

Construction Type	Minimum Compressive Strength	Minimum Cement Content	Maximum Water / Cement Ratio	Air Entrainment Percentage	Maximum Slump
Retaining Walls	4,000 psi	560 LB/CY	0.44	6.5 ±1.5	4 ±1
Walking Surfaces – Sidewalks, Patios, Driveways, Stairs	4,500 psi	564 LB/CY	0.44	6.5 ±1.5	4 ±1
Walking Surfaces with Reinforcement – Sidewalks, Patios, Driveways, Stairs	5,000 psi	611 LB/CY	0.40	6.5 ±1.5	4 ±1

B. Fly ash may be used to replace a portion of the Portland cement in the concrete mix. The fly ash used shall not exceed twenty five percent of the total cement material in the mix. The cement material in the mix includes both Portland cement and fly ash. Fly Ash shall be Class F conforming to AASHTO M 295 with the additional requirement that the available alkalies in the fly ash shall not exceed 2 percent.

C. Ready-mixed concrete shall conform to the provisions in ASTM C 94 regarding batching, mixers and agitators, mixing and delivery, inspection, consistency and air content, and certification of batches.

2.5 TRUNCATED DOMES

A. Detectable warning domes shall be pre-manufactured units integrally cast into concrete ramp. The detectable warning surface shall be cast-iron Duralast, or approved equal. See Section 32 17 26 for more information.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall not incorporate ready mix concrete into the work that does not meet these specifications. The ready mix concrete that is in non-compliance shall be removed from the project.

3.2 FORMING

A. Make forms sufficiently tight to prevent loss of cement paste. Arrange facing material orderly and symmetrical, keeping number of seams to a practical minimum.

B. Place chamfer strips in corners of forms to produce beveled edges on permanently exposed surfaces.

C. To maintain specified finish tolerances, chamfer formwork to compensate for anticipated deflections.

D. Provide positive means of adjustment using wedges or jacks, or shores and struts, and take up all settlement during concrete placing operation.

E. Securely brace forms against lateral deflection.

F. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close ports with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

G. At construction joints, overlap forms over hardened concrete at least six inches (6"). Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain true surface.

H. Anchor formwork to shores or other supporting surfaces or members so that upward or lateral movement of any part of formwork system is prevented during concrete placement.

I. Anchor formwork to shores or other supporting surfaces or members so that upward or lateral movement of any part of formwork system is prevented during concrete placement.

J. Position expansion joint material and other embedded items accurately and support against displacement.

3.3 REINFORCING

A. Place all reinforcement in the exact position shown on the plans and approved shop drawings and secure in position during the placing and compacting of concrete. Wire bars together with No. 16 gage wire with ties at all intersections except where spacing is less than 12 inches in each direction, in which case tie alternate intersections.

B. Place dobie blocks to maintain clearance from subgrade.

3.4 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

B. Install accessories in accordance with manufacturer's instructions, level and plumb with templates where necessary. Ensure items are not disturbed during concrete placement.

3.5 CONVEYING CONCRETE MIX

A. Unless specifically approved by the Engineer prior to placement of ready mix concrete, all concrete mix shall be placed and discharged completely within 90 minutes of the introduction of water into the mix or before the drum has been revolved 300 revolutions, whichever comes first.

B. Handle concrete from mixer to location of final placing as rapidly as practicable by methods which prevent segregation or loss of ingredients, and assure that quality is maintained.

C. Use only equipment conforming to ASTM C 94.

D. Use only approved pumping equipment that is rated for the lift and the capacity required for placement.

1. Control pneumatic placement to prevent segregation.

2. Loss of slump in pumping or pneumatic conveying equipment shall not exceed two inches (2”).

3. Do not use aluminum or aluminum alloy pipes.

E. Consolidate concrete using internal vibrators in accordance with ACI 309 to eliminate rock pockets, voids, and honeycombing.

F. Do not place concrete that has exceeded 90 minutes after water introduction OR 300 drum revolutions, unless a hydration stabilizer has been approved in writing by the Engineer.

3.6 TRUNCATED DOMES

A. Place truncated domes in fresh concrete in accordance with manufacture’s recommendations.

3.7 CONTROL JOINTS

A. For flatwork, place control (contraction) joints of the type indicated in the plans prior to concrete curing.

B. Install joints spaced no more than 24 times the slap thickness (i.e. a 4-inch thick slab shall have a control joint at least every 96-inches = 8-feet). Contraction joints should be placed to produce panels that are as square as possible and never exceeding a length to width ratio of 1 ½ to 1

C. Joint depth shall be at least 25% of slab depth.

D. Tooled joints shall be installed using a grooving tool. Contraction joints may be tooled into the concrete surface at the time of placement. Joints may be tooled into the surface (first pass) prior to the onset of bleeding or immediately with the first pass of the floating operation.

E. Sawcut joints between 6-12 hours after finishing concrete, unless specifically approved otherwise by the engineer. Sawcut as soon as the concrete is hard enough to withstand the energy of sawing without raveling or dislodging aggregate particles, and that the edges abutting the cut do not chip from the saw blade.

3.8 REMOVAL OF FORMS

A. Formwork for columns, walls, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.

3.9 FINISHES

A. Provide formed concrete walls to be left exposed with Sacked Finish.

1. Point and Patch: Patch defects, chip or rub off fins exceeding one-quarter inch (1/4) in height with Patch Mortar. Patch tie holes and defects and remove fins completely. When surface texture is impaired and form joints misaligned by more than one-eighth (1/8) inch, grind or bushhammer.

2. Sacked Finish: Remove forms and perform necessary patching as soon after placement as possible. Finish newly hardened concrete no later than the day following form removal. Wet surfaces and rub with carborundum brick or other abrasive until uniform color and texture are produced. No cement grout to be used other than cement paste drawn from concrete by rubbing process.

B. Concrete flatwork shall not be trowelled, use screed, float, and broom.

C. Stairs to receive a light broom finish parallel to the nose of the tread. And shall receive nose end treatment as shown in the plans.

D. Sidewalks to receive a light broom finish perpendicular to the direction of travel.

E. Patios to receive light broom finish.

F. Curbs and Gutter to receive light broom finish parallel to flow line of gutter.

G. Pedestrian ramps to receive a light broom finish perpendicular to the direction of travel.

H. Light pole, sign, fence foundations to receive light broom finish.

3.10 CURING AND PROTECTION

A. To preserve moisture in unformed concrete surfaces, apply one of the following immediately after placement and finishing.

1. Continuous mist spray.

2. Waterproof sheet materials, ASTM C 171.

3. Curing compound, ASTM C 309. Apply in accordance with recommendations of manufacturer immediately after water sheen has disappeared. Do not use on any surface against which additional concrete or other material is to be bonded or adhesively applied, unless it is proven that curing compound will not prevent bond, or unless positive measures are taken to remove it completely from areas to receive bonded applications. Provide curing compound compatible with hardener in areas where hardener is to be used.

B. Cure concrete for seven (7) days.

C. When mean daily outdoor temperature is less than 40°F, maintain temperature of concrete between 50°F and 70°F for required curing period.

3.11 SEALER

A. Apply sealer to vertical walls, stairs, and walkways. Apply two coats. Apply in accordance with manufactures recommendations.

3.12 TESTING

A. The Contractor shall obtain and pay for the services of certified materials testing laboratory to perform all sampling and testing of installed materials to assure that the requirements of this specification are met. The Contractor shall pay all testing costs associated with product submittal prior to use in the Work.

B. Perform the following testing:

1. Entrained Air – Test every 30 yards of concrete delivered to the project.

2. Slump – Test every 30 yards of concrete delivered to the project.

3. Strength characteristics – Test every 30 yards of concrete placement with four compressive test cylinders.

4. Temperature: If air temperature is less than 40°F, test every 30 yards of concrete delivered.

C. Test results shall be reported in writing to the Engineer within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

D. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

3.13 ACCEPTANCE

A. The Engineer will base acceptance of the concrete on parameters specified for the given concrete class. The Engineer will base acceptance of strength from the results of 28-day compression strength test results on cylinders made from concrete being placed. The engineer will consider average strength from three companion cylinders as one test.

B. Replace unacceptable concrete at no additional cost to the Owner.

C. The Engineer will use a price adjustment for concrete that does not meet the intended strength, but is allowed to remain in place by the Engineer, in accordance with the following pay factor (PF) reductions:

1. If compression strength is ≥ 100% of required, PF = 1.0.

2. If compression strength is ≥ 95% < 100% of required, PF = 0.90.

3. If compression strength is ≥ 90% < 95% of required, PF = 0.80.

4. If compression strength is < 90% of required, subject to rejection, if allowed to remain in place, the PF will be 0.50.

3.14 SPECIAL WARRANTY

A. Scaled or spalled surfaces exceeding 5% (randomly dispersed or concentrated) per twenty (20) square feet of concrete surfacing area will be considered defective and shall be replaced at the Contractor's expense. The area requiring replacement will be as directed by the Engineer.

END OF SECTION 32 13 13

SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Pavement marking materials and installation.

B. Reflectorized thermoplastic pavement markings.

1.2 SUBMITTALS

A. Submit manufacturer’s certification that paint meet or exceed specified requirements.

1.3 STORAGE AND HANDLING

A. Store paint in an area prepared to contain spills and prevent contamination of storm water.

PART 2 - MATERIALS

2.1 PAVEMENT PAINT (WATERBORNE)

A. Paint to be waterborne with volatile organic compound (VOC) less than 150 g/L.

B. Paint to conform to either the current Idaho Waterborne Traffic Line Paint Specifications or to Federal Specification TT-P-1952-D with the following modifications:

1. Viscosity: 80-95 K.U. per ASTM D 562.

2. Total Nonvolatile Solids: 75% minimum per ASTM D 2369.

3. Scrub Resistance: 1,000 cycles minimum per ASTM D 2486.

4. pH: 9.6 S.U. minimum per (ASTM E 70).

C. Paint Colors: Meet the Federal Test Standard 595 with color chip designations:

1. White: 37875.

2. Yellow: 33538.

3. Blue: OSHA Handicap Blue

2.2 SOURCE QUALITY CONTROL

A. Provide test and inspection reports required of the Manufacturer.

B. Inspect material shipping lists to verify type, class, thickness and marking information required by the Standard for paint.

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Airless spray-type marking equipment, compatible with waterborne paint, and capable of providing a uniform wet film thickness of 15 ± 2 mils.

3.2 EXAMINATIONS

A. Verify that pavement preparation work is complete prior to painting operations.

B. Verify paint delivered to the site meet the requirements of the Contract Documents.

C. Verify pavement has had cure time exceeding 7 days.

D. Verify size and dimension of pre-formed thermoplastic markings.

3.3 PAINT APPLICATION

A. Apply two coats of paint, allow 2 hours of drying time between applications.

B. Pavement surface must be clean and thoroughly dry.

C. Ambient air temperature must be above 50°F.

D. Paint stripes to be uniform and free of erratic waves.

E. Width and location of marking to be as designated in the drawings and be within a tolerance of 5%.

F. Paint stripes must not deviate from the intended alignment by more than 2 inches in 100 feet.

G. Apply paint in accordance with the manufacturer's recommendations.

H. Apply painted pavement markings (school crosswalk text, RR crossings, turn arrows, etc.) using an approved template.

I. Mix paint thoroughly prior to application.

J. Do not thin paint.

K. Apply paint at a rate of not more than 100 square feet/gallon.

L. All pavement markings to conform to the MUTCD.

M. If paint is unagitated for a period greater than 15 minutes, thoroughly agitate until the mixture is homogeneous prior to continuance of application.

END OF SECTION 32 17 23

32 17 26 – TACTILE WARNING SURFACING

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Section includes Specifications for furnishing and installing Cast-in-Place Cast Iron Tactile Warning Surface Tiles with an in-line truncated dome pattern, embedded in all curb ramps and walking surfaces at the locations and to the dimensions shown on the Drawings, in accordance with the Contract Documents and as directed by the Engineer.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 1 Specifications, apply to this Section.

B. Americans with Disabilities Act (ADA) Title 49 CFR Transportation, Part 37.9 Standards for Accessible Transportation Facilities, Appendix A, Section 4.29.2 Detectable Warnings on Walking Surfaces. FHA Memo (5-06-02) titled Truncated Domes. Federal Register Volume 71, No. 209, 49 CFR Part 37 (10-30-06), ADA Standards for Transportation Facilities (11-29-06, DOT): Sections 406, 705, and 810. ADA Standards for Accessible Design – 2010 (9/05/11, DOJ), ADAAG: Sections 705 and 810. Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Rights of Way (7/23/11, Access Board), PROWAG: Sections R208, R304, R305, R308, and R309.

C. American Society for Testing and Materials (ASTM) Test Methods B117, C501, C1028, D543, D570, D638, D695, D790, G151, G155, and E84.

D. American Association of State Highway and Transportation Officials (AASHTO): Test Method AASHTO-H20.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s literature describing products, installation procedures and maintenance instructions. Duralast detectable warnings, or approved equal, cast iron cast in place strips are required.

B. Shop Drawings: Submit Standard Manufacturer Shop Drawings showing all pertinent characteristics of the cast iron Cast-in-Place Replaceable Tactile Warning Surface Tile, including profile, sound on cane contact amplification feature and installation methods.

C. Material Test Reports: Submit current test reports from qualified, accredited independent testing laboratory in accordance with ASTM guidelines and indicating that materials proposed for use are in compliance with specification requirements and meet the properties indicated. All test reports submitted shall be representative of the Cast-in-Place Tactile Warning Surface Tile delivered to the Project.

D. Maintenance Instructions: Submit copies of manufacturer’s specified maintenance practices for each type of Tactile Warning Surface Tile and accessory.

1.4 QUALITY ASSURANCE

A. Provide cast iron Cast-in-Place Tactile Warning Surface Tiles as produced by a single manufacturer with a minimum of five years experience in manufacturing Cast-in-Place Tactile Warning Surface Tiles.

B. Cast-in-Place Tactile Warning Surface Tiles shall meet or exceed the following test criteria using the most current test methods:

1. Compressive Strength: 28,900 psi minimum, when tested in accordance with ASTM D695.

2. Flexural Strength: 29,300 psi minimum, when tested in accordance with ASTM D790.

3. Water Absorption: Not to exceed 0.10%, when tested in accordance with ASTMD570.

4. Slip Resistance: 1.05 minimum wet and 1.18 dry static coefficient of friction when tested in accordance with ASTM C1028.

5. Salt and Spray Performance of Tactile Warning Surface: No deterioration or other defects after 200 hours of exposure, when tested in accordance with ASTM-B117.

6. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, motor oil, calcium chloride, gum, soap solution, bleach, and antifreeze, when tested in accordance with ASTM D543.

7. Abrasion Resistance: 500 minimum, when tested in accordance with ASTM C501.

8. Accelerated Weathering of Tactile Warning Surface when tested by ASTM-G155 or ASTM G151 shall exhibit the following result: ΔE<5.0 at 2,000 hours minimum exposure.

9. Tensile Strength: 11,000 psi minimum, when tested in accordance with ASTM D638.

10. AASHTO-H20 Load Bearing Test: No Damage at 16,000# loading.

11. Freeze/Thaw/Heat: No deterioration when tested in accordance with ASTM C 1026.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Cast In Place Tactile Warning Surface Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings.

B. Storage Facility

1. Store Tiles in an area that is within an acceptable temperature range (40-90 degrees F). In particular, protect sealants from freezing.

2. Maintain Storage Facility in a clean dry condition to prevent contamination or damage to Tiles and incidentals.

1.6 GUARANTEE

A. Tiles shall be guaranteed in writing for a period of ten (10) years from date of Contract's final completion. The guarantee includes manufacturing defects, breakage, and deformation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Composition: Tiles shall be manufactured using cast iron. Truncated domes must contain fiberglass reinforcement within the truncated dome for superior structural integrity and impact resistance. A matte finish will be required on the Tactile Warning Surface for superior slip resistance performance superior to that offered by a gloss finish. Use of Tactile Warning Surface Products employing coatings or featuring layers of material with differing composition, performance, or color properties is expressly prohibited under this Section.

B. Color: Color shall be homogeneous throughout Tile.

1. Natural Patina Finish.

C. Domes: Square grid pattern of raised truncated domes of 0.2"nominal height, base diameter of 0.9" and top diameter of 0.45". The Federal Code of Regulations permits a truncated dome spacing range of 1.6"-2.4." For superior wheelchair, walker and shopping cart mobility, the preferred truncated dome spacing shall have a center-to center (horizontally and vertically) spacing of 2.35", measured between the most adjacent domes on square grid.

D. Configuration: Tile sizes shall be as indicated on the Contract Drawings.

1. The field area shall consist of a non-slip textured surface with a minimum static coefficient of friction of 0.80, wet and dry.

2. At a minimum, Tile thickness shall measure ¼" nominal exclusive of the perimeter minimum 3/8" thick (nominal) by 1" wide flange. The body of the Tactile Warning Surface Tile must consist of a SOLID body for maximum strength and to eliminate the possibility of air entrapment and cracking.

E. Radius Tile:

1. Radius Tile measures 24"x 33.25" and features reverse score lines on each 24" dimension for a 10', 15', and 20' radius condition. The Radius Tile out of the box measures 11' - 6" radius.

2. Truncated domes feature proper dome alignment for a radius application. Radius Tile shall be cut to the appropriate configuration using the reverse score lines as a guide.

F. Truncated Dome Surface of Tile shall be protected with factory installed plastic sheeting for cleanliness during the installation process. Basic Installation Guidelines shall be printed on the plastic sheeting in both English and Spanish for customer convenience.

G. Dimensions: Tiles shall be held within the following dimensions and tolerances:

H. Length and Width: As shown on the drawings

I. Cleaning materials used on site shall have code acceptable low VOC solvent content and low flammability.

J. The Specifications of the concrete, sealants and related materials shall be in accordance with the Contract Documents and the guidelines set by their respective manufacturers.

2.2 MANUFACTURERS

A. Available manufacturers, subject to compliance with these Specifications include, but are not limited to, the following:

1. DURALAST of Marysville, WA (Phone: 360-651-6144, Fax: 360-651-6150, Web Site:https://www.ejco.com/am/en/resource-center/product-briefs/product-duralast-detectable-warning-plate, E: customersupport@ejco.com), or approved equal.

2. Requests for Approved Equal Status must be submitted and approved by the Owner during the Bid Phase of the Project.

2.3 EQUIPMENT

A. Contractor shall provide all tools, equipment and services required for satisfactory installation per manufacturer’s instruction as Incidental Work. Equipment, which may be required include typical mason’s tools, a 2-foot-long level with electronic slope readout, (2) 25-pound weights, and a rubber mallet with a piece of wood for tamping down the Tactile Warning Unit(s).

PART 3 - EXECUTION

3.1 PREPARATION

A. During all concrete pouring and Tile Installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.

B. The physical characteristics of the concrete shall be consistent with the Contract Specifications while maintaining a slump range of 4 - 7 to permit solid placement of the Tile. An overly wet mix will cause the Tile to float. Under these conditions suitable weights such as 2 concrete blocks or sandbags (25 pounds) shall be placed on each Tile.

C. The concrete shall be poured and finished, true and smooth to the required dimensions and slope prior to Tile placement.

3.2 INSTALLATION

A. Contractor will not be allowed to install Tactile Warning Surface Tiles until all submittals have been reviewed and approved by the Engineer.

B. Tile shall be installed per manufacturer’s instructions.

C. To the maximum extent possible, the Tiles shall be oriented such that the rows of in-line truncated domes are parallel with the direction of the ramp. When multiple Tiles regardless of size are used, the truncated domes shall be aligned between the tactile warning surface tiles and throughout the entire tactile warning surface installation.

D. In accordance with the Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Rights of Way (7/23/11, Access Board): Sections 304 + 305), Tactile Warning Surface Tile shall be located relative to the curb line as shown within Sections 304+305 of the Guidelines.

E. The Tiles shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the Tactile Warning Surface Tile is flush to the adjacent concrete surface or as the Drawings indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

F. On Continuous Runs: The Installer shall leave a 1/8” nominal gap between successive Tactile Warning Surface Tiles. As part of the concrete finishing operation, the Installer shall apply ¼” edge treatment around the perimeter of the Tactile Warning Surface Tiles such as Sikaflex 1a or BASF NP1 shall be applied to the edge treatment for a watertight Tactile Warning Surface Tile installation.

3.3 CLEANING AND PROTECTING

A. Protect Tiles against damage during construction period to comply with Tiles manufacturer’s Specifications.

B. During and after the Tile installation and the concrete curing stage, it is imperative that there are no walking, leaning or external forces placed on the Tile to rock the Tile, causing a void between the underside of the Tile and the concrete substrate.

C. Remove Protective Plastic Sheeting from Tile within 24 hours of installation of the Tile. Particularly under hot weather conditions (80 degrees or higher), plastic sheeting will adhere strongly (resulting in difficult removal of same) to Tactile Warning Surface Tile when not removed quickly.

D. If requested by the Project Manager, clean Tiles not more than four (4) days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean Tile by method specified by Tactile Warning Surface Products manufacturer.

END OF SECTION 32 17 26

SECTION 32 91 13 - SEEDING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Furnish and apply seed, including seed bed preparation, fertilizing, seeding, mulch mixture, tackifier, and watering in disturbed areas not covered with aggregate. Spread native topsoil over areas to be seeded.

B. Apply seeding between March 15th – April 30th or October 1st – October 15th. If seed is applied in autumn and does not establish, reseed in spring.

1.2 REFERENCE STANDARDS

A. FS O-F-241 - Fertilizers, Mixed, Commercial

1.3 SUBMITTALS

A. Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

B. The Contractor shall furnish a certificate with each delivery of bulk material delivery, stating source, quantity, and type of material.

C. Certification of Grass Seed: Submit current certification documents and seed test results, including seed purity, germination/viability, and free of noxious weeds.

D. Seed Supplier's License: Submit a copy of the seed supplier's Oregon seed dealer's license.

E. Submit a seed analysis report for each species issued from Association of Official Seed Certifying Agency. The seed analysis report will include:

1. Test Date:

a. Seed germination tested within 8 months of the target seeding date.

b. Seed purity and noxious weed tested within 15 months of the target seeding date.

c. Pure Live Seed (PLS) germination percentage and purity percentage.

1.4 QUALITY ASSURANCE

A. Once approved by the Engineer, deliver seed to the project site unopened, in original and individually packaged bags or containers according to species type (i.e. one species per bag or container). If seed is received in opened packages, packages without certification tags, or packages or containers containing multiple species, the seed will not be approved for use.

B. Field Inspections: Request inspection at least 24 hours in advance of the time inspection is required. Inspection will be required when all specified work, except the maintenance period, has been completed.

C. Maintenance Guarantee: The Contractor shall be responsible for all seeding until acceptance of all work under the Contract.

1. The Work covered by the maintenance and guarantee portions of these specifications consists of providing all replacements of seeded areas, labor, materials, equipment, and supplies and in performing all operations in connection with maintenance and guarantees.

2. The inspection of the seeded areas is independent of the final inspection and maintenance period.

3. Inspection of work will be made at the conclusion of the Contract period. Written notice requesting inspection shall be submitted to the Engineer at least ten (10) days before the anticipated inspection date.

4. Final acceptance of the Work prior to the maintenance guarantee period of the Contract, will be accepted upon written approval by the Engineer, on the satisfactory completion of all work, but exclusive of the replacement of plant material.

1.5 MAINTENANCE

A. The Contractor shall be responsible for protecting seeded areas until final acceptance of all work under the contract.

B. At time of acceptance of the complete project, all seeded areas shall be totally established with no bare spots.

C. Protection: Provide adequate protection to all newly seeded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until acceptance.

D. Replace any materials damaged by its employees or subcontractors.

E. Partial utilization of the project shall not relieve the Contractor of any of the requirements contained in this specification.

F. Maintenance shall include, in addition to the foregoing, cleaning, the repair of erosion, and all other necessary work of maintenance.

PART 2 - PRODUCTS

2.1 GROWING MEDIA

A. All mulch and soil conditioners are required to be certified noxious weed-free by state-accredited laboratories.

B. Topsoil: Natural, fertile, agricultural soil capable of sustaining vigorous plant growth; not in frozen or muddy condition; and free from subsoil, slag, clay, stones, lumps, live plants, roots, sticks, crabgrass, coughgrass, noxious weeds, and foreign matter.

C. Fertilizer: Use commercial fertilizer that is a 16-16-8 grade commercial fertilizer, uniform in composition, dry and free flowing, containing by weight: 16 percent nitrogen, 16 percent phosphorous acid, 8 percent potash. Deliver fertilizer mixed as specified in standard size bags showing weight, analysis, name of manufacturer, as required by State regulations. Store in a weatherproof storage location in such a manner that it will be kept dry and its effectiveness will not be impaired.

2.2 SEED

1. The seed supplier must hold a current and valid Oregon seed dealer's license.

2. Provide seed collected or harvested within 2 years of the targeted seeding date. Provide all seed in pure live seed (PLS) unless otherwise directed.

3. Seed will be true of genus and species.

4. Test all seed for prohibited and restricted noxious weed seed before delivery.

5. Ensure each bag or container of individual seed species has labeling indicating seed classification (genus and species), lot number, purity, germination, percentage of weeds found, percentage of noxious weeds found, and test date.

6. Minimum allowable rates for seed by species as follows:

Material	PLS Rate
All grass seed	0.800
All legume seed	0.785
All native wildflower and forb seed	0.765
Big sagebrush	0.160
Antelope bitterbrush	0.665
Rabbitbrush	0.160
Oregon Grape	0.500
Snowberry	0.580
Woods Rose	0.500

7. To obtain the PLS Rate = purity% x germination% / 100

8. To obtain the bulk seed needed per acre = (PLS lb/acre) / PLS rate

9. For certified or non-certified seed:

   a. Noxious weed seeds prohibited.

   b. Less than 1 percent by weight weeds seeds including restricted noxious weed seed.

   c. Less than 3 percent by weight of allowable cheat, chess, or downy brome seed.

10. Do not use seed which has become wet, moldy, or otherwise damaged prior to use.

11. Provide the following seed blend and bulk rate:

GRASS & NATIVE SPECIES MIX	Lbs/Ac
Bluebunch Wheatgrass (PSSPS)	8 Lbs/Ac
Ephraim Crested Wheatgrass (AGCR)	4 Lbs/Ac
Sheep Fescue (FEOVO)	4 Lbs/Ac
Mountain Home Sandberg Bluegrass (POSE)	8 Lbs/Ac
Western Yarrow (ACMIL)	2 Lbs/Ac
Lewis Blue Flax (LILE)	5 Lbs/Ac
Thickleaf Penstemon (PEPA6)	5 Lbs/Ac
Total	36 Lbs/Ac

2.3 MULCH

A. Supply mulch consisting of straw or grass hay (air dry) or wood fiber.

2.4 TACKIFIER

A. Supply tackifier of an organic, biodegradable, non-polluting, non-volatile, and non-toxic tackifier that is transparent, flexible, water soluble, retains flexibility after curing, and makes a porous lattice-like membrand structure within the upper soil layer.

PART 3 - EXECUTION

3.1 GENERAL

A. Perform seeding during the season(s) specified, except for seeding used as a temporary erosion and sediment control measure. Do not apply on frozen soil.

B. Perform seeding before mulch, tackifiers, or erosion control blanket (if used) installation.

C. Inspect areas within the project site and identify noxious weeds present or which weeds are most likely to be found on the project site and included treatment recommendations. Treat material used as specified throughout the growing season, and up to 2 weeks before transporting to the project site and seeding applications.

D. Use mechanical (drill) seeding on areas with 3H:1V slopes or flatter and areas without excessive rock, gravel, or hardpan soil.

E. Apply fertilizer, seed, and mulch in separate operations, one following the other in this order with the exception that fertilizer may be applied with a fertilizer attachment at seeding time or with water when watering is specified, or as otherwise approved.

F. Perform cultivating, tilling and drill seeding operations in a cross-slope direction (horizontal) and ensure furrows remain open.

G. Use hydroseeding application on areas with slopes steeper than 3H:1V or areas where a mechanical seeder cannot reach. Perform hydro-applications with approved combination of seed, fertilizer, soil amendments, mulch mixtures, mulching, tackifier, and hydraulically applied mulch with hydro-application equipment and equipped with appropriate centrifugal pump and engine size, paddle-type mechanical agitation, and independent liquid bypass circulation capable of handling and applying a thick homogenous slurry.

H. Seeding shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, recompacted, and refinished to finish grades. The construction operations shall be completed to a point where the seeding areas will not be disturbed.

I. The seeding work shall not be performed at any time when it may be subject to damage by climatic conditions.

J. Where ever physically possible, place fertilizer with the seed when mechanical (drill) seeding using a fertilizer attachment.

K. Do not apply seeding mixture if rainy conditions within three days or outside manufacturer’s recommendations are anticipated. In the event of unanticipated rainy conditions, re-apply the seeding mixture to uncured areas at no additional cost to the Owner.

3.2 SOIL PREPARATION

A. Proportions per acre shall be as follows:

1. Mulch: 2,500 pounds
2. Seed: Per seed mixture PLS rate.
3. Stabilizer: 120 pounds
4. Fertilizer: 350 pounds

B. Waste materials shall be removed and disposed of off the Owner’s property unless otherwise indicated.

C. Keeps weeds from going to seed. Maintain areas to be seeded visibly free of weeds throughout the growing season using mechanical or hand-pulling methods, or by applying appropriate chemicals, or combinations until seeding time.

D. Cultivate areas to be drilled-seeded at least 3 inches deep. Work the soil to obtain a surface that permits proper operation of drill seeding equipment.

E. Leave slopes in a rough condition after final grading and before seeding, or mulch or soil amendment applications. Do not apply the mulch, mulch mixture, or soil amendments to smooth slopes.

F. Grade subgrade by grading ridges to eliminate high points and uneven ground.

G. Spread topsoil evenly to a minimum depth of 3 inches.

3.3 MECHANICAL SEEDING

A. Set drill rows according to the seed species size and dimensions. Ensure drill spacing does not exceed 9 inches. Set drill depth according to the seed size and dimension, not to exceed 1-inch depth, and place seed on the furrow bottom.

B. Regulated the seed drill speed and spring pressure so 1/2-inch of soil covers the seed and the furrows are left open. Do not use drag chains.

C. Thoroughly mix seed before placing in the drill or seeder box.

D. When mulch is applied or used after mechanically seeding, place seed just below the soil surface and cover.

E. Do not perform seeding when soil is too wet or too dry, frozen or otherwise untillable, or when wind or rain interferes with mulch or seed placement.

F. Broadcast native seeds immediately ahead of the drill or seed separately. Seed legume seed through a separate box form the grass seed, with seed spouts out, or broadcast ahead of the drill.

G. Do not allow trucks or equipment to drive on the rea after seed is in place.

3.4 HYDRO-SEEDING

A. Equipment: Mixing shall be performed in a tank. The tank shall have a built-in continuous agitation and circulation system, of sufficient operating capacity to produce homogenous slurry of mulch, stabilizer, seed, fertilizer and water in the designated unit proportions for a minimum coverage of one-half acre. The tank shall have a discharge system that will permit attachment of at least 500 feet of hose extensions, a change of elevation of 150 feet in height from tank to discharge nozzle, and still retain enough pressure to apply the slurry to the areas at a continuous and uniform rate.

B. Application: With agitation system operating at part speed, water shall be added to the tank and good recirculation shall be established. Materials shall be added in such a manner that they are uniformly blended into the mixture. When the tank is 1/3 filled with water, add the following materials in the sequence listed:

Sequence	Material
1	Stabilizer, 1/2 acre requirement
2	Three 50-pounds bales mulch
3	Seed, 1/2 acre requirement
4	Fertilizer, 1/2 acre requirement

1. Agitate mixture at full speed when the tank is half filled with water.

2. Add remainder of mulch requirement before tank is 3/4 full.

3. Slurry distribution shall begin immediately. The entire tank of each batch of slurry shall be emptied and the slurry evenly applied to areas to be seeded within a 2-hour period following the mixing of each slurry batch. Slurry batches not applied during this time will be rejected.

3.5 MULCH

A. Within 14 days of seeding apply mulch.

B. Mulch application rate:

1. Straw or grass hay (air dry), 2 Ton/Acre

2. Wood Fiber, 1 Ton/Acre

C. Mechanical: Use mechanical mulch anchoring on 3H:1V slopes or flatter. Use a heavy disc with flat scalloped disc approximately ¼-inch thick, having dull edges, and spaced at least 9 inches apart to anchor mulch into the soil. Ensure anchoring to a depth of at least 2 inches with no more than 1 equipment pass on the same surface. Install mechanical anchoring in a horizontal direction to the slope.

D. Hydro-mulch: Hydro-mulch on slopes steeper than 3H:1V.

3.6 TACKIFIER

A. After seeding, apply tackifier.

B. Apply tackifier in accordance with the manufacturer's written requirements.

3.7 WATERING

A. Seeding that occurs outside of the seeding window will require watering.

B. Apply water using a tanker or water tank with pump, hose, and approved nozzle apparatus. The spray head must deliver a fine mist that will not damage plants or the mulch and tackifier.

C. Apply water on seeded and stabilized areas until vigorous growth is established as determined by the Engineer. Saturate the soil to a depth of 4 inches, estimated at 16,000 gallons per acre.

END OF SECTION 32 91 13

APPENDIX A

Geotechnical Report

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SHANNON & WILSON

February 24, 2026

Curtis Butterfield, PE
Keller Associates, Inc.
1060 Jadwin Avenue, Suite 375
Richland, Washington 99352

RE: PENDLETON WWTRRF NEW ADMIN AND STORAGE BUILDINGS, PENDLETON, OREGON

Dear Mr. Butterfield:

This letter summarizes our review of the past geotechnical explorations we performed at the City of Pendleton Wastewater Treatment and Resource Recovery Facility (WWTRRF) site and our geotechnical design recommendations to support structural and civil design associated with the new administration and storage buildings at the site. The general location of the project is shown in Figure 1, Vicinity Map. Shannon & Wilson is providing these services as a subconsultant to Keller Associates, Inc. (Keller).

PROJECT UNDERSTANDING

Project Description

We understand the project includes the construction of two new single-story, at-grade buildings. The proposed building locations within the WWTRRF site are shown in Figure 2, Site and Exploration Plan. The new administrative building will have a footprint of 40 by 80 feet and will be located north of the east primary clarifier and existing administration building, and east of the secondary clarifiers, in an undeveloped portion of the site.

The new storage building will be located south of the secondary clarifiers and immediately east of the in-plant pump station. An existing facility currently occupies the eastern portion of the planned storage building footprint, which we understand will be demolished prior to construction. The storage building will be a pre-engineered metal building (PEMB) with a footprint of 75 by 40 feet and will include a mezzanine level in the eastern portion of the structure.

Foundation loads were not available at the time this letter report was prepared; however, we assume that loads will be typical for this type of construction, with column loads of less than 75 kips and wall loads of less than 2 kips per lineal foot. We understand that the

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www.shannonwilson.com

buildings will be designed in accordance with the 2022 Oregon Structural Specialty Code (OSSC).

Site Description

The proposed improvements are located within the WWTRRF site, where the surface topography is generally flat, with a gentle downward slope to the Umatilla River located to the north and west. The site is developed with asphalt concrete (AC) and gravel pavements, existing buildings and facilities, and a grass lawn. An existing dike separates the plant from the Umatilla River along the northwest portion of the site.

Scope of Services

Our services were performed in accordance with the scope described in our Subconsultant Agreement with Keller, fully executed on November 25, 2025. Specifically, our scope includes the following items:

- Review existing geotechnical information for the site;
- Develop and provide foundation design parameters, including allowable bearing capacity, estimated settlement, and lateral resistance;
- Develop and provide seismic design parameters based on an ASCE 7-16 site classification; and
- Develop and provide recommendations for foundation subgrade preparation and backfilling.

SUBSURFACE CONDITIONS

Previous Explorations

On February 28, 2008, Shannon & Wilson conducted 17 test pits, designated as TP-1 through TP-17, which were advanced to depths between 3 to 10 feet below ground surface (bgs). Among these test pits, TP-5, TP-6, and TP-7 are approximately 35 to 60 feet away from the proposed building footprints. Later on August 26, 2008, Shannon and Wilson's subsurface exploration program at the WWTRRF site was expanded to include two additional test pits, TP-1A and TP-18, and 17 air-track rock probes. Geotechnical engineering staff from Shannon & Wilson were present during the subsurface explorations to locate the exploration sites, log the encountered materials, and collect soil samples.

Nearby Explorations

The nearest explorations to the proposed building improvements are shown in Figure 2. Subsurface conditions encountered in these explorations generally consisted of fill, native silt deposits, and silty gravel to gravel deposits. Relevant logs of subsurface explorations are included in Attachment A, Nearby Subsurface Exploration Logs.

Fill

The three nearest explorations to the proposed building sites are test pits TP-1 and TP-5 through TP-7. Topsoil was encountered in the upper 1 foot in test pit TP-5. All four test pits encountered fill to varying depths between 0.5 to 6.5 feet bgs. The fill encountered in test pits TP-5 and TP-7 consists of soft to medium stiff brown Silt (ML) with no to low plasticity, with varying amounts of rounded and subangular fine to coarse gravel. The fill encountered in test pits TP-1 and TP-6 consists of a 0.5- to 0.7-foot-thick layer of crushed gravel.

Alluvium

Beneath the fill, alluvium consisting of a 1- to 3-foot-thick layer of medium stiff to stiff Silt (ML) overlying medium dense to dense sandy Gravel (GW-GM) was encountered to maximum depths explored. In test pit TP-6, the excavator met refusal into basalt bedrock at an approximate depth of 8.5 feet bgs. Bedrock was encountered in other nearby explorations, including at 12 feet bgs in air-track borings A-1 and A-3 and at 4.1 feet in test pit TP-11.

Groundwater

Water levels in the existing treatment operations areas were measured at depths between 4 and 10 feet bgs in the test pits during the subsurface exploration programs on February 28, 2008, and August 26, 2008. The observed and recorded water levels are indicated on the test pits logs included in Attachment A.

Groundwater levels should be expected to vary with changes in topography and precipitation. The water levels at the site will likely be influenced by the water levels in the nearby Umatilla River and McKay Creek.

GEOLOGIC AND SEISMIC HAZARD EVALUATION

Seismic Design Parameters

We understand that the proposed improvements will be designed in accordance with the 2022 OSSC, which references ASCE 7-16 for seismic site classification. As noted in the subsurface conditions section, basalt bedrock was encountered at relatively shallow depths of approximately 4.1 to 12 feet bgs in some of the test pit locations. Review of nearby well logs indicates that the basalt formation extends to depths greater than 100 feet in the vicinity of the site. Based on these subsurface conditions, we recommend assigning a Site Class C. The code-based seismic design parameters corresponding to Site Class C are provided in Exhibit 1 below.

Exhibit 1: Recommended ASCE 7-16 Seismic Design Parameters

Seismic Parameters	Symbol	Value
Site Class	-	C
Mapped MCE PGA	PGA	0.162g
PGA Site Coefficient	F_{PGA}	1.238
Peak Ground Acceleration Corrected for Site Effects	PGA_M	0.200g
Mapped Short Period Spectral Acceleration	S_S	0.361g
Mapped 1-Second Spectral Acceleration	S_1	0.136g
Short Period Site Coefficient	F_a	1.3
1-Second Period Site Coefficient	F_v	1.5
Adjusted MCER Spectral Response Acceleration for Short Periods	S_{MS}	0.469g
Adjusted Spectral Response Acceleration at 1-Second Period	S_{M1}	0.204
Short Period Design Spectral Acceleration	S_{DS}	0.313g
1-Second Period Design Spectral Acceleration	S_{D1}	0.136g

NOTES:

1 g = gravity acceleration; N/A = Not applicable; PGA= Peak Ground Acceleration.

Liquefaction and Lateral Spreading

Soil liquefaction is a phenomenon in which excess pore water pressure within loose to medium-dense, saturated granular soils increases during seismic shaking to levels approaching the initial effective stress. Soils most susceptible to liquefaction typically include sands and low-plasticity silts. This increase in pore pressure reduces the soil's shear strength and can result in ground deformation such as lateral spreading, slope instability, and settlement.

The behavior of soil under seismic loading is the primary factor influencing its liquefaction potential. Based on our review, the saturated soils beneath the proposed building area consist of medium-dense to dense gravelly alluvium, which is generally not considered susceptible to liquefaction. Accordingly, we consider the likelihood of liquefaction at the site to be low. Because lateral spreading is contingent upon liquefaction occurring, the potential for lateral spreading is also considered low.

Fault Surface Rupture

The nearest mapped fault to the site is part of the Hite Fault Zone, located approximately 9.5 miles east of the site. This fault is classified as a Class A fault, indicating it is potentially active. The estimated slip rate for the fault is less than 0.2 mm/year. Based on this information, we conclude that the likelihood of surface fault rupture impacting the site is low.

FOUNDATION DESIGN RECOMMENDATIONS

Based on our understanding of the subsurface conditions at the site and the assumed foundation loads, column loads up to 75 kips and wall loads up to 2 kips per lineal foot, we consider it geotechnically feasible to support the proposed administrative and storage buildings on shallow foundations underlain by a minimum 12-inch-thick granular pad established over firm, undisturbed native subgrade or as described in the preceding subsection addressing undocumented fill.

Granular Pads

The granular pads should consist of ¾-inch minus crushed rock meeting the requirements of Section 2630.10 of the 2024 Oregon Standard Specifications for Construction and should be compacted to at least 95 percent of the maximum dry density, as determined by ASTM D1557. The crushed rock should contain no more than five percent by dry weight of material passing the No. 200 sieve. The crushed rock should horizontally extend a minimum of 6 inches beyond the edges of the footings.

Undocumented Fill

Undocumented fill of varying composition and depth was encountered in the vicinity of the proposed structures and likely underlies each building footprint. Because reliable strength and settlement characteristics cannot be assigned to undocumented fill, we recommend removing the fill to a minimum depth of 3 feet below the foundation subgrade and replacing it with ¾-inch minus crushed rock meeting the requirements of Section 2630.10 of the 2024 Oregon Standard Specifications for Construction. The crushed rock should be placed in loose lifts not exceeding 8 inches in thickness and compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557. The crushed rock should extend horizontally beyond the footing edges at a rate of 6 inches for every 1 foot of crushed-rock thickness below the foundation, resulting in crushed rock being present within a 1H:2V projection beneath the footing.

We recommend that a qualified representative of the Owner observe the subgrade prior to placement of crushed rock to determine if further over-excavation of material is needed if deleterious materials are present.

Allowable Bearing Capacity

Provided these recommendations are followed, we recommend that foundations be sized based on a net allowable bearing capacity of 2,000 pounds per square foot (psf). The footings should have minimum widths of 18 and 12 inches for spread and wall footings, respectively. Due to frost depth, the foundations should be embedded a minimum of 24 inches from the lowest adjacent grade.

Foundation Settlement

Foundations designed according to the recommended allowable bearing capacity should experience total settlement of less than 1 inch, with differential settlement of less than ½ inch over a distance of 30 feet.

Foundation Lateral Resistance

Lateral resistance to wind and earthquake loading can be achieved through frictional resistance between the base of foundation elements and the supporting crushed rock. Based on the soils encountered, a friction factor of 0.4 may be used for design.

Passive earth pressures may also be considered for lateral resistance; however, we do not anticipate that passive resistance will be feasible because the upper 24 inches of adjacent soil should be disregarded due to potential disturbance from frost penetration. If footings are embedded deeper than 24 inches, we recommend using a reduced, or partial, passive pressure equal to approximately 50 percent of the full passive resistance. For sliding and overturning evaluations, a passive resistance of 150H psf (triangular distribution) may be used, where H is the height of the foundation element engaged within the passive zone.

CONSTRUCTION CONSIDERATIONS

Subgrade Preparation

Organic material and topsoil should be stripped and removed from all structural areas and replaced with crushed rock compacted as fill. We recommend that soil disturbed during clearing and grubbing operations be removed and replaced with crushed rock structural fill. All subgrades should be neatly trimmed and carefully prepared. Any organic, deleterious, loose, or softened material should be removed from the excavation prior to placing crushed rock. Given the minimum footing depth and the incorporation of a minimum 12-inch-thick granular pads beneath foundations, we anticipate that the topsoil will be removed during subgrade preparation.

Temporary Slopes

The Earthwork Contractor is responsible for maintaining the safety of all temporary excavations and must be familiar with applicable local, state, and federal safety regulations, including current OSHA Excavation and Trench Safety Standards. Site safety, including construction means, methods, and sequencing, is solely the Contractor's responsibility. The Contractor must also continuously monitor excavation conditions and provide any necessary shoring to safeguard personnel, adjacent improvements, and existing facilities such as buried pipelines near the excavation areas. For planning purposes, we recommend assuming temporary excavation slopes no steeper than 1.5 Horizontal to 1 Vertical (1.5H:1V).

LIMITATIONS

The analyses, conclusions, recommendations, and conceptual construction information contained in this report are based on site conditions as they existed at the time of our previous subsurface exploration and further assume that the explorations are representative of the subsurface conditions throughout the site; that is, the subsurface conditions everywhere are not significantly different from those disclosed by the explorations. If subsurface conditions different from those encountered in the explorations are encountered or appear to be present during construction, we should be advised at once so that we can review these conditions and reconsider our recommendations, where necessary. If there is a substantial lapse of time between the submission of this report and the start of construction at the site, or if conditions have changed because of natural forces or construction operations at or adjacent to the site, we recommend that we review our report to determine the applicability of the conclusions and recommendations.

Within the limitations of scope, schedule, and budget, the analyses, conclusions, and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical engineering principles and practice in this area at the time this report was prepared. We make no other warranty, either express or implied. These conclusions and recommendations were based on our understanding of the project as described in this report and the site conditions as observed at the time of our explorations.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples from test borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

This report was prepared for the exclusive use of Keller and the City of Pendleton. This report is interpretive with data included, and if provided to the Contractors, it should be for their information only and not as a basis of bidding. Our report's interpretations and conclusions should not be construed as a warranty of the subsurface conditions included in this report.

The scope of our present work did not include environmental assessments or evaluations regarding the presence or absence of wetlands, or hazardous or toxic substances in the soil, surface water, groundwater, or air, on or below or around this site, or for the evaluation or disposal of contaminated soils or groundwater should any be encountered.

Shannon & Wilson has prepared and included the attached "Important Information About Your Geotechnical/Environmental Report" to assist you and others in understanding the use and limitations of our reports.

CLOSING

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON

REGISTERED PROFESSIONAL ENGINEER
86997PE
OREGON
SEPT. 12, 2017
JORDAN LUKE MELBY
EXPIRES: 12-31-26

Jordan Melby, PE
Senior Engineer

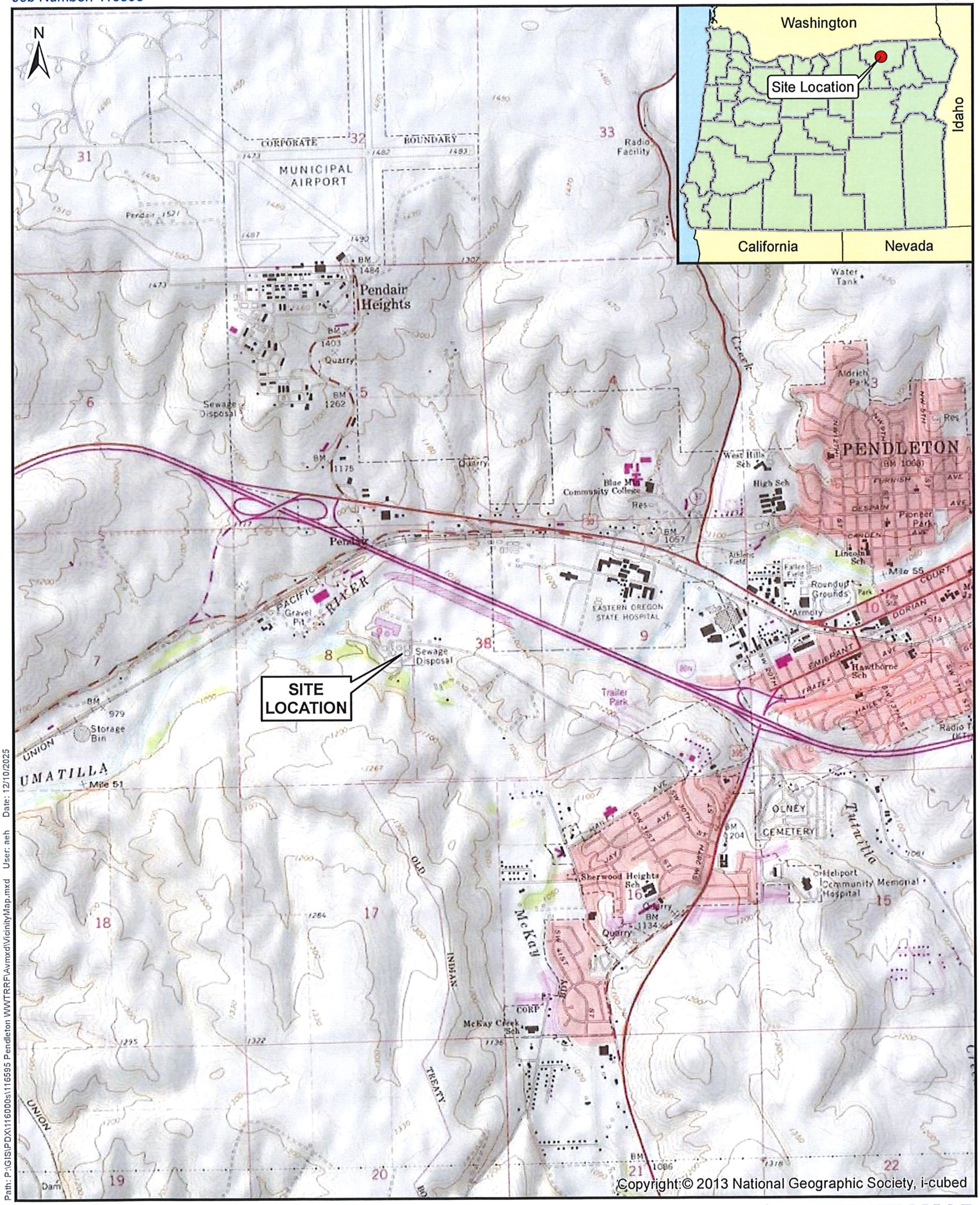
JLM/lxr

Enc. Figure 1 – Vicinity Map
Figure 2 – Site and Exploration Plan
Attachment A – Nearby Subsurface Exploration Logs
Important Information About Your Geotechnical/Environmental Report

SHANNON & WILSON

Job Number: 116595

Pendleton WWTRRF Improvements
Pendleton, Oregon



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0 0.5 1

1" = 0.5mi

VERIFY SCALE - BAR IS TWO INCHES ON ORIGINAL FIGURE

VICINITY MAP

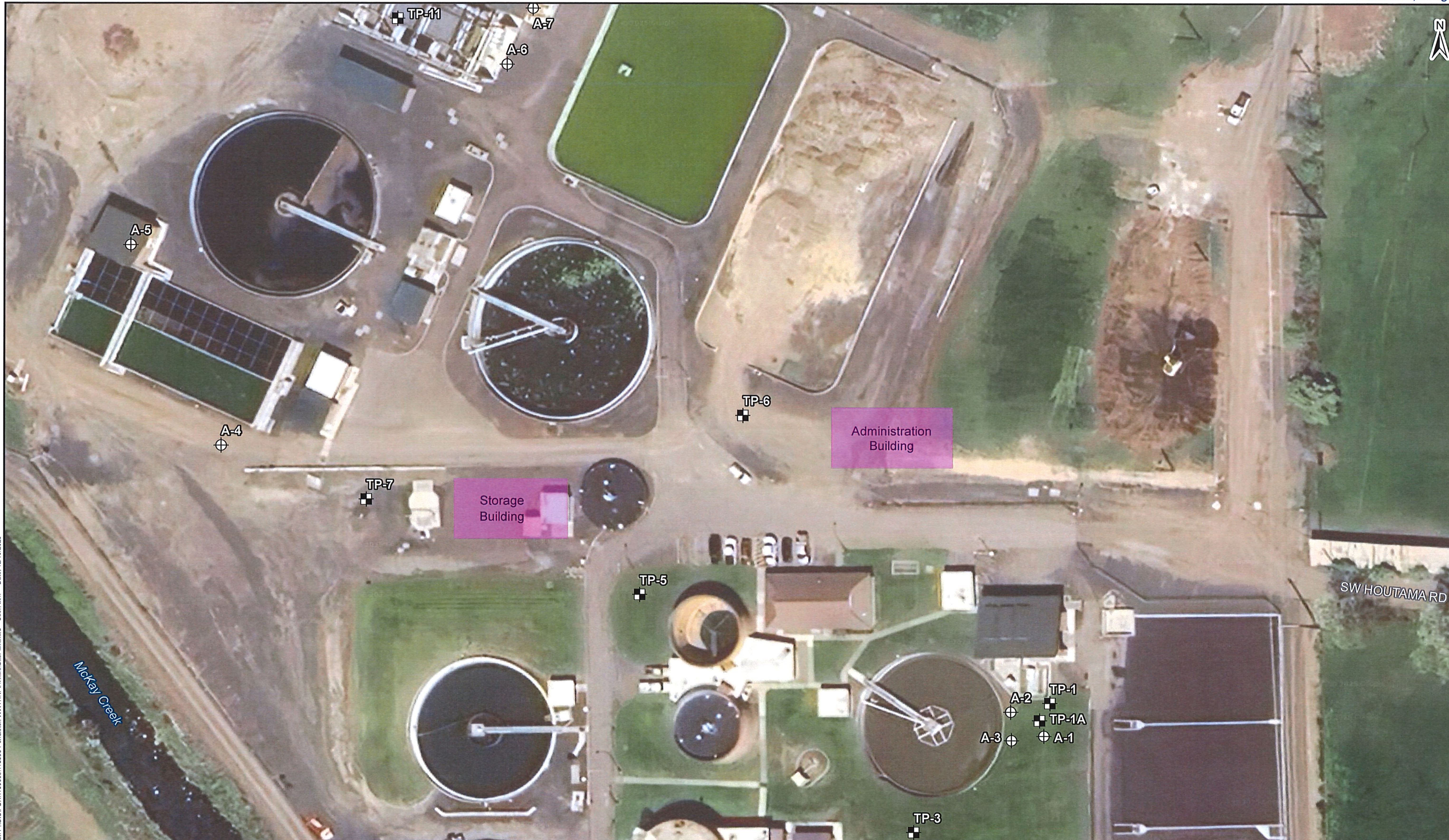
February 2026

FIGURE 1

SHANNON & WILSON

Job Number: 116595

Pendleton WWTRRF Improvements
Pendleton, Oregon



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NOTES

1. Aerial imagery obtained through Google Maps Satellite.
2. Approximate proposed building locations provided by Keller Associates, Inc., on November 24, 2025.

LEGEND

A-1 — Designation and Approximate Location of Air-Track Probe (Shannon & Wilson, 2008)

TP-1 — Designation and Approximate Location of Test Pit (Shannon & Wilson, 2008)

Approximate Location of Proposed Building

0 60 120

1" = 60'

VERIFY SCALE - BAR IS TWO INCHES ON ORIGINAL FIGURE

SITE AND EXPLORATION PLAN

February 2026

FIGURE 2

ATTACHMENT A

NEARBY SUBSURFACE EXPLORATION LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(From ASTM D 2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL		TYPICAL DESCRIPTION
COARSE-GRAINED SOIL *(more than 50% retained on No. 200 sieve)*	Gravel *(more than 50% of coarse fraction retained on No. 4 sieve)*	Clean Gravel *(less than 5% fines)*	GW		Well-graded gravel, gravel, gravel/sand mixtures, little or no fines.
			GP		Poorly graded gravel, gravel-sand mixtures, little or no fines
		Gravel with Fines *(more than 10% fines)*	GM		Silty gravel, gravel-sand-silt mixtures
			GC		Clayey gravel, gravel-sand-clay mixtures
	Sand *(50% or more of coarse fraction passes the No. 4 sieve)*	Clean Sand *(less than 5% fines)*	SW		Well-graded sand, gravelly sand, little or no fines
			SP		Poorly graded sand, gravelly sand, little or no fines
		Sand with Fines *(more than 10% fines)*	SM		Silty sand, sand-silt mixtures
			SC		Clayey sand, sand-clay mixtures
FINE-GRAINED SOIL *(50% or more passes the No. 200 sieve)*	Silt and Clay *(liquid limit less than 50)*	Inorganic	ML		Inorganic silt of low to medium plasticity, rock flour, sandy silt, gravelly silt, or clayey silt with slight plasticity
			CL		Inorganic clay of low to medium plasticity, gravelly clay, sandy clay, silty clay
		Organic	OL		Organic silt and organic silty clay of low plasticity
	Silt and Clay *(liquid limit 50 or more)*	Inorganic	MH		Inorganic silt, micaceous or diatomaceous fine sand or silty soils, elastic silt
			CH		Inorganic clay or medium to high plasticity
		Organic	OH		Organic clay of medium to high plasticity, organic silt
HIGHLY-ORGANIC SOIL	Primarily organic matter, dark in color, and organic odor		PT		Peat, humus, swamp soils with high organic content (see ASTM D 4427)

NOTE: No. 4 size = 5 mm; No. 200 size = 0.075 mm

NOTES

1. Dual symbols (symbols separated by a hyphen, i.e., SP-SM, SAND with silt) are used for coarse-grained soils with 10 percent fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart.

2. Borderline symbols (symbols separated by a slash, i.e., CL/ML and GW/SW) indicate that the soil may fall into one of two possible basic groups.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

SOIL CLASSIFICATION AND LOG KEY

March 2009 | 24-1-03406-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A1

Total Depth: 8 ft.	Northing: ~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation: 1004 ft.	Easting: ~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:	Station: ~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:	Offset: ~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
Crushed Gravel (GW); angular to subangular gravel; moist. **FILL**	*1003.3* 0.7				
Medium stiff brown SILT (ML) trace of gravel; no to low plasticity, rounded to subrounded gravel; moist. **ALLUVIUM**	*1001.5* 2.5				
Medium dense to dense brown sandy GRAVEL (GW) trace of silt; rounded to subrounded, fine to coarse sand and gravel, occasional rounded cobbles; moist to wet.					5
Water observed at 8.0 feet.	*996.0* 8.0			∇	
Bottom of Test Pit 8.0 feet on 02-28-2008.					10

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop:

0 20 40 60

Plastic Limit —●— Liquid Limit
Natural Water Content

LEGEND

* Sample Not Recovered

∇ Ground Water Level

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP- 1

March 2009 24-1-03406-002

SHANNON & WILSON, INC.
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FIG. A2

MASTER_LOG_E 3406.GPJ SHAN_WIL.GDT 3/19/09 Log: Rev: Typ:

Total Depth:	*10 ft.*	Northing:	~	Drilling Method:	Hole Diam.:
Top Elevation:	*1004 ft.*	Easting:	~	Drilling Company:	Rod Type:
Vert. Datum:		Station:	~	Drill Rig Equipment:	Hammer Type:
Horiz. Datum:		Offset:	~	Other Comments:	

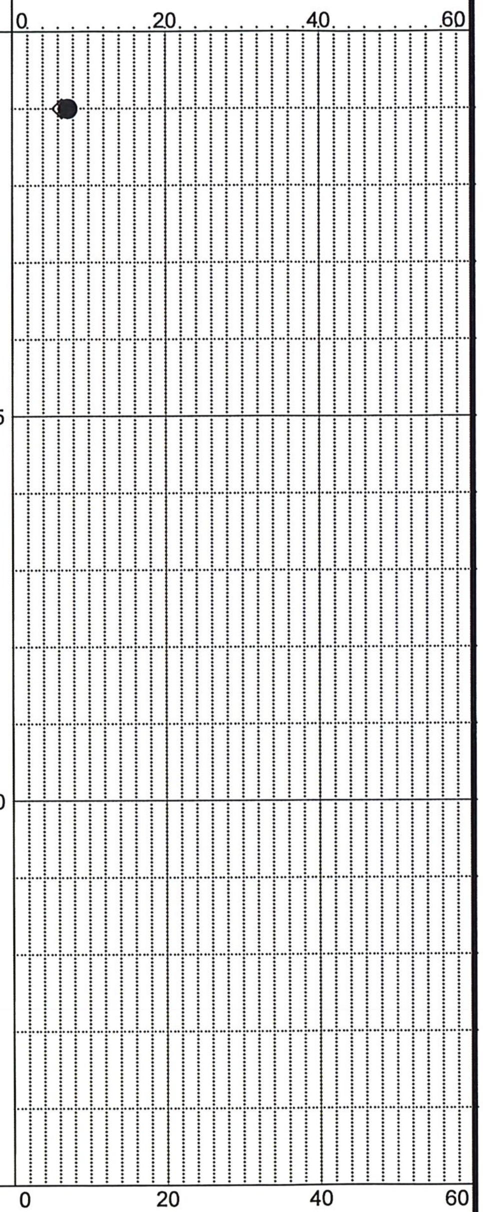
SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
Crushed Gravel	*1003.5* 0.5				
FILL Medium stiff brown SILT (ML) trace of gravel; no to low plasticity, rounded to subrounded gravel; moist.	*1001.5* 2.5				
ALLUVIUM Medium dense to dense brown sandy GRAVEL (GW) trace of silt; rounded to subrounded, fine to coarse sand and gravel, occasional rounded cobbles; moist to wet.				∇	5
Bottom of Test Pit 10.0 feet completed on 8-24-08	*994.0* 10.0				10

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop:



◇ % Fines (<0.075mm)

● % Water Content

Plastic Limit |—●—| Liquid Limit

Natural Water Content

LEGEND

* Sample Not Recovered

∇ Ground Water Level

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP-1A

March 2009 — 24-1-03406-002

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A3

MASTER LOG E 3406.GPJ SHAN WIL.GDT 3/19/09 Log: Rev: Typ:

Total Depth: 10 ft.	Northing: ~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation: 1003.8 ft.	Easting: ~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:	Station: ~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:	Offset: ~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Depth, ft.
Topsoil.	1002.8 / 1.0	
Medium dense to dense brown to gray-brown sandy GRAVEL (GW) trace of silt; rounded to subrounded fine to coarse gravel, fine to coarse sand, occasional rounded to subrounded cobbles; moist. **ALLUVIUM**	1000.3 / 3.5	
Medium stiff to stiff brown SILT (ML); no to low plasticity, silt seam from 3.5 to 4.1 feet; moist.	999.7 / 4.1	
Medium dense to dense brown sandy GRAVEL(GW-GM) with silt and cobbles; rounded to subrounded fine to coarse gravel, fine to coarse sand, no to low plasticity silt, rounded to subrounded occasional cobbles <2%; moist.		5
Water observed at 9.5 feet.	993.8 / 10.0	10
Bottom of Test Pit 10.0 feet on 02-28-2008.		

Columns: Symbol | Samples | Ground Water

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop:

0 20 40 60

LEGEND

* Sample Not Recovered

Ground Water Level

Plastic Limit —●— Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP- 3

March 2009 24-1-03406-002

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FIG. A5

MASTER_LOG_E 3406.GPJ SHAN_WIL.GDT 3/19/09 Log: Rev: Typ:

Total Depth:	8.5 ft.	Northing:	~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation:	1003 ft.	Easting:	~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:		Station:	~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.
Topsoil.	1002.0 1.0				
Soft brown SILT (ML) with gravel trace of sand; no to low plasticity, rounded to subangular fine to coarse gravel, fine to medium sand; moist. **FILL**	1000.5 2.5				
Medium stiff to stiff dark Brown SILT (ML); no to low plasticity; moist. **ALLUVIUM**	999.5 3.5				
Medium dense to dense brown sandy GRAVEL (GW) trace of silt; rounded to subrounded fine to coarse gravel, fine to coarse sand, occasional rounded to subrounded cobbles; moist. Water observed at 8.0 feet.	994.5 8.5			∇	5
Bottom of Test Pit. 8.5 feet on 02-28-2008.					10

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop: ______

0 20 40 60

Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

LEGEND

* Sample Not Recovered

∇ Ground Water Level

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP- 5

March 2009 24-1-03406-002

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FIG. A7

MASTER_LOG_E 3406.GPJ SHAN_WIL.GDT 3/19/09 Log: Rev: Typ:

Total Depth:	8.5 ft.	Northing:	~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation:	1005 ft.	Easting:	~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:		Station:	~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:		Offset:	~	Other Comments:			

SOIL DESCRIPTION

Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.

Soil Description	Elev. Depth (ft.)	Ground Water	Depth, ft.
Crushed GRAVEL (GW-GM) with silt, angular to subangular gravel; moist. **FILL**	1004.5 0.5		
Medium stiff to stiff brown SILT (ML) trace of sand; no to low plasticity; moist. **ALLUVIUM**	1003.5 1.5		
Medium dense to dense brown to gray sandy GRAVEL (GW-GM) with silt; rounded to subrounded fine to coarse gravel, fine to medium sand, no plasticity, occasional rounded cobbles; moist.			5
Water observed at 8.0 feet.	996.5 8.5	∇	
Hard excavating (possible bedrock)			
Bottom of Test Pit - REFUSAL 8.5 feet on 02-28-2008.			10

Columns also: Symbol, Samples

PENETRATION RESISTANCE, N (blows/ft.)

▲ Hammer Wt. & Drop:

0 20 40 60

0 20 40 60

LEGEND

* Sample Not Recovered

∇ Ground Water Level

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP- 6

March 2009 24-1-03406-002

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FIG. A8

Typ: Rev: Log:

MASTER_LOG_E 3406.GPJ SHAN_WIL.GDT 3/19/09

Total Depth: 11 ft.	Northing: ~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation: 1001 ft.	Easting: ~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:	Station: ~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:	Offset: ~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	*Elev.* Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE, N (blows/ft.) ▲ Hammer Wt. & Drop:
Soft to medium stiff brown SILT (ML) with gravel trace of sand; no to low plasticity, rounded to subangular fine to coarse gravel; moist. **FILL**					5	
Medium stiff to stiff dark brown SILT (ML); no to low plasticity; moist. **ALLUVIUM**	*994.5* 6.5					
Medium dense to dense gray sandy GRAVEL (GW) trace of silt; rounded to subrounded fine to coarse gravel, fine to coarse sand, occasional rounded to subrounded cobbles; wet. Water observed at 9.5 feet.	*991.5* 9.5			∇	10	
Bottom of Test Pit. 11.0 feet on 02-28-2008.	*990.0* 11.0					

Penetration resistance scale: 0, 20, 40, 60

LEGEND

* Sample Not Recovered

∇ Ground Water Level

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP- 7

March 2009 24-1-03406-002

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FIG. A9

Typ: Rev: Log:

MASTER LOG E 3406.GPJ SHAN WIL.GDT 3/19/09

Total Depth: 4.1 ft.	Northing: ~ 46 ft.	Drilling Method:		Hole Diam.:	
Top Elevation: 996.5 ft.	Easting: ~ 119 ft.	Drilling Company:		Rod Type:	
Vert. Datum:	Station: ~	Drill Rig Equipment:		Hammer Type:	
Horiz. Datum:	Offset: ~	Other Comments:			

SOIL DESCRIPTION *Refer to the report text for a proper understanding of the subsurface materials and drilling methods. The stratification lines indicated below represent the approximate boundaries between soil types, and the transitions may be gradual.*	Elev. Depth (ft.)	Symbol	Samples	Ground Water	Depth, ft.	PENETRATION RESISTANCE, N (blows/ft.) ▲ Hammer Wt. & Drop:
Concrete.	*996.3* 0.3					
Crushed Gravel (GW); angular to subangular gravel; moist. **FILL**	*995.7* 0.8					
	995.0 1.5					
Medium stiff to stiff dark brown to black SILT (ML) with gravel trace of sand; no to low plasticity, rounded to subrounded fine to medium gravel, fine to medium sand; moist. **ALLUVIUM**				⊽		
Medium dense to dense brown to gray sandy GRAVEL (GW-GM) with silt; rounded to subrounded fine to coarse gravel, fine to coarse sand, no plasticity silt, occasional rounded to subrounded cobbles, some reddish-brown oxidation stained zones; moist. Water observed at 3.5 feet.	*992.4* 4.1				5	
Hard excavating (Bedrock) Bottom of Test Pit - REFUSAL 4.1 feet on 02-28-2008.					10	

0 20 40 60

LEGEND

* Sample Not Recovered

⊽ Ground Water Level

Plastic Limit ├──●──┤ Liquid Limit
Natural Water Content

NOTES

1. Refer to KEY for explanation of symbols, codes, abbreviations and definitions.
2. Groundwater level, if indicated above, is for the date specified and may vary.
3. USCS designation is based on visual-manual classification and selected lab testing.
4. The hole location and elevation should be considered approximate.
5. UCS: Unconfined Compressive Strength, PSI: Pounds per Square Inch.

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

LOG OF TEST PIT TP-11

March 2009 24-1-03406-002

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FIG. A13

MASTER_LOG_E 3406.GPJ SHAN_WIL.GDT 3/19/09 Log: Rev: Typ:

Photo 1: Test Pit TP1- Silty Gravel to Gravel Deposit

Photo 2: Groundwater Seepage in Test Pit TP3

Pendleton Wastewater Treatment Plant,
Pendleton, Oregon

TEST PIT PHOTOS
Photos 1 and 2

March 2009 24-1-03406-002

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FIG. A21

Photo 3: Ground Water Seepage in Test Pit TP5

Photo 4: Groundwater Seepage and Gravel Deposits Cave-In in TP8

Pendleton Wastewater Treatment Plant, Pendleton, Oregon
TEST PIT PHOTOS **Photos 3 and 4**
March 2009   24-1-03406-002
SHANNON & WILSON, INC. Geotechnical and Environmental Consultants   **FIG. A22**

Air Track Logs

Probe A1 Approx. Elevation 1004 ft

Depth (ft)	Unit Description
0-12.0	Overburden
12.0-14.0	Bedrock (fractured)
14.0-	Sound Rock

Probe A2 Approx. Elevation 1003 ft

Depth (ft)	Unit Description
0.0-10.0	Overburden
10.0-	Bedrock

Probe A3 Approx. Elevation 1003 ft

Depth (ft)	Unit Description
0 .0-12.0	Overburden
12.0 – 16.0	Fractured rock
16.0 -	Sound rock

Probe A4 Approx. Elevation 999 ft

Depth (ft)	Unit Description
0.0-9.0	Overburden
9.0-	Bedrock

Probe A5 Approx. Elevation 999 ft

Depth (ft)	Unit Description
0.0-7.0	Overburden
7.0-	Bedrock

Probe A6 Approx. Elevation 996.5 ft

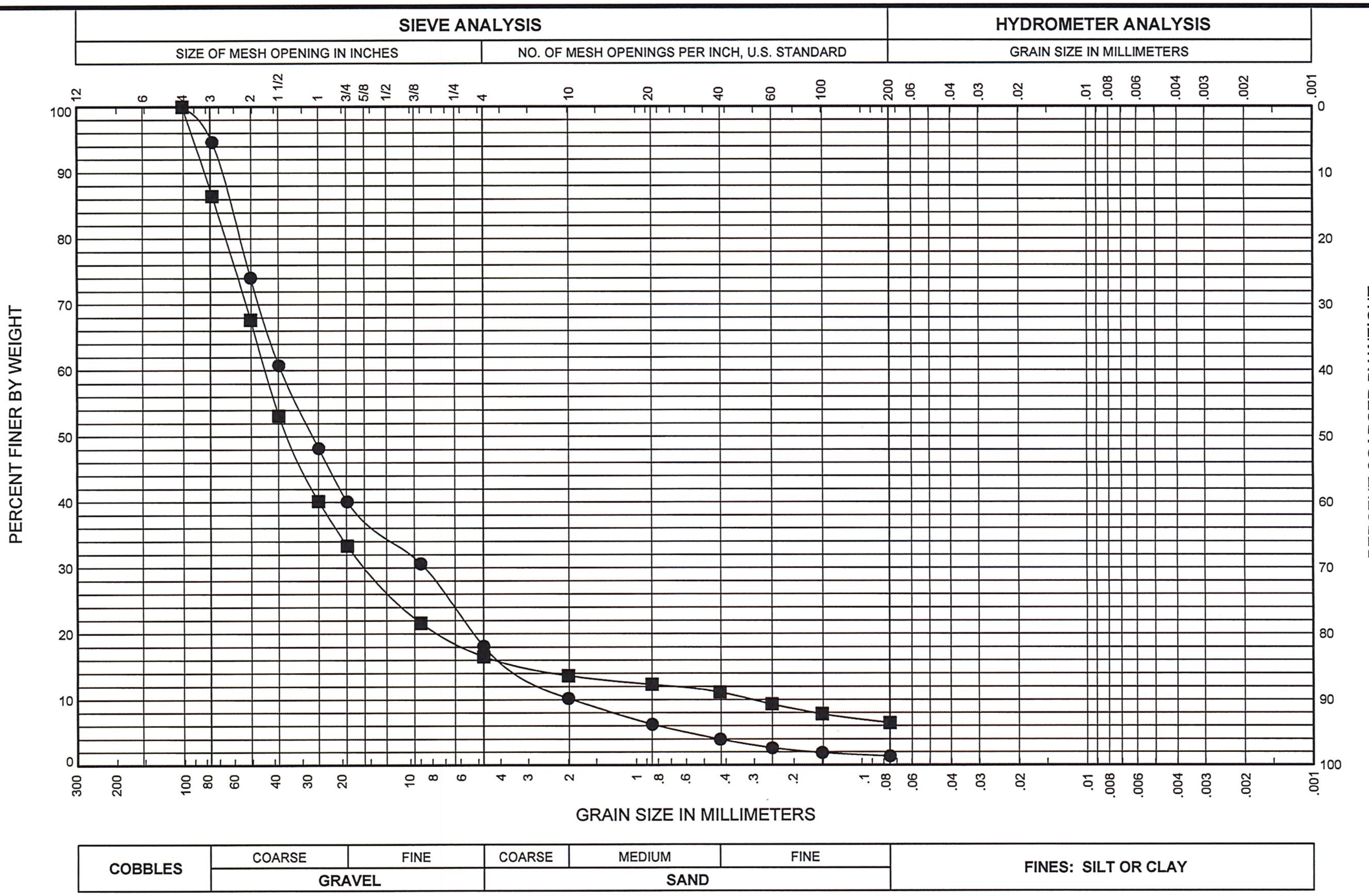
Depth (ft)	Unit Description
0.0-5.0	Overburden
5.0-	Bedrock

Probe A7 Approx. Elevation 996.5 ft

Depth (ft)	Unit Description
0.0-5.0	Overburden
5.0-	Bedrock

Probe A8 Approx. Elevation 996.5 ft

Depth (ft)	Unit Description
0.0-3.0	Overburden
3.0-	Bedrock



BORING AND SAMPLE NO.	DEPTH (feet)	U.S.C.S. SYMBOL	SAMPLE DESCRIPTION	GRAVEL %	SAND %	FINES %	NAT. W.C. %	DRY DENSITY PCF
● TP-18,	1.0	GW	Brown GRAVEL with sand	76.5	16.8	1.3	4.7	
■ TP-1A,	1.0	GM	Brown GRAVEL, trace silt	69.9	10.1	6.5	7.3	

Pendleton Wastewater Treatment Plant Outfall
Pendleton, Oregon

GRAIN SIZE DISTRIBUTION

March 2009
24-1-03406-002

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FIG. B-1

Kennedy Jenks

ATTACHMENT B

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the Geoprofessional Business Association (https://www.geoprofessional.org)

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