CAROTHERS ROAD SOLID WASTE FACILITY

WHITMAN COUNTY, WASHINGTON

# CONTRACT DOCUMENTS

for the construction of the

NEW WASTE TRANSFER BUILDING AND SITE IMPROVEMENTS

CONTRACT NO. XEW28

VOLUME II

DIVISIONS 22 THRU 49

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CH2M HILL

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Project No. 437927

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**SECTION 22 07 00**
**PLUMBING PIPING INSULATION**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   c. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
3. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
4. Underwriters Laboratories, Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Product description, include list of materials, thickness for each service scheduled, and locations.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Manufacturer’s installation instructions.

1.03 QUALITY ASSURANCE

A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site shall have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation packages and containers shall be marked "asbestos-free."

**PART 2 PRODUCTS**

2.01 GENERAL

A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.

B. Insulation shall conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

D. Fire Resistance:

1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
2. Use no fugitive or corrosive treatments to impart flame resistance.
3. Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
5. Materials exempt from fire-resistant rating:
   a. Nylon anchors.
   b. Treated wood inserts.

6. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
    a. Polyurethane insulation.
    b. PVC casing.
    c. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Flexible, closed cell elastomeric.
2. Nominal 6 PCF density, K factor 0.27 maximum at 75 degrees F mean.
3. Water Vapor Transmission: 0.1 perm-inch, or less.
4. Manufacturers and Products:
    a. Armacell; AP Armaflex.
    b. Nomaco; K-Flex LS.
    c. Rubatex; R-180-FS.

2.03 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, white, for straight run piping and fitting locations, temperatures to 159 degrees F.
2. Manufacturers and Products:
    a. Johns Manville; Zeston.
    b. Ceel-Co; 550.

B. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100 or 3105 to ASTM B209 with H-14 temper, minimum 0.016-inch thickness, with smooth mill finish.
2. Moisture Barrier: Provide factory applied moisture barrier, consisting of 40-pound kraft paper with 1-mil-thick low-density polyethylene film, heat and pressure bonded to inner surface of the aluminum jacketing.
3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
4. Manufacturer and Product: RPR Products; INSUL-MATE.

**PART 3 EXECUTION**

3.01 INSTALLATION OF INSULATION

A. Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean, finish painted, and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage. Seal open ends of insulation with mastic. Sectionally seal butt ends of chilled water and condensate drain piping insulation at fittings with white vapor barrier coating.

H. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units. Finish cold pipe fittings with white vapor barrier coating and hot piping with white vinyl acrylic mastic, both reinforced with glass cloth.

I. Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise indicated.

J. Install protective metal shields and foamglass inserts where pipe hangers bear on outside of insulation.

K. Insulation on piping that is to be heat traced shall be installed after installation of heat tape.

L. Insulate valve bodies, flanges, and pipe couplings.

M. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.

N. Do not insulate flexible pipe couplings and expansion joints.

O. Do not allow insulation to cover nameplates or code inspection stamps.

P. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

Q. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

R. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.

S. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

T. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

U. Vapor Barrier:

1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
3. Do not use staples and screws to secure vapor sealed system components.

## 3.02 INSTALLATION OF INSULATION FINISH SYSTEMS

A. Use a continuous friction type joint to hold jacket in-place, providing positive weatherproof seal over entire length of jacket.

B. Secure circumferential joints with preformed snap straps containing weatherproof sealant.

C. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.

D. Do not use screws or rivets to fasten the fitting covers.

E. Install removable prefabricated aluminum covers on exterior flanges and unions.

F. Caulk and seal exterior joints to make watertight.

3.03 INSULATION APPLICATIONS

A. Potable Cold Water:

1. Type P3, elastomeric.
2. 1-inch thickness for all pipe sizes.

B. Potable Hot Water, Recirculated Hot Water:

1. Type P3, elastomeric.
2. 1-inch thickness for all pipe sizes.

C. Pipe Hangers:

1. Type P3, Elastomeric: Rigid insulation section with 9-inch-long, 16-gauge galvanized steel saddle.

3.04 INSULATION FINISH APPLICATIONS

A. Piping Insulation (Concealed Areas): Factory finish.

B. Piping Insulation (Exposed to View, Indoors): Type F3, aluminum.

C. Piping Insulation (Outdoors):

1. Type F1, PVC (buried).
2. Type F3, aluminum. (exposed).

D. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

3.05 FIELD QUALITY CONTROL

A. Test factory-applied materials assembled. Field-applied materials may be tested individually.

**END OF SECTION**

**SECTION 22 10 01**
**PLUMBING PIPING AND ACCESSORIES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Gas Association (AGA):
   a. B109.1, Diaphragm Type Gas Displacement Meters (under 500 Cubic Feet Per Hour Capacity).
   b. B109.2, Diaphragm Type Gas Displacement Meters (500 Cubic Feet Per Hour Capacity and Over).
2. American National Standards Institute (ANSI).
3. American Public Works Association (APWA): Uniform Color Code.
4. American Society of Sanitary Engineering (ASSE):
   a. 1010, Performance Requirements for Water Hammer Arresters.
   b. 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
5. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   d. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A179/A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes.
   g. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A197/A197M, Standard Specification for Cupola Malleable Iron.
   k. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
m. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
n. A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
o. A536, Standard Specification for Ductile Iron Castings.
p. A563, Standard Specification for Carbon and Alloy Steel Nuts.
q. A861, Standard Specification for High-Silicon Iron Pipe and Fittings.
r. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
s. B32, Standard Specification for Solder Metal.
t. B61, Standard Specification for Steam or Valve Bronze Castings.
u. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
v. B75/B75M, Standard Specification for Seamless Copper Tube.
w. B88, Standard Specification for Seamless Copper Water Tube.
x. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
y. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
z. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
aa. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
bb. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
cc. B306, Standard Specification for Copper Drainage Tube (DWV).
dd. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
ee. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
ff. C1460, Standard Specification for Shielded Transition Couplings for use with Dissimilar DWV Pipe and Fittings Above Ground.
gg. C1540, Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
hh. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ii. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
jj. D2000, Standard Classification System for Rubber Products in Automotive Applications.

kk. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
ll. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
mm. D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
nn. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
oo. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
pp. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
qq. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
rr. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ss. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
tt. E438, Standard Specification for Glasses in Laboratory Apparatus.
uu. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
vv. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ww. F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
xx. F1924, Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing.
yy. F1973, Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.

f. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied.
g. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
h. C606, Grooved and Shouldered Joints.
i. C651, Disinfecting Water Mains.

7. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Strom Drain, Waste, and Vent Piping Applications.
8. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arresters Standard.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Sanitary Building Drainage and Vent Systems: ICBO/IAPMO Uniform Plumbing Code.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets.
2. Shop Drawings: Show Contractor recommended changes in location of fixtures or equipment.
3. Isometric riser diagrams.

B. Informational Submittals:

1. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the Work.
2. Complete list of products proposed for installation.
3. Test records produced during testing.

**PART 2 PRODUCTS**

2.01 PIPING

A. Piping Material: Refer to Piping Data Sheets and Article Supplements.

## 2.02 HOSE VALVES AND HYDRANTS

A. HV-1, Post Hydrant:

1. Bronze casing, 3/4-inch to 2-inch inlet and outlet, for 3-foot of bury.
2. Size as indicated on Drawings.
3. Manufacturers and Products:
    a. J. R. Smith; Figure 5910 Series.
    b. Wade, Division of Tyler Pipe; 8610 Series.
    c. Zurn; 1385 (3/4 inch) and 1396 (1 inch to 2 inch).

## 2.03 PIPE HANGERS AND SUPPORTS

A. Hangers:

1. Clevis Type: MSS SP 58 and SP 69, Type 1 or 6.
    a. Anvil; Figure 104 or 260, sizes 1/2 inch through 30 inches.
    b. B-Line; Figure B3198H or B3100, sizes 3/8 inch through 30 inches.
2. Hinged Split-Ring Pipe Clamp: MSS SP 58 and SP 69, Type 6 or 12.
    a. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
    b. B-Line; Figure B3198H, sizes 3/8 inch through 3 inches.
3. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.
4. Attachments:
    a. I-Beam Clamp: Concentric loading type, MSS SP 58 and SP 69, Type 21, 28, 29, or 30, which engage both sides of flange.
    b. Concrete Insert: MSS SP 58 and SP 69, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.

B. Saddle Supports:

1. Pedestal Type: Schedule 40 pipe stanchion, saddle, and anchoring flange.
    a. Nonadjustable Saddle: MSS SP 58 and SP 69, Type 37 with U-bolt.
        1) Anvil; Figure 259, sizes 4 inches through 36 inches.
        2) B-Line; Figure B3090, sizes 2-1/2 inches through 36 inches.
    b. Adjustable Saddle: MSS SP 58 and SP 69, Type 38 without clamp.
        1) Anvil; Figure 264, sizes 2-1/2 inches through 36 inches.
        2) B-Line; Figure B3093, sizes 2-1/2 inches through 36 inches.

C. Wall Brackets:

1. Welded Steel Bracket: MSS SP 58 and SP 69, Type 33 (heavy-duty).
   a. Anvil; Figure 199, 3,000-pound rating.
   b. B-Line; Figure B3067, 3,000-pound rating.
2. One-Hole Clamp: Anvil; Figure 126, sizes 3/8 inch through 4 inches.
3. Channel Type:
   a. Unistrut.
   b. Anvil; Power-Strut.
   c. B-Line; Strut System.
   d. Aickinstrut (FRP).

D. Pipe Clamps:

1. Riser Clamp: MSS SP 58 and SP 69, Type 8.
   a. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
   b. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

E. Channel Type Support Systems:

1. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, 1-1/2-inch wide, minimum FRP.
2. Members and Connections: Design for all loads with safety factor of 5.
3. Manufacturers:
   a. B-Line; Strut System.
   b. Unistrut.
   c. Anvil; Power-Strut.
   d. Aickinstrut (FRP System).

F. Accessories:

1. Insulation Shields:
   a. Type: Galvanized steel or stainless steel, MSS SP 58 and SP 69, Type 40.
   b. Manufacturers and Products:
      1) Anvil; Figure 167, sizes 1/2 inch through 24 inches.
      2) B-Line; Figure B3151, sizes 1/2 inch through 24 inches.
2. Welding Insulation Saddles:
   a. Type: MSS SP 58 and SP 69, Type 39.
   b. Manufacturers and Products:
      1) Anvil; Figure Series 160, sizes 1 inch through 36 inches.
      2) B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

G. Galvanize hangers, rods, clamps, protective shields, and hanger accessories.

H. Trapeze Hangers:

1. Assembly consisting of structure attachments with rod size dependent upon total weight supported, and spacing of assemblies determined by minimum pipe size included in group supported.
2. Trapeze Horizontal: Structural angle or channel section of sufficient size to prevent measurable sag between rods.
3. Manufacturers:
   a. Unistrut.
   b. B-Line; Strut System.
   c. Anvil; Power-Strut.
   d. Aickinstrut (FRP System).

2.04 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

2.05 VALVES

A. General:

1. Furnish complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches.
2. Renewable Parts Including Discs, Packing, and Seats: Types as recommended by valve manufacturer for intended service.
3. Units shall have name of manufacturer and size of valve cast on body or bonnet or shown on a permanently attached plate in raised letters.

B. Design Features:

1. Brass and bronze components, including appurtenances in contact with water.
2. Alloys containing less than 16 percent zinc and 2 percent aluminum.
3. Alloys are of the following ASTM designations:
   a. B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.
   b. Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Engineer.
4. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.

C. Valve Operators:

1. Open by turning counterclockwise.
2. Worm and Gear Operators On Manually Operated Valves: Totally enclosed design, proportioned as to permit operation of valve under full

operating head with maximum pull of 40 pounds on handwheel or crank.

3. Self-locking type to prevent the disc or plug from creeping.
4. Self-Locking Worm Gears:
    a. One-piece design of gear bronze material, accurately machine cut.
    b. Worm: Hardened alloy steel, with thread ground and polished.
    c. Reduction gearing shall run in a proper lubricant.
5. Galvanize handwheels.

D. Gate Valves:

1. 3 Inches and Smaller for Water and Air Services:
    a. All-bronze with screwed bonnet, single solid wedge gate with nonrising stem, and handwheel operator.
    b. Rated 125-pound SWP, 200-pound WOG.
    c. Manufacturers and Products for Threaded Ends:
        1) Crane; No. 438.
        2) Nibco; Model No. T-113.
    d. Manufacturers and Products for Soldered Ends:
        1) Crane; No. 1701S.
        2) Nibco; Model No. S-113.

E. Ball Valves:

1. 2 Inches and Smaller for General Water and Air Service:
    a. Three-piece body type, bronze body and end pieces, hard-chrome plated bronze or brass ball, full bore port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip.
    b. Rated 6-pound WOG, 150-psi SWP.
    c. Manufacturers and Products:
        1) Threaded Ends:
            a) Milwaukee; BA-300.
            b) Nibco; T-595-Y.
            c) Conbraco Apollo; 82-100.
        2) Soldered Ends:
            a) Milwaukee; BA-350.
            b) Nibco; S-595-Y.
            c) Conbraco Apollo; 82-200.

F. Globe Valves:

1. 3 Inches and Smaller:
    a. Bronze body, replaceable composition disc, screwed ends, union bonnet, inside screw rising stem, and TFE disc.
    b. Rated 150-pound SWP, 300-pound WOG.

c. Manufacturers and Products:
   1) Crane; No. 7TF.
   2) Nibco; No. T-235-Y.

G. Plug Valve:

1. 2 Inches and Smaller for Natural Gas and Propane Gas Service:
   a. Eccentric type, nonlubricated, cast iron body, and bronze plug with Buna N elastomer O-ring seal.
   b. UL listed and CSA (AGA-CGA) approved.
   c. Pressure Rating: ANSI 125, 175 psi.
   d. Threaded end connections.
   e. Manufacturers and Products:
      1) Milliken Valve Company, Inc.; Series 625.
      2) Key Port Valve; Series 400.
2. 2-1/2 Inches to 4 Inches for Natural Gas and Propane Gas Service:
   a. Eccentric type, nonlubricated, cast iron body and nickel plated cast iron plug with Buna N elastomer O-ring seal.
   b. UL listed and CSA (AGA-CGA) approved.
   c. Pressure Rating: ANSI 125, 175 psi.
   d. End Connections:
      1) 2-1/2 Inches to 3 Inches: Threaded.
      2) 4 Inches: Flanged, ASME B16.1, Class 125/150.
   e. Manufacturers and Products:
      1) Milliken Valve Company, Inc.; Series 625.
      2) Key Port Valve; Series 400.

H. Check Valves 3 Inches and Smaller:

1. Bronze body, wye pattern, threaded ends and cap, regrinding seat, and swing type disc.
2. Rated 125-pound SWP, 200-pound WOG.
3. Manufacturers and Products:
   a. Crane; No. 37.
   b. Walworth Co.; Figure 406.

I. Balancing Valves (Recirculating Hot Water):

1. Bronze, calibrated balancing type with provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves.
2. An integral pointer shall register degree of valve opening.
3. Construct with internal seals to prevent leakage around rotating element.
4. Rated for 125 psig working pressure at maximum temperature of 250 degrees F.
5. Furnish one pressure gauge type readout meter in carrying case.

6. Furnish with preformed polyurethane insulation valve enclosure, suitable for use on hot water systems.
7. Manufacturers and Products:
    a. Bell & Gossett; No. CB circuit setter.
    b. TACO; Series 790.

J. Water Pressure Reducing Valves 1/2 Inch Through 2-1/2 Inches:

1. Spring controlled, with a neoprene diaphragm.
2. Manufacturers and Products:
    a. Fisher; Type 75.
    b. Watts; No. 223.

K. Gauge Cock Valves 1/8 Inch to 3/8 Inch:

1. Bronze body, hexagon male and female ends, and tee head.
2. Rated for 125-pound SWP.
3. Manufacturers and Products:
    a. Ernst Gage Co.
    b. Lunkenheimer.

L. Thermostatic Mixing Valve Assembly:

1. Function: Provide tepid water at 3 gpm to 50 gpm.
2. Components:
    a. High flow mixing valve for 15 gpm to 50 gpm.
    b. Low flow mixing valve for 3 gpm to 7 gpm.
    c. Pressure reducing valve.
    d. Pressure gauge.
    e. Isolation valve.
    f. Thermometer.
    g. Pipe fittings.
    h. Heavy-gauge steel cabinet with access door and manufacturer's standard baked enamel finish.
3. Inlets: One each, 3/4-inch NPT, cold and hot water.
4. Outlets: 1 inch NPT.
5. Self-contained; no electrical requirements.
6. Performance: With 140 degrees F hot inlet and 60 degrees F cold inlet, deliver 86 degrees F at inlet pressures between 30 psig and 100 psig. Set outlet at 95 degrees F.
7. Manufacturers and Products:
    a. Powers Process Controls; Series 430/420 Hydroguard.
    b. Leonard; Model TM 650.
    c. Guardian G3707.

## 2.06 MISCELLANEOUS PIPING SPECIALTIES

A. Strainers for Water Service:

1. Iron body, Y-pattern, 125-pound rated, with screwed bronze or bolted iron cap.
2. Screen: Heavy-gauge stainless steel or monel, 30 mesh.
3. Manufacturers and Products:
    a. Crane; No. 988-1/2.
    b. Mueller; No. 758.

B. Flexible Connectors for Stainless Steel Gas Lines:

1. Corrugated, Type 316 stainless steel hose, with 10-inch live length and Type 316 stainless steel male NPT pipe connectors at each end.
2. Manufacturers:
    a. Flexonics Braided Rex-Weld.
    b. Kin-Line.

C. Vacuum Breakers 2 Inches and Smaller:

1. Angle type, as required.
2. Manufacturers:
    a. Febco.
    b. Watts.

D. Water Hammer Arresters:

1. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.
2. Manufacturers and Products:
    a. Sioux Chief Mfg. Co., Inc.; Series 650 and 660.
    b. Precision Plumbing Products, Inc.

E. Water Hose:

1. Furnish two 50-foot length(s) of 1-inch EPDM black cover and EPDM tube, reinforced with two textile braids. Furnish each length with brass male and female NST hose thread couplings to fit hose nozzle(s) and hose valve(s) specified.
2. Rated minimum working pressure of 200 psi.
3. Manufacturers:
    a. Goodyear.
    b. Boston.

F. Hose Nozzles:

1. Furnish 1-inch cast brass satin finish nozzle(s) with adjustable fog, straight-stream, and shut-off features and rubber bumper. Provide nozzle(s) with female NST hose thread.
2. Manufacturers:
   a. Croker.
   b. Elkhart.

G. Sleeves:

1. Manufacturers and Products:
   a. J. R. Smith; Figure 1720.
   b. Josam; No. 26400.

H. Flashing Sleeves for Roof Penetrations:

1. Built-Up Bituminous Roofing: Fabricate of lead as specified in Section 07 62 00, Sheet Metal Flashing and Trim.
2. Single-Ply Membrane Roofing: Pipe seals as specified in Section 07 70 01, Roof Specialties and Accessories.

I. Insulating Dielectric Unions and Flanges:

1. Galvanically compatible with piping to which attached and pressure ratings suitable for system working pressures.
2. Unions 2 Inches and Smaller: Screwed or solder-joint type.
3. Unions 2-1/2 Inches and Larger: Flanged type, complete with bolt insulators, dielectric gasket, bolts, and nuts.
4. Manufacturers:
   a. Epco Sales, Inc., Cleveland, OH.
   b. Capitol Insulation Unions.

J. Joint Solder: 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.

K. Pipe Joint Sealer: Compound insoluble in water or Teflon tape; approved by NFS for use in potable water.

L. Rubber Gaskets: ASTM C564.

## 2.07 MEASURING DEVICES

A. Thermometers:

1. Adjustable angle, organic spirit type, blue in color, with 9-inch case and scale range in degrees F, as shown.

2. Furnish with 3-1/2-inch stem length and separable NPT brass thermowell.
3. Manufacturers:
   a. Trerice Co.; Model A005.
   b. Weksler.

B. Pressure Gauges:

1. Construction: 3-1/2-inch gauge size, 0 to 690 kPa, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/4-inch NPT lower connection.
2. Furnish with 1/4-inch brass gauge cock.
3. Manufacturers and Products:
   a. Ashcroft; Type 1008.
   b. Marsh; J80.
   c. Marshalltown.

## PART 3 EXECUTION

3.01 GENERAL

A. Install plumbing systems to meet applicable plumbing code.

B. Field Obstructions:

1. Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.
2. Do not modify structural components, unless approved by Engineer.

C. Sleeves:

1. Pipe sizes shown are nominal sizes, unless shown or specified otherwise.
2. Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.
3. Provide pipes passing through finished walls with chrome-plated canopy flanges.
4. Dry pack sleeves in existing work in-place and provide finished appearance.
5. Pack holes left by removal of existing piping with grout and finish to match adjacent surface.

D. Provide unions in piping systems at connections to equipment.

E. Provide shielded transition couplings, insulating dielectric unions and flanges between ferrous and nonferrous piping and where otherwise required for electrically insulated connection.

F. Pipe air release valves, water-lubricated bearings, and other appurtenances having water effluent with copper tubing to nearest drain.

G. Trench Excavation and Backfill: As specified in Section 31 23 16, Excavation and 31 23 23.15, Trench Backfill.

3.02 INSTALLATION

A. Steel Pipe:

1. Ream, clean, and remove burrs and mill scale from piping before making up.
2. Seal joints with pipe joint sealer or Teflon tape.

B. Copper Tubing:

1. Cut tubing square and remove burrs.
2. Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.
3. Prevent annealing of fittings and hard-drawn tubing when making connections.
4. Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

C. Water System Balancing: Provide a qualified registered engineer or firm specializing in testing and balancing to adjust domestic water system. Balance system for required water flows at each plumbing fixture, terminal device, and recirculating hot water loop.

D. Water Hammer Arresters:

1. Install in piping systems where shown on Drawings and adjacent to pieces of equipment where quick closing valves are installed.
2. Install at all emergency safety showers and eyewashes.
3. Size and install in accordance with PDI-WH201.
4. Shock arresters to have access panels or to be otherwise accessible.

E. Valves: Install in accordance with manufacturer’s recommendations.

F. Miscellaneous Piping Specialties: Install in accordance with manufacturer’s recommendations.

G. Measuring Devices: Install in accordance with manufacturer’s recommendations.

## 3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

A. Installation:

1. Set piping above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
4. Extend vents minimum 1 foot above roof.
5. Provide cleanouts where shown and where required by code.

## 3.04 WATER SUPPLY PIPING

A. Water supply piping includes potable W1, hot water (HW), return hot water (RHW), tepid water (TW) systems and nonpotable W2 systems.

B. Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer's recommended flow.

C. Do not run water piping through electrical rooms, stairwells, or immediately over or within a 3-foot horizontal clearance of electrical panels, motor starters, or environmental control panels.

D. Provide exterior water piping with minimum 3 feet of cover or install below frost line, whichever is greater.

E. Hose Valves and Hydrants: Attach handle with setscrew and provide manufacturer's recommended gravel fill around drain hole of post hydrants.

F. Provide valve operators with position indicators, where indicated, to show position of valve disc or plug.

G. Provide bypass with globe valve for emergency throttling around each reducing valve.

H. Protect buried copper and steel pipe and fittings with a single wrap of coal-tar saturated felt in accordance with AWWA C203.

I. Vacuum Breakers 2 Inches and Smaller: Install minimum 6 inches above flood line of equipment they serve.

J. Provide manual air vents at high points in domestic hot water system.

3.05 FUEL GAS PIPING

A. Installation shall comply with applicable local gas code.

B. Slope piping 1/4 inch per foot downward in direction of flow toward respective drip traps.

C. Install drip traps at end of runs and where pipe changes elevation.

D. Provide union adjacent to each flexible connector hose.

E. Label “GAS” at intervals not to exceed 5 feet.

3.06 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

3.07 HANGERS AND SUPPORTS

A. Install pre-engineered support equipment in accordance with manufacturer’s recommendations.

B. Hanger Rod Sizing and Spacing for:

1. Steel Pipe:

| Pipe Size | Max. Hanger Spacing (feet) | Min. Rod Size (inches) |
|---|---|---|
| 1 inch and smaller | 6 | 1/4 |
| 1-1/4 through 2-1/2 inches | 8 | 1/4 |
| 3 and 4 inches | 10 | 3/8 |
| 6 inches | 12 | 3/8 |
| 8 inches | 12 | 1/2 |

2. Copper Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: 2 feet less per size than for steel pipe, except pipe 1-1/4 inches and smaller shall be supported every 6 feet.
3. Cast Iron Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: Locate hanger rods at each pipe joint and change of direction, 10-foot maximum spacing.

C. Attach Support Rods For Horizontal Piping:

1. To steel beams with I-clamps.
2. To concrete with inserts or with flanges fastened with flush shells.
3. To wood with thickness of 2-1/2 inches or more with bolts or angle clips.

D. Trapeze Hangers:

1. Trapeze hangers may be used in lieu of individual hangers where horizontal piping is arranged with two or more parallel lines.
2. Attach lines to horizontal with U-bolts or one-hole clamps.

E. Vertical Piping:

1. Support by channel type support system and pipe clamps on 10-foot maximum centers.
2. Copper, and Plastic Piping: Isolate from channels and pipe clamps with pipe isolators.

F. Insulated Piping: Furnish galvanized protection shield and oversized hangers under insulated piping.

3.08 INTERIM CLEANING

A. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

B. Examine piping to assure removal of foreign objects prior to assembly.

C. Shop cleaning may employ conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

3.09 TESTING

A. General:

1. Conduct pressure and leakage tests on newly installed pipelines.
2. Provide necessary equipment and material, and make taps in pipe, as required.
3. General Contractor will monitor tests. Provide 24-hour advance notice of start of testing.
4. Test Pressures: As specified herein and in Piping Schedule.

5. Test Records: Make records of each piping system installation during test to document the following:
    a. Date of test.
    b. Description and identification of piping tested.
    c. Test fluid.
    d. Test pressure.
    e. Remarks, including:
        1) Leaks (type, location).
        2) Repairs made on leaks.
    f. Certification by Contractor and signed acknowledgment by General Contractor that tests have been satisfactorily completed.

B. Testing New Pipe Connected to Existing Pipe: Isolate new pipe with grooved end pipe caps, spectacle blinds, or blind flanges.

C. Preparation and Execution:

1. Buried Pressure Piping:
    a. An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by Engineer.
    b. Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.
    c. Conduct final hydrostatic acceptance tests after trench has been completely backfilled.

2. Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

D. Hydrostatic Leak Tests:

1. Equipment: Provide the following:

| Amount | Description |
|---|---|
| 2 | Graduated containers |
| 2 | Pressure gauges |
| 1 | Hydraulic force pump |
| | Suitable hose and suction pipe as required |

2. Procedure:
    a. Use water as the hydrostatic test fluid.
    b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.

c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.
d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
e. Test piping systems at test pressure specified in Piping Schedule.
f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
g. Examine joints and connections for leakage.
h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
i. Correct visible leakage and retest until no leakage is present.

3. Buried Water Lines:
   a. A limited amount of leakage is permissible according to formula specified.
   b. Conduct hydrostatic testing as follows:
      1) Pipe with Concrete Thrust Blocking: Do not make pressure test until a minimum of 5 days after thrust blocking is installed.
      2) If high-early strength cement is used for thrust blocking, time may be reduced to 2 days.
   c. Expel air from piping system prior to testing.
   d. Apply and maintain specified test pressure with hydraulic force pump.
   e. Valve off the piping system when test pressure is reached.
   f. Conduct pressure test for 2 hours, reopening isolation valve only as necessary to restore test pressure.
   g. Accurately measure amount of water required to maintain test pressure by placing pump suction in a barrel or similar device, or by metering.
   h. The measurement represents leakage, defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.

i. Determine maximum allowable leakage in gallons per hour from the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

j. Correct leakage greater than the allowable determined under this formula, and retest until no leakage is present.

4. Test Pressure for Water: 1-1/2 times system pressure.
5. Gravity Sewers and Drains:
   a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
   b. Repair leaks and retest system until no further leakage is evident.

E. Pneumatic Leak Tests:

1. Perform on compressed air, natural gas, and vacuum piping.
2. Equipment: Provide the following:

| Amount | Description |
|---|---|
| 1 | Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure |
| 1 | Calibrated test gauge |

3. Procedure:
   a. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.
   b. Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.
   c. Test piping system at test pressure specified in Piping Schedule.
   d. Take necessary precautions to protect test personnel from hazards associated with air testing.
   e. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.

f. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
g. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.
h. Examine joints and connections for leakage with soap bubbles.
i. Correct visible leaks and retest until no leakage is present.
j. Gradually increase pressure in system to not more than one-half of test pressure.
k. Thereafter increase pressure in steps of approximately 1/10 of maximum test pressure until required test pressure is reached.
l. Maintain pneumatic test pressure continuously for minimum 10 minutes and for such additional time as necessary to conduct a soap bubble examination for leakage.
m. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.
n. Correct visible leakage retest until no leakage is present.
o. Following pneumatic testing, thoroughly purge lines that are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in system during filling process.

## 3.10 CLEANING AND DISINFECTION

A. Prior to final acceptance, following assembly and testing, flush pipelines with water, except for plant process air lines and instrument air lines, and remove accumulated construction debris and other foreign matter.

B. Minimum Flushing Velocity: 2.5 feet per second.

C. Insert cone strainers in the connections to attached equipment and leave until cleaning has been accomplished.

D. Remove accumulated debris through drains 2 inches and larger or by dropping spools and valves.

E. Immediately following drainage of flushed lines, dry piping with compressed air.

F. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

G. Disinfect pipelines intended to carry potable water before placing in service:

1. Meet the requirements of AWWA C651, unless otherwise specified.
2. Disinfecting Mixture:
   a. A chlorine-water solution having a free chlorine residual of 40 ppm to 50 ppm.

b. Prepare by injecting one of the following:
   1) Liquid chlorine gas-water mixture.
   2) Dry chlorine gas.
   3) Calcium or sodium hypochlorite and water mixture.
c. Inject mixture into pipeline at a measured rate while freshwater is allowed to flow through the pipeline at a measured rate so the combined mixture of freshwater and chlorine solution or gas is of the specified strength.
d. Apply liquid chlorine gas-water mixture by means of a chlorinating device.
e. Feed dry chlorine gas through proper devices for regulating the rate of flow and providing effective diffusion of gas into water within pipe being treated.
f. Chlorinating devices for feeding solutions of chlorine gas or gas itself must prevent backflow of water into chlorine cylinder.
g. Calcium Hypochlorite: If this procedure is used, first mix dry powder with water to make a thick paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine).
h. Sodium Hypochlorite: If this procedure is used, dilute liquid with water to obtain a 1 percent solution.
i. The following proportions of hypochlorite to water will be required:

| Product | Quantity | Water |
|---|---|---|
| Calcium Hypochlorite[1] (65 - 70 percent C1) | 1 lb | 7.5 gal |
| Sodium Hypochlorite[2] (5.25 percent C1) | 1 gal | 4.25 gal |

[1]Comparable to commercial products known as HTH, Perchloron, and Pittchlor.
[2]Known as liquid laundry bleach, Clorox, and Purex.

H. Point of Application:

1. Inject chlorine mixture into pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of pipeline.
2. Control clean water from existing system or another source so it flows slowly into newly installed piping during chlorine application.
3. Manipulate valves so the strong chlorine solution in the line being treated will not flow back into line supplying the water. Use check valves, if necessary.

I. Retention Period:

1. Retain treated water in pipeline for a minimum of 24 hours or long enough to destroy nonspore-forming bacteria.
2. At the end of the retention period, the disinfecting mixture shall have strength of at least 10 ppm of chlorine.
3. Operate valves, hydrants, and other appurtenances during disinfection to assure disinfecting mixture is dispersed into all parts of the pipeline including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
4. Do not place concentrated quantities of commercial disinfectants in pipeline before filling with water.
5. After chlorination, flush water from permanent source of supply until water through pipeline is equal chemically and bacteriologically to permanent source of supply.

J. Disposal of Disinfecting Water:

1. Dispose of disinfecting water in an acceptable manner that will protect the public and receiving waters from harmful or toxic concentrations of chlorine.
2. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.

## 3.11 BONDING

A. Buried Piping: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

## 3.12 PROTECTION OF INSTALLED WORK

A. Protective Covers:

1. Provide over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.
2. Cover roof drains and emergency overflow drains during roofing process so roofing material and gravel do not enter drain piping.
3. Remove at time of Substantial Completion.

## 3.13 FIELD FINISHING

A. Provide per Division 22, Plumbing.

3.14 PIPING IDENTIFICATION

A. Per ANSI/ASME A13.1.

3.15 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this Specification.

1. Plumbing Piping Schedule.
2. Plumbing Piping Data Sheets:

| Section Number | Title |
|---|---|
| 22 10 01.03 | Cast Iron Soil Pipe (CISP) and Fittings |
| 22 10 01.14 | Carbon Steel Pipe and Fittings—Special Service |
| 22 10 01.15 | Copper and Copper Alloy Pipe, Tubing, and Fittings |

**END OF SECTION**

| PLUMBING PIPING SCHEDULE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Legend** | **Service** | **Size(s) (in.)** | **Exposure** | **Piping Material** | **Specification Section** | **Operating Pressure (psig)** | **Test Type** | **Test Pressure (psig)** | **Pipe Colors and Labels** | **Notes** |
| D, SS | Sanitary Drain | All | EXP/BUR | CISP | 22 10 01.03 | NA | H | 5 | ANSI/ASME A13.1 | |
| HW, RHW | Hot Water, Potable | All | EXP/BUR | COP | 22 10 01.15i | | H | 90 | ANSI/ASME A13.1 | |
| NG | Natural Gas | All | EXP | STL | 22 10 01.14i | | P | 30 | ANSI/ASME A13.1 | |
| NG | Natural Gas | All | BUR | HDPE | 33 05 01.10 | | P | 30 | ANSI/ASME A13.1 | |
| SPD | Sump Pump Discharge | 1 - 3 | EXP/BUR | CISP | 22 10 01.03 | | H | 25 | ANSI/ASME A13.1 | |
| TP | Trap Primer | 1/2 - 3/4 | EXP/BUR | COP | 22 10 01.15i | NA | H | 90 | ANSI/ASME A13.1 | |
| TW | Tepid Water, Potable | All | EXP/BUR | COP | 22 10 01.15i | | H | 90 | ANSI/ASME A13.1 | |
| V, VTR | Sanitary Vent | All | EXP | CISP | 22 10 01.03 | NA | H | 5 | ANSI/ASME A13.1 | |
| W1 | Cold Water, Potable | All | BUR | HDPE | 33 05 01.10 | | H | 90 | ANSI/ASME A13.1 | |
| W1 | Cold Water, Potable | All | EXP | COP | 22 10 01.15i | | H | 90 | ANSI/ASME A13.1 | Copper Inside Building |
| W2 | Cold Water, Nonpotable | All | BUR | HDPE | 33 05 01.10 | | H | 90 | ANSI/ASME A13.1 | |
| W2 | Cold Water, Nonpotable | All | EXP | COP | 22 10 01.15i | | H | 90 | ANSI/ASME A13.1 | Copper Inside Building |

| Legend | | | | | |
|---|---|---|---|---|---|
| **Exposure** | | **Pressure Test** | | **Material** | |
| BUR | Buried | H | Hydrostatic | ACR | Air-Conditioning and Refrigeration |
| EXP | Exposed | I | In Service | CISP | Cast Iron Soil Pipe |
| SUB | Submerged | P | Pneumatic | CLDI | Cement-Lined Ductile Iron |
| ENC | Concrete Encased | NA | Not Applicable | CMP | Corrugated Metal Pipe |
| | | | | COP | Copper |
| | | | | DWV | Drain Waste and Vent |
| | | | | HDPE | High Density Polyethylene |
| | | | | MDPE | Medium Density Polyethylene |
| | | | | STL | Steel |

**END OF SECTION**

| SECTION 22 10 01.03<br>CAST IRON SOIL PIPE (CISP) AND FITTINGS | | |
|---|---|---|
| **Item** | **Size** | **Description** |
| Pipe | 6" and smaller | Hubless, CISPI 301, service weight, no-hub ends. |
| | 8" and larger | Hub and spigot, ASTM A74, service weight, single hub and spigot. |
| Joints | 6" and smaller | Coupling: Conform to ASTM C564, ASTM C1277, and CISPI 310.<br>Compression: Neoprene sealing sleeve with 24-gauge Type 304 stainless steel shield and clamp assembly.<br>Joints to dissimilar material shall comply with ASTM C1460. |
| | 8" and larger | Rubber gaskets, ASTM C564. |
| Fittings | 6" and smaller | Conform to ASTM A888 and CISPI 301 |
| | 8" and larger | Conform to ASTM A74 |
| Coating | All | Bituminous-coated inside and out; marked with manufacturer’s name or trademark and CISPI symbol. |

**END OF SECTION**

| SECTION 22 10 01.14<br>CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE | | |
|---|---|---|
| **Item** | **Size** | **Description** |
| Pipe | | Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints: |
| | 1-1/2" & smaller | Schedule 40. |
| | 2" thru 10" | Schedule 40. |
| | 12" thru 16" | Schedule 30. |
| | 18" thru 24" | Schedule 20. |
| Joints | 2" & smaller | Threaded or socket-welded; flanged at equipment as required or shown. |
| | 2-1/2" & larger | Butt-welded or flanged at valves and equipment. |
| Fittings | 2" & smaller | Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 2,000- or 3,000-pound WOG (3,000-pound chlorine service), conforming to ASME B16.11; bore to match pipe inside diameter. |
| | 2-1/2" & larger | Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. |
| Branch Connections | 2" & smaller | Threadolet or socket in conformance with Fittings above. |
| | 2-1/2" & larger | Butt-welding tee in accordance with Fittings above. |
| Flanges | 2" & smaller | Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face. |
| | 2-1/2" & larger | Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, 1/16-inch raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. |

| SECTION 22 10 01.14<br>CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE | | |
|---|---|---|
| **Item** | **Size** | **Description** |
| Unions | 2" & smaller | Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 2,000- or 3,000-pound WOG, integral ground steel-to-steel seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe. |
| Bolting | All | Carbon steel ASTM A193/A193M, Grade B7 studs; ASTM A194/A194M, Grade 2H hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. Quench and temper for chlorine service.<br>When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. |
| Gaskets | All flanges | General Service and Oil/Gas: 1/16-inch thick compressed nonasbestos composition flat ring type, rated 400 degrees F. continuous. Garlock, Blue-Gard 3000; Durlon 7950.<br>Steam Service: 1/8-inch thick compressed inorganic or carbon fiber with nitrile binder, flat ring type, rated 600 degrees F. continuous. Garlock, ST-706; Durlon, Style 8300; Leader Global Technologies, Type 2078.<br>Chlorine Unions: Chemical lead, 2 percent to 4 percent antimony, 1/8-inch thick. |
| Thread Lubricant | | General Service: 100 percent virgin PTFE Teflon tape.<br>Fuel Gas Service: Yellow Teflon tape designed for fuel gas service. Air Force A-A-58092. |

**END OF SECTION**

| SECTION 22 10 01.15<br>COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS | |
|---|---|
| **Item** | **Description** |
| General | Materials in contact with potable water shall conform to NSF 61 acceptance. |
| Pipe | Oxygen Service: Red brass, seamless, standard wall thickness, conforming to ASTM B43. |
| Tubing | Seamless, conforming to ASTM B88 as follows:<br>Water (buried) .....Type K, soft or hard temper<br>Water (exposed).....Type L, hard drawn<br>Domestic hot water .....Type L, hard drawn<br>P-Trap priming service .....Type L, soft temper |
| Fittings | ASTM B75 commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22. |
| Flanges | Class 150, ASTM B75 commercially pure wrought copper, socket joint, ASME B16.24 standard. |
| Bolting | ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. |
| Gaskets | 1/16-inch thick nonasbestos compression type, full face, Cranite, John Manville. |
| Solder | Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder.<br>Joints Larger than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder. |

**END OF SECTION**

**SECTION 22 30 00**
**PLUMBING EQUIPMENT**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Gas Association (AGA).
2. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. American Society of Mechanical Engineer's (ASME).
4. American Society of Sanitary Engineering (ASSE):
   a. 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Backflow Preventers.
   b. 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Backflow Fire Protection Assemblies.
5. American Water Works Association (AWWA):
   a. C510, Double Check Valve Backflow Prevention Assembly.
   b. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   c. C550, Protective Interior Coatings for Valves and Hydrants.
6. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
7. Canadian Standards Association (CSA):
   a. B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
   b. B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
8. FM Global (FM).
9. Food and Drug Administration (FDA).
10. Foundation for Cross-Connection Control and Hydraulic Research at University of Southern California (FCCHR): Manual of Cross-Connection Control.
11. International Code Council (ICC): International Plumbing Code (IPC).
12. National Electrical Code (NEC).
13. National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.
14. NSF International (NSF).
15. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's product data.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
2. Performance test report for submersible pump.

1.03 SPECIAL GUARANTEE

A. Where note below, provide manufacturer's extended guarantee in writing with Owner named as beneficiary. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of products found defective during the stated period after date of Substantial Completion.

**PART 2 PRODUCTS**

2.01 WATER HEATERS

A. Gas Water Heater:

1. Description:
   a. Type: Automatic, vertical, gas-fired, closed combustion, power direct vent, storage type.
   b. Regulatory Compliance: ASHRAE 90.1.
   c. Tank: Steel, glass-lined, 150 psig working pressure.
   d. Insulation: Foam or fiberglass type with minimum R value of 16.
   e. Thermal Trap: Factory installed on inlet and outlet.
   f. Dip Tube: Required on inlet connection down to bottom section of tank.
   g. Anode: Heavy-duty, tank-mounted, screw-in type.
   h. Pressure/Temperature Relief Valve: ASME rated.
   i. Connections: Inlet and outlet with factory-installed dielectric unions and brass drain valve with hose thread.
   j. Burner: Plus 95 percent efficient, cast iron, with primary air injection.
   k. Vent: Modular electric blower, power direct-vent, with 7-foot power three-prong connection. Two-pipe closed combustion system.

l. Vent Material: 3-inch Schedule 40 PVC, CPVC, or ABS pipe. Factory wall intake and vent terminals.
m. Controls: Fully automatic electronic temperature control, push-button pilot igniter.
n. Warranty: 1 year.

2. Capacity: See schedule on Drawings.
3. Manufacturers and Products:
   a. AO Smith; BTH Series.
   b. Bradford White; EF Series.
   c. Rheem; GHE Series.

2.02 DOMESTIC WATER EXPANSION TANK

A. Description:

1. Type: Prepressurized diaphragm type, horizontal or vertical per expansion tank data sheet at end of Section.
2. Shell: Welded steel.
3. Diaphragm: FDA-approved, heavy-duty butyl with polypropylene liner.
4. Connection Size: Per expansion tank data sheet at end of Section.
5. Maximum Operating Pressure: Per expansion tank data sheet at end of Section.
6. Maximum Operating Temperature: Per expansion tank data sheet at end of Section.
7. Finish: Manufacturer’s standard air-dry enamel.

B. Capacity: See data sheet at end of Section.

C. Manufacturer: AMTROL, Inc.; Model AST.

2.03 DOMESTIC HOT WATER CIRCULATING PUMP

A. Description:

1. Type: In-line, direct-drive, close-coupled centrifugal pump.
2. Construction: Bronze body, stainless steel face plate, glass-filled noryl impeller, carbon steel shaft, mechanical carbon on ceramic seals, and bronze oil lubricated motor bearings.
3. Motor: Permanent split-capacitor with thermal overload protection.
4. Accessories: Aquastat and automatic timer kit.

B. Capacity: See data sheet at end of Section.

C. Manufacturers:

1. Bell & Gossett.
2. Taco, Inc.
3. Grundfos Pump Corporation.

## 2.04 SUBMERSIBLE CENTRIFUGAL SUMP PUMPS

A. Duplex, Submersible Sump Pump:

1. Construction:
   a. Impeller and Volute: Nonclog design, ASTM A48/A48M, Class 30, cast iron capable of passing 2-inch spherical solid.
   b. Electrical: Water-resistant, UL listed and CSA approved electrical power cord.
   c. Motor: Sealed, oil-filled, NEMA B design with winding thermal sensors.
   d. Bearings and Shaft: Upper and lower thrust bearings, solid Type 303 stainless steel shaft.
   e. Seals: Two mechanical seals, carbon rotating seal face and ceramic stationary seal face, and lower seal failure sensor and warning device.
2. Controller:
   a. Control Panel: Fabricated steel, NEMA 4 enclosure, door disconnect switch, and bear UL listing mark. Components shall bear UL recognized marking. Wiring, schematics, and workmanship shall comply with NEC and UL.
   b. Wiring and Conduit: Minimum of MTH, 600V rated, 18-gauge with 90 degrees C rating, in accordance with NEC standards. Wire sized in accordance with NEC standards.
   c. Motor Protection: Magnetic motor starter, across the line type, UL listing mark, under voltage and over voltage protection with manual reset button mounted in panel door.
   d. Level Sensors (Duplex): Automatic pump cycle and alternation. Polypropylene encapsulated mechanical level sensors for pump on, pump off, and override (standby pump on). Additional level sensor shall activate audible-visual panel mounted light and horn. Panel mount, push-to-silence button for deactivating audible alarm.
3. Sump:
   a. Construction: Fiberglass basin with corresponding cover plate.
   b. Cover Plate: With vaportight gasket, hinged equipment doors with drop handles, accessory mounting plates, discharge and vent pipe openings, and sealed power and control cable openings.

4. Quick Removal System:
    a. Fittings: Steel baseplate with cast iron stationary fitting, removable discharge fitting, and gasket material for positive locking.
    b. Rails: Galvanized steel guide rails and base plate with stainless steel lifting rope.
5. Capacity: See data sheet at end of Section.
6. Manufacturers:
    a. Hydromatic Pumps.
    b. Liberty Pump.
    c. Weil Pump Company, Inc.

2.05 BACKFLOW PREVENTERS

A. Reduced-Pressure Backflow Preventers (3/4-Inch Through 2 Inches):

1. Description:
    a. Regulatory Compliance: AWWA C511, CSA B64.4, FCCHR of USC Section 10, ASSE 1013, ICC (IPC).
    b. Valve Body: Bronze.
    c. End Connections: Threaded, NPT.
    d. Maximum Working Pressure: 175 psi (350 psi test).
    e. Temperature Range: 32 to 140 degrees F.
    f. Shutoff Valve: Full port, resilient seated, bronze ball valve with bronze ball valve test cock.
    g. Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.
    h. Accessories: Drainline air gap fitting.
2. Sizes: See data sheet at end of Section.
3. Manufacturers and Products:
    a. Febco; Model 860.
    b. Watts; Model 909.
    c. Wilkins; Model 975.

B. Water Meter and Meter Boxes: Refer to civil utility design drawings.

**PART 3 EXECUTION**

3.01 INSTALLATION

A. Install, arrange, and connect equipment as shown on Drawings and in accordance with manufacturer’s recommendations.

3.02 FIELD QUALITY CONTROL

A. Pumps: Do not hydrostatic test pumps with mechanical seals.

B. Startup:

1. In accordance with Section 01 91 14, Equipment Testing and Facility Startup, and Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Piping Systems: Verify that flushing, cleaning, and testing has been completed prior to startup.

3.03 SUPPLEMENT

A. Supplement listed below, following "End of Section," is a part of this Specification.

1. Domestic Water Expansion Tank Data Sheet.

**END OF SECTION**

| Domestic Water Expansion Tank Data Sheet | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Tag Number** | **Configuration (horiz/vert)** | **Total Volume (gallons)** | **Acceptance Volume (gallons)** | **Air Precharge (psi)** | **Diameter (inches)** | **Height (inches)** | **Manufacturer, Model No.** |
| ET-01 | Vertical | 4.7 | 2.4 | 12 | 12 | 12 | Amtrol, Model AST-12 |

**SECTION 22 40 00**
**PLUMBING FIXTURES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Americans with Disabilities Act (ADA).
2. American Gas Association (AGA).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
6. Food and Drug Administration (FDA).
7. Plumbing and Drainage Institute (PDI):
   a. Code Guide 302 and Glossary of Industry Terms.
   b. WH-201, Water Hammer Arrester Standard.
8. Underwriters Laboratories Inc. (UL).

1.02 SUBMITTALS

A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

## PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fixture Trim:

1. Supply Stops and Traps:
   a. McGuire.
   b. American Standard.
   c. Kohler.
2. Flush Valves:
   a. Sloan.
   b. Zurn.

3. Water Closet Seats:
    a. Bemis.
    b. Church.
    c. Olsonite.
4. Lavatory Supply, Tailpiece, and Trap Insulation:
    a. McGuire.
    b. Trap Wrap.
    c. Truebro.

B. Plumbing Fixtures:

1. Water Closets and Lavatories:
    a. American Standard.
    b. Kohler.
    c. Zurn.
2. Faucet Fittings:
    a. Lavatories:
        1) Chicago.
        2) Symmons.
        3) Zurn.

C. Emergency Showers and Eyewashes:

1. Haws.
2. Western.
3. Guardian.

D. Drainage Products:

1. General:
    a. Smith.
    b. Wade.
    c. Zurn.

E. Plumbing Specialties:

1. Shock Arresters:
    a. Smith.
    b. Sioux Chief.
    c. Precision Plumbing Products.
2. Trap Primers:
    a. Precision Plumbing Products.
    b. Smith.
    c. Wade.

3. Pressure/Temperature Relief Valves:
    a. Cash-Acme.
    b. Kunkle Valve.
    c. Watts.
4. Pressure Gauges:
    a. Ashcroft.
    b. Marsh.
    c. Marshalltown.
5. Thermometers:
    a. Trerice.
    b. Weksler.

2.02 GENERAL

A. Fixture Trim: Provide plumbing fixture trim where applicable on fixtures.

B. Plumbing Fixtures: Indicated by fixture number as shown on Drawings.

C. Drainage Products: Indicated by fixture number as shown on Drawings.

D. Plumbing Specialties: Indicated by fixture number as shown on Drawings.

E. Exposed fixture connections and piping shall be polished chrome-plated.

2.03 MATERIALS

A. Fixture Trim:

1. Supply Stop:
    a. Flexible supply with heavy cast brass, loose key, 1/2-inch IPS by 3/8-inch outside diameter tubing angle stop to wall with escutcheon plate; chrome-plated finish.
    b. Provide stop with stuffing box.
    c. Manufacturer: McGuire Manufacturing Company, Inc.
2. Trap:
    a. Chrome-plated, 17-gauge, semicast P-trap with compression ring cast brass waste and vent connection and cleanout.
    b. 1-1/2 inches for lavatories and drinking fountains.
    c. 1-1/2 inches for sinks.
    d. Manufacturer: McGuire Manufacturing Company, Inc.
3. Water Closet Flush Valves: low flush, quiet action with screwdriver stop and vacuum breaker.

B. Plumbing Fixtures: See schedule on Drawings for fixture and trim specifications.

C. Plumbing Specialties:

1. Water Hammer Arresters:
   a. Materials: ASSE 1010 certified, Type L copper tube, HHPP piston with two lubricated EPDM O-rings, FDA approved lubricant, rolled piston stop, wrought copper male thread adapter.
   b. Manufacturer and Product: Sioux Chief Mfg. Co., Inc.; Series 650 and 660.
2. Pressure/Temperature Relief Valve:
   a. Materials: ASME/AGA rated, bronze body construction, vacuum relief valve vent in drain, backup emergency safety fuse plug, tamper-resistant bonnet screws, test lever, short thermostat, and automatic reseating.
   b. Manufacturer and Product: Watts Industries, Inc.; Series 40.
3. Pressure Gauge:
   a. Materials: 3-1/2-inch gauge size, 0 to 160 psi range, steel case, glass crystal, brass movement, and 1/3-inch NPT lower connection.
   b. Manufacturer and Product: Ashcroft Dresser Instrument Division, Dresser Industries, Inc.; Type 1008.
4. Thermometer:
   a. Materials: Adjustable angle, red reading mercury type with 9-inch case and 30 degrees F to 180 degrees F range, 3-1/2-inch aluminum stem, and separate NPT brass thermowell.
   b. Manufacturer and Product: H.O. Trerice Co.; Model A005.

D. Sealant: In accordance with Section 07 92 00, Joint Sealants.

## PART 3 EXECUTION

### 3.01 PREPARATION

A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Engineer for review before proceeding with the Work.

### 3.02 INSTALLATION

A. Fixture Trim: Install fixture trim where applicable on fixtures.

B. Plumbing Fixtures, Mounting Heights:

1. Standard rough-in catalogued heights, unless shown otherwise on Drawings.

2. Caulk fixtures in contact with finished walls with waterproof, white, nonhardening sealant which will not crack, shrink, or change color with age. See Section 07 92 00, Joint Sealants.

C. Exact fixture location and mounting arrangement shall be as indicated on toilet room elevations and details as shown on Drawings.

D. Unless noted otherwise and as a minimum, fixtures shall be supported as indicated in PDI Code Guide 302.

E. Safety Equipment:

1. System Shutoff Valves:
   a. Shutoff valves shall give visual indication of position (open or closed).
   b. Shutoff valves shall be lockable valves and locked in open position.
2. Each safety shower, eyewash, combination safety shower/eyewash shall have red safety signoff tag. After completing requirements listed below, Contractor and Owner shall sign red safety signoff tag. Requirements are as follows:
   a. Visually check safety shower/eyewash piping for leaks.
   b. Verify that upon operation, stay-open valves remain open.
   c. Showerheads to be between 82 inches and 96 inches above standing surface.
   d. Shower spray pattern, when valve is full open, shall be a minimum 20 inches in diameter at 60 inches above standing surface.
   e. Water arcs from eyewash spray heads must cross. Test with eyewash gauge; Haws Drinking Faucet Co., Model 9015.
   f. Minimum flow rates for safety showers shall be 20 gpm.
   g. Minimum flow rates for eyewashes shall be 3 gpm.
   h. Tempered water shall be temperature indicated on Drawings.

F. Drainage Products:

1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
2. Cleanouts: Install where shown or required for purposes intended. Set cover flush with finished floor.

G. Plumbing Specialties:

1. Shock Arresters:
   a. Install PDI-certified and rated shock arresters, sized and located in accordance with PDI WH-201 and as shown on Drawings.

b. Install adjacent to equipment wherein quick closing valves are installed.
c. Install at each emergency safety shower.
d. Shock arresters to have access panels or to be otherwise accessible.

2. Drain P-Trap Priming:
   a. Pipe: Type K, soft copper.
   b. Trap and prime floor drains and hub drains, unless shown otherwise on Drawings. No attempt has been made to show trap primer valve locations or trap primer pipe routing.
   c. Field route trap primer piping during installation of floor drains and hub drains, and install trap primer valves in mechanical rooms, janitor rooms, or other locations acceptable to Engineer.
3. Trap Priming Valves:
   a. Floor drain traps primed with priming valves, 1/2-inch copper to floor drain.
   b. Two traps maximum primed from one priming valve or as recommended by manufacturer. Locate in mechanical spaces or janitor's rooms and as indicated on Drawings.
   c. Provide shutoff valve ahead of priming valves.
4. Thermometers and Pressure Gauges:
   a. Arrange devices to facilitate use and observation.
   b. Install in orientation that will allow clear observation from ground level.
   c. Provide pressure gauges with block valves.
   d. Install thermometers in thermowells.

H. Caulk penetrations of exterior walls with weatherproof sealant in accordance with Section 07 92 00, Joint Sealants.

I. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

## 3.03 FIELD QUALITY CONTROL

A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

B. Notify Owner and Engineer 48 hours prior to shower testing. Owner and Engineer reserve the right to witness all tempered water and safety shower testing.

C. Test safety shower and eyewash units. Water flow must be tested at both showerhead and eyewash/face ring.

1. Shower Flow:
   a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 5-gallon container.
   b. Container shall fill in 10 seconds or less, with a minimum 20-gpm flow.
2. Eyewash Flow:
   a. Test with tube-type water gauge (Haws Drinking Faucet Co., Model 9010) and 1-gallon container.
   b. Container shall fill in 20 seconds or less.
3. Contractor shall log, date, and initial inspection upon passing flow tests.

**END OF SECTION**

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

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Air Moving and Conditioning Association, Inc. (AMCA): 203, Field Performance Measurement of Fan Systems.
2. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE): HVAC Applications Handbook.
3. Associated Air Balance Council (AABC): National Standards for Field Management and Instrumentation Total System Balance.
4. National Environmental Balancing Bureau (NEBB):
   a. Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
   b. Procedural Standards for Measuring Sound and Vibration.
5. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Testing, Adjusting, and Balancing Manual.

### 1.02 SUBMITTALS

A. Informational Submittals:

1. Documentation of experience record of testing authority.
2. Documentation of current AABC or NEBB certifications for those technicians in responsible charge of the Work under this Contract.
3. Submit detailed test and balance procedures, including test conditions for systems to be tested, prior to beginning the Work.
4. Written verification of calibration of testing and balancing equipment.
5. Balancing Log Report following completion of system adjustments including test results, adjustments, and rebalancing procedures.

### 1.03 QUALITY ASSURANCE

A. Air Balancing and Test Agency Qualifications:

1. Certification by AABC of NEBB for testing, adjusting and balancing of HVAC systems.
2. Corporately and financially independent organization functioning as an unbiased testing authority.
3. Professionally independent of manufacturers, suppliers, and installers of HVAC equipment being tested.
4. Have a proven record of at least five similar projects.

5. Employer of engineers and technicians regularly engaged in testing, adjusting and balancing of HVAC equipment and systems.

## PART 2 PRODUCTS

2.01 MATERIALS

A. Provide materials, tools, test equipment, computers and instrumentation required to complete the Work included.

B. Test Hole Plugs: Plug test holes in ducts with plugs made for that purpose and replace any insulation removed to specified conditions.

C. Drives for Belt-Driven Fans:

1. Furnish cast iron or flanged steel sheaves.
2. Sheaves and belt combination shall be capable of providing 150 percent of motor horsepower.

## PART 3 EXECUTION

3.01 GENERAL

A. Adjust and balance air and water systems in accordance with standard procedures and recognized practices of the AABC or SMACNA.

B. Adjust and balance the following systems:

1. Exhaust air systems.

3.02 ADJUSTING AND BALANCING AIR SIDE

A. Preparation:

1. Prior to beginning the Work, perform the following activities:
   a. Review Shop Drawings and installed system for adequate and accessible balancing devices and test points.
   b. Recommend to Engineer dampers that need to be added or replaced in order to obtain proper air control.
   c. Verify proper startup procedures have been completed on the system
   d. Verify controls installation is complete and system is in stable operation under automatic control.
   e. Verify test instruments have been calibrated to a recognized standard and are within manufacturer’s recommended calibration interval before beginning the Work.

B. General:

1. When adjustments are made to a portion of a fan system, reread other portions of that same system to determine effects imposed by adjustments. Readjust as necessary.
2. Lock and mark final positions of balancing dampers with permanent felt pen.
3. Correct fan and airflow measurements for Site elevation.

C. Equipment Data:

1. Collect the following data and included in final report:
    a. Type of unit.
    b. Equipment identification number.
    c. Equipment nameplate data (including manufacturer, model, size, type, and serial number).
    d. Motor data (frame, hp, volts, FLA rpm, and service factor).
    e. Sheave manufacturer, size, and bore.
    f. Belt size and number.
    g. Sheave centerline distance and adjustment limits.
    h. Starter and motor overload protection data.
    i. Include changes made during course of system balancing.

D. Fan Systems:

1. Measure fan system performance in accordance with AMCA 203.
2. In each system at least one airpath from fan to final branch duct termination shall have dampers fully open. Achieve final air quantities by adjusting fan speed.
3. Adjust Fan Air Volumes:
    a. Adjust fan speeds and motor drives for required equipment air volumes, with allowable variation of plus 10 percent minus 0 percent.
    b. After final adjustments, do not operate motor above nameplate amperage on any phase.
    c. After final adjustments, do not operate fan above maximum rated speed.
    d. Perform airflow test readings under simulated or actual conditions of full cooling, full heating, minimum outside air, full outside air and exhaust, and full return air.
    e. Provide and make drive and belt changes on motors or fans as required to adjust equipment to specified conditions. Drives shall be able to deliver 150 percent of motor horsepower.
4. Adjust outside air dampers, return air dampers, relief air dampers, exhaust air dampers, and motorized louvers for maximum and minimum air requirements.

5. Read and record static pressures at unit inlet and discharge, each filter set, coils, dampers, plenums, and mixing dual-duct or adjustable-volume boxes, on every supply, return, and exhaust fan for each test condition.
6. Read and record motor amperage on all phases for each test condition.

3.03 FIELD QUALITY CONTROL

A. General: Perform functional tests as required by Section 01 91 14, Equipment Testing and Facility Startup.

B. Performance Testing:

1. Gas and Electric Heating Coil Testing:
   a. Adjust system as required to achieve full output from coil.
   b. Read and record amperages and voltages for all phases.

C. Quality Control Verification:

1. After adjustments have been completed, Contractor shall be available to demonstrate the following:
   a. Air balancing procedures, and verification of test results.

**END OF SECTION**

**SECTION 23 31 13**
**METAL DUCTS AND ACCESSORIES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Air Movement and Control Association (AMCA): 500, Test Methods for Louvers, Dampers and Shutters.
2. American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Handbook.
3. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
4. Association of the Nonwoven Fabrics Industry (INDA): IST 80.6, Water Resistance (Hydrostatic Pressure).
5. ASTM International (ASTM):
    a. A36/A36M, Standard Specification for Carbon Structural Steel.
    b. A90/A90M, Standard Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
    c. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
    d. A176, Standard Specification for Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip.
    e. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
    f. A480/A480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
    g. A568/A568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
    h. A653/A653M, Standard Specifications for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
    i. A700, Standard Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment.
    j. A924/A924M, Specification for General Requirements for Sheet Steel, Metallic-Coated by the Hot-Dip Process.
    k. A1008/A1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

l. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
m. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
n. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
o. C916, Standard Specification for Adhesives for Duct Thermal Insulation.
p. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
q. C1139, Standard Specification for Fibrous Glass Thermal Insulation for Sound Absorbing Blanket and Board for Military Applications.
r. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
s. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.

6. National Air Duct Cleaners Association (NADCA): General Specifications for the Cleaning of Commercial Heating, Ventilation and Air Conditioning Systems.
7. National Fire Protection Association (NFPA):
   a. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
   b. 90B Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   c. 96, Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
   d. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   e. 259, Standard Test Method for Potential Heat of Building Materials.
   f. 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
8. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Duct Construction Standards.
   b. Guidelines for Seismic Restraints of Mechanical Systems.
   c. Fibrous Glass Duct Construction Standards.
   d. Fire, Smoke, and Radiation Damper Installation Guide for HVAC Systems.
   e. HVAC Air Duct Leakage Test Manual.
9. Underwriters Laboratories Inc. (UL):
   a. 181, Standard for Safety Factory-Made Air Ducts and Connectors.

b. 214, Standard for Tests for Flame-Propagation of Fabrics and Films.
c. 555, Standard for Safety Fire Dampers.
d. 555S, Standard for Safety Smoke Dampers.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:

1. CFM: cubic feet per minute.
2. FPM: feet per minute.
3. PCF: pounds per cubic foot.
4. WC: water column.

B. Sealing Requirements: For the purpose of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: Joining of two longitudinally (in direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on perimeter are deemed to be joints.
2. Joints, duct surface connections including:
   a. Girth joints.
   b. Branch and subbranch intersections.
   c. Duct collar tap-ins.
   d. Fitting subsections.
   e. Louver and air terminal connections to ducts.
   f. Access door, and access panel frames and jambs.
   g. Duct, plenum, and casing abutments to building structures.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data:
   a. Rectangular, Rigid Round, and Oval Ductwork:
      1) Schedules of duct systems, materials, joints, sealing, gage and reinforcement.
      2) SMACNA Figure Numbers for each shop fabricated item.
      3) Reinforcing details and spacing.
      4) Seam and joint construction details.
      5) Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
   b. Ductwork Accessories:
      1) Manufacturer’s product data including catalog sheets, diagrams, standard schematic drawings, installation instructions and details, details of materials, construction,

dimensions of individual components, and finishes, including the following items:

a) Fittings and volume control damper installation (both manual and automatic) details.
b) Duct liner.
c) Sealing materials.
d) Dampers; include leakage, pressure drop, and maximum back pressure data.
e) Duct-mounted access panels and doors.
f) Flexible ducts.
g) Sheet metal fasteners.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
2. Record Drawings: Include duct systems routing, fittings details, and installed accessories and devices.

1.04 QUALITY ASSURANCE

A. Industry Standards:

1. Unless otherwise indicated or specified, sheet metal ductwork shall be constructed and installed in accordance with SMACNA Duct Construction Standards relevant to ductwork system being provided. These standards are herein referenced as the SMACNA Manual, unless otherwise indicated.
2. Comply with ASHRAE Fundamentals Handbook recommendations, except as otherwise indicated.
3. NFPA Compliance: NFPA 90A and NFPA 90B.

B. Manufacturers: Firms regularly engaged in manufacture of ductwork products of types, materials, and sizes required, whose products have been satisfactorily used in similar service for not less than 5 years.

C. Suppliers of duct and fitting components shall provide on request the following information:

1. Laboratory performance data for duct, including leakage rate, bursting strength, collapse strength, seam strength, and pressure loss.
2. Laboratory performance data for fittings, including zero-length dynamic losses.

D. Installer shall be a firm with at least 3 years' experience of successful installation on ductwork systems similar to that required for this Project.

E. Changes or alterations to layout or configuration of duct system shall be:

1. Specifically approved in writing by Engineer.
2. Proposed layout shall provide original design results, without increasing system total pressure.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect ductwork from dirt, water, and debris. During storage on Job Site, keep ends of ductwork covered to prevent foreign objects and water from entering ductwork.

B. If fabricated sound-lined ductwork gets wet during installation, remove and dispose of ductwork from the Site.

C. Deliver sealant materials to Site in original unopened containers labeled with manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

D. Store and handle sealant materials in compliance with manufacturers' recommendations to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

E. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

**PART 2 PRODUCTS**

2.01 GENERAL

A. Specified components of this ductwork system, including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Internally Lined Ductwork: Duct sizes indicated for internally lined ducts are the clear inside dimensions, and shall be increased in both dimensions by twice the thickness of the liner.

C. Ductwork thinner than 26-gauge will not be allowed.

D. Ductwork Interior Surfaces:

1. Smooth.
2. No sheet metal parts, tabs, angles, or other items may project into air ducts, unless otherwise specified.

3. Seams and joints shall be external.
4. For ductwork that is required to be reinforced, use only external reinforcing.

## 2.02 SHEET METAL MATERIALS

A. Construct metal duct systems from galvanized steel.

B. Where no specific ductwork materials are indicated in Specifications or on Drawings, galvanized steel sheet metal shall be basis of Contract.

C. Galvanized Steel Ductwork:

1. Comply with ASTM A653/A653M and ASTM A924/924M.
2. Product Name: Steel Sheet, Zinc Coated (Galvanized Steel).
3. Sheet Designation: CS Type B.
4. Applicable Specification: ASTM A653/A653M.
5. (Zinc) Coating Designation: G90.
6. Coating designation in accordance with Test Method A, ASTM A90/A90M. and ASTM A924/A924M.
7. Provide mill-phosphatized finish for ducts exposed to view and for ducts scheduled to be painted.
8. Provide sheet metal packaged and marked as specified in ASTM A700.

D. Exposed Ductwork: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including pitting, seam marks, roller marks, oil canning, stains, discoloration, and other imperfections.

E. Reinforcement Shapes and Plates: Unless otherwise indicated, provide reinforcements of same material as ductwork.

## 2.03 DUCT SEALING MATERIALS

A. General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Adhesives, Cements, Sealant, and Installation Accessories: As recommended by duct manufacturer for application.

C. Solvent-Based Sealants:

1. Ultraviolet light resistant.
2. Mildew resistant.
3. Flashpoint: Greater than 70 degrees F, SETA CC.

4. Manufacturers and Products:
    a. Hardcast, Inc.; Versagrip 102.
    b. Rectorseal; AT-33.
    c. Childers CP-140.

D. Water-Based Sealants:

1. Listed by manufacturer as nonflammable in wet and dry state.
2. Manufacturers and Products:
    a. Foster; Series 32.
    b. Childers; CP-145A, 146.
    c. Rectorseal; Airlok 181.

## 2.04 DUCTWORK FASTENERS

A. General:

1. Rivets, bolts, or sheet metal screws.
2. Ductwork fasteners shall be same metal as duct being supported, unless otherwise noted.

B. Self-Drilling Screws:

1. Galvanized Steel Ductwork System: Sheet metal screws shall be hex washer head (HWH) TEKS® self-drilling type, formed from heat-treated carbon steel with zinc electroplated finish.

## 2.05 DUCTWORK PRESSURE CLASS

A. Construct duct systems to pressure classifications indicated as follows:

1. Supply Ducts: 3-inch WC.
2. Return Ducts: 2-inch WC, negative pressure.
3. Exhaust Ducts: 2-inch WC, negative pressure.

## 2.06 RECTANGULAR DUCTWORK

A. Fabricate rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible, unless specified otherwise.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20-gauge or less, with more than 10 square feet of unbraced panel area, as indicated in SMACNA Manual, unless they are lined or are externally insulated.

## 2.07 RECTANGULAR DUCTWORK FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

B. Elbows:

1. Fit square-turn elbows with vane side rails.
2. Shop fabricate double-blade turning vanes of same material as ductwork.
3. Fabricate with equal inlet and outlet.
4. Rectangular radius elbows with inside radius of 3/4 of duct width in direction of turn.

## 2.08 RECTANGULAR DUCTWORK BRANCH CONNECTIONS

A. Branch duct connections to rectangular duct mains shall be made using factory-fabricated fittings with spot welded tap to main duct connections.

## 2.09 DUCTWORK HANGERS AND SUPPORTS

A. General:

1. Attachments, hangers, and supports for ductwork shall be in accordance with SMACNA Manual referenced for type of duct system being installed.
2. Duct hanging system shall be composed of three elements; upper attachment to building, hanger itself, and lower attachment to duct.
3. Wire hangers are not acceptable.
4. Hanger Spacing:
   a. Ducts Up to 60 inches in Largest Dimension: 10 feet, maximum.
   b. Ducts Over 61 inches in Largest Dimension: 8 feet, maximum.

B. Construction Materials: Supporting devices including, but not limited to, angles used for support and bracing, baseplates, rods, hangers, straps, screws, bolts shall be as follows:

1. Galvanized Steel Ductwork:
   a. Indoors: Carbon steel, zinc electroplated.
   b. Outdoors: Carbon steel, hot-dipped galvanized after fabrication.
2. Aluminum Ductwork Indoors and Outdoors:
   a. Carbon steel, hot-dipped galvanized after fabrication.
   b. Non-metallic pad between lower attachment and ductwork, to achieve dielectric separation.

3. Stainless Steel Ductwork Indoor and Outdoors: Stainless steel, same ASTM Grade as ductwork.

C. Building Attachments:

1. Concrete inserts, powder-actuated fasteners, or structural steel fasteners appropriate for building materials.
2. Do not use powder-actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.
3. Upper Attachment (Concrete):
   a. Drive pin fastener and expansion nail anchor may be used for ducts up to 18-inch maximum dimension.
   b. Threaded stud fastener may be used for ducts up to 36-inch maximum dimension.
   c. Concrete attachments shall be made of steel.

D. Duct Fasteners: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials and conforming to requirements of Article Ductwork Fasteners.

E. Trapeze and Riser Supports: Steel shapes conforming to ASTM A36/A36M, hot-dipped galvanized after fabrication.

## 2.10 DUCTWORK FLEXIBLE CONNECTIONS

A. General:

1. Factory fabricated metal-edged fabric flexible connectors for commercial or industrial applications.
2. Sheet metal permanently secured to fabric with double fabric fold, double metal crimp.
3. Comply with NFPA 90A and NFPA 90B requirements.
4. Airtight and waterproof.

B. Materials:

1. Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.
2. Metal Edges: Construct from same material as ductwork, unless otherwise noted.
3. Fabric:
   a. Comply with NFPA 701 or UL 214 (except Teflon coated).
   b. Woven polyester or nylon for most applications.
   c. Woven fiberglass for high temperature applications.
   d. Coating: Vinyl or neoprene.

C. Construction:

1. Fold and crimp metal edge strips onto fabric as illustrated in SMACNA Manual.
2. Standard Metal Edged Connectors: Strip of fabric 3 inches wide attached to two strips of 3-inch-wide sheet metal.
3. Wide Metal Edged Connectors: Strip of fabric 4 inches wide attached to two strips of 4-inch-wide sheet metal.
4. Extra Wide Metal Edged Connectors: Strip of fabric 6 inches wide attached to two strips of 6-inch-wide sheet metal.

D. Manufacturers:

1. Ductmate; PROflex, Commercial.
2. Ventfabrics.
3. Duro-Dyne.

## 2.11 CEILING ACCESS DOORS

A. Size: 30 inches by 30 inches.

B. Finish in primer finish suitable for field painting.

C. Manufacturers:

1. Inryco Milcor.
2. Krueger.

## 2.12 DUCT INSPECTION DOORS

A. General:

1. Insulated, gasketed, and at least 15 inches by 15 inches when duct dimensions are large enough.
2. On ductwork where largest side dimension is less than 16 inches, furnish inspection doors at least 8 inches by 8 inches.
3. Complete with necessary hardware and either Amerlock 10 or Ventlock No. 100 latches, and Ventlock Series No. 100 hinges.
4. Fabricated of same material as ductwork.

B. Round Spin-in Type Access Doors:

1. Size: 18-inch and 24-inch diameter will be acceptable in lieu of comparable size square or rectangular access doors specified herein.
2. Complete with insulation, spin-in frame, inner door, attachment cable, gaskets, three latches, and pull ring.
3. Manufacturer and Product: Flexmaster; Inspector Series.

C. Manufacturers:

1. Ventlok.
2. Duro-Dyne.
3. Flexmaster.

## 2.13 MANUAL DAMPERS

A. Butterfly Manual Dampers:

1. Fabricate from two gauges heavier than duct in which installed, of same material as ductwork.
2. Align operating handle with damper blade.
3. Provide 2-inch standoff bracket for insulated duct systems.
4. Damper Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.

B. Manual Opposed-Blade Balancing Dampers:

1. Externally operated gang airfoil, damper blades.
2. Fabricate from same material as ductwork.
3. Stainless steel or nylon sleeve bearings.
4. Construction shall have interlocking edges and maximum 10-inch blade width.
5. Manufacturers:
   a. Ruskin.
   b. American Warming and Ventilating.

## 2.14 BACK DRAFT DAMPERS

A. General: Damper pressure drop ratings shall be based on tests and procedures performed in accordance with AMCA 500.

B. Steel Frame, Nonmetallic Blades:

1. Fabrication:
   a. Frame: 2 inches by minimum 18-gauge (51 mm by minimum 1.6 mm) galvanized steel with windstops to reduce backflow.
   b. Blades:
      1) Style: Single piece, independent.
      2) Action: Parallel.
      3) Material: Noncombustible, neoprene coated fiberglass.
      4) Orientation: Horizontal.
      5) Width: Maximum 6 inches (152 mm).
   c. Rear Bird Screen: Galvanized expanded metal.

d. Mounting:
1) Suitable for mounting in vertical or horizontal airflow up positions.
2) Configured for positions as shown on Drawings.
e. Finish: Mill galvanized.

2. Performance Data:
a. Temperature Rating: Withstand minus 30 degrees to 200 degrees F (minus 34 degrees to 93 degrees C).
b. Maximum Back Pressure: 4-inch WC (1.0 kPa).
c. Maximum System Air Velocity: 1,000 fpm (5.1 m/s).
d. Maximum Spot Air Velocity: 1,200 fpm (6.1 m/s).

3. Accessories:
a. Duct Transition Connection: Rectangular.
b. Factory Sleeve: Minimum 20-gauge (1.0 mm) thickness, minimum 8 inch (203 mm) length.

4. Manufacturers and Products:
a. Ruskin; Model NMS2.
b. Vent Products, Co.

## 2.15 CONTROL DAMPERS

A. General:

1. Specification applies to control dampers, except those specified to be furnished with equipment.
2. Furnish opposed-blade type for proportional action and parallel-blade type for two-position action, except where indicated otherwise.

B. Standard Duty Control Dampers (M):

1. Frame:
a. Nominal 5 inches deep, minimum 16-gauge roll formed, hat-shaped channel, reinforced at corners. (Structurally equivalent to 13 gauge (2.3 mm) U-channel.)
b. Material: Galvanized steel.

2. Blades:
a. Style: Single skin with three longitudinal grooves, minimum.
b. Orientation: Horizontal or vertical with thrust washers, as indicated on Drawings.
c. Minimum 14 gauge equivalent thickness.
d. Material: Galvanized steel.
e. Width: Nominal 6 inches (152 mm).

3. Bearings: Molded synthetic sleeve, turning in extruded hole in frame.
4. Seals:
a. Blade Seals: Mechanically attached to blade edge.
b. Jamb Seals: Flexible metal compression type.

5. Linkage: Concealed in frame.
6. Axles:
    a. Minimum 1/2 inch (13 mm) diameter, hex-shaped, mechanically attached to blade.
    b. Material: Plated steel.
7. Performance Data: As follows:
    a. Temperature Rating: Withstand minus 76 to 350 degrees F (minus 60 to 177 degrees C).
    b. Closed Position: Maximum pressure of 13 inches w.g. at a 12-inch blade length.
    c. Open Position: Maximum air velocity of 6,000 feet per minute.
    d. Leakage: Maximum 2 cubic feet per minute per square foot at 1-inch w.g. for all sizes 24 inches wide and above.
    e. Pressure Drop: Maximum 0.05 inch w.g. at 1,500 feet per minute across 24-inch by 24-inch damper.
    f. T-Flange Frame:
        1) Minimum 6-inch by 1-3/8-inch by 0.125-inch aluminum, bolt holes in corners.
        2) Mates to: TDC, TDF, Ductmate, Nexus, Ward, and other T-flange duct connections.
    g. Factory Sleeve: Minimum 20 gauge (1 mm) thickness, minimum 12-inch (305 mm) length.
    h. Duct Transition Connection: Configuration to suit ductwork cross-section, as shown on Drawings.
8. Manufacturers and Products:
    a. Ruskin; Model CD-35.
    b. American Warming and Ventilating.
    c. TAMCO.

## 2.16 CONTROL DAMPER OPERATORS

A. General:

1. Drawings and Control Diagrams indicate only one damper motor for each motorized damper (M).
2. Select actual quantity of motors required to operate each damper in accordance with size of damper provided.
3. Coordinate exact quantity of damper motors with electrical work to ensure that necessary wiring and conduit is provided for installation.
4. Provide operators for motorized dampers and motorized louvers.

B. Electric Damper Operators:

1. Performance: As follows:
    a. 120 volts, 60-Hz, two-position.
    b. Fail Position: Open.

2. Mounting: External side plate.
3. Ample power to overcome friction of damper linkage and air pressure acting on damper blades.
4. Furnished with external adjustable stops to limit stroke.
5. Operators on modulating dampers that are to be sequenced with other control devices shall have full relay type pilot positioner and interconnecting linkage to provide mechanical feedback that will accurately position and control damper.
6. Intake, relief, and exhaust dampers shall close and return dampers shall open on control failure, unless indicated otherwise.
7. Operating Torque:
    a. Provide multiple independent damper sections, each with separate actuator, as needed to provide minimum of 120 percent of operating torque required by damper(s).
    b. Required damper operating torque for actuator sizing calculations shall include friction of damper linkage and 1-inch WC air pressure on damper blades:
        1) Opposed-Blade Dampers: Minimum 5 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
        2) Parallel-Blade Dampers: Minimum 7 inch-pounds per square foot of damper area, unless higher values are recommended by damper manufacturer.
8. Manufacturers:
    a. Belimo.
    b. Neptronic.
    c. Siemens Building Technologies.
    d. Johnson Controls.
    e. Honeywell.
    f. Vibron; Model VRS-LX or SX.

## 2.17 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections:

1. Fabricate from 20-gauge sheets of same material as louver/grille.
2. Line with sound attenuation/insulating material.
3. Shop-prime and paint outside face of blank-off section with two coats of flat black exterior paint.

## 2.18 DUCTWORK IDENTIFICATION

A. Painted Identification Materials:

1. Stencils: Standard metal stencils, prepared for required applications with letter sizes generally comply with recommendations of

ASME A13.1 for piping and similar applications, but not less than 1-1/4-inch high letters for ductwork and not less than 3/4-inch-high letters for access door signs and similar operational instructions.

2. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray can form and grade.
3. Identification Paint: Standard identification enamel of colors indicated or in accordance with ASME A13.1 for colors for systems not identified herein.

B. Plastic Duct Markers

1. General: Provide manufacturer's standard laminated plastic, color coded duct markers. Conform to the following color code:
   a. Use colors and designs recommended by ASME A13.1.

C. Nomenclature: Include the following:

1. Direction of air flow.
2. Duct service (supply, return, exhaust).

D. Manufacturers:

1. W.H. Brady, Co.
2. Seton Identification Products.
3. Craftmark.
4. Brimar Industries, Inc.

## PART 3 EXECUTION

### 3.01 GENERAL INSTALLATION

A. Miscellaneous:

1. Install sheet metal ductwork and flexible ductwork in accordance with SMACNA Manual, NFPA 90A, and NFPA 90B.
2. Install ductwork using manufacturer's recommended adhesives, cement, sealant, and insulation accessories.
3. Align ductwork accurately at connections, within 1/8-inch misalignment tolerance and with internal surfaces smooth.
4. Interface Between Ductwork and Louvers: At locations where ductwork is connected to louver for either intake or exhaust purposes, ductwork shall be installed, sloped, and connected to louver so water entering ductwork system positively drains back to and out of louver.

B. Ductwork Location:

1. Locate ductwork runs vertically and horizontally, unless otherwise indicated.
2. Avoid diagonal runs wherever possible.
3. As indicated by diagrams, details, and notations or, if not otherwise indicated, run ductwork in shortest route that does not obstruct usable space or block access for servicing building and equipment.
4. In general, install as close to bottom of structure as possible.
5. For ductwork concealed above ceiling, maximize clearance between bottom of ductwork and top of ceiling construction.
6. Hold ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
7. Ductwork that must transition and drop below piping or other ductwork shall be transitioned back to bottom of structure immediately adjacent to obstruction.

C. Penetrations:

1. Provide duct sleeves or prepared openings for duct mains, duct branches, and ducts passing through roofs, walls and ceilings.
2. Clearances:
   a. For uninsulated ducts, allow 1-inch clearance between duct and sleeve, except at grilles, registers, and diffusers.
   b. For insulated ducts, allow 1-inch clearance between insulation and sleeve, except at grilles, registers, and diffusers.
3. Closure Collars:
   a. Minimum 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed.
   b. Fit collars snugly around ducts and insulation.
   c. Same gauge and material as duct.
   d. Grind edges of collar smooth to preclude tearing or puncturing insulation covering or vapor barrier.
   e. Use fasteners with maximum 6-inch centers on collars.
4. Packing: Mineral fiber in spaces between sleeve or opening and duct or duct insulation.

D. Concealment:

1. Wherever possible in finished and occupied spaces, conceal ductwork from view by locating in mechanical shafts, hollow wall construction, or above suspended ceiling.
2. Do not encase horizontal runs in solid partitions, except as specifically shown.
3. Limit clearance to 1-inch where furring is shown for enclosure or concealment of ducts, but allow for insulation thickness, if any.

E. Coordination with Other Trades:

1. Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls, and other associated work of ductwork system.
2. Ductwork shall be configured, positioned, and installed to permit installation of light fixtures as indicated on Drawings.
3. Coordinate ductwork layout with suspended ceiling, lighting and sprinkler head layouts and similar finished work.
4. Electrical Equipment Spaces: Do not run ductwork through transformer vaults and other electrical equipment spaces and enclosures.

3.02 RECTANGULAR DUCTWORK

A. General:

1. Where possible, install ductwork so seams and joints will not be cut for installation of grilles, registers, or ceiling outlets.
2. If cutting of seams or joints is unavoidable, reinforce cut portion to original strength.

B. Low Pressure Taps:

1. Use bell mouth or conical fittings with integral locking quadrant damper. Spin-in fitting shall be sealed at duct tap with a gasket or sealed with sealant as specified for medium pressure ductwork.
2. Determine location of spin-in after outlet location is determined.
3. Fitting shall be securely attached to shaft to prevent damper from rotating around shaft.

C. Fittings:

1. Use bell-mouth or conical tee fittings for round duct takeoffs from rectangular mains.
2. Use 45-degree entry fittings conforming to SMACNA requirements for rectangular takeoffs from rectangular or round mains.
3. Make offsets with maximum angle of 45 degrees.
4. Use fabricated fittings for changes in directions, changes in size and shape, and connections.

D. Rectangular Ductwork Transverse Joints:

1. Install each run with a minimum of joints.
2. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

3. Mechanical Joint Option:
    a. Construct transverse joints with Ductmate 25/35 duct connector systems, Ductmate W.D.C.I. Heavy/Lite duct connector systems, or Ductlok J/E duct connector system. Slip-on duct flange connectors shall have integral sealant pocket with permanently flexible sealant.
    b. When using Ductmate W.D.C.I. Heavy/Lite system, construct ductwork in accordance to the Ductmate W.D.C.I. Heavy J and Light H Assembly Manual and Duct Construction Standards.
    c. When using Ductlok J/E duct connector system, construct ductwork in accordance with Ductlok's Rectangular Duct Construction Manual for Low, Medium, and High Pressure.
    d. For longitudinal seams, use Pittsburgh lock seam sealed internally with permanently elastic sealer such as Ductmate 5511M mastic.
    e. Conform to SMACNA Class A sealing requirements.

## 3.03 DUCTWORK HANGERS AND SUPPORTS

A. Install ductwork with support systems in accordance with SMACNA Manual, unless otherwise noted.

B. Support ducts rigidly with suitable ties, braces, hangers, and anchors of type, which will hold ducts true-to-shape and to prevent buckling.

C. Install additional bracing on ductwork as required, to prevent ballooning or breathing.

D. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

E. Support vertical ducts at maximum interval of 16 feet and at each floor.

F. Upper attachments to structures shall have allowable load not exceeding 1/4 of failure (proof test) load, but are not limited to specific methods indicated.

G. In new construction, install concrete insert prior to placing concrete.

## 3.04 FLEXIBLE CONNECTIONS

A. Flexible Collars and Connections:

1. Use between fans and ducts.
2. For round ducts, securely fasten flexible connections by zinc-coated steel clinch-type draw bands.
3. For rectangular ducts, lock flexible connections to metal collars.

## 3.05 DAMPERS

A. General:

1. Inspection:
   a. Inspect areas to receive dampers.
   b. Notify Engineer of conditions that would adversely affect installation or subsequent utilization of dampers.
   c. Do not proceed with installation until unsatisfactory conditions are corrected.
2. Install dampers at locations indicated on Drawings and in accordance with manufacturer's installation instructions.
3. Install square and level.
4. Handle damper using sleeve or frame. Do not lift damper using blades or jack-shaft.
5. Damper blades and hardware shall operate freely without obstruction.
6. Damper blades and hardware that bind within frame or obstructed by adjacent construction will not be acceptable.
7. When installed, damper frames shall be gasketed or caulked to eliminate leakage between duct and damper frames.
8. Head and sill shall have stops.
9. Suitable for installation in mounting arrangement shown.
10. Do not compress or stretch damper frame into duct or opening.

B. Back Draft Dampers:

1. Install dampers square and free from racking with blades running horizontally.
2. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.

C. Control Dampers:

1. Install at locations indicated on Drawings and in accordance with manufacturer's instructions.
2. Install square and free from racking with blades running horizontally.
3. Operate opposed blade dampers from a power blade or drive axle.
4. Bracing:
   a. Install for multiple section assemblies to support assembly weight and to hold against system pressure.
   b. Install at every horizontal and vertical mullion.

## 3.06 ACCESS DOORS

A. Ceilings: Install in nonaccessible ceilings below each electric duct heater, booster coil, motorized damper, terminal unit, smoke detector, and fire damper.

## 3.07 MISCELLANEOUS ACCESSORIES

A. Louver and Grille Blank-Off Sections: Attach airtight to louver or grille and install to allow for easy removal.

## 3.08 DUCT SEALING

A. Seal duct seams and joints as follows:

1. In accordance with SMACNA requirements.

B. If no specific duct sealing requirements are specified, requirements of SMACNA manual shall govern.

C. Seal externally insulated ducts prior to insulation installation.

D. Provide additional duct sealing as required to comply with Article Ductwork Leakage Testing.

E. Seal all audible leaks.

## 3.09 DUCTWORK LEAKAGE TESTING

A. General:

1. Tests shall be conducted on completed ductwork systems.
2. Testing of partial installations or limited sections of ductwork will not be acceptable.
3. All ductwork leakage test procedures and results shall be submitted to Engineer for review.
4. Engineer shall retain the right to witness some or all ductwork leakage testing procedures.
5. Contractor shall notify Engineer in writing at least 5 working days prior to ductwork testing.

## 3.10 BALANCING OF AIR SYSTEMS

A. Perform air balancing in accordance with requirements of Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.

3.11 PROTECTION OF INSTALLED WORK

A. Open ends of installed ductwork systems shall be covered to prevent dust, foreign objects and water from entering ductwork.

B. Ductwork systems shall not be used for air conveyance until adequate air filtration devices are installed in air handling equipment, to prevent ingress of construction dust.

3.12 CLEANING

A. Ductwork shall be cleaned of rust, dust, and debris, both internally and externally, before placing in operation.

B. Before installing air outlets, use air handler to blow dry air through entire system at maximum attainable velocity. Provide temporary air filters for this operation.

C. If duct systems are found to contain construction debris at time of construction completion Contractor shall provide complete ductwork system cleaning in accordance with NADCA Standards.

**END OF SECTION**

**SECTION 23 34 00**
**HVAC FANS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Acoustical Society of America (ASA): S2.19, Mechanical Vibration—Balance Quality Requirements of Rigid Rotors—Part 1, Determination of Permissible Residual Unbalance.
2. Air Movement and Control Association International (AMCA):
   a. 99, Standards Handbook.
   b. 201, Fans and Systems.
   c. 203, Field Performance Measurement of Fan Systems.
   d. 204, Balance Quality and Vibration Levels for Fans.
   e. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   f. 300, Reverberant Room Method for Sound Testing of Fans.
   g. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
3. American Bearing Manufacturers Association (ABMA): 9, Load Ratings and Fatigue Life for Ball Bearings.
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
5. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2247, Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D3363, Standard Test Method for Film Hardness by Pencil Test.
   e. D4167, Standard Specification for Fiber-Reinforced Plastic Fans and Blowers.
   f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. National Electrical Manufacturers Association (NEMA).
7. National Fire Protection Association (NFPA): 45, Standard on Fire Protection for Laboratories Using Chemicals.
8. Occupational Safety and Health Act (OSHA).

9. Society for Protective Coatings (SSPC):
    a. SP 3, Power Tool Cleaning.
    b. SP 5, White Metal Blast Cleaning.
    c. SP 6, Commercial Blast Cleaning.
    d. SP 10, Near-White Blast Cleaning.
10. Underwriters Laboratories Inc. (UL): 507, Safety Standard for Electric Fans.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. SWSI: Single Width, Single Inlet.
9. TEFC: Totally Enclosed, Fan Cooled.
10. UV: Ultra Violet.
11. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide following for specified products:
    a. Identification as referenced in Contract Documents.
    b. Manufacturer’s name and model number.
    c. Descriptive specifications, literature, and drawings.
    d. Dimensions and weights.
    e. Fan sound power level data (reference 10 to power minus 12 watts) at design operating point.
    f. Fan Curves:
        1) Performance Curves Indicating:
            a) Relationship of flow rate to static pressure for various fan speeds.
            b) Brake horsepower curves.
            c) Acceptable selection range (surge curves, maximum revolutions per minute).
            d) Static pressure, capacity, horsepower demand and overall efficiency required at duty point, including drive losses.

2) For variable air volume applications, indicate operating points at 100, 80, 60 and 40 percent of design capacity on fan curves including data to indicate effect of capacity control devices such as inlet vanes on flow, pressure, and brake horsepower.

g. Capacities and ratings.
h. Construction materials.
i. Fan type, size, class, drive arrangement, discharge, rotation, and bearings.
j. Wheel type, diameter, maximum revolutions per minute for fan class, operating revolutions per minute, and tip speed.
k. Motor data, including service factor and operating horsepower.
l. Fan shaft first critical speed.
m. Belt service factor.
n. Drive assembly horsepower rating.
o. Sheave horsepower rating.
p. Power and control wiring diagrams, including terminals and numbers.
q. Factory run test and vibration test reports.
r. Vibration isolation.
s. Factory finish system.
t. Color selection charts where applicable.

2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.
3. "Or Equal" Equipment:
   a. Where submitted equipment results in change to fan inlet or outlet ductwork configuration shown on Drawings, submit system effect factor calculations indicating increased static pressure requirements as described in AMCA 201.
   b. Where submitted equipment results in change to ductwork and equipment configuration shown on Drawings, submit detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement to equipment furnished.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
2. Recommended procedures for protection and handling of products prior to installation.
3. Manufacturer's installation instructions.
4. Manufacturer's Certificate of Compliance in accordance with Section 01 43 33, Manufacturers' Field Services, for the following:
   a. Motors specified to be premium efficient type.
   b. FRP fans.

5. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
6. Test reports.
7. Operation and maintenance data in conformance with Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Performance Ratings: Tested in accordance with AMCA 210.

B. Sound Ratings: Tested in accordance with AMCA 300.

C. Fabrication: In accordance with AMCA 99.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

| Item | Quantity |
|---|---|
| Vee Belts | One complete set per unit |

**PART 2 PRODUCTS**

2.01 EQUIPMENT SCHEDULES

A. Some specific equipment requirements are listed in Equipment Schedule. Refer to Drawings.

2.02 GENERAL

A. Spark Resistant Construction: Fans required to be spark resistant shall comply with requirements of AMCA 99-0401.

B. Operating Limits: Fans designated to meet a specified fan class shall comply with requirements of AMCA 99-2408.

C. Acoustical Levels: Equipment selections shall produce sound power levels in each octave band no greater than shown in Equipment Schedule.

D. Fan Drives:

1. Drive assembly shall be sized for a minimum 140 percent of fan motor horsepower rating.
2. Furnish multiple drive belts where motor horsepower is 2 hp or larger.

3. Sheaves:
    a. Capable of providing 150 percent of motor horsepower.
    b. Unless otherwise noted, furnish belt-driven fans with cast iron or flanged steel sheaves.
4. Drive Adjustment:
    a. When fixed-pitch sheaves are furnished, accomplish system air balancing by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves.
    b. Provide trial and final sheaves, as well as drive belts, as required.
5. Fan Shafts: First critical speed of at least 125 percent of fan maximum operating speed.
6. Provide speed test openings at shaft locations.
7. Belts: Oil and heat resistant, nonstatic type.
8. Motors:
    a. Motors 20 hp or Smaller:
        1) Variable pitch V-belt sheaves allowing at least 20 percent speed variation.
        2) Final operating point shall be at approximate sheave midpoint.
    b. Motors Larger than 20 hp: Fixed-pitch sheaves.
    c. Furnish motors for V-belt drives with adjustable rails or bases.
9. Weather Cover: For outdoor applications, factory fabricated drive assembly of same material as fan housing, unless specified otherwise.
10. Belt and Shaft Guards:
    a. Easily removable and to enclose entire drive assembly, meeting federal and OSHA requirements.
    b. Guard faces of expanded metal having minimum 60 percent free area for ventilation.
    c. Bright yellow finish.

E. Finishes:

1. Carbon Steel Parts: Factory finish as follows, unless indicated otherwise.
    a. Parts cleaned and chemically pretreated with phosphatizing process.
    b. Alkyd enamel primer.
    c. Air dry enamel topcoat.
2. Aluminum Parts: Finished smooth and left unpainted, unless stated otherwise.
3. Stainless Steel Parts: Finished smooth and left unpainted.
4. Fiberglass Parts: Finished in accordance with Paragraph Fiberglass Material.

## 2.03 CABINET FAN

A. General:

1. Factory-assembled, ceiling, wall or inline mounted, centrifugal cabinet fan; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

1. Material: Minimum 20-gauge galvanized steel.
2. Construction:
    a. Minimum 14-gauge blower and motor support frame.
    b. Lined with minimum 1/2-inch acoustical insulation.
    c. Outlet duct collar with integral reinforced aluminum backdraft damper, with nylon bushings.
    d. Motor mounted on resilient vibration isolators.
    e. Motor and blower removable from unit without cabinet disassembly.
    f. Removable cabinet access panels.
    g. Air Inlet: Field convertible for bottom or end air inlet configuration.
    h. Predrilled universal mounting brackets, adjustable.

C. Wheel: Centrifugal forward curved type, galvanized steel or plastic construction.

D. Shaft, Bearings, Drive:

1. Shafts: Turned, ground and polished carbon steel.
2. Bearings: Grease lubricated, precision antifriction ball, sealed type.
3. Drives:
    a. In accordance with Paragraph Fan Drives.
    b. Factory set to specified fan revolutions per minute.
    c. Type: Direct.

E. Electrical:

1. Integral wiring box.
2. Factory-installed disconnect receptacle.

F. Accessories: Provide as scheduled in Equipment Schedule and as follows:

1. Ceiling Grille: Factory fabricated, steel construction, white baked enamel finish.

2. Speed Controller:
    a. Wall mount.
    b. Solid state electronics.
    c. Dial type combination ON/OFF switch and SPEED selector.
3. Wall Cap:
    a. Aluminum construction, mill finish.
    b. Built-in backdraft damper.
    c. Bird screen.
    d. Round duct connection.

G. Manufacturers and Products:

1. Loren Cook; Gemini Series.
2. Greenheck; SP Series.
3. ACME; Model VQ Series.
4. Twin City Fan; T Series.

2.04 INLINE FAN, CENTRIFUGAL, SQUARE

A. General:

1. Factory-assembled, centrifugal, inline fan, square housing configuration; including housing, fan wheel, drive assembly, motor and accessories.
2. Bearing AMCA Certified Ratings Seal for sound and air performance.

B. Housing:

1. Construction: Minimum 18-gauge galvanized steel.
2. Integral duct collars.
3. Removable side panels, for ease of service.
4. Field convertible for side air discharge configuration.
5. Predrilled universal mounting brackets for vertical or horizontal installation.
6. Inlets: Aerodynamic aluminum venturi.
7. Corrosion-resistant fasteners.
8. Drive belt and bearings separated from air steam by enclosure.

C. Wheel:

1. Centrifugal backward inclined, 100 percent aluminum construction.
2. Precision machined cast aluminum hub.
3. Die-formed airfoil or backward inclined blades.
4. Matched to inlet venturi.
5. Attached to fan shaft with split taper lock bushing.

D. Shaft, Bearings, Drive:

1. Shafts:
   a. Turned, ground and polished carbon steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, pillow block style, relubricatable or sealed type.
   b. Selected for average life (ABMA 9 $L_{50}$) of not less than 200,000 hours operation at maximum cataloged operating speed.
3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt.

E. Manufacturers and Products:

1. Greenheck; Model BSQ (Belt); SQ (Direct).
2. Loren Cook; Model SQNB (Belt); SQND (Direct).
3. ACME; Centri-Master Model XB Series (Belt); XD (Direct).
4. Twin City Fan (Aerovent); Model BSI (Belt); Model ISD (Direct).

2.05 WALL FAN, PROPELLER, HEAVY DUTY

A. General: Factory-assembled wall propeller fan; including housing, propeller, drive assembly, motor and accessories.

B. Housing:

1. Material: Metal components constructed from aluminum.
2. Panel:
   a. Minimum 14-gauge sheet metal construction.
   b. Integral formed venturi orifice.
   c. Continuously welded corners.
   d. Bolted to frame.
3. Frame:
   a. Minimum 14-gauge metal construction.
   b. Continuously welded joints.
   c. Reinforced motor baseplate.

C. Propeller:

1. Cast aluminum construction.
2. Hub keyed and mechanically locked to shaft.

D. Shaft, Bearings, Drive:

1. Shaft:
   a. Turned, ground, and polished carbon steel.
   b. Keyed for sheave installation.
2. Bearings:
   a. Grease lubricated, precision antifriction ball, self-aligning, sealed pillow block style.
   b. Mounted in cast iron pillow block housing.
   c. Selected for average life (ABMA 9 $L_{50}$) of not less than 200,000 hours operation at maximum cataloged operating speed.
3. Drives:
   a. In accordance with Paragraph Fan Drives.
   b. Factory set to specified fan revolutions per minute.
   c. Type: Belt.

E. Accessories: Provide as scheduled in Equipment Schedule and as follows:

1. Disconnect and Motor Starter: Factory-installed, nonfused, as scheduled.
2. Propeller-Side Guard: Galvanized steel construction.
3. Motor-Side Guard: Galvanized steel construction.
4. Weather Hood:
   a. Heavy-gauge galvanized steel construction, to match fan and accessory size.
   b. Galvanized steel expanded metal bird screen.
5. Wall Housing:
   a. Allows fan mounting on interior or exterior wall.
   b. Heavy-gauge galvanized steel construction.
6. Shutters, Gravity Operated:
   a. Welded steel frame.
   b. Extruded aluminum blades.
   c. Felt edge seals.
   d. Oil impregnated bronze bushings.
   e. Reverse flange for building exterior mounting. Standard flange for indoor mounting.
7. Corrosion Protection Coating:
   a. Provide factory-applied corrosion protection coating on these fan components:
      1) Housing.
      2) Accessories.
      3) Interior surfaces in contact with airstream.
   b. Coating system shall be baked enamel or baked epoxy and shall be in accordance with Article Corrosion Protection Coating.

F. Manufacturers and Products:

1. Cook; Model EW (Belt).
2. New York Blower; Model NYC.
3. Hartzell; Model Series 02.

2.06 MOTORS

A. General:

1. Fan motors shall comply with provisions of Division 26, Electrial.
2. Provide integral self-resetting overload protection on single-phase motors.
3. Motors for fans specified for use with variable frequency drives shall be inverter duty type.
4. Motors shall not operate into service factor in any case.

B. Motor requirements shall be as follows, unless designated otherwise on Equipment Schedule:

1. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
2. Winding Thermal Protection: None.
3. Space Heater: No.
4. Number of Speeds: Single.
5. Number of Windings: One.
6. Motor Efficiency: Premium efficient.
7. Shaft Type: Solid, carbon steel.
8. Mounting: As required for fan arrangement.
9. Service Factor: 1.15.

2.07 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved or die-stamped block-type black enamel filled equipment identification number and letters as shown on Drawings.

B. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

## 2.08 SOURCE QUALITY CONTROL

A. General:

1. Fan shall operate at single stable point as indicated by fan curve. Fans having two potential operating points are not acceptable.
2. Fan and motor combination shall be capable of delivering 110 percent of scheduled air quantity and static pressure. Motor shall not operate into motor service factor in any listed case.
3. Consider drive efficiency in motor selection according to manufacturer's published recommendation or according to AMCA 203, Appendix L.

B. Testing Provisions:

1. Provide tachometer access holes large enough to accept standard tachometer drive shaft.
2. Center punch fan shaft to accommodate tachometer readings.

C. Acoustical Levels:

1. Perform noise tests in accordance with AMCA 300 and AMCA 301.
2. Fan sound power levels (dB, Reference $10^{-12}$ Watts) shall be no greater than scheduled values.

D. Balancing:

1. Unless noted otherwise, each fan wheel shall be statically and dynamically balanced to ASA S2.19 Grade G6.3.
2. Fans controlled by variable frequency drives shall be dynamically balanced at speeds 25 percent, 50 percent, 75 percent, and 100 percent of design revolutions per minute.

E. Vibration Test:

1. Each fan furnished with 5-hp or larger motor shall have factory run vibration test, including vibration signatures taken on each bearing in horizontal, vertical, and axial direction.
2. Vibration reading as measured at scheduled rotational speed shall not exceed the following values when fan is rigidly mounted:
   a. Belt Drive (except Vane Axial): 0.15-inch per second peak velocity.
   b. Belt Drive Vane Axial: 0.08-inch per second peak velocity.
   c. Direct Drive: 0.08-inch per second peak velocity.
3. Written records of run test and vibration test shall be made available upon request.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. Install fans level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Scroll Drains: Pipe drain connection through running trap to floor drain.

D. Labeling:

1. Label fans in accordance with Article Accessories.
2. Mark exhaust fans serving fume hoods with arrows to indicate proper direction of rotation, in accordance with NFPA 45.

E. Service Access: Locate units to provide access spaces required for motor, drive, bearing servicing, and fan shaft removal.

F. Connections:

1. Isolate duct connections to fans.
2. Install ductwork adjacent to fans to allow proper service and maintenance.

### 3.02 FIELD QUALITY CONTROL

A. Functional Tests:

1. Verify blocking and bracing used during shipping are removed.
2. Verify fan is secure on mountings and supporting devices, and connections to ducts and electrical components are complete.
3. Verify proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify cleaning and adjusting are complete.
5. Disconnect fan drive from motor; verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
6. Reconnect fan drive system; align and adjust belts and install belt guards.
7. Verify lubrication for bearings and other moving parts.
8. Verify manual and automatic volume control and fire and smoke dampers in connected ductwork are in fully open position.

B. Performance Tests:

1. Starting Procedures:
   a. Energize motor and adjust fan to indicated revolutions per minute.
   b. Measure and record motor voltage and amperage.

2. Operational Test:
    a. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
    b. Repair or replace malfunctioning units; retest as specified after repairs or replacement is made.
    c. Test and adjust control safeties.
    d. Replace damaged and malfunctioning controls and equipment.

3.03 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Balancing:

1. Perform air system balancing as specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC.
2. Replace fan and motor sheaves as required to achieve design airflow.

E. Vibration Testing:

1. Perform field testing on rotating equipment, where specified in Section 23 05 93, Testing, Adjusting, and Balancing for HVAC, to determine actual operating vibration.
2. If vibration limits described therein are exceeded, rebalance equipment in-place until design tolerances are met.
    a. Vibration readings as measured at actual rotational speed shall not exceed the following values:
        1) Belt Drive, Flexibility Mounted: 0.25-inch per second peak velocity.
        2) Belt Drive, Rigidly Mounted: 0.16-inch per second peak velocity.

3.04 CLEANING

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

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

**END OF SECTION**

**SECTION 23 82 00**
**TERMINAL HEATING AND COOLING UNITS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans.
2. American Gas Association (AGA).
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
4. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. Canadian Gas Association (CGA).
6. Electrical Test Laboratories (ETL).
7. National Electrical Manufacturer's Association (NEMA).
8. National Fire Protection Association (NFPA):
   a. 54, National Fuel Gas Code.
   b. 70, National Electrical Code (NEC).
   c. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
9. Sheet Metal and Air Conditioning Contractors' National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
10. Underwriters Laboratories Inc. (UL): Product Directories.

### 1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this Section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.
9. SWSI: Single Width, Single Inlet.
10. TEFC: Totally Enclosed, Fan Cooled.

11. UV: Ultraviolet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.
2. Manufacturer's test reports for the following:
   a. Cabinet unit heater heat exchanger.
3. Recommended procedures for protection and handling of equipment and materials prior to installation.
4. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in Chapter 6 of ASHRAE 90.1 IP/SI and the State of Washington Energy Code.

**PART 2 PRODUCTS**

2.01 EQUIPMENT

A. Equipment Schedules: Refer to Drawings.

2.02 UNIT HEATER, GAS, PROPELLER FAN

A. Characteristics:

1. Factory assembled, wired and test fired.
2. Dynamically balanced, direct drive, propeller type fan.
3. UL listed.
4. AGA or CGA certified.
5. Minimum 80 percent efficient.
6. Steel cabinet with baked enamel or powder coated finish.
7. Designed for ceiling suspension.
8. Sealed flue product collection chamber.
9. Totally enclosed motors with thermal overload protection and vibration isolation.
10. Motor contactor.
11. Horizontal discharge with adjustable face louvers.
12. Horizontal and vertical vent outlets.
13. External gas connection.
14. Solid state ignition; a match lit pilot is not acceptable.

15. Described by manufacturer in published literature as commercial or industrial grade.

B. Controls:

1. Fan and limit safety controls.
2. Combustion air pressure switch.
3. 24-volt control transformer.

C. Accessories and Features: Provide as scheduled in Equipment Schedule and as follows:

1. Suitable for natural gas.
2. Venting and Combustion:
   a. Power venting.
   b. Combustion air inlet for combustion air ducting from outside.
3. Standard fan guard.
4. Spark ignited intermittent safety pilot with electronic flame supervision or direct spark ignition.
5. Single-stage heating control or Modulating control.
6. Aluminized steel heat exchanger.
7. Electrical disconnect.
8. Remote mounted thermostat.

D. Manufacturers:

1. Reznor.
2. Modine.
3. Trane.

2.03 UNIT HEATER, ELECTRIC, SUSPENDED

A. Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL listed.
3. Meet requirements of National Electrical Code.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gauge steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.
6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.

b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
e. Corrosion-resistant steel fins brazed to tubular heating elements.

7. Fan and Motor:
   a. Totally enclosed motor.
   b. Direct drive fan.
   c. Sealed bearings. Permanently lubricated.
8. Controls:
   a. Thermal overload protection with automatic reset.
   b. Controls, transformers, and contactors shall be factory assembled, except wall mounted thermostats when indicated.

B. Accessories and Features: Provide as scheduled in Equipment Schedule and as follows:

1. Airflow discharge shall be horizontal.
2. Electrical Disconnect: NEMA 4.
3. Wall mounting bracket.
4. Fan delay feature that starts fan after element warmup and stops fan after element cool down.
5. Independent summer fan operation with wall-mounted switch.
6. Thermostat: Adjustable, built in, line voltage with a minimum temperature range of 40 to 85 degrees F.

C. Manufacturers and Products:

1. Qmark; Type MUH.
2. Indeeco; UCI Series.
3. Modine: Type HER.
4. Markel; Series 5100.
5. Chromolox; Series LUH.

## 2.04 ACCESSORIES

A. Equipment Identification Plates: Furnish 16-gauge stainless steel identification plate securely mounted on each separate equipment component in a readily visible location. Plate shall bear 1/4-inch high engraved block-type black enamel filled equipment identification number and letters indicated on Drawings.

2.05 SOURCE QUALITY CONTROL

A. Functional Test:

1. Perform manufacturer's standard factory test on equipment.
2. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

## PART 3 EXECUTION

3.01 INSTALLATION

A. Gas-Fired Units:

1. Install in accordance with manufacturer's recommendations.
2. Mount bottom of unit at 8 feet above floor, except where noted otherwise on Drawings or as detailed.

B. Electric Unit Heaters, All Types:

1. Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.
2. Bottom of unit shall be a minimum of 8 feet above finish floor, unless indicated otherwise.
3. Heater shall be permanently mounted in position indicated with a fixed power supply.
4. Install so obstructions do not block heater air inlet or outlet.

**END OF SECTION**

**SECTION 26 05 02**
**BASIC ELECTRICAL REQUIREMENTS**

## PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. Underwriters Laboratories Inc. (UL).

1.03 ELECTRIC SERVICE DIVISION OF RESPONSIBILITY

A. Incoming aerial extensions and underground electrical service facilities provided by the serving utility as part of its normal obligation to customers is work provided outside this Contract. Under this Contract provide customer required service provisions and electrical work including, but not limited to, primary trench and backfill, primary duct system, transformer pad site preparation, transformer pad, metering components and associated conduit, and secondary facilities. Schedule and coordinate work of serving utility as required to provide electric service to the Work. Prepare all required service requests and pay the fees required by the serving utility.

1.04 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Electrical service components.
   b. Telephone service components.
   c. Nameplates, signs, and labels.

1.05 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.06 ENVIRONMENTAL CONDITIONS

A. The following areas are classified hazardous Class I, Division 1, Group D, due to the potential for occurrence of hazardous concentrations of combustible gases, and for exposure to corrosive environment. Use materials and methods required for such areas.

1. Inside wet well containing wastewater.

B. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas.

1. Outdoor abovegrade areas not covered above.
2. Belowgrade vaults.
3. Transfer building tunnel.

C. The following areas are classified as indoor and dry:

1. Restroom.
2. Storage Rooms.
3. Electrical Room.

D. The following areas are not classified. Use dust-tight and oil-tight NEMA 12 materials and methods.

1. Transfer building tipping floor.

## PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of minus 20 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of the Project Site.

2.02 EQUIPMENT FINISH

A. Manufacturer's standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment in accordance with Section 09 90 00, Painting and Coating.

2.03 NAMEPLATES

A. Material: Laminated plastic.

B. Attachment Screws: Stainless steel.

C. Color: Black, engraved to a white core.

D. Letter Height:

1. Pushbuttons/Selector Switches: 1/8 inch.
2. Other electrical equipment: 1/4 inch.

2.04 SIGNS AND LABELS

A. Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

## PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Engineer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Engineer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Engineer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

## 3.02 ANCHORING AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements for seismic zone criteria given in Section 01 88 15, Seismic Anchorage and Bracing.

## 3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Not all homerun circuits are shown on Drawings, but must be provided as part of the electrical work. Circuits may be combined into common raceways in accordance with the following requirements:

1. Analog control circuits from devices in same general area to same destination.
    a. No power or AC discrete control circuits shall be combined in same conduit with analog circuits.
    b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
    c. Raceways shall be sized per General Circuit and Raceway Schedule and do not exceed 40 percent fill.
    d. Changes shall be documented on record drawings.
2. Discrete control circuits from devices in the same general area to the same destination.
    a. No power or analog control circuits shall be combined in same conduit with discrete circuits.

b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
c. Raceways shall be sized per the General Circuit and Raceway Schedule and do not exceed 40 percent fill.
d. Changes shall be documented on record drawings.

3. Power circuits from loads in same general area to same source location.
   a. Lighting Circuits: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120-Volt Only: Combine no more than three circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   c. All Other Power Circuits: Do not combine power circuits without authorization of Engineer.

## 3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark switchboards and panelboards to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Calculate arc-flash boundary and energy in accordance with NFPA 70E. Determine level of personal protective equipment (PPE) required. Warning label on equipment shall include flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name.

B. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including switchgear, switchboards, motor control centers, panelboards, motor starters, transformers, terminal junction boxes, disconnect switches, switches and control stations.
2. Switchgear, motor control center, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

A. Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of Specification, and is acceptable to Engineer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor's convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Engineer.

**END OF SECTION**

**SECTION 26 05 04**
**BASIC ELECTRICAL MATERIALS AND METHODS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
   c. C12.1 Code for Electricity Metering
   d. C12.6 Phase-Shifting Devices Used in Metering, Marking and Arrangement of, Terminals for
   e. CP 1, Shunt Capacitors.
   f. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   g. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   h. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 98, Standard for Enclosed and Dead-Front Switches.
   b. 248, Standard for Low Voltage Fuses.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.

d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
e. 508, Standard for Industrial Control Equipment.
f. 810, Standard for Capacitors.
g. 943, Standard for Ground-Fault Circuit-Interrupters.
h. 1059, Standard for Terminal Blocks.
i. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Timers.
   g. Fuses.
   h. Magnetic contactors.
   i. Firestopping.
   j. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Seismic Anchorage and Bracing.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 to 600 Volts: Six of each type and each current rating installed.

**PART 2 PRODUCTS**

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. General:

1. Type: Molded case.
2. Trip Ratings: 15-800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.

4. Suitable for mounting and operating in any position.
5. NEMA AB 1 and UL 489.

B. Operating Mechanism:

1. Overcenter, trip-free, toggle type handle.
2. Quick-make, quick-break action.
3. Locking provisions for padlocking breaker in open position.
4. ON/OFF and TRIPPED indicating positions of operating handle.
5. Operating handle to assume a center position when tripped.

C. Trip Mechanism:

1. Individual permanent thermal and magnetic trip elements in each pole.
2. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
3. Two and three pole, common trip.
4. Automatically opens all poles when overcurrent occurs on one pole.
5. Test button on cover.
6. Calibrated for 40 degrees C ambient, unless shown otherwise.
7. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

D. Short Circuit Interrupting Ratings:

1. Equal to, or greater than, available fault current or interrupting rating shown.
2. Series Connected Ratings: Do not apply series connected short circuit ratings.

E. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).

1. Ground fault sensor shall be rated same as circuit breaker.
2. Push-to-test button.

F. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).

G. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.

H. Connections:

1. Supply (line side) at either end.
2. Mechanical wire lugs, except crimp compression lugs where shown.
3. Lugs removable/replaceable for breaker frames greater than 100 amperes.
4. Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.

I. Enclosures for Independent Mounting:

1. See Article Enclosures.
2. Service Entrance Use: Breakers in required enclosure and required accessories shall be UL 489 listed.
3. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. UL 98 listed for use and location of installation.

B. NEMA KS 1.

C. Short Circuit Rating: 200,000 amps RMS symmetrical with Class R, Class J, or Class L fuses installed.

D. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

E. Connections:

1. Mechanical lugs, except crimp compression lugs where shown.
2. Lugs removable/replaceable.
3. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.

F. Fuse Provisions:

1. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
2. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.

G. Enclosures: See Article Enclosures.

H. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. NEMA KS 1.

B. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.

C. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.

D. Enclosures: See Article Enclosures.

E. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Current-limiting, with 200,000 ampere rms interrupting rating.
2. Provide to fit mountings specified with switches.
3. UL 248.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Class: RK-1.
2. Type: Dual element, with time delay.
3. Manufacturers and Products:
    a. Bussmann; Types LPS-RK (600 volts) and LPN-RK (250 volts).
    b. Littelfuse; Types LLS-RK (600 volts) and LLN-RK (250 volts).

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

B. Selector Switch Operating Lever: Standard.

C. Indicating Light: LED, full voltage.

D. Pushbutton Color:

1. ON or START: Black.
2. OFF or STOP: Red.

E. Pushbutton and selector switch lockable in OFF position where indicated.

F. Legend Plate:

1. Material: Aluminum.
2. Engraving: Enamel filled in high contrasting color.
3. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
4. Letter Height: 7/64-inch.

G. Manufacturers and Products:

1. Heavy-Duty, Oil-Tight Type:
   a. General Electric Co.; Type CR 104P.
   b. Square D Co.; Type T.
   c. Eaton/Cutler-Hammer; Type 10250T.
2. Heavy-Duty, Watertight, and Corrosion-Resistant Type:
   a. Square D Co.; Type SK.
   b. General Electric Co.; Type CR 104P.
   c. Eaton/Cutler-Hammer; Type E34.
   d. Crouse-Hinds; Type NCS.

## 2.06 TERMINAL BLOCK, 600 VOLTS

A. UL 486E and UL 1059.

B. Size components to allow insertion of necessary wire sizes.

C. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.

D. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.

E. Yoke, current bar, and clamping screw of high strength and high conductivity metal.

F. Yoke shall guide all strands of wire into terminal.

G. Current bar shall ensure vibration-proof connection.

H. Terminals:

1. Capable of wire connections without special preparation other than stripping.
2. Capable of jumper installation with no loss of terminal or rail space.
3. Individual, rail mounted.

I. Marking system, allowing use of preprinted or field-marked tags.

J. Manufacturers:

1. Weidmuller, Inc.
2. Ideal.
3. Electrovert USA Corp.

2.07 MAGNETIC CONTROL RELAY

A. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

B. NEMA ICS 2, Designation: A300 (300 volts) or A600 (600 volts), as required for the service in which installed.

C. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

D. Manufacturers and Products:

1. Eaton/Cutler-Hammer.
2. General Electric Co.

2.08 TIME DELAY RELAY

A. Industrial relay with contacts rated 5 amps continuous, 3,600VA make, 360VA break.

B. NEMA ICS 2 Designation: B150 (150 volts).

C. Solid-state electronic, field convertible ON/OFF delay.

D. One normally open and one normally closed contact (minimum).

E. Repeat accuracy plus or minus 2 percent.

F. Timer adjustment from 1 second to 60 seconds, unless otherwise indicated on Drawings.

G. Manufacturers and Products:

1. Square D Co.
2. Eaton/Cutler-Hammer.
3. General Electric Co.

2.09 MAGNETIC CONTACTOR

A. UL listed.

B. Electrically operated, electrically held.

C. Main Contacts:

1. Power driven in one direction with mechanical spring dropout.
2. Silver alloy with wiping action and arc quenchers.
3. Continuous-duty, rated 20 amperes unless otherwise noted.
4. Poles: As shown.

D. Control: Two wire.

E. Auxiliary Contacts: Convertible, quantity as shown, rated 7200VA make, 720VA break, at 600V, A600 per NEMA ICS 5.

F. Enclosures: See Article Enclosures.

G. Manufacturers and Products:

1. Eaton/Cutler-Hammer; Class A201.
2. General Electric Co.; CR 353.
3. Square D Co.; Class 8910.

2.10 MAGNETIC LIGHTING CONTACTOR

A. Comply with NEMA ICS 2; provide UL 508 listing.

B. Electrically operated by dual-acting, single coil mechanism.

C. Inherently interlocked and mechanically held in both OPEN and CLOSED position.

D. Main Contacts:

1. Double-break, continuous-duty, rated a minimum of 20 amperes, 600 volts, withstand rating of 14,000 amps rms symmetrical at 480 volts.
2. Marked for electric discharge lamps, tungsten, and general purpose loads.
3. Position not dependent on gravity, hooks, latches, or semipermanent magnets.
4. Capable of operating in any position.
5. Visual indication for each contact.

E. Provision for remote pilot lamp with use of auxiliary contacts.

F. Clamp type, self-rising terminal plates for solderless connections.

G. Enclosures: See Article Enclosures.

H. Manufacturers and Products:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D.

## 2.11 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Material: Rolled, mild strip steel, 12-gauge minimum, ASTM A1011/A1011M, Grade 33.
2. Finish: Hot-dip galvanized after fabrication.

B. Paint Coated Framing Channel: Carbon steel framing channel with electro-deposited rust inhibiting acrylic or epoxy paint.

C. PVC Coated Framing Channel: Carbon steel framing channel with 40-mil polyvinyl chloride coating.

D. Stainless Steel Framing Channel: Rolled, ASTM A167, Type 316 stainless steel, 12-gauge minimum.

E. Extruded Aluminum Framing Channel:

1. Material: Extruded from Type 6063-T6 aluminum alloy.
2. Fittings fabricated from Alloy 5052-H32.

F. Nonmetallic Framing Channel:

1. Material: Fire retardant, fiber reinforced vinyl ester resin.
2. Channel fitting of same material as channel.
3. Nuts and bolts of long glass fiber reinforced polyurethane.

G. Manufacturers:

1. B-Line Systems, Inc.
2. Unistrut Corp.
3. Aickinstrut.

## 2.12 ROLL-UP GENERTOR TERMINAL CABINET

A. Rating:

1. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current of 35,000 amperes symmetrical at rated voltage.
2. Amperage Rating: 400.
3. Voltage Rating: 480Y/277, three-phase, 4-wire.

B. Construction:

1. Roll up generator termination cabinet shall consist of a vertical free-standing or wall-mount rigid assembly. All edges of the hinged front panel(s) shall be formed. Provide lockable front hinged door for access to terminations within the enclosure.
2. All terminations shall be accessible from the front of the enclosure.
3. The assembly shall be provided with adequate lifting means.
4. The assembly shall be rated NEMA 4 constriction.

C. Terminations:

1. Cable termination landings shall be copper. Main horizontal landing bars shall be mounted with all three phases arranged in a staggered vertical plane to accommodate wire terminations. Sizing shall be based on NEMA standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient.
2. Provide a full capacity neutral bus.
3. A copper ground bus (minimum 1/4 inch by 2 inch).

D. Wiring/Terminations: Mechanical-type and compression terminals shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size as indicated on Drawings.

E. Enclosures:

1. Outdoor NEMA 4 Enclosure:
   a. Enclosure shall have flat roof.
   b. Doors shall have provisions for padlocking.

F. Finish: All exterior and interior steel surfaces of the terminal cabinet shall be properly cleaned and provided with a rust-inhibiting phosphatized coating and finished with ANSI-61 gray polyester powder paint.

2.13 ENCLOSURES

A. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrode position process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.

B. Color: Manufacturer's standard color (gray) baked-on enamel, unless otherwise shown.

C. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

D. Enclosure Selections: Except as shown otherwise, provide electrical enclosures according to the following table:

| ENCLOSURES | | | |
|---|---|---|---|
| **Location** | **Finish** | **Environment** | **NEMA 250 Type** |
| Indoor | Finished | Dry | 1 |
| Indoor | Unfinished | Dry | 1 |
| Indoor | Unfinished | Industrial Use | 12 |
| Indoor and Outdoor | Any | Wet | 4 |
| Indoor and Outdoor | Any | Denoted "WP" | 3R |
| Indoor and Outdoor | Any | Wet and Corrosive | 4X 304 Stainless Steel |
| Indoor and Outdoor | Any | Wet, Dust or Oil | 13 |
| Indoor and Outdoor | Any | Hazardous Gas | 7 |

**PART 3 EXECUTION**

3.01 GENERAL

A. Install equipment in accordance with manufacturer's recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Unless otherwise shown, install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations.

B. Unless otherwise shown, install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas.

3.03 ROLL-UP GENERATOR TERMINAL CABINET

A. The Contractor shall install all equipment per the manufacturer's instructions, Contract Drawings and National Electrical Code.

B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the wall or concrete per manufacturer's recommendations. All necessary hardware to secure the assembly in place shall be provided by the Contractor.

3.04 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC-Coated Conduit: PVC coated.
   c. Steel Raceway and Other Systems Not Covered: Carbon steel or paint coated.
2. Interior, Corrosive (Wet or Dry) Locations:
   a. Aluminum Raceway: Extruded aluminum.
   b. PVC Conduit: Type 316 stainless steel or nonmetallic.
   c. PVC-Coated Steel Conduit and Other Systems Not Covered: Type 316 stainless steel, nonmetallic, or PVC-coated steel.
3. Outdoor, Noncorrosive Locations:
   a. Steel Raceway: Carbon steel or paint coated framing channel, except where mounted on aluminum handrail, then use aluminum framing channel.
   b. Aluminum Raceway and Other Systems Not Covered: Aluminum framing channel.

C. Paint cut ends prior to installation with the following:

1. Carbon Steel Channel: Zinc-rich primer.
2. Painted Channel: Rust-inhibiting epoxy or acrylic paint.
3. Nonmetallic Channel: Epoxy resin sealer.
4. PVC-Coated Channel: PVC patch.

**END OF SECTION**

**SECTION 26 05 05**
**CONDUCTORS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM):
   a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   b. B3, Standard Specification for Soft or Annealed Copper Wire.
   c. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   d. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
2. National Electrical Manufacturers' Association (NEMA):
   a. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
3. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
4. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
5. Underwriters Laboratories Inc. (UL):
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety for Service-Entrance Cables.
   h. 1569, Standard for Safety for Metal-Clad Cables.
   i. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

### 1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: Wire and cable.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.

**PART 2 PRODUCTS**

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. Conform to applicable requirements of NEMA WC 70.

B. Conductor Type:

1. 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
2. 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
3. All Other Circuits: Stranded copper.

C. Insulation: Type THHN/THWN-2.

2.02 600-VOLT RATED CABLE

A. General:

1. Permanently and legibly marked with manufacturer’s name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
2. Suitable for installation in open air, in cable trays, or conduit.
3. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
4. Overall Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 1, Multiconductor Control Cable:

1. Conductors:
   a. 14 AWG, seven-strand copper.
   b. Insulation: 15-mil PVC with 4-mil nylon.
   c. UL 1581 listed as Type THHN/THWN rated VW-1.
   d. Conductor group bound with spiral wrap of barrier tape.
   e. Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.

2. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
3. Cable Sizes:

| No. of Conductors | Max. Outside Diameter (Inches) | Jacket Thickness (Mils) |
|---|---|---|
| 3 | 0.41 | 45 |
| 5 | 0.48 | 45 |
| 7 | 0.52 | 45 |
| 12 | 0.72 | 60 |
| 19 | 0.83 | 60 |
| 25 | 1.00 | 60 |
| 37 | 1.15 | 80 |

4. Manufacturers:
   a. Okonite Co.
   b. Southwire.

C. Type 7, Multiconductor Metal-Clad (UL Type MC) Power Cable:

1. Meeting requirements of UL 44 and UL 1569.
2. Conductors:
   a. Class B stranded, coated copper.
   b. Insulation: 600-volt cross-linked polyethylene, UL Type XHHW or EPR.
   c. Grounding Conductors: Bare, stranded copper.
3. Sheath:
   a. UL listed Type MC.
   b. Continuous welded, corrugated aluminum sheath.
   c. Suitable for use as grounding conductor.
4. Outer Jacket: PVC per UL 1569.
5. Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.
6. Cable Sizes:

| Conductor Size | Minimum Ground Wire Size (AWG) | No. of Insulated Conductors | Max. Outside Diameter (Inches) | Jacket Thickness (Mils) |
|---|---|---|---|---|
| 12 AWG | 12 or 3x16 | 3<br>4 | 0.79<br>0.85 | 50 |

| Conductor Size | Minimum Ground Wire Size (AWG) | No. of Insulated Conductors | Max. Outside Diameter (Inches) | Jacket Thickness (Mils) |
|---|---|---|---|---|
| 10 AWG | 10 or 3x14 | 3<br>4 | 0.82<br>0.90 | 50 |
| 8 AWG | 10 or 3x14 | 3<br>4 | 0.85<br>1.00 | 50 |
| 6 AWG | 8 or 3x12 | 3<br>4 | 0.99<br>1.10 | 50 |

7. Manufacturers:
   a. Okonite Co.
   b. Southwire.
   c. General Cable.

2.03 300-VOLT RATED CABLE

A. General:

1. Type PLTC, meeting requirements of UL 13 and NFPA 70, Article 725.
2. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.
3. Suitable for installation in open air, in cable trays, or conduit.
4. Minimum Temperature Rating: 105 degrees C.
5. Passes Vertical Tray Flame Test.
6. Outer Jacket: PVC, flame-retardant, sunlight- and oil-resistant.

B. Type 24, Twisted Pair Fire Alarm Cable, Nonshielded: Power limited fire protective signaling circuit cable meeting requirements of NFPA 70, Article 760.

1. Cable: Pass NFPA 262, 70,000 Btu flame test and listed by State Fire Marshall.
2. Outer Jacket: Red in color, identified along its entire length as fire protective signaling circuit cable.
3. Conductors:
   a. Solid, tinned, or bare copper.
   b. Insulation: 15-mil PVC.

4. Cable Sizes:

| Wire Size | Maximum Outside Diameter (Inches) | Nominal Jacket Thickness (Inches) |
|---|---|---|
| 12 | 0.36 | 0.042 |
| 14 | 0.32 | 0.042 |
| 16 | 0.26 | 0.037 |
| 18 | 0.23 | 0.037 |

5. Manufacturers:
   a. West Penn Wire.
   b. Coleman Cable, Inc.

2.04 GROUNDING CONDUCTORS

A. Equipment: Stranded copper with green, Type USE/RHH/RHW-XLPE or THHN/THWN, insulation.

B. Direct Buried: Bare stranded copper.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose, Flame Retardant: 7-mil, vinyl plastic, Scotch Brand 33+, rated for 90 degrees C minimum, meeting requirements of UL 510.
2. Flame Retardant, Cold and Weather Resistant: 8.5-mil, vinyl plastic, Scotch Brand 88.
3. Arc and Fireproofing:
   a. 30-mil, elastomer.
   b. Manufacturers and Products:
      1) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
      2) Plymouth; 53 Plyarc, with 77 Plyglas glass cloth tapebinder.

B. Identification Devices:

1. Sleeve:
   a. Permanent, PVC, yellow or white, with legible machine-printed black markings.

b. Manufacturers and Products:
1) Raychem; Type D-SCE or ZH-SCE.
2) Brady, Type 3PS.

2. Heat Bond Marker:
a. Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
b. Self-laminating protective shield over text.
c. Machine printed black text.
d. Manufacturer and Product: 3M Co.; Type SCS-HB.

3. Marker Plate: Nylon, with legible designations permanently hot stamped on plate.

4. Tie-On Cable Marker Tags:
a. Chemical-resistant white tag.
b. Size: 1/2 inch by 2 inches.
c. Manufacturer and Product: Raychem; Type CM-SCE.

5. Grounding Conductor: Permanent green heat-shrink sleeve, 2-inch minimum.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
a. Manufacturers and Products:
1) Thomas & Betts; Sta-Kon.
2) Burndy; Insulug.
3) ILSCO.

2. Nylon, Self-Insulated, Crimp Locking-Fork, Torque-Type Terminator:
a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
b. Seamless.
c. Manufacturers and Products:
1) Thomas & Betts; Sta-Kon.
2) Burndy; Insulink.
3) ILSCO; ILSCONS.

3. Self-Insulated, Freespring Wire Connector (Wire Nuts):
a. UL 486C.
b. Plated steel, square wire springs.
c. Manufacturers and Products:
1) Thomas & Betts.
2) Ideal; Twister.

4. Self-Insulated, Set Screw Wire Connector:
a. Two piece compression type with set screw in brass barrel.
b. Insulated by insulator cap screwed over brass barrel.

c. Manufacturers:
    1) 3M Co.
    2) Thomas & Betts.
    3) Marrette.

D. Cable Lugs:

1. In accordance with NEMA CC 1.
2. Rated 600 volts of same material as conductor metal.
3. Uninsulated Crimp Connectors and Terminators:
    a. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
    b. Manufacturers and Products:
        1) Thomas & Betts; Color-Keyed.
        2) Burndy; Hydent.
        3) ILSCO.
4. Uninsulated, Bolted, Two-Way Connectors and Terminators:
    a. Manufacturers and Products:
        1) Thomas & Betts; Locktite.
        2) Burndy; Quiklug.
        3) ILSCO.

E. Cable Ties:

1. Nylon, adjustable, self-locking, and reusable.
2. Manufacturer and Product: Thomas & Betts; TY-RAP.

F. Heat Shrinkable Insulation:

1. Thermally stabilized cross-linked polyolefin.
2. Single wall for insulation and strain relief.
3. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
4. Manufacturers and Products:
    a. Thomas & Betts; SHRINK-KON.
    b. Raychem; RNF-100 and ES-2000.

## 2.06 PULLING COMPOUND

A. Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant; UL listed.

B. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.

C. Approved for intended use by cable manufacturer.

D. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

E. Manufacturers:

1. Ideal Co.
2. Polywater, Inc.
3. Cable Grip Co.

2.07 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

2.08 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

## PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

H. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

| System | Conductor | Color |
|---|---|---|
| All Systems | Equipment Grounding | Green |
| 240/120 Volts, Single-Phase, Three-Wire | Grounded Neutral<br>One Hot Leg<br>Other Hot Leg | White<br>Black<br>Red |
| 208Y/120 Volts, Three-Phase, Four-Wire | Grounded Neutral<br>Phase A<br>Phase B<br>Phase C | White<br>Black<br>Red<br>Blue |
| 480Y/277 Volts, Three-Phase, Four-Wire | Grounded Neutral<br>Phase A<br>Phase B<br>Phase C | White<br>Brown<br>Orange<br>Yellow |
| Note: Phase A, B, C implies direction of positive phase rotation. | | |

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

B. Circuits Appearing in Circuit Schedules: Identify using circuit schedule designations.

C. Circuits Not Appearing in Circuit Schedules:

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

D. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Engineer.

C. Connections and Terminations:

1. Install wire nuts only on solid conductors. Wire nuts are not allowed on stranded conductors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
3. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.
4. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
5. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
6. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
7. Place no more than one conductor in any single-barrel pressure connection.
8. Install crimp connectors with tools approved by connector manufacturer.
9. Install terminals and connectors acceptable for type of material used.

**END OF SECTION**

**SECTION 26 05 26**
**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

## PART 2 PRODUCTS

2.01 GROUND ROD

A. Material: Copper.

B. Diameter: Minimum 1/2 inch.

C. Length: 8 feet.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Exothermic Weld Type:

1. Outdoor Weld: Suitable for exposure to elements or direct burial.
2. Indoor Weld: Utilize low-smoke, low-emission process.

3. Manufacturers:
    a. Erico Products, Inc.
    b. Thermoweld.

B. Compression Type:

1. Compress-deforming type; wrought copper extrusion material.
2. Single indentation for conductors 6 AWG and smaller.
3. Double indentation with extended barrel for conductors 4 AWG and larger.
4. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
5. Manufacturers:
    a. Burndy Corp.
    b. Thomas and Betts Co.
    c. ILSCO.

C. Mechanical Type: Split-bolt, saddle, or cone screw type; copper alloy material.

1. Manufacturers:
    a. Burndy Corp.
    b. Thomas and Betts Co.

2.04 GROUNDING WELLS

A. Ground rod box complete with cast iron riser ring and traffic cover marked GROUND ROD.

B. Manufacturers and Products:

1. Christy Co.
2. Lightning and Grounding Systems, Inc.

## PART 3 EXECUTION

3.01 GENERAL

A. Grounding shall be in compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.

C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.

D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Furnish compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

E. Circuits 20 Amps or Above: Tap motor frame or equipment housing; install solderless terminal with minimum 5/16-inch diameter bolt.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

3.05 CONNECTIONS

A. General:

1. Abovegrade Connections: Install exothermic weld, mechanical, or compression-type connectors; or brazing.
2. Belowgrade Connections: Install exothermic weld or compression type connectors.
3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.

B. Exothermic Weld Type:

1. Wire brush or file contact point to bare metal surface.
2. Use welding cartridges and molds in accordance with manufacturer's recommendations.
3. Avoid using badly worn molds.
4. Mold to be completely filled with metal when making welds.
5. After completed welds have cooled, brush slag from weld area and thoroughly clean joint.

C. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies.

D. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.06 METAL STRUCTURE GROUNDING

A. Ground metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.07 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each.

B. Ground Rod Floor Protrusion: 4 to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts, and any metallic raceway grounding bushings to ground rod with No. 6 AWG copper conductor.

3.08 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network, and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to locally driven ground rods and buried ground wire encircling transformer and system ground network.

3.09 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

**END OF SECTION**

**SECTION 26 05 33**
**RACEWAY AND BOXES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractors Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   e. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   f. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   g. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. Underwriters Laboratories Inc. (UL):
   a. 1, Standard for Safety for Flexible Metal Conduit.
   b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
   c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.

d. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
e. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
f. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
g. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
h. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
i. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
j. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
k. 1684, Standard for Safety for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.02 SUBMITTALS

A. Action Submittals:

1. Precast Manholes and Handholes:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

B. PVC-Coated, Rigid Galvanized Steel Conduit Installer: Certified by conduit manufacturer as having received minimum 2 hours of training on installation procedures.

## PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized with chromated protective layer.

B. Electric Metallic Tubing (EMT):

1. Meet requirements of NEMA C80.3 and UL 797.
2. Material: Hot-dip galvanized with chromated and lacquered protective layer.

C. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

D. PVC Schedule 80 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.

E. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of NEMA RN 1.
2. Material:
   a. Meet requirements of NEMA C80.1 and UL 6.
   b. Exterior Finish: PVC coating, 40-mil nominal thickness; bond to metal shall have tensile strength greater than PVC.
   c. Interior finish: Urethane coating, 2-mil nominal thickness.
3. Threads: Hot-dipped galvanized and factory coated with urethane.
4. Bendable without damage to interior or exterior coating.

F. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel with extruded PVC jacket.

G. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 1.
2. Material: Galvanized steel.

2.02 FITTINGS

A. Rigid Galvanized Steel and Intermediate Metal Conduit:

1. General:
   a. Meet requirements of UL 514B.
   b. Type: Threaded, galvanized. Set screw and threadless compression fittings not permitted.
2. Bushing:
   a. Material: Malleable iron with integral insulated throat, rated for 150 degrees C.
   b. Manufacturers:
      1) Appleton.
      2) O-Z/Gedney.
3. Grounding Bushing:
   a. Material: Malleable iron with integral insulated throat rated for 150 degrees C, with solderless lugs.
   b. Manufacturers:
      1) Appleton.
      2) O-Z/Gedney.
4. Conduit Hub:
   a. Material: Malleable iron with insulated throat with bonding screw.
   b. UL listed for use in wet locations.
   c. Manufacturers:
      1) Appleton, Series HUB-B.
      2) O-Z/Gedney.
      3) Meyers.
5. Conduit Bodies:
   a. Sized as required by NFPA 70.
   b. Manufacturers (For Normal Conditions):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
      4) Thomas & Betts.
   c. Manufacturers (For Hazardous Locations):
      1) Appleton.
      2) Crouse-Hinds.
      3) Killark.
6. Couplings: As supplied by conduit manufacturer.
7. Unions:
   a. Concrete tight, hot-dip galvanized malleable iron.
   b. Manufacturers:
      1) Appleton.
      2) O-Z/Gedney.

8. Conduit Sealing Fitting:
    a. Manufacturers:
        1) Appleton.
        2) Crouse-Hinds.
        3) Killark.
9. Drain Seal:
    a. Manufacturers:
        1) Appleton.
        2) Crouse-Hinds.
10. Drain/Breather Fitting:
    a. Manufacturers:
        1) Appleton.
        2) Crouse-Hinds.
11. Expansion Fitting:
    a. Manufacturers:
        1) Deflection/Expansion Movement:
            a) Appleton.
            b) Crouse-Hinds.
        2) Expansion Movement Only:
            a) Appleton.
            b) Crouse-Hinds.
            c) Thomas & Betts.
12. Cable Sealing Fitting:
    a. To form watertight nonslip cord or cable connection to conduit.
    b. For Conductors with OD of 1/2-inch or Less: Neoprene bushing at connector entry.
    c. Manufacturers:
        1) Appleton.
        2) Crouse-Hinds.

B. Electric Metallic Tubing:

1. Meet requirements of UL 514B.
2. Type: Steel body and locknuts with steel or malleable iron compression nuts. Set screw and drive-on fittings not permitted.
3. Electro zinc-plated inside and out.
4. Raintight.
5. Coupling Manufacturers:
    a. Appleton.
    b. Crouse-Hinds.
    c. Thomas & Betts.
6. Connector Manufacturers:
    a. Appleton.
    b. Crouse-Hinds.
    c. Thomas & Betts.

C. PVC Conduit and Tubing:

1. Meet requirements of NEMA TC 3.
2. Type: PVC, slip-on.

D. PVC-Coated Rigid Galvanized Steel Conduit:

1. Meet requirements of UL 514B.
2. Fittings: Rigid galvanized steel type, PVC coated by conduit manufacturer.
3. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC coated by conduit manufacturer.
4. Finish: 40-mil PVC exterior, 2-mil urethane interior.
5. Overlapping pressure-sealing sleeves.
6. Conduit Hangers, Attachments, and Accessories: PVC-coated.
7. Manufacturers:
   a. Robroy Industries.
   b. Ocal.
8. Expansion Fitting:
   a. Manufacturer: Ocal.

E. Flexible Metal, Liquid-Tight Conduit:

1. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
2. Insulated throat and sealing O-rings.
3. Manufacturers:
   a. Thomas & Betts.
   b. O-Z/Gedney.

F. Flexible Metal, Nonliquid-Tight Conduit:

1. Meet requirements of UL 514B.
2. Body: Galvanized steel.
3. Throat: Nylon insulated.
4. 1-1/4-Inch Conduit and Smaller: One screw body.
5. 1-1/2-Inch Conduit and Larger: Two screw body.
6. Manufacturer: Appleton.

G. Flexible Coupling, Hazardous Locations:

1. Approved for use in atmosphere involved.
2. Rating: Watertight and UL listed for use in Class I, Division 1 and 2 areas.
3. Outer bronze braid and an insulating liner.
4. Conductivity equal to a similar length of rigid metal conduit.

5. Manufacturers:
    a. Crouse-Hinds.
    b. Appleton.

H. Watertight Entrance Seal Device:

1. New Construction:
    a. Material: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
    b. Manufacturer: O-Z/Gedney.
2. Cored-Hole Application:
    a. Material: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
    b. Manufacturer: O-Z/Gedney.

2.03 OUTLET AND DEVICE BOXES

A. Sheet Steel: One-piece drawn type, zinc-plated or cadmium-plated.

B. Cast Metal:

1. Box: Malleable iron or cast ferrous metal.
2. Cover: Gasketed, weatherproof, malleable iron or cast ferrous metal, with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers, Nonhazardous Locations:
    a. Crouse-Hinds.
    b. Appleton.
    c. Killark.
6. Manufacturers, Hazardous Locations:
    a. Crouse-Hinds.
    b. Appleton.

C. PVC-Coated Cast Metal:

1. Type: One-piece.
2. Material: Malleable iron, cast ferrous metal, or cast aluminum.
3. Coating:
    a. Exterior Surfaces: 40-mil PVC.
    b. Interior Surfaces: 2-mil urethane.
4. Manufacturers:
    a. Robroy Industries.
    b. Ocal.

## 2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Large Sheet Steel Box:

1. NEMA 250, Type 1.
2. Box: Code-gauge, galvanized steel.
3. Cover: Full access, screw type.
4. Machine Screws: Corrosion-resistant.

D. Large Cast Metal Box:

1. NEMA 250, Type 4.
2. Box: Cast malleable iron or ferrous metal, electrogalvanized finished, with drilled and tapped conduit entrances and exterior mounting lugs.
3. Cover: Hinged with clamps.
4. Gasket: Neoprene.
5. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
6. Manufacturers, Surface Mounted Nonhinged Type:
   a. Crouse-Hinds.
   b. O-Z/Gedney.
7. Manufacturer and Product, Surface Mounted, Hinged Type: O-Z/Gedney.
8. Manufacturers, Recessed Type:
   a. Crouse-Hinds.
   b. O-Z/Gedney.

E. Large Steel Box:

1. NEMA 250 Type 1 or 3R.
2. Box: 14-gauge steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide gray finish.
3. Cover: Hinged with clamps.
4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
5. Manufacturers:
   a. Hoffman Engineering Co.
   b. Robroy Industries.
   c. Wiegman.

F. Concrete Box, Nontraffic Areas:

1. Box: Reinforced, cast concrete with extension.
2. Cover: Steel diamond plate with locking bolts.

3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Size: 10 inches by 17 inches, minimum.
5. Manufacturers:
    a. Utility Vault Co.
    b. Christy, Concrete Products, Inc.
    c. Quazite.

G. Concrete Box, Traffic Areas:

1. Box: Reinforced, cast concrete with extension and bottom slab.
2. Cover: Steel checked plate; H/20 loading with screw down.
3. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
4. Manufacturers:
    a. Christy, Concrete Products, Inc.
    b. Utility Vault Co.

## 2.05 TELEPHONE TERMINAL CABINET

A. Material: Code-gauge galvanized steel box with hinged doors and 3/4-inch fire-resistant plywood backboard, meeting requirements of telephone service provider.

B. Finish: Provide gray finish.

C. Minimum Size: 18 inches high by 18 inches wide by 6 inches deep.

## 2.06 TELEPHONE AND DATA OUTLET

A. Provide outlet boxes and cover plates meeting requirements of TIA 569B.

## 2.07 TERMINAL JUNCTION BOX

A. Cover: Hinged, unless otherwise shown.

B. Interior Finish: Paint with white enamel or lacquer.

C. Terminal Blocks:

1. Separate connection point for each conductor entering or leaving box.
2. Spare Terminal Points: 25 percent, minimum.

## 2.08 SURFACE METAL RACEWAY

A. General:

1. Meet requirements of UL 5.
2. Material: Two-piece, code-gauge steel.

3. Finish: Factory applied rust inhibiting primer and gray semi-gloss finish suitable for field painting.
4. Configuration: Single, 1-17/32-inch by 2-3/4-inch section, unless otherwise indicated.

B. Fittings and Accessories:

1. Wire clips at 30 inches on center.
2. Couplings, cover clips, supporting clips, ground clamps, and elbows as required; to comply with manufacturer's recommendations.

C. Outlets:

1. Provide bracket or device covers as required to support wiring devices indicated.
2. Wiring Devices and Device Plates: In accordance with Section 26 27 26, Wiring Devices.
3. Manufacturers:
   a. The Wiremold Co.
   b. Walker.

## 2.09 PRECAST MANHOLES AND HANDHOLES

A. Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

B. Loading: AASHTO, H-20 in accordance with ASTM C857.

C. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole and finished grade at required elevations.

D. Drainage: Slope floors toward drain points, leaving no pockets or other nondraining areas.

E. Raceway Entrances:

1. Provide on all four sides.
2. Provide knockout panels or precast individual raceway openings.
3. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

F. Embedded Pulling Iron:

1. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.

2. Location:
    a. Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
    b. Floor: Centered below manhole or handhole cover.

G. Manhole Frames and Covers:

1. Material: Machined cast iron.
2. Diameter: 36-1/2 inches.
3. Cover Type: Indented, solid top design, with two drop handles each.
4. Cover Loading: AASHTO H-20.
5. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
    a. Above 600 Volts: ELECTRIC HV.
    b. 600 Volts and Below: ELECTRIC LV.

H. Handhole Frames and Covers:

1. Material: Steel, hot-dipped galvanized.
2. Cover Type: Solid, bolt-on, of checkered design.
3. Cover Loading: AASHTO H-20.
4. Cover Designation: Burn by welder, on upper side in integral letters, minimum 2 inches in height, appropriate titles:
    a. 600 Volts and Below: ELECTRIC LV.

I. Hardware: Steel, hot-dip galvanized.

J. Furnish knockout for ground rod in each handhole and manhole.

K. Manufacturers:

1. Utility Vault Co.
2. Penn-Cast Products, Inc.
3. Concrete Conduit Co.
4. Associated Concrete Products, Inc.
5. Pipe, Inc.

## 2.10 ACCESSORIES

A. Identification Devices:

1. Warning Tape:
    a. Material: Polyethylene, 4-mil gauge with detectable strip.
    b. Color: Red.
    c. Width: Minimum 3 inches.
    d. Designation: Warning on tape that electric circuit is located below tape.

e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.
f. Manufacturers:
1) Panduit.
2) Reef Industries.

2. Buried Raceway Marker:
a. Material: Sheet bronze, consisting of double-ended arrows, straight for straight runs and bent at locations where runs change direction.
b. Designation: Engrave to depth of 3/32 inch; ELECTRIC CABLES, in letters 1/4-inch high.
c. Minimum Dimension: 1/4-inch thick, 10 inches long, and 3/4-inch wide.

B. Heat Shrinkable Tubing:

1. Material: Heat-shrinkable, cross-linked polyolefin.
2. Semi-flexible with meltable adhesive inner liner.
3. Color: Black.
4. Manufacturers:
a. Raychem.
b. 3M.

C. Wraparound Duct Band:

1. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
2. Width: 50 mm minimum.
3. Manufacturer: Raychem.

## PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete equipment pads, foundations, or beams without Engineer approval.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

S. Install conduits for telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

## 3.02 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1-inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Engineer.

E. Slabs and Walls:

1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams:

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.03 CONDUIT APPLICATION

A. Diameter: Minimum 3/4 inch.

B. Exterior, Exposed:

1. Rigid galvanized steel.
2. PVC-coated rigid galvanized steel.

C. Interior, Exposed:

1. Rigid galvanized steel.
2. Electric metallic tubing for ceiling portion of lighting circuits.

D. Interior, Concealed (Not Embedded in Concrete):

1. Rigid galvanized steel.
2. Electric metallic tubing.
3. PVC-coated rigid galvanized steel.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:

1. Rigid galvanized steel.
2. PVC Schedule 40.

F. Direct Earth Burial:

1. PVC Schedule 80.
2. PVC-coated rigid galvanized steel.

G. Concrete-Encased Ductbank: PVC Schedule 40.

H. Under Slabs-On-Grade:

1. PVC Schedule 80.
2. PVC-coated rigid galvanized steel.

I. Transition from Underground or Concrete Embedded to Exposed: PVC-coated rigid steel conduit.

J. Under Equipment Mounting Pads: PVC-coated rigid steel, PVC Schedule 80 conduit.

K. Exterior Light Pole Foundations: PVC-coated rigid steel, PVC Schedule 80 conduit.

L. Hazardous Gas Areas: Rigid galvanized steel.

3.04 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, other locations where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet Areas: Flexible metal liquid-tight.
4. Dry Areas: Flexible metallic nonliquid-tight conduit.
5. Hazardous Areas: Flexible coupling suitable for Class I, Division 1 areas.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.05 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

D. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal device on each side.
   c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
   d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Manholes and Handholes:
   a. Metallic Raceways: Provide insulated grounding bushings.
   b. Nonmetallic Raceways: Provide bell ends flush with wall.
   c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

## 3.06 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 10 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Multiple Adjacent Raceways: Provide ceiling trapeze.

C. Application/Type of Conduit Strap:

1. Rigid Steel or EMT Conduit: Zinc coated steel, pregalvanized steel or malleable iron.
2. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
3. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.

D. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.

3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
    a. Dry, Noncorrosive Areas: Galvanized.
    b. Wet, Noncorrosive Areas: Stainless steel.

E. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.07 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30 Degrees and Larger: Provide factory-made elbows.
2. 90-Degree Bends: Provide rigid steel elbows, PVC-coated where direct buried.
3. Use manufacturer’s recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.08 EXPANSION/DEFLECTION FITTINGS

A. Provide on raceways at structural expansion joints and in long tangential runs.

B. Provide expansion/deflection joints for 120 degrees F maximum temperature variation.

C. Install in accordance with manufacturer’s instructions.

3.09 PVC CONDUIT

A. Solvent Welding:

1. Apply manufacturer recommended solvent to joints.
2. Install in order that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit or IMC: PVC female adapter.

C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.10 PVC-COATED RIGID STEEL

A. Install in accordance with manufacturer’s instructions.

B. Tools and equipment used in cutting, bending, threading and installation of PVC-coated rigid conduit shall be designed to limit damage to PVC coating.

C. Provide PVC boot to cover exposed threading.

3.11 WIREWAYS

A. Install in accordance with manufacturer’s instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer’s premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures:

1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.

C. Sheet Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 3R boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Electric Metallic Tubing: Provide gland compression, insulated connectors.
4. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
5. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
6. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

D. Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

## 3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Transition from Underground to Exposed: PVC-coated rigid steel conduit.

I. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

J. Metallic Raceway Coating: At couplings and joints, apply wraparound duct band with one-half tape width overlap to obtain two complete layers or apply heat shrinkable tubing.

K. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.

L. Provide expansion/deflection fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.

M. Concrete Encasement:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Concrete Color: Red.

N. Backfill: As specified in Section 31 23 23.15, Trench Backfill.

## 3.14 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

## 3.15 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.

3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
    a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. Avoid interference with mechanical equipment or structural features.
3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
    a. Dimensions given to centerline of box.
    b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
    c. Do not straddle CMU block or other construction joints.
2. Light Switch:
    a. 48 inches above floor.
    b. When located next to door, install on lock side of door.
3. Thermostat: 54 inches above floor.
4. Telecommunications Outlet:
    a. Wall Mounted: 52 inches above floor.
5. Convenience Receptacle:
    a. General Interior Areas: 48 inches above floor.
    b. Outdoor Areas: 24 inches above finished grade.
6. Special-Purpose Receptacle: 48 inches above floor or as shown.
7. Switch, Motor Starting: 48 inches above floor, unless otherwise indicated on Drawings.

E. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.

3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

## 3.16 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Flush Mounted:

1. Install with concealed conduit.

2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

C. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Use boxes and covers suitable to support anticipated weights.

F. Install Drain/breather fittings in NEMA 250 Type 4 enclosures.

## 3.17 TELEPHONE TERMINAL CABINET

A. Install with top of cabinet 6 feet above floor.

B. Door Opening: 120 degrees, minimum.

## 3.18 TELEPHONE AND DATA OUTLET

A. Provide empty 4-11/16-inch square, deep outlet box.

B. Provide blank single gang raised device cover if cables are not installed.

## 3.19 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

B. Do not install until final raceway grading has been determined.

C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

## 3.20 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

## 3.21 IDENTIFICATION DEVICES

A. Warning Tape: Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.

B. Buried Raceway Marker:

1. Install at grade to indicate direction of underground raceway.
2. Install at bends and at intervals not exceeding 100 feet in straight runs.
3. Embed and secure to top of concrete base, sized 14 inches long, 6 inches wide, and 8 inches deep; top set flush with finished grade.

## 3.22 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

D. Touch up coating damage to PVC-coated conduit with patching compound approved by manufacturer. Compound shall be kept refrigerated according to manufacturers' instructions until time of use.

**END OF SECTION**

**SECTION 26 14 13**
**SWITCHBOARDS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. National Electrical Manufacturers Association (NEMA):
   a. PB 2, Deadfront Distribution Switchboards.
   b. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
3. Underwriters Laboratories (UL):
   a. 489, Standard for Safety for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   b. 891, Standard for Safety for Switchboards.
   c. 1561, Standard for Safety for Dry-Type General Purpose and Power Transformers.

### 1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive product information.
2. Itemized Bill of Material.
3. Dimensional drawings.
4. Connection and interconnection drawings.
5. Circuit Breakers: Copies of time-current characteristics.
6. Bus data.
7. Incoming line section equipment data.
8. Conduit entrance locations.
9. Anchoring instructions and details.
10. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s installation instructions.
2. Factory Test Report.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories Inc. shall conform to those standards and shall have an applied UL listing mark.

**PART 2 PRODUCTS**

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this Section shall be products of:

1. General Electric.
2. Westinghouse.
3. Siemens.
4. Square D.

2.02 GENERAL REQUIREMENTS

A. Equipment suitable for 480Y/277-volt, three-phase, four-wire solid grounded-wye electrical system having available short-circuit current at line terminals of amperes rms symmetrical as shown on Drawings.

B. Comply with NEMA PB 2 and UL 891.

C. Switchboard and its major components to be manufactured and assembled by single manufacturer in order to achieve standardization for appearance, operation and maintenance, spare parts replacement, and manufacturer's services.

D. Lifting lugs on equipment and devices weighing over 100 pounds.

E. Operating Conditions:

1. Ambient Temperature: Maximum 40 degrees C.
2. Equipment shall be fully rated without derating for the above operating conditions.

2.03 STATIONARY STRUCTURE

A. Type: NEMA PB 2 construction, dead front, completely metal enclosed, self-supporting.

B. Sections bolted together to form one rigid assembly capable of being moved into position and bolted directly to floor without use of floor sills.

2.04 ENCLOSURE

A. Equipment Finish: Baked enamel applied over rust-inhibiting phosphated base coating.

B. Indoor Enclosure: NEMA 250, Type 1:

1. Rear, full-height, bolt-on panels for each enclosure section.
2. Cable Termination Access: Padlock provision.
3. Front Access:
    a. Service line and load terminations, internal devices, device and bolted bus connections, and protective device removal, serviceable from front only.
    b. Sections aligned across back to permit placement flush against wall.
    c. Working Space: As required by NFPA 70.
4. Front and Rear Access:
    a. With service line and load terminations, internal devices, and device and bolted bus connections serviceable from rear and protective devices serviceable from front.
    b. Align sections across back and front with NFPA 70 required working space in front, back, and sides.
5. Transition sections as required or shown.

2.05 BUSWORK

A. Material: Phase, copper of sufficient cross section to limit temperature rise at rated current to 55 degrees C.

B. Bus Arrangement: A-B-C, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.

C. Brace for short-circuit currents 100,000 amperes rms symmetrical.

D. Main Horizontal Bus: Nontapered, continuous current rating as shown.

E. Neutral Bus: Continuous current rating 100 percent of main horizontal bus rating.

F. Ground Bus:

1. Copper.
2. Rating: 500 amperes.
3. Bolted to each vertical section.
4. Bus Connections and Joints: Bolted with Belleville washers.

G. Extend each bus entire length of switchboard.

2.06 PROTECTIVE DEVICES

A. Molded-Case Circuit Breakers:

1. Main and Branch Feeder Protective Devices: Group mounted, suitable for use with 75 degree C wire at full 75 degree C ampacity when mounted in switchboard.
2. Arrangement: Fully rated main and branch feeder.
3. Breakers 225-Ampere Frame and Above: Continuously adjustable magnetic pickups five to ten times trip rating.
4. Interrupting Rating: As shown.
5. Mechanical interlock to prevent opening compartment door while breaker is in closed position.

B. Ground Fault Protection:

1. Ground sensor encircling phase conductors and neutral conductor, where used.
2. Solid-state sensing relay and monitor/test panel.
3. Zero sequence current detection, adjustable over range shown.
4. Monitor panel with fault detection indicating light, test, and reset buttons.
5. Control Power Source: Suitable to operate circuit protective device when connected to faulted phase conductor.

2.07 CONTROL WIRING

A. Control, Instrumentation, and Power/Current Circuits: NFPA 70, Type SIS, single-conductor, Class B, stranded copper, rated 600 volts.

B. Transducer Output/Analog Circuits: Shielded cable rated 600 volts, 90 degrees C minimum.

C. Conductor Lugs: Preinsulated, self-locking, spade-type, with reinforced sleeves.

D. Identification: Individually, with permanent wire markers at each end.

E. Enclose in top and vertical steel wiring troughs, and front-to-rear in nonmetallic wiring troughs.

F. Splices: Not permitted in switchboard wiring.

2.08 TERMINAL BLOCKS

A. Enclosed in steel wiring troughs.

B. Rated 600 volts, 30 amperes minimum, one-piece barrier type with strap screws.

C. Shorting type for current transformer leads.

D. Provide terminal blocks for:

1. Conductors connecting to circuits external to switchboard.
2. Internal circuits crossing shipping splits.
3. Equipment parts requiring replacement and maintenance.

E. Spare Terminals: Not less than 20 percent.

F. Group terminal blocks for external circuit wiring leads.

G. Maintain 6-inch minimum space between columns of terminal blocks.

H. Identification: Permanent, for each terminal and columns of terminal blocks.

I. Manufacturer: General Electric.

2.09 IDENTIFICATION

A. Nameplates:

1. Master:
   a. Deep-etched aluminum, with manufacturer’s name and model number.
   b. Riveted to main vertical section.
2. Circuit Breaker Cubicle and Door-Mounted Device:
   a. Engraved, phenolic.
   b. Color: Black with white lettering.
   c. Characters: Block-type, 3/16-inch high.
   d. Size: Manufacturer’s standard.
   e. Inscription: As shown on one-line diagram.
   f. Blank plates for future spaces.
   g. Attachment Screws: Self-tapping.

2.10 FACTORY TESTING

A. Performance tests in accordance with UL 891 and production tests in accordance with NEMA PB-2.

## PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions and recommendations.

B. Secure to mounting pads with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Install plumb and in longitudinal alignment with pad or wall.

D. Coordinate terminal connections with installation of secondary feeders.

**END OF SECTION**

**SECTION 26 22 00**
**LOW-VOLTAGE TRANSFORMERS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
2. National Electrical Contractors Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
   c. TP 1, Guide For Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Descriptive information.
2. Dimensions and weight.
3. Transformer nameplate data.
4. Schematic and connection diagrams.

## PART 2 PRODUCTS

2.01 GENERAL

A. UL 1561, NEMA ST 20, unless otherwise indicated.

B. Dry-type, self-cooled, two-winding, with aluminum windings.

C. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

D. Efficiency: Meet or exceed values in Table 4.2 of NEMA TP 1.

E. Maximum Sound Level per NEMA ST 20:

1. 40 decibels for 0 to 9 kVA.
2. 45 decibels for 10 to 50 kVA.
3. 50 decibels for 51 to 150 kVA.
4. 55 decibels for 151 to 300 kVA.
5. 60 decibels for 301 to 500 kVA.

F. Overload capability: Short-term overload per IEEE C57.96.

G. Wall Bracket: For single-phase units, 15 to 37-1/2 kVA, and for three-phase units, 15 to 30 kVA.

H. Vibration Isolators:

1. Rated for transformer's weight.
2. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
3. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
4. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

I. Manufacturers:

1. General Electric Co.
2. Square D Co.
3. Siemens.
4. Eaton/Cutler-Hammer.

## 2.02 GENERAL PURPOSE TRANSFORMER

A. Insulation Class and Temperature Rise: Manufacturer's standard.

B. Core and Coil:

1. Encapsulated for single-phase units 1/2 to 25 kVA and for three-phase units 3 to 15 kVA.
2. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

C. Enclosure:

1. Single-Phase, 3 to 25 kVA: NEMA 250, Type 3R, nonventilated.
2. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
3. Three-Phase, 3 to 15 kVA: NEMA 250, Type 3R, nonventilated.
4. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
5. Outdoor Locations: NEMA 250, Type 3R.

D. Voltage Taps:

1. Three-Phase, 3 to 15 kVA: Two 5 percent, full capacity, below normal voltage rating.
2. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.

E. Impedance: 4.5 percent minimum on units 75 kVA and larger.

## PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer's instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

E. Provide wall brackets for single-phase units, 15 to 167-1/2 kVA, and three-phase units, 15 to 112 kVA.

**END OF SECTION**

**SECTION 26 24 16**
**PANELBOARDS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronics Engineers (IEEE):
   a. C62.1, Surge Arresters for Alternating Current Power Circuits.
   b. C62.11, Standards for Metal-Oxide Surge Arrestors for AC Power Circuits.
2. National Electrical Contractors Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. AB 1, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   d. KS 1, Enclosed Switches.
   e. LA 1, Surge Arrestors.
   f. PB 1, Panelboards.
   g. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. Underwriters Laboratories Inc. (UL):
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Standard for Ground-Fault Circuit-Interrupters.

### 1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer’s shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.

3. Tabulation of features for each panelboard to include the following:
    a. Protective devices with factory settings.
    b. Provisions for future protective devices.
    c. Space for future protective devices.
    d. Voltage, frequency, and phase ratings.
    e. Enclosure type.
    f. Bus and terminal bar configurations and current ratings.
    g. Provisions for circuit terminations with wire range.
    h. Short circuit current rating of assembled panelboard at system voltage.
    i. Features, characteristics, ratings, and factory settings of auxiliary components.

B. Informational Submittals: Manufacturer's recommended installation instructions.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled as defined in NEC Article 100.

## PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this Section shall be products of:

1. Eaton/Cutler-Hammer.
2. General Electric Co.
3. Square D Co.
4. Siemens.

2.02 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this.

B. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.

C. Wire Terminations:

1. Panelboard assemblies, including protective devices, shall be suitable for use with 75 degrees C or greater wire insulation systems at NEC 75 degrees C conductor ampacity.
2. In accordance with UL 486E.

D. Load Current Ratings:

1. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
2. Where indicated “continuous”, “100 percent”, etc., selected components and protective devices shall be rated for continuous load current at value shown.

E. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the fault current available as shown at point of application in distribution system.

F. Overcurrent Protective Devices:

1. In accordance with NEMA AB 1, NEMA KS 1, UL 98, and UL 489.
2. Protective devices shall be adapted to panelboard installation.
    a. Capable of device replacement without disturbing adjacent devices and without removing main bus.
    b. Spaces: Cover openings with easily removable cover.
3. Series-Connected Short Circuit Ratings: Devices shall be fully rated; series-connected ratings unacceptable.

G. Circuit Breakers:

1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
2. Noninterchangeable: In accordance with NEC.
3. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120 and 240/120-volt branch circuit panelboards.
4. Trip Mechanism:
    a. Individual permanent thermal and magnetic trip elements in each pole.
    b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
    c. Two and three pole, common trip.
    d. Automatically opens all poles when overcurrent occurs on one pole.
    e. Test button on cover.
    f. Calibrated for 40 degrees C ambient, unless shown otherwise.
5. Unacceptable Substitution:
    a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.

b. Do not use tandem or dual circuit breakers in normal single-pole spaces.

6. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel).
   a. Ground fault sensor shall be rated same as circuit breaker.
   b. Push-to-test button.
   c. Reset button.
7. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

H. Enclosures:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Material: Type 1 and Type 3R shall be code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Finish: Rust inhibitor prime followed by manufacturer's standard gray baked enamel or lacquer.

I. Bus:

1. Material: Copper.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

J. Feeder Lugs: Main, feed-through, and neutral shall be replaceable, bolted mechanical type.

K. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.

L. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.

1. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
2. Provide individual termination points for all other neutral conductors.

M. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

2.03 LIGHTING AND APPLIANCE BRANCH CIRCUIT PANELBOARDS

A. Protective Device Locking: Furnish provisions for handle padlocking for main and subfeed devices; also provide for branch devices where indicated.

B. NEMA 250 Type 1 Branch Panelboard Enclosure:

1. Front trim shall be secured to box with concealed trim clamps.
2. Surface-mount panelboard front trim shall have same dimensions as box.
3. Flush panelboards front trims shall overlap box nominal 3/4-inch on all sides.
4. Door in panelboard front trim, with concealed hinges, shall provide access to protective device operating handles.
5. Doors over 30 inches in height shall have multi-point latching.
6. Door lock shall be secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
7. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

**PART 3 EXECUTION**

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1 and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle, and wrap with nylon wire ties.

3.02 BRANCH CIRCUIT PANELBOARD

A. Mount flush panels uniformly flush with wall finish.

B. Provide typewritten circuit directory for each panelboard.

**END OF SECTION**

**SECTION 26 27 26**
**WIRING DEVICES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
   a. W-C-596G, General Specification for Connector, Electrical, Power.
   b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   c. WD 1, General Color Requirements for Wiring Devices.
   d. WD 6, Wiring Devices – Dimensional Specifications.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. Underwriters Laboratories Inc. (UL):
   a. 498, Standard for Safety for Attachment Plugs and Receptacles.
   b. 508, Standard for Safety for Industrial Control Equipment.
   c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   d. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s product data for wiring devices.

## PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. NEMA WD 1 and FS W-S-896F.
2. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.

3. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
4. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
5. Rating: 20 amps, 120/277 volts.
6. Automatic grounding clip and integral grounding terminal on mounting strap.
7. Manufacturers, Industrial Grade:
    a. Cooper Arrow Hart.
    b. Bryant.
    c. Hubbell.
    d. Leviton.

B. Switch, Motor Rated:

1. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
2. UL 508 listed.
3. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
4. Minimum General Purpose Rating: 30 amperes, 600V ac.
5. Minimum Motor Ratings:
    a. 2 horsepower for 120V ac, single-phase, two-pole.
    b. 3 horsepower for 240V ac, single-phase, two-pole.
    c. 15 horsepower for 480V ac, three-phase, three-pole.
6. Screw-type terminal.
7. Manufacturers and Products:
    a. Cooper Arrow Hart.
    b. Hubbell Bryant; HBL78 Series.
    c. Leviton.

## 2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. NEMA WD 1 and FS W-C-596G.
2. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
3. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.
4. One-piece mounting strap with integral ground contact (rivetless construction).
5. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
6. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, unless otherwise indicated.

7. Size: For 2-inch by 4-inch outlet box.
8. Commercial Grade Manufacturers:
    a. Cooper Arrow Hart.
    b. Hubbell Bryant.
    c. Leviton.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Listed Class A to UL 943, tripping at 5 mA.
3. Rectangular smooth face with push-to-test and reset buttons.
4. Listed weather-resistant per NEC 406.8.
5. Feed-through Capability: 20 amps.
6. Manufacturers:
    a. Hubbell Bryant.
    b. Cooper Arrow Hart.
    c. Leviton.

C. Receptacle, Special-Purpose:

1. Rating and number of poles as indicated or required for anticipated purpose.
2. Where indicated provide matching plug with cord-grip features for each special-purpose receptacle.

2.03 DEVICE PLATES

A. Sectional type plate not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Copper-free aluminum with gaskets.
2. Screw: Oval-head stainless steel.

D. Sheet Steel:

1. Finish: Zinc electroplate.
2. Screws: Oval-head stainless steel.

3. Manufacturers:
    a. Appleton.
    b. Crouse-Hinds.

E. Weatherproof:

1. Receptacle, Weatherproof Type 1:
    a. Gasketed, cast-aluminum, with individual cap over each receptacle opening.
    b. Mounting Screw and Cap Spring: Stainless steel.
    c. Manufacturers and Products:
        1) Crouse-Hinds; Type WLRD-1.
        2) Appleton; Type FSK-WRD.
2. Switch:
    a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
    b. Mounting Screw: Stainless steel.
    c. Manufacturers and Products:
        1) Crouse-Hinds; DS-181 or DS-185.
        2) Appleton; FSK-1VTS or FSK-1VS.

F. Raised Sheet Metal: 1/2-inch high zinc- or cadmium-plated steel designed for one-piece drawn type sheet steel box.

G. Sheet Steel: Formed sheet steel or Feraloy designed for installation on cast-metal box.

## 2.04 OCCUPANCY SENSOR, WALL SWITCH

A. Description:

1. Passive-infrared type, 120/277-volt, adjustable time delay up to 30 minutes, 180-degree field of view, with a minimum coverage area of 900 square feet (84 square meters).
2. Provide dual switch unit where indicated.
3. Color: Manufacturer’s standard white.

B. Manufacturers and Products:

1. Hubbell; WS1277.
2. Leviton; ODS 10-ID.
3. Pass & Seymour; WS3000.
4. Watt Stopper (The); WS-200.

## PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with NECA 1.

B. Coordination with Other Trades:

1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.
2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.

5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
    a. Do not use oversized or extra deep plate.
    b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

C. Occupancy Sensor, Wall Switch: Install in accordance with manufacturer's instructions.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot.
2. Ground receptacle to box with grounding wire only.
3. Weatherproof Receptacle:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for "downstream" conventional receptacles.
5. Special-Purpose Receptacle: Install in accordance with manufacturer's instructions.

3.04 DEVICE PLATE INSTALLATION

A. Securely fasten to wiring device; ensure tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

C. Using test plug, verify device and its outlet box are securely mounted.

D. Line Voltage Range: 105 to 132 volts.

E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.

F. Ground Impedance: 2 ohms, maximum.

G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

**END OF SECTION**

**SECTION 26 43 00**
**TRANSIENT VOLTAGE SUPPRESSION**

## PART 1 GENERAL

1.01 SUBMITTALS

A. Submit product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.

B. Submit manufacturer's UL certified test data and nameplate data for each TVSS.

C. Submit electrical single-line diagram showing location of each TVSS.

1.02 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. For power and signal circuits, TVSS devices shall comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units that are listed and labeled by UL.
2. For telephone circuit protection, TVSS devices shall comply with UL 497A.

B. ANSI Compliance: Use TVSS devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

## PART 2 PRODUCTS

2.01 GENERAL

A. All TVSS devices for power circuits, provided under this Section, shall be the product of a single manufacturer.

B. TVSS devices shall be capable of performance at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.

C. TVSS devices shall be fused to disconnect the suppressor from the electrical source should the suppressor fail. The fusing shall allow full surge handling capabilities and to afford safety protection from thermal overloads and short circuits.

D. Design TVSS devices for the specific type and voltage of the electrical service. Single-phase and three-phase wye-configured systems shall have L-N, L-G, and N-G protection. Grounded delta-configured systems shall have L-L and L-G protection.

E. Power Filter: The TVSS shall include a high frequency extended range power filter complimentary listed to UL 1283 as an electromagnetic interference filter.

2.02 MANUFACTURER

A. Innovative Technology, VanGuard Series.

B. Advanced Protection Technologies, Inc.

C. General Electric.

2.03 MAIN DISTRIBUTION TVSS

A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.

B. Surge current capacity shall be not less than the following:

1. L-N Capacity: 200 kA.
2. L-G Capacity: 120 kA.
3. N-G Capacity: 120 kA.

C. Suppressor housing shall be in an enclosure that has the same NEMA rating as the equipment it protects and painted to match.

D. UL 1449 maximum suppression voltage shall not be more than:

| System Voltage | Phase | L-L or L-N Suppression Voltage |
|---|---|---|
| 120 | 1 | 400 |
| 208Y/120 | 3 | 400 |
| 240 | 3 | 800 |
| 480Y/277 | 3 | 800 |

2.04 PANELBOARD TVSS

A. Provide TVSS meeting IEEE C62.41.1 and IEEE C62.41.2 Location Category B.

B. Surge current capacity shall be not less than the following:

1. L-L Capacity: 80 kA.
2. L-N Capacity: 80 kA.
3. L-G Capacity: 80 kA.
4. N-G Capacity: 80 kA.

C. Suppressor shall be in an enclosure that has the same NEMA rating as the panel it protects or the TVSS may be integral to a panelboard.

D. UL 1449 maximum clamp voltage shall not be more than:

| System Voltage | Phase | L-L or L-N Clamp Voltage |
|---|---|---|
| 120 | 1 | 400 |
| 208Y/120 | 3 | 400 |
| 240 | 3 | 800 |
| 480Y/277 | 3 | 800 |

2.05 ANNUNCIATION

A. Provide unit or separately mounted LED-type indication lights to show the normal and failed status of each module. Provide one normally open and one normally closed contacts which operate when the unit fails.

2.06 SURGE COUNTER

A. Provide each TVSS rated above 100 kA with a counter displaying the number of voltage transients that have occurred on the unit input. The counter shall be battery backed and retain the count through system power outages.

2.07 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Use bi-polar 1,500-watt silicon avalanche diodes between the protected conductor and earth ground.

C. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).

D. Breakdown voltage shall not exceed 36 volts.

2.08 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

A. Provide units meeting IEEE C62.41, Location Category A.

B. Suppressors shall be a hybrid design with a minimum of three stages, utilizing solid-state components and operating bi-directionally.

C. Suppressors shall meet or exceed the following criteria:

1. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
2. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform): 2,000 occurrences.
3. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of the normal applied signal voltage by 200 percent.

**PART 3 EXECUTION**

3.01 APPLICATION REQUIREMENTS

A. Install TVSS when indicated on Drawings and:

1. Main Distribution TVSS in or near each low-voltage switchgear (load center).
2. Main Distribution TVSS in or near each motor control center.
3. Panelboard TVSS In or near each distribution panelboard unless otherwise indicated.

B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.

1. Use secondary protectors on lines that do not exit the structure.
2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer’s recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with all conductors laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Connecting wires shall be as short as possible with gently twisted conductors, tied together, to prevent separation. Connecting wires shall not exceed 24 inches in length at any point.

D. Field installed conductors shall be the same as specified for building wire, not smaller than No. 8 AWG and not larger than No. 4 AWG. Device leads shall not be longer than the length recommended by the manufacturer, unless specifically reviewed and approved by the manufacturer.

E. Provide dedicated disconnecting means for TVSS devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for TVSS devices installed at panelboards. The interrupting capacity of the circuit breakers shall be that specified for the other breakers at that location.

**END OF SECTION**

**SECTION 26 50 00**
**LIGHTING**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Canadian Standards Association (CSA).
2. Certified Ballast Manufacturer (CBM).
3. Federal Communications Commission (FCC).
4. Illuminating Engineering Society of North America (IESNA).
5. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
6. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
7. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
8. Underwriters Laboratories, Inc. (UL):
   a. 595, Marine-Type Electric Lighting Fixtures.
   b. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
   c. 924, Emergency Lighting and Power Equipment.

### 1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Interior Luminaires:
      1) Catalog data sheets and pictures.
      2) Luminaire finish and metal gauge.
      3) Lens material, pattern, and thickness.
      4) Candle power distribution curves in two or more planes.
      5) Candle power chart 0 to 90 degrees.
   b. Exterior Luminaires:
      1) Catalog data sheets and pictures.
      2) Luminaire finish and metal gauge.
      3) Lens material, pattern, and thickness.
      4) IESNA lighting classification and isolux diagram.
      5) Ballast type, location, and method of fastening.

c. Lamps:
    1) Voltages.
    2) Colors.
    3) Approximate life (in hours).
    4) Approximate initial lumens.
    5) Lumen maintenance curve.
    6) Lamp type and base.
    7) Copy of lamp order, including individual quantities, for Project.
d. Ballasts:
    1) Type.
    2) Wiring diagram.
    3) Nominal watts and input watts.
    4) Input voltage and power factor.
    5) Starting current, line current, and restrike current values.
    6) Sound rating.
    7) Temperature rating.
    8) Efficiency ratings.
    9) Low temperature characteristics.
    10) Emergency ballasts rating and capacity data.
e. Photo-Time Control:
    1) Wiring diagram.
    2) Contact ratings.
f. Photocells:
    1) Voltage, and power consumption.
    2) Capacity.
    3) Contacts and time delay.
    4) Operating levels.
    5) Enclosure type and dimensions.
    6) Temperature range.
g. Occupancy Sensors:
    1) Type.
    2) Switching capacity.
    3) Coverage.
    4) Time delay AUTO/OFF adjustment.
h. Low Voltage Remote Control Wiring System:
    1) Type.
    2) Switching capacity.
    3) Voltage rating.
    4) Wiring diagrams.
i. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Seismic Anchorage and Bracing.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

B. Preinstallation Meeting:

1. Occupancy Sensors: Arrange preinstallation meeting with manufacturer's factory authorized representative at Owner's facility, to verify placement of sensors and installation criteria.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and materials:

| Item | Quantity |
|---|---|
| Spare ballast of each type | One complete set |
| Spare lamps of each type | One complete set |

**PART 2 PRODUCTS**

2.01 LUMINAIRES

A. Specific requirements relative to execution of the Work of this section are located in Luminaire Schedule on Drawings.

B. Feed-through type, or separate junction box.

C. Ballasts: Two-lamp when possible.

D. Wire Leads: Minimum 18 AWG.

E. Component Access: Accessible and replaceable without removing luminaire from ceiling.

F. Exterior Installations:

1. UL Labeled: SUITABLE FOR WET LOCATIONS.
2. Ballast: Removable, prewired.
3. When factory-installed photocells are provided, entire assembly shall have UL label.

G. Emergency Lighting:

1. Power Pack: Self-contained, 120/277-volt dual voltage transformer, inverter/charger, sealed nickel cadmium battery, and indicator switch in accordance with UL 924.
2. Lighted, push-to-test indicator.
3. Capable of providing full illumination for 1-1/2 hours in emergency mode.
4. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.
5. Capable of protecting against excess charging and discharging.
6. Emergency Self-Diagnostic System:
   a. Solid state device with LED display and audible alarm.
   b. Automatic and manual test unit.
   c. Test for malfunction of lamps, battery, and charger board.
   d. Manufacturer: Lithonia.

2.02 LAMPS

A. Fluorescent:

1. Type Efficiency: Energy.
2. Color: 3500k.

B. High Intensity Discharge:

1. Type: High pressure sodium and metal halide.
2. Color: Clear.

C. Manufacturers:

1. General Electric Co.
2. Osram Sylvania.
3. Phillips Lighting Company.

2.03 BALLASTS

A. General:

1. Meet requirements for fixture light output, reliable starting, radio interference, total harmonic distortion, electromagnetic interference, and dielectric rating.
2. Certified by electrical testing laboratory to conform to CBM specifications.

B. Fluorescent (Electronic):

1. Provide in 1 lamp, 2 lamp, or 3 lamp models.
2. High frequency ballast of 20k Hz or greater; rapid-start.
3. Meets FCC Part 18.
4. UL listed, Class P, sound rating A.
5. Power factor of 98 percent or greater.
6. Total harmonic distortion THD shall be less than 10 percent.
7. Shall withstand line transients per IEEE C62.41, Cat A.
8. Shall not contain PCB's and shall carry a minimum 3-year manufacturer's warranty.
9. Ballast shall start lamp at a minimum temperature of 0 degree F.

C. Metal Halide:

1. High power factor, normal ambient, 180 degrees C insulation class.
2. Types:
   a. Autotransformer with capacitor and ignitor for lamps 150 watts and less.
   b. Constant wattage autotransformer with capacitor for lamps above 150 watts.

D. High Pressure Sodium:

1. High power factor, normal ambient, 180 degrees C insulation class, with capacitor and ignitor.
2. Type:
   a. Autotransformer for 50-watt lamps.
   b. Constant wattage autotransformer for lamps 70 watts and above.

E. Manufacturers:

1. MagneTek Lighting Products.
2. Advance Transformer Co.
3. Motorola Lighting Inc.

4. SLI Inc.
5. General Electric.

2.04 LIGHTING CONTROL

A. Photocell:

1. Automatic ON/OFF switching photo control.
2. Housing: Self-contained, die-cast aluminum, unaffected by moisture, vibration, or temperature changes.
3. Setting: ON at dusk and OFF at dawn.
4. Time delay feature to prevent false switching.
5. Field adjustable to control operating levels.
6. Manufacturers:
   a. Tork.
   b. Paragon Electric Company.

B. Low Voltage Remote Control Wiring System:

1. Provide a complete low-voltage, remote control wiring system for control of lighting fixtures as indicated on Drawings and Schedules. System shall be complete with transformers, rectifiers, relays, switches, master switches, electronic controls, enclosures, wall plates, and wiring. System and components shall be of same manufacturer.
2. Remote control wiring shall be in accordance with Article 725, Class 2 of NFPA 70.
3. Provide for direct-wired connection of:
   a. Standard of pilot light switches for individual control of relays.
   b. Two independent master override inputs which allow ON/OFF control of all relays while still supporting individual control of each relay.
4. Relay panels shall be configured to allow future addition of up to two master controls of programmable control of all relays.

C. Occupancy Sensors:

1. Passive Infrared:
   a. Wall switch sensors shall be capable of detection of motion at desk top level up to 300 square feet and gross motion up to 1,000 square feet.
   b. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1,200 watts at 277 volts and shall have 180-degree coverage capability.
   c. Bi-level wall switch sensors shall accommodate up to two loads from 0 to 800 watts at 120 volts; 0 to 1,200 at 277 volts, for each load.

d. Passive infrared sensors shall have a multiple segmented lens, in a multiple-tier configuration, with grooves-in to eliminate dust and residue build-up.
e. Wall switches shall be compatible with electronic ballasts.

2. Dual Technology Units:
   a. Unit to be ceiling mounted for 360-degree coverage.
   b. Unit shall utilize both passive infrared and ultrasonic technologies and be easily programmed to accommodate different environmental and architectural conditions.
   c. Unit must detect up to 2,000 square feet with no blind spots.
   d. No audio dual technology units will be accepted.
3. Circuit Control Hardware—CU Power Packs:
   a. Control Units: Able to mount through a 1/2-inch knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of two sensors.
   b. Relay contacts shall have ratings of:
      1) 13A, 120V ac tungsten.
      2) 20A, 120V ac ballast.
4. Wiring: Control wiring between sensors and control units shall be Class II, 14-AWG, stranded, UL Classified, PVC insulated or Teflon jacketed cable approved for use in plenums, where applicable.
5. General:
   a. Sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.
   b. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to cycling of air conditioner or heating fans.
   c. Sensors shall have readily accessible, user adjustable controls for time delay and sensitivity.
   d. In event of failure, bypass manual OVERRIDE ON key shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.
   e. Units shall have an extra Form C (1-NO-1-NC) contact for interface with building system. Units shall be designed to be mountable in standard electrical box.
   f. Units shall have capability of being ordered with integral power pack.
   g. Manufacturers:
      1) Unenco, Inc.
      2) The Watt Stopper, Inc.

2.05 POLES

A. Rating (With Luminaire): 100 mph steady winds, without incurred damage.

B. Material: Steel.

2.06 EMERGENCY BALLAST

A. In accordance with UL 924.

B. Nickel cadmium battery, charger, and electronic circuitry in metal case plus ac ballast.

C. Solid state charging indicator monitoring light and double-pole test switch.

D. Capable of operating two fluorescent lamps for a period of 90 minutes with output of 1,100 to 1,200 lumens.

E. Manufacturers:

1. MagneTek Lighting Products.
2. The Bodine Co., Inc.
3. Lithonia.

2.07 IN-LINE FUSE HOLDER AND FUSE

A. Fuse Holder:

1. General: Waterproof, of corrosion-resistant material.
2. Rating: 600 volts.

B. Fuse:

1. General: Midget, dual element.
2. Rating: 5-amp, voltage as required by application.

C. Manufacturer: Methods Electronics Inc. Network, Buss Div.

**PART 3 EXECUTION**

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer’s recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.

3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building and to concrete pole bases required to safely mount.
4. Install plumb and level.
5. Install each luminaire outlet box with galvanized stud.

B. Mounting:

1. General:
   a. Mounting, fastening, and environmental conditions shall be coordinated with Section 26 05 02, Basic Electrical Requirements.
   b. Refer to Fastener Schedule in Section 05 50 00, Metal Fabrications.
2. Wall Mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.
3. Pendant Mounted:
   a. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   b. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   c. Provide twin-stem hangers on single luminaires.
   d. Measure mounting heights from bottom of luminaire to finished floor or finished grade, whichever is applicable.
4. Pole Mounted:
   a. Provide cast-in-place concrete base.
   b. Provide branch circuit in-line fuses in pole base handhole.

C. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.

D. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
   a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
   b. In concealed locations, install junction boxes to be accessible by removing luminaire.

6. Wiring and Conduit:
    a. Provide wiring of temperature rating required by luminaire.
    b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
    a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.
    b. Tensile strength of chain or wire, and method of fastening to structure shall be adequate to support weight of luminaire.
    c. Fasten chain or wire to each end of luminaire.

E. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 3/8-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

F. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.

3.02 LAMPS

A. Provide in each fixture, number and type for which fixture is designed, unless otherwise noted.

3.03 BALLASTS

A. Install in accordance with manufacturer’s recommendations.

B. Utilize all ballast mounting holes to fasten securely within luminaire.

C. Replace noisy or defective ballasts.

3.04 LIGHTING CONTROL

A. Outdoor Luminaires: Photocells switch lights ON at dusk and OFF at dawn.

B. Dimming Systems:

1. Install in accordance with manufacturer’s recommendations.
2. Do not connect ballasts or equipment to dimming system unless acceptable to dimming system manufacturer.

C. Occupancy Sensors: Locate and aim sensors in correct location required for complete and proper volumetric coverage within range of coverage(s) of controlled areas per manufacturer's recommendations. Rooms shall have 90 to 100 percent coverage to completely cover controlled area to accommodate all occupancy habits of single or multiple occupants at any location within room(s). Locations and quantities of sensors shown on Drawings are diagrammatic and indicate only rooms which are to be provided with sensors. Provide additional sensors if required to properly and completely cover respective room.

3.05 EMERGENCY BALLAST

A. Install battery, charger, and electronic circuitry metal case inside fluorescent fixture housing.

B. Install monitoring light and double-pole switch adjacent to light fixture.

C. Wire in accordance with manufacturer's wiring diagrams.

3.06 EMERGENCY LIGHTING UNIT

A. Install in accordance with manufacturer's recommendations.

B. Provide permanent circuit connections with conduit and wire.

C. Connect to branch circuit feeding normal lighting in area ahead of all local switches.

D. Provide separate circuit wiring to luminaire.

E. Field services to inspect installation, test unit, and put into service.

3.07 CLEANING

A. Remove labels and markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace defective lamps at time of Substantial Completion.

**END OF SECTION**

**SECTION 28 31 00**
**FIRE DETECTION AND ALARM**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Surge Voltages in Low-Voltage AC Power Circuits.
2. International Fire Code (IFC).
3. International Building Code (IBC).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 72, National Fire Alarm Code.
   c. 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
   d. 101, Code for Safety to Life from Fire in Buildings and Structures.
   e. 820, Fire Protection in Wastewater Treatment and Collection Facilities.
   f. 1221 Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems.
5. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. National Institute for Certification in Engineering Technologies (NICET).
7. Telecommunications Industry Association (TIA):
   a. 232, Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange.
   b. 485, Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
8. Underwriters Laboratories, Inc. (UL):
   a. 217, Single and Multiple Station Smoke Alarms.
   b. 228, Door Closures-Holders, With or Without Integral Smoke Detectors.
   c. 268, Smoke Detectors for Fire Protective Signaling Systems.
   d. 464, Audible Signal Appliances.
   e. 864, Control Units for Fire-Protective Signaling Systems.
   f. 1449, Standard for Transient Voltage Surge Suppressors.
   g. 1638, Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.
   h. 1971, Signaling Devices for the Hearing Impaired.

1.02 DEFINITIONS

A. Addressable: A fire alarm system component with a unique identification that can have its status individually identified or that is used to individually control other functions.

B. AHJ: Authority Having Jurisdiction.

C. CAD: Computer Aided Design.

D. Coded: Audible or visible signal that conveys information about alarm event. Examples are, number of rings of a bell or flashes of a strobe. This could be used to convey location or type of alarm.

E. dB: Decibels.

F. DXF: Drawing Interchange Format.

G. FACP: Fire Alarm Control Panel.

H. I/O: Input/Output.

I. LCD: Liquid Crystal Display.

J. LED: Light-Emitting Diode.

K. MOV: Metal Oxide Varistor.

L. RAM: Random Access Memory.

M. SOM: Sequence of Operations Matrix.

N. Zone: A defined area within the protected premises. A zone can define an area from which an alarm signal can be received or an area to which a signal can be sent. The term zone is typically used when describing conventional, nonaddressable systems.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:

1. Contract Drawings show location of fire alarm system components.
2. Design, coordinate, and provide system in accordance with building codes indicated in Article References.
   Design conduit layout and wiring interconnection of devices specified herein.

B. Performance Requirements:

1. Actuation of manual fire alarm pull station or smoke detector shall cause the following operations:
   a. Audible and visual alarm notification within the transfer facility.
   b. Audible and visual indications of alarmed devices on fire alarm control panel display.

1.04 SUBMITTALS

A. Action Submittals:

1. Descriptive product information for each individual system component.
2. Dimensional drawings of panels and associated equipment.
3. Itemized bill of material.
4. Operating and programming instructions.
5. Control panel configuration and module data.
6. Complete point to point wiring diagrams of system and device interconnection. Identify spare connection points.
7. Alarm initiating, indicating, and supervisory device electrical data.
8. Annunciator configuration and module data.
9. Plans showing device and panel locations as well as conduit and cable sizes. Prepare drawings and diagrams on drawing sheets of uniform size without extraneous information. Marked up electrical, lighting or similar drawings or copies of catalog data sheets are not acceptable in lieu of required drawings or diagrams.
10. Sequence of Operation Matrix.
11. Battery sizing calculations.
12. Supervisory power requirements for equipment.
13. Alarm power requirements for equipment.
14. Power supply rating justification showing power requirements for system power supplies.
15. Voltage drop calculations for wiring runs, demonstrating worst case condition.

B. Informational Submittals:

1. Experience and qualifications of firm(s) proposed to design and install system.
2. Certifications documenting service technician’s training. Certification shall indicate name of individual, training, dates, systems qualified, and current status.
3. Copy of design documents, Shop Drawings, and calculations submitted to code-enforcement authorities.
4. Code-enforcement authority approval letter.
5. Factory test reports.

6. Detailed program and schedule for testing, inspection, and maintenance of fire alarm system that satisfies requirements of NFPA 72, manufacturer's recommendations, and local authority having jurisdiction.
7. Written documentation for logic modules as programmed, for system operation, with matrix showing interaction of input signals with output commands.
8. Documentation of system voltage, current, and resistance readings taken during installation, testing, and ATP phases of system installation.
9. System record drawings and wiring details including one set of reproducible masters and drawings on CD-ROM in a DXF format suitable for use in a CAD drafting program.
10. NFPA 72, Record of Completion: Submit to Owner and code-enforcement authorities.
11. NFPA 72, Inspection and Testing Form: Submit to Owner and code enforcement authorities.
12. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Provide names of projects, locations, and telephone numbers of persons to contact for at least two installations where Contractor or Subcontractor has installed detection and alarm systems that are similar in size and scope as this.
2. System design, installation and testing shall be performed by licensed firm(s) with established reputation in fire alarm system industry having 10 years' experience in design, installation, and testing of fire alarm systems.
3. Technician with minimum of NICET Level II Certification for fire alarm systems or Professional Engineer registered in State of Washington shall be available onsite.
4. Service technician shall be formally trained by manufacturer.

1.06 MAINTENANCE

A. Maintenance Service: For 2 years after Correction Period, provide maximum of two service calls, at Owner's request, to make adjustments or repairs required to keep system in satisfactory, full operation.

## PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this Section shall be products of:

1. Siemens Building Technologies.
2. Simplex/Grinnell.
3. FCI.
4. Notifier Fire Systems.
5. Edwards Systems Technology.
6. Silent Knight.

2.02 GENERAL

A. Material and equipment shall be standard products of their respective manufacturers, and shall be of a model that has been in production for not less than 3 years. Equipment shall be supported by a service organization that is, in the opinion of Owner, reasonably convenient to Site.

B. Contractor shall become familiar with details of Project, verify dimensions in field, and revise conduit and equipment locations to avoid obstructions and allow installation of new equipment.

C. Contractor shall not begin system installation prior to receiving written approval of Shop Drawings from Engineer.

2.03 UL COMPLIANCE

A. Products manufactured within scope of Underwriters Laboratories, Inc. shall conform to UL Standards and have an applied UL listing mark.

B. Equipment shall be UL listed in accordance with requirements of NFPA.

2.04 SERVICE CONDITIONS

A. Altitude: Not greater than 3,300 feet above sea level.

B. Ambient Temperature:

1. Maximum 40 degrees C.
2. Minimum minus 30 degrees C.

C. Equipment shall be fully rated without derating for these conditions.

2.05 POSTED OPERATING INSTRUCTIONS (POI)

A. POIs shall be prepared on full size drawing sheets.

B. POIs shall be framed in extruded metal frames, mounted under glass and shall be water/weather resistant. Instructions shall be permanently mounted on reserved wall area in space shown on Drawings.

C. POIs shall include:

1. Facility floor plans showing location of fire equipment and devices with coordinated identification. Show items such as firewalls, fire dampers, and fire alarm devices.
2. Fire alarm wiring diagrams and schematics, and device address list.

2.06 FIRE ALARM CONTROL PANEL

A. General:

1. Control panel circuit for 24V dc, power limited, initiating circuits per NFPA 70, Article 760.
2. Assembled panel UL 864 listed Product Category UOJ2, as an integrated control system.
3. Enclosure:
   a. NEMA 250 Type suitable for location installed.
   b. Color: Red.
4. Internally Mounted Module with:
   a. Transformer with 120V ac input and 21.5V ac output.
   b. Solid state rectifier for 21.5V ac input and fuse protected, filtered, and regulated 26V dc no-load output.
   c. Solid state transfer switch, minimum 8 amp-hours.
   d. Standby sealed, gelled electrolyte (lead acid) batteries sized for system operating period of 24 hours of standby mode operation.
   e. Solid state battery charger.
   f. Over/under voltage monitor supervisory circuit.
   g. LEDs for status of normal power, battery trouble, and power supply module trouble.
   h. Alarm mode of 5 minutes after standby operation.
5. Local differentiating audible sound device for alarm, trouble, and supervisory conditions.
6. Full digital transmission protocol.
7. Addressable signal transmission protocol to be either digital pole/response protocol or proprietary communication protocol, with all antilog sensing device signals digitally transmitted to control panel.
8. MOV/gas discharge transient protection for power supply module, plus initiating and indicating alarm devices.

9. EMI/RF Protection:
    a. Protect control equipment, devices, and wiring against unwanted radiated electro-magnetic interference (EMI) and from affects of audio and radio frequencies (RF) that can cause transmission of spurious alarms.
    b. System shall be designed and installed so as to be unaffected (with control cabinet faceplates installed) by operation of handheld, portable radios of up to 5 watts, or portable cellular telephones up to 1 watt, within 12 inches of system components.

B. Addressable Control Panel:

1. Modular construction with solid state, microprocessor-based components, programmable central processor unit, back lighted display of primary control status and essential alarm operating conditions, and concealed, maintenance, purpose operator's keypad.
2. Main control module consisting of operator's keyboard/keypad, local and remote communications and supervision capabilities, system control memory, and programming interface.
    a. Two-line, back lighted, 80 alphanumerical LCD characters with:
        1) Visible cursor for entering data information.
        2) Displayable when cabinet door is open.
    b. Primary operators keypad with:
        1) Acknowledge keys and LEDs for system alarm, supervisory service, and system trouble conditions.
        2) Power on LED.
        3) Alarm silence reset keys.
        4) Displayable when cabinet door is closed.
    c. Pass code protected action display keypad for:
        1) Circuit/device enable or disable.
        2) Control on/off.
        3) Test/status.
        4) Auto or manual.
        5) Activate/reset.
        6) Display historical logs/real time.
        7) Function/menu.
        8) Program.
        9) Delete.
        10) Displayable when cabinet door is open.
    d. Numerical entry and selection keypad, used in conjunction with action display keypad, to perform control function on system zones, initiating circuits, or auxiliary relays, and to gain access to system information. Displayable when cabinet door is closed.
    e. Four function keys for control of variable functions related to primary operations keypad, displayable when door is open.

3. TIA 485, NFPA 72, Style 4, Style 6, or Style 7 data circuit capability for remote annunciators.
4. Form C relay contacts rated 2 amperes, 24V dc.
5. Down loader port for connection to microprocessor-based transponder.
6. Power supply interface module generating digital voltage and current data to LCD with:
    a. dc power conversion and output terminals.
    b. Supervision and control of power supply.
7. Modules with coded input on first alarm, local trouble LED, and in/out capabilities for:
    a. 120 addressable initiating alarm sensors consisting of analog/addressable or traditional detector methods.
    b. Four hardwired I/O points, field selectable in any combination to be either NFPA 72, Style B or Style D, initiating device circuits or NFPA 72, Style Y or Style Z, indicating appliance circuits or auxiliary control circuits.
    c. Auxiliary control circuit contacts shall be single-pole, double-throw, rated 2 amperes at 24V dc and 0.5 amperes at 120V ac.
8. Auxiliary control circuit contacts shall be single-pole, double-throw rated, 2 amperes at 24V dc and 0.5 ampere at 120V ac.
9. Two isolated TIA 232 communication port modules.

2.07 INITIATING DEVICE

A. Pull Station, Fire:

1. Double-action station for general alarm.
2. Constructed of red molded polycarbonate material, and raised white letters stating “FIRE.”
3. Surface-mounted with hinged front cover having keyed or allen-wrench reset lock.
4. Push plate and pull handle for double action operating station with plastic break rod.
5. Activated station pull handle, latched in protruding position until reset by key.
6. Stations keyed alike with fire alarm control panel.
7. Screw terminal for field connections.
8. Normally open, double-pole contacts rated 3 amperes, 30V dc for resistive loads.
9. Manual Pull Station: Dip switch selectable address, and compatible with fire alarm control panel.

B. Smoke Detector:

1. Ionization type with plug-in, twist-lock addressable base per UL 217 and UL 268.

2. Solid state circuitry, unipolar, single source, dual sensing chamber, suitable for device releasing service.
3. Concealed, field adjustable, sensitivity test switch.
4. LED; pulsed indication for power availability and steady indication for activated detectors.
5. Self-Compensating Circuitry:
    a. Voltage Range: 15 to 30V dc, 24V dc nominal.
    b. Temperature Range: 0 to 38 degrees C.
    c. Operating Temperature Range: Minus 10 degrees C to 50 degrees C.
    d. Humidity Range: 0 to 95 percent relative humidity.

2.08 ALARMS

A. Audio Visual Alarm:

1. Audible/visible base housing with visual alarm and front mounted horn as specified.
2. Semi-flush mounting on recessed 4-gauge square electrical box or surface mounted on backbox with adapter.
3. Audibility: In accordance with NFPA 72 and local requirements.
4. Synchronous audible/visible output.

2.09 WIRING

A. AC power wiring shall meet requirements of Section 26 05 05, Conductors.

B. Low voltage wiring shall be solid copper or bunch tinned (bonded) stranded copper, minimum 14 AWG, and shall meet NEC Article 760 for nonpower limited service.

2.10 RACEWAYS

A. Conduit used for installation of Fire Alarm system shall follow requirements as identified in Section 26 05 33, Raceway and Boxes.

2.11 END-OF-LINE RESISTORS

A. Ohmic value and power rating as determined by manufacturer based upon number of circuit devices supplied and circuit configuration as installed.

2.12 SURGE SUPPRESSORS

A. Transient Voltage Surge Suppressors (TVSS):

1. Provide to suppress voltage transients that might damage fire alarm panel/transmitter components. Unit shall wire in series to power supply of protected equipment with screw terminations.
2. Unit shall be UL 1449 listed with a 330-volt suppression level and have a maximum response time of 5 nanoseconds.
3. Unit shall meet IEEE C62.41 Category B tests for surge capacity.
4. Features:
   a. Multi-stage construction that includes inductors and silicon avalanche zener diodes.
   b. Long life indicator lamp (LED or neon lamp) which extinguishes upon failure of protection components. Fusing shall be externally accessible when this feature is available.
5. Manufacturer and Product: Edco of Florida, Ocala, FL; Model HSP-121BT2.

## PART 3 EXECUTION

3.01 GENERAL

A. Coordinate with other trades for mounting and interfacing with fire alarm system related devices.

B. Install control panels, initiating and alarm devices, conduit, and wiring for interconnection of devices specified herein for complete and operable system.

3.02 INSTALLATION

A. Install and connect fire alarm equipment in accordance with manufacturer's instructions and recommendations, and in accordance with applicable codes and standards.

B. Mount devices in accordance with manufacturer's instructions.

C. Provide outlet and junction boxes that are compatible with raceway system.

D. Install conductors in accordance with Section 26 05 05, Conductors, and NFPA 70, Article 760.

E. Install initiating alarm, signal, and communication conductors in separate and independent raceway system.

F. Circuit wiring color-code, as established by installer, to be maintained throughout installation.

G. Size conductors in accordance with device manufacturer's recommendations. Increase AWG size of alarm conductors, if necessary, to maintain terminal voltage drop within acceptable level required by NEC and NFPA.

H. Detectors shall not be installed until after construction clean up of trades is complete, per requirements of NFPA.

3.03 CONDUIT

A. Requirements apply to fire alarm system conduits, electrical enclosures, terminal cabinets, junction boxes, pullboxes, and device backboxes.

B. Conduit systems shall be dedicated to fire alarm system and shall contain no unrelated conductors.

C. Fire alarm system conduits shall be of sizes and types specified under Section 26 05 33, Raceway and Boxes.

1. Conduit shall be as identified under Section 26 05 33, Raceway and Boxes. Flexible metallic conduit may be used for whips to devices only, maximum length 6 feet, 3/4-inch diameter minimum. Set screw type couplings or connectors are specifically prohibited.
2. Size conduits according to conductors contained therein. Cross sectional area percentage fill for fire alarm system conduits shall not exceed 40 percent.

D. Route and install conduit to minimize potential for physical damage, either mechanical or by fire, and so as not to interfere with existing building systems, facilities or equipment, and to facilitate service and minimize maintenance. Coordinate installation between different trades to avoid conflicts.

1. Conduit, except flexible conduit whips to devices, shall be solidly attached to building structural members or permanent walls. Conduit shall not be attached to existing conduit, ductwork, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, evacuation signaling or auxiliary function devices.
2. Conduit shall be routed either parallel or perpendicular to building structural members.
3. Conduit shall be installed at a height so as not to obstruct any portion of a window, doorway cable tray, stairway or a passageway, and shall not interfere with operation of existing mechanical or electrical equipment.
4. Conduit, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device backboxes shall be readily accessible for inspection, testing, service and maintenance.

5. Conduits shall be arranged to minimize the possibility of water in those conduits draining through control panels.
    a. Conduit, except nipples between control panels shall be arranged to enter control cabinets from below.
    b. Conduit shall be provided with three, 1/4-inch drain holes at horizontal low point beneath each control cabinet.
6. Bushings shall be provided at termination of conduit, prior to installation of wire.
7. Install junction boxes as necessary. Conductors shall be pulled through junction boxes, without splices.
8. Pullboxes shall be installed in each conduit at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.
9. Device backboxes and junction boxes shall be sized to accommodate number of conductors contained. Extension rings or extension boxes are prohibited.
10. Junction boxes, pull boxes, terminal cabinets, device backboxes, and raceways shall be gasketed and weather-tight per requirements of Section 26 05 33, Raceway and Boxes.

E. Conduit, junction boxes, panels, electrical enclosures, relays and device backboxes shall be exposed in unfinished areas. Conduit and device backboxes shall be concealed in walls, ceiling spaces, electrical shafts or closets, in finished areas, except as noted on Drawings. Exposed conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.

F. Pull boxes, junction boxes, conduit bodies, and terminal cabinets shall be painted “fire engine red” prior to installation. Provide touch-up painting, of normally visible pull boxes, junction boxes, and terminal cabinets prior to final acceptance testing.

G. Conduit shall be grounded by approved ground clamps, and per NEC requirements.

H. Mount end-of-line resistors on terminal blocks.

I. Detection and alarm wire shall be installed in separate conduits. Outgoing and return conductors for each supervised circuit shall be routed in separately as required by NFPA 72. The minimum separation of outgoing and return conduits shall be 1 foot vertically and 4 feet horizontally.

## 3.04 IDENTIFICATION

A. Junction, terminal, and pulling box covers shall be painted red.

## 3.05 CONDUCTORS

A. Requirements apply to fire alarm system conductors, including all signaling line, initiating device, indicating appliance, releasing function, remote signaling, ac and dc power and grounding/shield drain circuits.

B. Conductors shall be:

1. New; wire that has scrapes, nicks, gouges or crushed insulation shall not be used.
2. Installed in conduit.
3. Continuous between devices and between devices and intermediary terminal cabinets.
4. Low voltage conductors shall be minimum size No. 14 AWG. In accordance with requirements of NEC, Article 760 for nonpower limited service.

C. Splices in conductors are specifically prohibited.

D. Types:

1. Conductors, except ac power conductors and grounding conductors, shall be solid copper or bunch tinned (bonded) stranded copper.
2. Stranded copper conductors are acceptable for ac power conductors and grounding conductors only.

E. Terminations, including field connections to supervisory resistors, diodes, relays or other devices shall be to numbered terminals or terminal strips and readily accessible for inspection, service, testing and maintenance.

1. Terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.
2. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
3. Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on Contractor’s Record Drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of conductor terminations.
4. Wire nuts are prohibited.
5. Where pigtail devices are factory provided with wires too short to be connected to terminal strips (i.e., solenoids), such connections shall be soldered and taped.

F. Control Panel Wiring:

1. Fully dressed and bundled with nylon tie wraps at 3-inch intervals.
2. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections.
3. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between ac power conductors and low voltage conductors wherever possible.
4. Control cabinets shall be sized to accommodate the requirements of this Section.
5. Control panels shall not be used as raceways. Conductors that do not terminate within a control panel shall not be routed through that control panel.

G. Conductors shall be separated into the following categories:

1. Low voltage circuits that serve devices.
2. ac power circuits.

H. Each category of conductors shall be installed in physically separated, dedicated conduits, and shall not interface with one another, except at common associated control equipment. Conductors shall be further segregated as necessary to conform to fire alarm system manufacturer's recommendations and as necessary to prevent electrical crosstalk between conductors installed in common conduits.

I. Wiring shall be THHN or TFFN stranded. Use of multi-conductor twisted pair or similar wiring is not permitted.

J. Install as nonpower limited circuits in accordance with NFPA 72, and NEC, Article 760.

K. Conductors looped around terminals are prohibited.

L. Wire nut splices are prohibited.

M. T-tapping of circuits is prohibited.

N. Circuits shall be megger tested to voltage rating of their insulation before final terminations are made.

## 3.06 OVERVOLTAGE AND SURGE PROTECTION

A. Install TVSS for fire alarm control panel per manufacturer's requirements.

3.07 REPAIR/RESTORATION

A. Touch up scratches, mars, and dents, incurred during shipment or installation of equipment.

B. If required because of extensive damage, as determined by Engineer, refinish entire assembly.

C. Keep covers on smoke detectors until areas have been thoroughly cleaned.

3.08 TESTS AND INSPECTION

A. In accordance with Section 01 91 14, Equipment Testing and Facility Startup, and NFPA 72.

B. Demonstrate entire system meets performance requirements specified in Article System Description.

C. Perform tests in presence of code-enforcement authorities, Owner or Owner's Representative.

D. Each smoke detector shall be individually field tested prior to installing device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating type of device, sensitivity and initials of technician performing test, using test equipment specifically designed for that purpose, shall be prepared and kept for final acceptance documentation. After testing detection devices, base shall be labeled with system address, date, and initials of installing technician. Labeling shall not be visible after installation is complete.

E. Test wiring runs for continuity, short circuits, and grounds before system is energized. Resistance, current, and voltage readings shall be made as work progresses.

1. Systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on logging form for readings, dates, and witnesses.
2. Notify Fire Marshal and Owner before start of any required tests. Correct items found at variance with Drawings or Specification during testing or inspection.
3. Deliver test reports to Fire Marshal and Owner as completed.

F. Prepare complete listing of device labels for alphanumeric annunciator displays and logging printers prior to acceptance test.

1. Test system wiring to demonstrate correct system response and correct subsequent system operation in event of:
    a. Open, shorted, and grounded intelligent analog signaling line circuit.
    b. Open, shorted, and grounded network signaling line circuit.
    c. Open, shorted, and grounded conventional initiating device circuits.
    d. Primary power or battery disconnected.
2. Demonstrate system evacuation alarm indicating appliances as follows:
    a. Alarm notification appliances actuate as programmed.
    b. Audibility and visibility at required levels.
3. System indications shall be demonstrated as follows:
    a. Correct message display for each alarm input, at control panel, each remote alphanumeric LCD display.
4. Demonstrate system onsite and offsite reporting functions as follows:
    a. Correct alarm custom message display, address, device type, date and time transmitted, for each alarm input.
    b. Correct trouble custom message display, address, device type, date and time transmitted, for each alarm input.
    c. Trouble signals received for disconnect.
5. Secondary power capabilities shall be demonstrated as follows:
    a. Disconnect system primary power for a period of time as specified herein; at end of period, alarm condition shall be created and system shall perform as specified for period as specified.
    b. Restore system primary power for 48 hours and system-charging current shall be normal trickle charge for fully charged battery bank.
    c. Check system battery voltages and charging currents at fire alarm control panel using test codes and LCD displays

G. In the event system fails to perform as specified and programmed during acceptance test, test shall be terminated at discretion of acceptance inspector.

1. Retest system, correcting deficiencies and providing test documentation to acceptance inspector.
2. In event that software changes are required during acceptance test, system manufacturer to compare edited program with original and shall furnish utility program. Utility shall yield printed list of changes and system functions, inputs and outputs affected by changes. Items listed by program shall be minimum acceptable to be retested before calling for resumption of acceptance test. Submit printed list and printer log of retesting before scheduling of acceptance test.

3. Acceptance inspector may elect to require complete acceptance test to be performed again if, in their opinion, modifications to system hardware or software warrant complete retesting.

H. Upon completion of tests, complete and provide the following:

1. NFPA 72, Record of Completion, and Inspection and Testing Form.
2. Certification that final system meets UL.

3.09 MANUFACTURER'S SERVICES

A. Furnish manufacturer's representative in accordance with Section 01 43 33, Manufacturers' Field Services, for the following services at site as designated by Owner:

1. 1 person-day for functional testing.

**END OF SECTION**

**SECTION 31 10 00**
**SITE CLEARING**

## PART 1 GENERAL

1.01 DEFINITIONS

A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

D. Stripping: Removal of topsoil.

E. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 QUALITY ASSURANCE

A. Obtain Owner's or Engineer's approval of staked clearing, grubbing, and stripping limits, prior to commencing such Work.

1.03 SCHEDULING AND SEQUENCING

A. Prepare Site for clearing, grubbing, and stripping activities only after adequate erosion and sediment control measures are in place in accordance with Section 01 57 13, Temporary Erosion and Sediment Control.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping: 2 feet beyond toe of permanent fill, including surcharge embankment area.
4. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat finished appearance.
5. Structures: 15 feet outside of new structures.
6. Roadways: Clearing, grubbing, and stripping as shown on Drawings.
7. Overhead Utilities:
   a. Clearing and Grubbing: Entire width of easements and rights-of-way.
   b. Stripping: Wherever grading is required.
8. Other Areas: As shown.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.

C. Cut stumps not designated for grubbing flush with ground surface.

D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.04 GRUBBING

A. Grub areas within limits shown or specified.

3.05 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, as directed by Owner.

3.06 TEST PIT LOCATIONS

A. Excavate spoils from test pits located within the new commercial scale pit footprint; or other areas to be occupied by structures. Dispose of spoils as specified herein. Backfill test pits with granular structural fill as specified in Section 31 23 23, Fill and Backfill.

3.07 DISPOSAL

A. Clearing and Grubbing Debris: Dispose of debris onsite at location(s) approved by Owner.

B. Strippings: Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil in waste disposal areas onsite in location(s) approved by Owner.

C. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

D. Test Pit Spoils: As specified for clearing and grubbing debris.

**END OF SECTION**

**SECTION 31 23 13**
**SUBGRADE PREPARATION**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM): D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, stripping of topsoil, excavation to grade, aeration, inspection of surface for suitability, and compaction of subgrade as necessary.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 10 00, Site Clearing, and 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Engineer when subgrade is ready for inspection or compaction, or whenever compaction is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section. Perform excavation with smooth blade equipment to prevent excessive disturbance.

C. Allow subgrade to aerate and dry for 3 to 5 days prior to inspection of subgrade suitability.

D. Native subgrade with a pocket penetrometer measurement of 2 tons per square foot (tsf) or greater is suitable for material placement. Subgrade not meeting suitability should be corrected as specified in Article Correction.

E. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

F. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under General Structural Fill: Three passes with three-wheeled power roller weighing approximately 10 tons.

B. Under Pavement Structure, Floor Slabs On Grade, Granular Structural Fill Under Structures:

1. Subgrade with a pocket penetrometer measurement of 2 tons per square foot (tsf) or greater does not require compaction.
2. If required, compact the upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

3.03 MOISTURE CONDITIONING

A. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact as specified, or
2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

**END OF SECTION**

# SECTION 31 23 16
# EXCAVATION

## PART 1 GENERAL

1.01 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.02 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.03 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

C. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Construction vibrations, seepage, or surface loading can cause excavation to slough or cave. Use care in performing construction activities near open excavations.

C. Do not overexcavate without written authorization of Owner or Engineer.

D. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

3.02 GENERAL EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

3.04 EMBANKMENT AND CUT SLOPES

A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.

B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.

C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

3.05 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Confine stockpiles to within approved work areas. Do not obstruct roads.

C. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.

3.06 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, in designated onsite spoil disposal areas at location(s) approved by Owner.

B. Dispose of debris resulting from removal of any existing structures or facilities in onsite location(s) as approved by Owner.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

**END OF SECTION**

**SECTION 31 23 19.01**
**DEWATERING**

## PART 1 GENERAL (NOT USED)

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

3.01 GENERAL

A. Remove and control water during periods when necessary to properly accomplish Work.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
3. To relieve artesian pressures and resultant uplift of excavation bottom.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

3.04 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

**END OF SECTION**

**SECTION 31 23 23**
**FILL AND BACKFILL**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/$ft^3$ (2,700 kN-m/$m^3$)).
   e. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   f. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   g. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### 1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

C. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

D. Prepared Ground Surface: As defined in Section 31 23 13, Subgrade Preparation.

E. Completed Course: A course or layer that is ready for next layer or next phase of Work.

F. Lift: Loose (uncompacted) layer of material placed in consistent effort (without delay or work stoppage).

G. Geosynthetics: Geotextiles or geogrids.

H. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

I. Influence Area: Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:

1. 1 foot outside outermost edge at base of foundations or slabs.
2. 1 foot outside outermost edge at surface of roadways or shoulder.
3. 0.5 foot outside exterior at spring line of pipes or culverts.

J. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

K. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

L. Imported Material: Materials obtained from sources offsite, suitable for specified use.

M. Standard Specifications: When referenced in this Section, shall mean Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction, 2010.

N. USCS: Unified Soil Classification System.

1.03 SUBMITTALS

A. Informational Submittals: Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:

1. Structure is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

C. Do not place fill material until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

**PART 2 PRODUCTS**

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:

1. As necessary to locate acceptable sources of imported material, minimum of one test per imported material type.
2. During production of imported material, test as follows:
   a. Granular Fill: One test per 1,000 cubic yards.
   b. Structural Fill: One test per 2,000 cubic yards.

2.02 GENERAL EARTHFILL

A. Select excavated material from required onsite excavations meeting the following requirements:

1. Soil classified as GP, GM, GW, SP, SM, SW, ML, or CL in accordance with USCS.
2. Soil consisting of inert earthen materials with less than 3 percent organics and free from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.
3. 6-inch maximum particle size in diameter.

4. Provide imported material of equivalent quality, if required to accomplish Work.

2.03 GRANULAR FILL

A. Well graded mixture of sand, cobbles and boulders with less than 5 percent passing the No. 200 sieve.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine which creates a dense and interlocking matrix with a minimum in-place unit weight of 130 pounds per cubic foot.

2.04 STRUCTURAL FILL

A. Material meeting Section 9-03.9(3) – Crushed Surfacing of the Standard Specifications.

2.05 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.06 DRAIN TILE

A. Corrugated, perforated HDPE piping, rated appropriately to avoid crushing, 4-inch nominal diameter. Pipe shall come prewrapped in nonwoven separation geotextile.

**PART 3 EXECUTION**

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this Section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

## 3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 9-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Place 12 inches minimum thickness of structural fill directly beneath foundation and slab bearing elevations. Place in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

C. Other Areas: Backfill with general earthfill to lines and grades shown, with proper allowance for topsoil thickness where required. Place in lifts of 9-inch maximum thickness and compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557.

## 3.03 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place general earthfill as follows:

1. Allow for 6-inch thickness of topsoil where required.

2. Maximum 9-inch thick lifts.
3. Place and compact fill across full width of embankment.
4. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
5. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.04 SITE TESTING

A. Gradation:

1. As specified in Article Source Quality Control or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests: In accordance with ASTM D6938. During placement of materials, test as follows:

1. General Earthfill: One test per 1,000 square feet for every other vertical lift placed and compacted.
2. Granular Fill: One test per 1,000 square feet for every other vertical lift placed and compacted.
3. Structural Fill: One test per 1,000 square feet for every vertical lift placed and compacted.

3.05 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Granular fill or structural fill as determined by Engineer.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill or stuctural fill, as determined by Engineer.
4. Trenches:
    a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
    b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.

5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    b. Steep Slopes (Steeper than 3:1):
        1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
        2) Backfilling overexcavated areas is prohibited, unless in Engineer's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

## 3.06 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. EXTREME CARE must be used to avoid damaging sensitive subgrade when placing fill over geosynthetics.
2. Place fill over geosynthetics with sufficient care so as not to damage them.
3. Place fill only by back dumping and spreading only.
4. Dump fill only on previously placed fill.
5. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

B. Hauling: Operate hauling equipment on minimum of 3 feet of covering.

C. Spreading:

1. Low bearing pressure, track-mounted, drum, low tire pressure equipment shall be used to compact fill materials placed over subgrade or geosynthetics overlying subgrade.
2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
4. Never push fill downslope. Spread fill over sideslopes by pushing up from slope bottom.
5. Flatten wrinkles of geogrids in direction of spreading.
6. Maintain proper overlap of unseamed geosynthetics.
7. Avoid overstressing geosynthetics and seams.

D. Compaction: Compact fill only after uniformly spread to full thickness shown.

1. Heavy equipment (10-ton or greater) will be required to properly compact granular fill in surcharge embankment area. Transitioning from low-ground pressure equipment to heavy equipment must be done with care and consideration.

E. Geosynthetic Damage:

1. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
2. Clear overlying fill as necessary to repair damage.
3. Repairs to geosynthetics shall be made by respective installers as specified in respective specification section for each geosynthetic.

**END OF SECTION**

**SECTION 31 23 23.15**
**TRENCH BACKFILL**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)).
   i. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   j. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)).
   k. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   l. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   m. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   n. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   o. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Imported Material: Material obtained by Contractor from source(s) offsite.

D. Lift: Loose (uncompacted) layer of material.

E. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

F. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

G. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

H. Relative Density: As defined by ASTM D4253 and ASTM D4254.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:

   1. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
   2. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

## PART 2 PRODUCTS

2.01 MARKING TAPE

A. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: Minimum 3 inches.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

B. Color: In accordance with APWA Uniform Color Code.

| Color* | Facility |
|---|---|
| Red | Electric power lines, cables, conduit, and lightning cables |
| Orange | Communicating alarm or signal lines, cables, or conduit |
| Yellow | Gas, oil, steam, petroleum, or gaseous materials |
| Green | Sewers and drain lines |
| Blue | Potable water |
| Purple | Reclaimed water, irrigation, and slurry lines |
| *As specified in NEMA Z535.1, Safety Color Code. | |

2.02 TRENCH STABILIZATION MATERIAL

A. Base Rock:

1. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.
2. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

B. Granular Fill: As specified in Section 31 23 23, Fill and Backfill.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
    a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
    b. Individual Particles: Free of sharp edges.
    c. Maximum Size Particle: Pass a No. 4 sieve.
    d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.04 GENERAL EARTHFILL

A. As specified in Section 31 23 23, Fill and Backfill.

2.05 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Courses.

2.06 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. General earthfill material.
2. Trench stabilization material.
3. Bedding and pipe zone material.

## PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. As specified in Section 31 23 19.01, Dewatering.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Trench stabilization material is not expected to be required; however, if unsuitable soil is encountered in trench bottom:

1. Rebuild trench bottom with trench stabilization material.
2. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.
3. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: 4 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

## 3.05 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls.

## 3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping. Coordinate with piping installation drawings.

3.07 BACKFILL ABOVE PIPE ZONE

A. Adjust moisture content as necessary to obtain specified compaction.

B. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.

C. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.

D. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.

E. Backfill around structures with same backfill material as specified for adjacent trench, unless otherwise shown or specified.

F. Place in lifts not exceeding thickness of 9 inches.

G. Mechanically compact each lift to a minimum of 95 percent relative compaction.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 6 inches of backfilled trench where shown.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

**END OF SECTION**

**SECTION 31 32 00**
**SOIL STABILIZATION**

## PART 1 GENERAL

### 1.01 WORK OF THIS SECTION

A. This Section covers the Work to permanently manage and stabilize the Site. Refer to Section 01 57 13, Temporary Erosion and Sediment Control, during construction, for requirements associated with managing stormwater and erosion control practices during construction activities, both to stabilize the Site before work starts and during all construction work. Permanent soil stabilization measures shall be coordinated with temporary measures that are used. Contractor shall stage work in such manner to limit disturbance and finish and stabilize areas as work is completed. Leaving areas open and vulnerable to erosion and sediment transport is not acceptable. Work shall include furnishing all labor, materials, tools, and equipment to perform such work and services necessary as herein specified and as shown on Drawings.

### 1.02 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. Official Seed Analysts of North America.

### 1.03 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted and continue for a period of 8 weeks after planting under this Section is completed.

B. Satisfactory Stand: Grass or section of grass 10,000 square feet or larger that has:

1. No bare spots larger than 3 square feet.
2. Not more than 10 percent of total area with bare spots larger than 1 square foot.
3. Not more than 15 percent of total area with bare spots larger than 6 square inches.

### 1.04 SUBMITTALS

A. Action Submittals: Product data for commercial products; seed, fertilizer, and lime.

B. Informational Submittals:

1. Seed certifications.
2. Copies of delivery invoices or other proof of quantities of mulch, lime, and fertilizer.
3. Manufacturer's Installation Instructions: Commercial products.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Seed:

1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
2. Keep dry during storage.

B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.06 SEQUENCING AND SCHEDULING

A. Complete soil preparation, seeding, fertilizing, mulching, and matting, where applicable, within 10 calendar days after final grades have been reached.

B. Notify Owner or Engineer at least 3 days in advance of:

1. Materials delivery.
2. Start of planting/seeding activity.

C. Seeding: Perform under favorable weather conditions during seasons that are normal for such Work as determined by accepted local practice.

1.07 MAINTENANCE

A. Operations:

1. Perform during maintenance period to include:
   a. Watering: Keep seeded surface moist Washouts: Repair by filling with topsoil, fertilizing, seeding, and mulching.
   b. Mulch: Replace wherever and whenever washed or blown away.
   c. Reseed unsatisfactory areas or portions thereof immediately at end of maintenance period if a satisfactory stand has not been produced.
   d. Reseed entire area if satisfactory stand does not develop by July 1 of the following year.

## PART 2 PRODUCTS

2.01 FERTILIZER

A. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.

B. Fertilizer shall be a commercially acceptable mix used in the local area and as approved by the Engineer.

2.02 SEED

A. Fresh, clean new-crop seed that complies with tolerance for purity and germination established by Official Seed Analysts of North America.

B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer's instructions.

C. The seed mix for summer or winter application shall be commercially acceptable mixes used in the local area and as approved by the Engineer.

2.03 MULCH

A. Wood Cellulose Fiber Mulch:

1. Specially processed wood fiber containing no growth or germination inhibiting factors.
2. Dyed suitable color to facilitate inspection of material placement.
3. Manufactured such that after addition and agitation in slurry tanks with water, material fibers become uniformly suspended to form homogenous slurry.
4. When hydraulically sprayed on ground, material will allow absorption and percolation of moisture.

B. Straw:

1. Clean salt hay or threshed straw of oats, wheat, barley, or rye, free from seed of noxious weeds. Suitable for spreading with mulch blower equipment.
2. Average Stalk Length: 6 inches.
3. Seasoned before baling or loading.

2.04 EROSION CONTROL MATTING

A. General Matting:

1. Excelsior mat or straw blanket; staples as recommended by matting manufacturer.
2. Manufacturers and Products:
   a. Akzo Industries, Asheville, NC; Curlex Mat.
   b. North American Green, Evansville, IN; S150 blanket.

B. Ditch matting.

C. Ditches:

1. Long lasting and suitable for ditch lining applications; staples as recommended by the manufacturer (size and spacing); seaming as recommended by the manufacturer.
2. Minimum Width: 6 feet
3. The blanket shall be covered on the top side with heavy weight photodegradable polypropylene netting having ultraviolet additives to delay breakdown and an approximate 0.63- by 0.63-inch mesh, and on the bottom side with a heavy weight photodegradable polypropylene netting with an approximate opening of 0.50- by 0.50-inch opening.
4. Manufacturer and Product: North America Green, Evansville, IN; P300.

2.05 S150 BLANKET TACKIFIER

A. Derived from natural organic plant sources containing no growth or germination-inhibiting materials.

B. Capable of hydrating in water, and to readily blend with other slurry materials.

C. Wood Cellulose Fiber: Add as tracer, at rate of 150 pounds per acre.

D. Manufacturers and Products:

1. Chevron Asphalt Co.; CSS-1.
2. Terra; Tack AR.
3. J-Tack; Reclamare.

**PART 3 EXECUTION**

3.01 SOIL PREPARATION

A. Before start of seeding, and after surface has been shaped and graded and lightly compacted to uniform grade, scarify soil surface to minimum depth of 1 inch.

3.02 SEEDING

A. Prepare 1-inch-deep seed bed; obtain Engineer's acceptance prior to proceeding.

B. Apply by hydroseeding method on moist soil, but only after free surface water has drained away. Prevent drift and displacement of mixture into other areas.

C. Application as recommended by a local seed supplier for the type of seed that is provided, and approved. Water as necessary.

3.03 MULCHING

A. Apply uniformly on seeded areas. Do not apply mulch on seeded areas that will be immediately covered with erosion control matting.

B. Application: Sufficiently loose to permit penetration of sunlight and air circulation, and sufficiently dense to shade ground, reduce evaporation rate, and prevent or materially reduce erosion of underlying soil.

1. Straw: Apply by hand or mechanical means to minimum depth of 2 inches.
2. Wood Cellulose Fiber: 1,000 to 1,500 pounds per acre.

3.04 EROSION CONTROL MATTING

A. Place on seeded slopes 4H:1V and steeper, staple/stake in place and with the appropriate overlap in accordance with manufacturer's instruction.

3.05 TACKIFIER

A. Apply on mulched areas.

B. Spray on after mulch is in place.

C. Apply in quantities sufficient to equal retention properties of a CSS-1 asphalt emulsion being applied at rate of 400 gallons per acre.

3.06 FIELD QUALITY CONTROL

A. Upon completion of maintenance period and on written notice from Contractor, Engineer will within 15 days of receipt, determine if a satisfactory stand has been established.

B. If a satisfactory stand has not been established, Engineer will make another determination upon written notice from Contractor following the next growing season.

**END OF SECTION**

**SECTION 31 41 00**
**SHORING**

## PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan.

## PART 2 PRODUCTS (NOT USED)

## PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
2. Design assumptions and calculations.
3. Methods and sequencing of installing excavation support.
4. Proposed locations of stockpiled excavated material.
5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
6. Anticipated difficulties and proposed resolutions.

3.03 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.04 TRENCHES

A. Provide trench excavations exceeding 4 feet in depth with adequate safety systems meeting the requirements of the Washington Industrial Safety and Health Act, Chapter 49.17 RCW.

**END OF SECTION**

**SECTION 32 11 23**
**AGGREGATE BASE COURSES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T11, Standard Method of Test for Materials Finer Than 75μm (No. 200) Sieve in Mineral Aggregates by Washing.
   b. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   c. T89, Standard Specification for Determining the Liquid Limit of Soils.
   d. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.
   e. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   f. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.
   g. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.
   h. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   i. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.
   j. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
2. ASTM International (ASTM):
   a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   b. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   c. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   d. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

1.03 SUBMITTALS

A. Action Submittals:

1. Samples: Submit for specified materials 10 days prior to delivery to Site.

B. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
2. Certified results of in-place density tests from independent testing agency.

**PART 2 PRODUCTS**

2.01 BASE COURSE AND GRAVEL SURFACING FOR ROADS

A. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

B. Physical Qualities:

1. Abrasion, AASHTO T96: 35 percent maximum wear.
2. Fractured Face: 60 percent minimum particles.
3. Liquid Limit, AASHTO T89: Maximum 30 percent.
4. Plasticity Index, AASHTO T90: Maximum 6 percent.
5. Resistance (R) Value, AASHTO T190: 75, minimum.

C. Gradation, AASHTO T27, Based on U.S. Standard Sieves:

**Table 1**
**Gradation**
**Percent Passing by Weight**

| **Sieve Designation** | **Material** | |
|---|---|---|
| **(Square Opening)** | **Aggregate Base Course (3/4" B)** | **Gravel Surfacing for Roads (3/4" A)** |
| 25 mm (1") | 100 | 100 |
| 19 mm (3/4") | 90—100 | 90—100 |

| Table 1<br>Gradation<br>Percent Passing by Weight | | |
|---|---|---|
| **Sieve Designation** | **Material** | |
| **(Square Opening)** | **Aggregate Base Course (3/4" B)** | **Gravel Surfacing for Roads (3/4" A)** |
| 4.75 mm (No. 4) | 40—65 | 30—60 |
| 2.36 mm (No. 8) | 30—50 | |
| 0.60 mm (No. 30) | | 8—30 |
| 75 μm (No. 200) | 3—9 | 0—7 |

2.02 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

**PART 3 EXECUTION**

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

## 3.03 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.
3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

## 3.04 CONSTRUCTION OF COURSES

A. Untreated Aggregate Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Blade or broom surface to maintain true line, grade, and cross-section.

B. Leveling Course:

1. Maximum Completed Lift Thickness: 4 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on roadway or preceding course to depth, grade, and cross-section shown.
4. Lightly blade surface and roll until thoroughly compacted to line and grade shown.
5. Maintain moisture levels to prevent loss of fines during processing.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 5 inches.
2. Completed Course Total Thickness: As shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base after spreading operations and continue until density of 98 percent of maximum density has been achieved as determined by AASHTO T99.

B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to required density before succeeding lift is placed.

F. Remove floating or loose stone from surface of preceding course before placing leveling course.

G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base and Leveling Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Provide testing laboratory at least 2 hours advance notification prior to testing.
2. Show proof that areas meet specified requirements before identifying density test locations.

3. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

**Table 2**
**Minimum Sampling and Testing Requirements**

| Property | Test Method | Frequency | Sampling Point |
|---|---|---|---|
| Gradation | AASHTO T11 and AASHTO T27 | One sample every 500 tons but at least every 4 hours of production | Roadbed after processing |
| Moisture Density (Maximum Density) | AASHTO T99, Method D | One test for every aggregate grading produced | Production output or stockpile |
| In-Place Density and Moisture Content | AASHTO T310, and AASHTO T265 for moisture content | One for each 500 ton but at least every 10,000 sq ft of area per lift | In-place completed, compacted area |

## 3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

**END OF SECTION**

**SECTION 32 12 16**
**ASPHALT PAVING**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M208, Standard Specification for Cationic Emulsified Asphalt.
   f. T166, Standard Method of Test for Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens.
   g. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   h. T230, Standard Method of Test for Determining Degree of Pavement Compaction of Bituminous Aggregate Mixtures.
   i. T245, Standard Method of Test for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
   j. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus.
   k. T247, Standard Method of Test for Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor.
   l. T283, Standard Method of Test for Resistance of Compacted Bituminous Mixture to Moisture Induced Damage.
   m. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate (Method A).
2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
   a. D2041, Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.

b. D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
c. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
d. D5821, Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
e. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Standard Specifications: 2012 Standard Specifications for Road, Bridge, and Municipal Construction, WSDOT.

1.03 DESIGN REQUIREMENTS

A. Prepare asphalt concrete mix design, meeting the following design criteria, tolerances, and other requirements of this Specification.

B. Design Criteria: In accordance with the Standard Specifications.

C. Furnished Mix Tolerances: As specified in the Standard Specifications.

1.04 SUBMITTALS

A. Action Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 15 calendar days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with the Standard Specifications.
      4) Properties as stated in the Standard Specifications for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
      5) Percent of asphalt lost due to absorption by aggregate.
      6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.

7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
8) Optimum mixing temperature.
9) Optimum compaction temperature.
10) Temperature-viscosity curve of asphalt cement to be used.
11) Brand name of any additive to be used and percentage added to mixture.

2. Test Report for Asphalt Cement:
   a. Submit minimum 10 calendar days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Statement of qualification for independent testing laboratory.
4. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.
   d. Field density.
   e. Quality control.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

B. Compaction Control Strip:

1. General:
   a. Construct to approximately 1,000 square feet in area and at location that will become a portion of completed paved area.
   b. Thickness: Typical of thickness to be paved on Project.
2. Rollers Used for Compaction: As specified in the Standard Specifications.
3. Compaction:
   a. Compact bituminous mat, using a standard rolling pattern that covers entire control strip. Field density testing shall be conducted by the independent testing laboratory.
   b. Continue rolling until no further compaction can be obtained as determined by field density testing.
   c. Temperature and condition of bituminous mat shall be considered workable when further compaction can no longer be obtained.

4. Target Density Determination:
    a. Select test point near center of normal roller pass, but no closer than 600 millimeters (2 feet) from edge of mat and 15 meters (50 feet) from either end of control strip. Mat thickness at this point shall be at least depth of finished pavement.
    b. Point at which no further densification can be obtained.
5. Establish new target density if change is made in mix design, nominal depth of mat being placed, aggregate source, or material properties.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 10 degrees C (50 degrees F) or air temperature is lower than 4 degrees C (40 degrees F). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

## PART 2 PRODUCTS

2.01 MATERIALS

A. Asphalt Binder as specified in Section 9-02.1(4) of the Standard Specifications.

B. Tack Coat: Emulsified asphalt, as specified in the Standard Specifications.

C. Sand (Blotter Material): Clean, dry, with 100 percent passing No. 4 sieve, and a maximum of 10 percent passing No. 200 sieve.

2.02 HOT MIX ASPHALT (HMA)

A. General:

1. Hot Mix Asphalt (HMA): HMA shall be composed of asphalt binder and mineral materials as may be required, mixed in the proportions specified to provide a homogenous, stable and workable mixture.
2. Mix formula shall not be modified except with written approval of Engineer or Owner.
3. Source Changes:
    a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
    b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer or Owner to confirm that properties are in compliance with design criteria.

c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Aggregate: As specified in Section 9-03.8 of the Standard Specifications.

C. Mineral Filler: In accordance with Section 9-03.8(5) of the Standard Specifications.

D. Asphalt Binder: Performance Grade (PG) 70-28 as specified in Section 9-02.1(4) of the Standard Specifications.

## PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Paving shall not be conducted during normal facility operating hours.
3. Keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with the Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Follow requirements of the Standard Specifications for new construction of untreated roadways.

C. General: Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

## 3.05 PAVEMENT APPLICATION

A. General: Place HMA on approved, prepared base in conformance with the Standard Specifications.

B. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day's paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate: Minimum 0.25 liter to maximum 0.70 liter of asphalt (residual if diluted emulsified asphalt) per square meter (0.05 to 0.15 gallon per square yard) of surface area.

C. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in two equal lifts of 1.5 inches (compacted thickness).
3. Total Compacted Thickness: 3 inches.
4. Apply such that meet lines are straight and edges are vertical.
5. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
6. Joints:
   a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.
7. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
8. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cut-back or emulsified asphalt. Cover immediately with sand.

D. Compaction: Uniformly compact each course to target density arrived at in compaction control strip.

E. Surface Smoothness Tolerances: As specified in Section 5-04.3(13) of the Standard Specifications.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least 1/2 the roller width. Progress toward center of patch overlapping each preceding track by at least 1/2 width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T230 and AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

**END OF SECTION**

**SECTION 32 16 00**
**CURBS AND GUTTERS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ASTM International (ASTM):
   a. C94, Standard Specification for Ready-Mixed Concrete.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

### 1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Informational Submittals:

1. Curing Compound: Manufacturer’s Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

### 1.03 QUALITY ASSURANCE

A. Inspection Requirements: All formwork shall be inspected and approved by the Engineer or Owner prior to placement of concrete.

B. Provide Engineer or Owner a minimum of 24 hours advanced notice before placing concrete to perform form inspection.

## PART 2 PRODUCTS

2.01 EXPANSION JOINT FILLER

A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2 inch thick.

2.02 CONCRETE

A. Ready-mixed meeting ASTM C94, Option A, with compressive strength of 4,000 psi at 28 days.

B. Maximum Aggregate Size: 1-1/2 inches.

C. Slump: 2 inches to 4 inches.

2.03 CURING COMPOUND

A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

## PART 3 EXECUTION

3.01 FORMWORK

A. Lumber Materials:

1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed structure.
2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:

1. Construct forms to shape, lines, grades, and dimensions.
2. Stake securely in place.

D. Bracing:

1. Brace forms to prevent change of shape or movement resulting from placement.
2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.02 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this Section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.03 VERTICAL CURB AND VALLEY GUTTER CONSTRUCTION

A. Reinforcing Steel: Provide rebar reinforcing as shown in standard project details.

B. Gutter Expansion Joints: Place at connections to building foundations and sidewalks. Install expansion joint filler at each joint.

C. Valley Gutter Expansion Joints: Place at maximum 45-foot intervals. Install expansion joint filler at each joint.

D. Curb Facing: Do not allow cold joints in the curb or gutter, except at expansion joints.

E. Contraction Joints:

1. Maximum 15-foot intervals in curb and gutter.
2. Curbs: Provide scribed joint type using groove tool.
3. Valley Gutter: Provide 3/16-inch by 1-inch deep weakened plane saw cut joints.
4. Finish top of curb with steel trowel and finish edges with steel edging tool.

F. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.

2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
3. Remove and replace defective concrete.

G. Valley Gutter Finish:

1. Broom surface with fine-hair broom at right angles to length of structure and tool at edges, joints, and markings.
2. Finish edges with rounded steel edging tool.
3. Apply the curing compound to exposed surfaces upon completion of the finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

H. Curing:

1. Apply curing compound to exposed surfaces of curb and gutter upon completion of finishing.
2. Continue curing for a minimum of 7 days.

I. Backfill against curb upon completion of the curing period.

1. Backfill with applicable materials taking care not to compact material into the curb.

## 3.04 SIDEWALK CONSTRUCTION

A. Thickness: As shown on the standard project detail.

B. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

C. Contraction Joints:

1. Provide transversely to walks at locations opposite contraction joints in curb.
2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
3. Construct straight and at right angles to surface of walk.

D. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
2. Finish edges with rounded steel edging tool.

3. Apply curing compound to exposed surfaces upon completion of finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

**END OF SECTION**

**SECTION 32 17 23**
**PAVEMENT MARKINGS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M237, Standard Specification for Epoxy Resin Adhesives for Bonding Traffic Markers to Hardened Portland Cement and Asphalt Concrete.
   b. M247, Standard Specification for Glass Beads Used in Traffic Paint.
   c. M248, Standard Specification for Ready-Mixed White and Yellow Traffic Paints.
   d. M249, Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form).
2. ASTM International (ASTM): D4280, Standard Specification Extended Life Type, Nonplowable, Prismatic, Raised, Retroreflective Pavement Markers.
3. Federal Specifications (FS):
   a. A-A-2886A, Paint, Traffic, Solvent Based.
   b. TT-B-1325C, Beads (Glass Spheres); Retroreflective.

### 1.02 DEFINITIONS

A. Standard Specifications: 2012 Standard Specifications for Road, Bridge, and Municipal Construction, WSDOT.

### 1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Paint.
      2) Thermoplastic material.
      3) Reflective markers.
      4) Epoxies, resins, and primers to be used.
   b. Glass Beads: Proposed gradation.

B. Informational Submittals:

1. Description of proposed methods for removal of drips, overspray, improper markings, paint and thermoplastic material tracked by traffic, and existing markings.
2. Manufacturer's Certificate of Compliance for products specified in this Section.
3. Equipment List: Proposed equipment to be used, including descriptive data.
4. Manufacturer's Instructions:
   a. Application of preformed tape.
   b. Application of glass beads.
   c. Application of epoxy resin.
   d. Installation of reflective markers.

## PART 2 PRODUCTS

2.01 GENERAL

A. All products shall be in accordance with Section 8-22 of the Standard Specifications.

2.02 PAINT

A. Color: White or yellow.

B. Homogeneous, easily stirred to smooth consistency, with no hard settlement or other objectionable characteristics during storage period of 6 months.

2.03 THERMOPLASTIC MARKING

A. In conformance with the Standard Specifications.

2.04 GLASS BEADS

A. In accordance with the Standard Specifications.

## PART 3 EXECUTION

3.01 GENERAL

A. Surface Preparation, Application, and Protection: In accordance with Section 8-22 of the Standard Specifications.

## 3.02 SURFACE PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to be marked before application of pavement marking material.
2. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.
3. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.
4. Scrub areas of old pavement affected with oil or grease with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.
5. Surfaces shall be completely free of dirt and ice, and dry of water at the time of application of materials specified herein.
6. Oil-Soaked Areas: After cleaning, seal with cut shellac to prevent bleeding through the new paint.
7. Reclean surfaces when the Work has been stopped due to rain.
8. Existing Pavement Markings:
    a. Remove existing pavement markings that may interfere or conflict with newly applied marking patterns, or that may result in a misleading or confusing traffic pattern.
    b. Do not apply thermoplastic markings over existing preformed or thermoplastic markings.
    c. Perform grinding, scraping, sandblasting or other operations so finished pavement surface is not damaged.

B. Pretreatment for Early Painting: Where painting is required prior to 30 days after paving rigid pavements, pretreat with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride.

C. New Concrete Pavement/Slabs:

1. Allow a minimum cure time of 30 days before cleaning and marking.
2. Clean by either sandblasting or water blasting to the following results:
    a. No visible evidence of curing compound on peaks of textured concrete surface.
    b. No heavy puddled deposits of curing compound in valleys of textured concrete surface.
    c. Remaining curing compound is intact, with loose and flaking material completely removed.
    d. Peaks of textured pavement surface are rounded in profile and free of sharp edges and irregularities.
3. Allow a minimum drying time of 24 hours after water blasting before applying thermoplastic markings.

D. New Asphalt Pavement: Allow a minimum pavement cure time of 30 days before applying paint.

3.03 PAINT APPLICATION

A. General:

1. Thoroughly mix pigment and vehicle together prior to application, and keep thoroughly agitated during application.
2. Do not add thinner.
3. Apply only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Maintain paint temperature within these same limits.
4. Apply only when surface is dry.
5. Do not apply when conditions are windy to the point of causing overspray or fuzzy line edges.
6. Provide guidelines and templates to control paint application.
7. Take special precautions in marking numbers, letters, and symbols.
8. Sharply outline edges of markings and apply without running or spattering.

B. Rate of Application:

1. Reflective Markings: Apply evenly, 105 plus or minus 5 square feet per gallon.
2. Glass Bead Application:
   a. Apply immediately following application of paint.
   b. Use evenly distributed drop-on application method.
   c. Rate: 6 pounds per gallon of paint.
3. Nonreflective Markings: Apply paint evenly to pavement surface at a rate of 105 plus or minus 5 square feet per gallon.
4. On new pavement or new asphalt surface treatments, apply two coats of paint at a uniform rate of 210 square feet per gallon.

C. Drying:

1. Provide maximum drying time to prevent undue softening of bitumen and pickup, displacement, or discoloration by traffic.
2. If drying is abnormally slow, discontinue painting operations until cause is determined and corrected.

D. Protection:

1. Protect markings from traffic until paint is thoroughly dry.
2. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.

E. Cleanup: Remove paint spatters, splashes, spills, or drips from the Work and staging areas including areas outside the immediate Work area where spills occur.

3.04 THERMOPLASTIC MARKING APPLICATION

A. Following specified surface preparation, prime and apply marking and glass beads to provide a reflectorized strip as shown on Drawings.

B. Application Temperatures:

1. Pavement Surface: Minimum 40 degrees F and rising.
2. Thermoplastic: Minimum 375 degrees F, maximum 425 degrees F.

C. Primer:

1. On portland cement concrete and existing asphalt pavements, apply epoxy resin primer/sealer according to thermoplastic manufacturer's recommendations.
2. All primer/sealer to dry prior to applying thermoplastic.

D. Thermoplastic Marking:

1. Extrude or spray in a molten state, free of dirt or tint at a minimum thickness of 0.125 inch; maximum thickness of 0.190 inch.
2. Apply centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator.
3. Apply special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable, extrusion-type applicator.

E. Glass Bead Application:

1. Immediately after marker application, mechanically apply such that the beads are held by and imbedded in the surface of the molten material.
2. Application Rate: 1 pound per 20 square feet of compound.

F. Cool completed marking to ambient temperature prior to allowing vehicular traffic.

**END OF SECTION**

**SECTION 33 05 01.01**
**STAINLESS STEEL PIPE AND FITTINGS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.9, Factory-Made Wrought Buttwelding Fittings.
   b. B36.10M, Welded and Seamless Wrought Steel Pipe.
   c. BPVC SEC VIII, Div. 1, Rules for Construction of Pressure Vessels.
   d. BPVC SEC IX, Welding and Brazing Qualifications.
2. American Society for Nondestructive Testing Inc. (ASNT):
   SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing.
3. American Water Works Association (AWWA):
   a. C200, Steel Water Pipe - 6 In. (150 mm) and Larger.
   b. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. (100 mm) and Larger - Shop Applied.
   c. C206, Field Welding of Steel Water Pipe.
   d. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C602, Cement-Mortar Lining of Water Pipelines in Place - 4 In. (100 mm) and Larger.
   g. M11, Steel Pipe - A Guide for Design and Installation.
4. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   b. A3.0M/A3.0, Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying.
   c. D1.1/D1.1M, Structural Welding Code - Steel.
   d. QC 1, Standard for AWS Certification of Welding Inspectors.
5. ASTM International (ASTM):
   a. A20/A20M, Standard Specification for General Requirements for Steel Plates for Pressure Vessels.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

d. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
e. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
f. A435/A435M, Standard Specification for Straight-Beam Ultrasonic Examination of Steel Plates.
g. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
h. A770/A770M, Standard Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications.
i. A1018/A1018M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
k. E1255, Standard Practice for Radioscopy.

6. International Organization for Standardization (ISO): 9001:2000, Quality Management Systems - Requirements.
7. Lloyd's Registry.
8. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
9. Steel Pipe Fabricators Association (SFPA).

1.02 DEFINITIONS

A. Fittings: Including, but not limited to fittings, closure pieces, bends, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, wall sleeves, bulkheads, and other piping and appurtenances fabricated from steel plate, sheet, or coils as required to provide the Work, complete. Fittings shall include piping above ground or inside structures and vaults.

B. Acronyms:

1. CJP: Complete Joint Penetration.
2. CWI: Certified Welding Inspector.
3. MT: Magnetic Particle Testing.
4. NDE: Nondestructive Examination.
5. NDT: Nondestructive Testing.
6. PJP: Partial Joint Penetration.
7. PQR: Procedure Qualification Record.
8. PT: Liquid Penetrant Testing.
9. RT: Radiographic Testing.
10. UT: Ultrasonic Testing.
11. VT: Visual Testing.

12. WPQ: Welder/Welding Operator Performance Qualification.
13. WPS: Welding Procedure Specification.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings showing pipe layout.
2. Material list and steel reinforcement schedules for materials specified.
3. Fabrication Information:
    a. Pipe and fitting details.
    b. Welded joint details including:
        1) Butt joints.
        2) Miter-cut ends for alignment conformance.
        3) Lap joints.
        4) Special thermal control joints required for control of temperature stresses.
        5) Butt strap joints.
4. Welding Data (Shop and Field Welding):
    a. Show on a weld map, complete information regarding base metal specification designation location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
    b. Distinguish between shop and field welds.
    c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for all welds.
    d. Welding and NDE symbols shall be in accordance with AWS A2.4.
    e. Welding terms and definitions shall be in accordance with AWS A3.0M/A3.0.
    f. Submit welding data together with Shop Drawings as a complete package.
5. Product data for the following:
    a. Stainless Steel Pipe and Fittings: Material data.

B. Informational Submittals:

1. Certificates.
2. Statements of Qualification:
    a. Pipe manufacturer.
    b. Fittings fabricator.
    c. Pipe welder(s).

3. Procedures:
    a. Shop and field welding information.
    b. Welder Qualifications and Welding Procedure.
    c. Written weld repair procedures for the Work.
4. Reports:
    a. Source Quality Control Test Reports: Nondestructive weld testing.
    b. Field Quality Control Test Reports:
        1) Weld tests, including re-examination of repaired welds, on each weld joint for the following tests, as applicable:
            a) RT.
            b) UT.
5. Field Testing Plan: Submit at least 15 days prior to testing and include following information at a minimum:
    a. Testing dates.
    b. Piping system and sections to be tested.
    c. Method of isolation.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Manufacturer:
    a. Experienced in fabricating pipe of similar diameters, lengths, and wall thickness required for the Work.
    b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9001:2000 Certification.
2. Fittings Fabricator:
    a. Experienced in fabricating fittings of similar diameters and wall thickness required for the Work.
    b. Steel Pipe Fabricators Association (SPFA), Lloyd's Registry Certification, or ISO 9001:2000 Certification.
3. Welders and Welding Operators:
    a. Shop Welders: In accordance with ASME BPVC SEC IX.
    b. Field Welders: In accordance with AWS D1.1/D1.1M.

1.05 DELIVERY, HANDLING, AND STORAGE

A. Pipe Marking:

1. Legibly mark installation sequence number on pipe and fittings in accordance with piping layout. Standard pipe sections do not need sequence number labeled provided wall thickness is clearly marked.
2. Fittings shall be marked at each end with notation "TOP FIELD CENTERLINE".
3. The word "TOP" shall be painted or marked on outside top spigot of each fitting.

4. Mark “TOP MATCH POINT” for compound bends per AWWA C208 so end rotations can be easily oriented in field.

B. Delivery:

1. Securely bulkhead or otherwise seal ends of pipe and fittings prior to loading at manufacturing site.
2. Pipe ends shall remain sealed until installation.
3. Damage to pipe and fittings, including linings and coatings, found upon delivery to Site shall be repaired to Engineer’s satisfaction or removed from Site and replaced with new.

C. Storage:

1. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
2. Place in a secured location protected from the weather.

1.06 SEQUENCING AND SCHEDULING

A. Notify Engineer in writing of the following:

1. Not less than 5 calendary days prior to start of each of the following:
   a. System fabricating and welding.
   b. Hydrostatic testing.

## PART 2 PRODUCTS

2.01 GENERAL

A. Pipe Manufacturer:

1. Manufacturing of steel pipe and fittings shall be under direction of one pipe Supplier.
2. Responsibility shall include, at minimum, coordinating work of other suppliers for fittings.

B. Pipe Size:

1. Diameter shown shall be per ASME B36.10M.
   a. Pipe size shall be nominal inside diameter.

C. Steel pipe and fittings shall be manufactured, tested, inspected, and marked to comply with AWWA C200 and any additional requirements of these Specifications.

2.02 PIPE

A. Stainless Steel: Type 304 or Type 316 stainless steel pipe; Schedule 40. Refer to ASME B36.10M for definitions of wall thickness for standard weight pipe and nominal pipe size (NPS).

B. Fabrication:

1. Shop fabricate. No field fabrication will be allowed, unless otherwise approved by Engineer.
2. Fabricate from materials of straight pipe in conformance with specified requirements and dimensions of AWWA C208, unless otherwise indicated.

2.03 JOINTS

A. Shop Welded:

1. Fabricate in accordance with AWWA C200 as modified herein.
2. Complete joint penetration (CJP) butt joints shall be used for longitudinal, girth, and spiral welds, unless otherwise indicated.
3. Lengths of pipe shall not be shop-joined using lap joints.

B. Preparation of Joints for Field Welding:

1. Butt Joint Welded:
   a. Plain ends beveled as required by AWWA C200 and Contractor's field WPS.
   b. Provide protection for factory beveled pipe ends so ends are not damaged during transport.

2.04 FLANGES

A. In accordance with AWWA C207.

2.05 RUBBER GASKET

A. General:

1. In accordance with AWWA C200.
2. Clearance between bell and spigot shall, when combined with gasket groove.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. General:

1. Joints and related work for field assembly of fittings shall conform to requirements for straight pipe, unless otherwise shown.
2. Inspect pipe and fittings before installation. Clean ends thoroughly, remove foreign matter and dirt from inside.
3. Make minor field adjustments by pulling standard joints.
   a. Maximum Allowable Angle: 75 percent of manufacturer's recommended or angle which results from 3/4-inch pull out from normal joint closure, whichever is less.
   b. Maximum Allowable Gap: 1/8-inch between bell and spigot at weld location.

B. Control of Temperature Stresses:

1. To control temperature stresses, shade unbackfilled special temperature control joint area of pipe, where applicable, from direct rays of sun by use of properly supported awnings, umbrellas, tarpaulins or other suitable materials until pipe is backfilled at least 1 foot over top of pipe. The special temperature control joint area is defined as the entire length of pipe left exposed. Shading materials shall not rest directly on pipe, but shall be supported to allow air circulation around pipe. Shading of special temperature control joints is not required when ambient air temperature is below 50 degrees F.
2. Install special temperature control joints as indicated on Drawings.
3. Temperature Control Requirements:
   a. Prior to and during placement of pipe backfill, pipeline steel temperature shall be at or below 90 degrees F. Monitor specified temperature and control for at least 3 hours after placement of pipe backfill. Provide supplemental cooling as required.
   b. Place pipe backfill from a single heading starting at one special temperature control joint and proceed toward next special temperature control joint, where appliacable.
   c. During period of pipe backfill placement, pipeline section that is partially backfilled shall be shaded as indicated in above. Temperature of partially backfilled pipe shall not be allowed to exceed 110 degrees F. Provide supplemental cooling as required.

### 3.02 WELDING

A. Conform to AWS D1.1/D1.1M, AWWA C206, approved welding procedures, and referenced welding codes. In case of conflict AWS D1.1/D1.1M shall govern.

B. Preheat and Interpass temperature requirements for unlisted base metals shall be determined according to AWS D1.1/D1.1M, Annex XI Guideline on Alternative Methods for Determining Preheat.

C. Rejectable weld defects shall be repaired or redone, and retested until sound weld metal has been deposited in accordance with appropriate welding codes.

3.03 FIELD QUALITY CONTROL

A. Field Welding:

1. All welds, 100 percent inspection, shall be inspected and marked to indicate acceptance or rejection.
2. Test butt-strap or double-welded lap joint welds by pressurizing connection between the two fillet welds in accordance with AWWA C206.
    a. Apply air or other Engineer-approved gas into connection between the two fillet welds.
    b. Paint welds with soap solution.
    c. Mark leaks indicated by escaping gas bubbles.
    d. Close threaded openings with flush pipe plugs or by welding them.
3. CJP Welds:
    a. Inspect 10 percent of butt joint welds with full circumference RT.
    b. Inspect 10 percent of other groove welds with UT.
4. Inspect 10 percent of lap joint welds with PT or MT.
5. Weld Acceptance:
    a. If, in the opinion of Engineer, inspections indicate inadequate quality of welds, percentage of welds inspected shall be increased.
    b. Welds to be inspected, if less than 100 percent rate, shall be selected at random by Engineer.
    c. VT: Perform VT per AWS D1.1/D1.1M Paragraph 6.9, Visual Inspection, Statically Loaded Nontubular Connections.
    d. UT: Perform UT of CJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.13.1.
    e. RT: Perform RT of CJP butt joint welds in accordance with AWS D1.1/D1.1M, Paragraph 6.12.1.
    f. PT or MT:
        1) Perform on fillet and PJP groove welds in accordance with AWS D1.1/D1.1M, Paragraph 6.10.
        2) Acceptance shall be in accordance with VT standards specified above.
    g. Remove in manner that permits proper and complete repair by welding.
    h. Caulking or peening of defective welds is not permitted.
    i. Retest unsatisfactory welds.

6. Verification Acceptance: Engineer may conduct random nondestructive inspections of field-welded joints. Inspections will be of an appropriate type for weld being evaluated. Possible types of inspection include, but are not limited to, RT, UT, PT, and VT. Testing will be performed and evaluated per AWS D1.1/D1.1M. Provide Owner's Verification Inspector access to the Work.

B. Hydrostatic Testing:

1. Pipeline:
   a. General:
      1) Notify Engineer in writing 5 calendar days prior to testing. Perform testing in presence of Engineer. Coordinate with HDPE pipe testing in accordance with Section 33 05 01.10, High-Density Polyethylene (HDPE) Pipe and Fittings.
      2) Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.
      3) Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements under specified conditions.
      4) Isolate new pipelines that are connected to existing pipelines.
      5) Conduct field hydrostatic test on buried piping after trench has been completely backfilled, where applicable. Testing may, as approved by Engineer, be done prior to placement of roadway structural section.
      6) Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct an initial service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above, and where appliable.
      7) Dispose of water used in testing in accordance with federal, state, and local requirements.
   b. Procedure:
      1) Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.
      2) Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points.
      3) Test Pressure: 200 psi psi. Coordinate with HDPE pipe leak testing. No leakage is allowed through the stainless steel pipe sections.

**END OF SECTION**

**SECTION 33 05 01.10**
**HIGH-DENSITY POLYETHYLENE (HDPE) PIPE AND FITTINGS**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Society of Mechanical Engineer's (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B18.2.2, Square and Hex Nuts (Inch Series).
2. American Water Works Association (AWWA):
   a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 63 in., for Water Distribution and Transmission.
   b. Manual M55, PE Pipe - Design and Installation.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   e. A536, Standard Specification for Ductile Iron Castings.
   f. A563, Standard Specification for Carbon and Alloy Steel Nuts.
   g. D638, Standard Test Method for Tensile Properties of Plastics.
   h. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
   i. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
   j. F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
   k. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.
4. Code of Federal Regulations (CFR): Title 49 Part 192.285, Plastic Pipe: Qualifying Persons to Make Joints.
5. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

6. Plastics Pipe Institute (PPI):
    a. Handbook of Polyethylene Pipe.
    b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
    c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
    a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
    b. Drawings of specific connection details.

B. Informational Submittals:

1. Certificates of qualification for persons to be fusing HDPE pipe
2. Testing Plan: Submit at least 15 days prior to testing and include the following as a minimum:
    a. Testing dates.
    b. Piping systems and section(s) to be tested.
    c. Method of isolation.
    d. Method of conveying water from source to system being tested.
3. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Pipe Manufacturer: Listed with Plastic Pipe Institute.
2. Persons fusing HDPE pipe shall be certified under 49 CFR § 192.285 with current certificate (current in the last 2 years from a reputable HDPE pipe welding certification firm), and shall have minimum of 10 years of experience with fusing HDPE pipe.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage:

1. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
2. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
3. Keep pipe shaded from direct sunlight prior to installation in trench.

## PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pipe and fittings specified in this section shall be products of:

1. CP Chem Performance Pipe.
2. J-M Manufacturing Co.

2.02 MATERIALS

A. Pipe and Fittings:

1. Conform to requirements of AWWA C906.
2. Resin: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 3408 material. Pressure rating shall be based on hydrostatic design stress of 800 psi at 73.4 degrees F.
3. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.
4. Fittings:
   a. Sizes 6 Inches and Smaller: Molded and fabricated from polyethylene pipe.
   b. Sizes 8 Inches and Larger: Use thermal butt-fusion.
   c. Polyethylene fittings shall have same or higher pressure rating as pipe.

B. Backup Rings:

1. Convoluted for Flanged Connections:
   a. ASTM A240/A240M, Type 316 stainless steel.
   b. Complete with one-piece, molded polyethylene flange adapters.
   c. Flanged Connections: Same or greater pressure rating as pipe.

C. Gaskets: Material, size, and thickness shall be as recommended by pipe or flange manufacturer, and in accordance with PPI Technical Note 38.

D. Joints: Thermal butt-fusion, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Electrofusion couplers are allowed in areas approved by the Engineer or Owner.

E. Bolts, Nuts, Washers:

1. Type 316 stainless steel, ASTM A193/A193M, Grade B8 hex head bolts; and ASTM A194/A194M, Grade 8 hex head nuts.
2. Bolts: Fabricated in accordance with ASME B18.2.2 and provided with washers of same material as bolts.

F. Electrofusion Coupler: Rigid, straight coupler constructed of injection-molded polyethylene resin with embedded heating coils. Electrofusion couplers shall be Frialen Straight couplers as manufactured by Friatec, or approved equal.

2.03 HDPE PIPE SCHEDULE

A. General: All nominal pipe sizes noted on Drawings are iron pipe sizes (IPS).

B. Water Distribution Line: Diameter as shown on Drawings, SDR 7.

C. Septic System Lines:

1. Pressure Lines: Diameter as shown on Drawings, SDR 9.
2. Gravity Drain Lines: Diameter as shown on Drawings, SDR 21.

D. Contact Water Conveyance Lines:

1. Pressure Lines: Diameters as shown on Drawings, SDR 9.
2. Gravity Drain Lines: Diameter as shown on Drawings, SDR 21.

## PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.
2. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer's recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavation.
3. Remove and extract internal fusion bead from pipe.
   a. Verify complete internal fusion bead removal was performed on all gravity drain lines. Accomplish by examination of extracted

internal fusion bead or by means of closed circuit television (CCTV) examination.

b. Extracted Internal Fusion Bead:
   1) Appearance shall have same double roll back semblance as does the external fusion bead.
   2) Possess smooth root cut, or pipe smoothness and shall be verified by means of closed circuit television (CCTV) examination.

c. Removal of internal bead may include pipe wall mass. However, wall mass that is removed shall not exceed 1/10th of pipe wall thickness.

4. If HDPE pipe surface temperature is above 120 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.
5. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
   a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange “stub ends” are not allowed.
   b. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard.
   c. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.
6. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
7. Minimum Long-Term Field Bending Radius: Restricted to limits recommended by AWWA M55, Table 8-2.

B. Placement in Trench:

1. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.
2. Position slings for handling pipeline away from butt-fused joints.
3. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.
4. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.
5. Snake pipe laterally in the trench to allow for thermal and settling movements, and as recommended by pipe manufacturer.
6. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.

## 3.02 TESTING AND INSPECTION

A. Joint Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine, and shall be capable of being retrieved electronically. Data to be logged shall include the following:
    a. Pipe size and dimensions.
    b. Machine model and size.
    c. Operator identification.
    d. Job identification number.
    e. Weld number.
    f. Fusion, heating, and drag pressure settings.
    g. Heater plate temperature.
    h. Time stamp showing when weld was performed.
    i. Heating and curing time of weld.
    j. Curing temperature readings and time stamps of readings.
    k. Error messages and warnings for out of range temperature or pressure settings.
2. In addition to logged items above, the following shall be logged or annotated on report:
    a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
    b. Ambient temperature and humidity.
    c. If internal bead was removed.

B. Joint Weld Testing:

1. Test Procedure: ASTM D638.
2. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
3. Test Frequency:
    a. To be implemented by Engineer or Owner if joints are considered to be suspect.
    b. Each Test Failure: An additional joints selected at random by Engineer or Owner.

C. Final Quality Testing: For those pipes that can pass a CCTV camera (gravity drain lines), camera-inspect all lines to demonstrate that the pipe has been placed on a constant slope without any high or low points in the line, the pipeline is clean, all beads have been removed, and the pipeline has no obstructions.

D. Pipeline Pressure Test:

1. General:
    a. Notify Engineer or Owner in writing 7 calendar days in advance of testing. Perform testing in presence of Engineer or Owner.
    b. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of initial service leak and allowable make-up water volume under specified conditions.
    c. Test all newly installed pipelines.
    d. Isolate new pipelines that are connected to existing pipelines, where applicable.
    e. Using water as test medium, pipes shall successfully pass a pressure test prior to acceptance.
    f. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Engineer or Owner, be done prior to placement of asphaltic concrete or roadway structural section.
    g. Contractor may, if field conditions permit and as determined by Engineer or Owner, partially backfill trench and leave joints open for inspection and conduct initial service leak test. Final field pressure test shall not be conducted until backfilling has been completed as specified above.
    h. Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
    i. Dispose of water used in testing in accordance with federal, state, and local requirements.
2. Preparation:
    a. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
    b. Wait 5 calendar days minimum after concrete thrust blocking or designed thrust collars are installed to perform pressure tests.
    c. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
    d. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.
3. Procedure:
    a. Test pressure shall be 150 percent of system operating pressure for all pressure lines based on the pressure as measured at lowest point in pipeline, and as approved by Engineer or Owner. All gravity lines shall be tested with a pressure of 3 psi.
    b. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on full area of the pipe.

c. Expel air from pipe system during filling.
d. Test procedure consists of two steps: (1) Initial Expansion Phase and (2) Test Phase. During the Initial Expansion Phase, apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached. Add makeup water at hourly intervals for 3 hours to maintain test pressure. Continue initial expansion phase for 4 hours and then begin Test Phase. Test phase shall continue for 2 hours.
e. At conclusion of Test Phase, determine actual leakage by measuring quantity of water necessary to return system to test pressure.
f. If test is not successful due to leakage, equipment failure, or other reasons, depressurize test section and allow it to relax for at least 8 hours before retesting.
g. If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.

4. Allowable Leakage:
   a. Maximum allowable make-up water at conclusion of test phase shall not exceed recommended amounts stated in the following table.
   b. Table is based on test pressure equal to 1.5 times pressure class of pipe. If lower pressure is used for test, allowances shall be reduced by ratio of test pressure-to-pressure class of pipe.

**Makeup Water Allowance for Test Phase (U.S. Gallons per 100 feet of Pipe)**

| Nominal Pipe Size (inches) | 1-Hour Test (gallons) | 2-Hour Test (gallons) | 3-Hour Test (gallons) |
|---|---|---|---|
| 3 | 0.10 | 0.15 | 0.25 |
| 4 | 0.13 | 0.25 | 0.40 |
| 6 | 0.30 | 0.60 | 0.90 |

*Pipe sizes not shown will be calculated and allowances made for different SDR pipe ratings. Coordinate with Engineer or Owner as needed.

3.03 CLEANING AND DISINFECTION (WATER SERVICE LINES)

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Flush service connections. Operate valves during flushing process at least twice during each flush.

C. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

D. Disinfection of Domestic Water Supply System: As specified in Section 33 13 00, Disinfecting of Water Utility Distribution System.

E. Sanitary Sewer and Contact Water Pipelines Cleaning (Gravity Sections):

1. Prior to final acceptance and final manhole-to-manhole inspection of the system by Engineer or Owner, where applicable, flush and clean all parts of the system. Remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the lines system at or near the closest downstream manhole. If necessary, use mechanical rodding or bucketing equipment.
2. Upon Engineer's or Owner's final manhole-to-manhole inspection of the sewer system, if any foreign matter is still present in the system, reflush and clean the sections and portions of the lines as required.

**END OF SECTION**

**SECTION 33 05 13**
**MANHOLES**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
   p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
   q. C1311, Standard Specification for Solvent Release Sealants.

r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft$^3$ (600 kN-m/m$^3$)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Precast Manholes: Details of construction.

B. Informational Submittals:

1. Precast Manhole Sections: Manufacturer's results of tests performed on representative sections to be furnished.
2. Certified load test data for precast manhole steps.

**PART 2 PRODUCTS**

2.01 PRECAST MANHOLES

A. Riser Sections:

1. Minimum 48 inches in diameter.
2. Fabricate in accordance with ASTM C478.
3. Minimum Wall Thickness: 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom shall be parallel.
5. Joints: Tongue-and-groove or confined groove with mortar.

B. Cone Sections:

1. Provide concentric cones, or as otherwise shown on Drawings.
2. Same wall thickness and reinforcement as riser section.
3. Top and bottom shall be parallel.

C. Base Sections and Base Slab:

1. Base Sections: Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.

E. Preformed Plastic Gaskets: Hamilton Kent of Nevada, Sparks, NV; Kent-Seal No. 2.

F. Polypropylene Steps:

1. Fabricate from minimum 1/2 inch, Grade 60, steel bar meeting ASTM A615/A615M.
2. Polypropylene encasement shall conform to ASTM D4101.
3. Minimum Width: 13 inches, center-to-center of legs.
4. Embedment: 3-1/2-inch minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
5. Cast in manhole sections by manufacturer.
6. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.

G. Source Quality Control:

1. All test specimens shall be mat tested and meet permeability test requirements of ASTM C14.
2. Conduct tests at point of manufacture prior to delivery of any section.
3. Sections to be tested will be selected at random from stockpiled material to be supplied for the Project.

## 2.02 MANHOLE FRAMES AND COVER

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
2. Cast Iron: ASTM A48 Class 30B.
3. Ductile Iron: ASTM A536, Grade 60-40-12.
4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: True and seat within ring at all points with the word SEWER in 2-inch raised letters.

C. Capscrews for tamper-proof covers.

## 2.03 MANHOLE FRAME TO STRUCTURE SEALS

A. Gasket:

1. Extrude or mold from a high-grade rubber compound.
2. Comply with material test requirements of ASTM C923.
3. Minimum Thickness: 3/16 inch.
4. Minimum Unstretched Length: Sufficient to extend from the manhole frame, across a maximum of 12 inches of extension rings, to the manhole cone section.
5. Fabricate bands for compressing sleeve against manhole from Type 304 stainless steel:
    a. Channeled Sheet: Minimum 16-gauge, ASTM A167.
    b. Round: 5/16-inch diameter, ASTM A240.

B. Screws, Bolts, or Nuts: Stainless steel conforming to ASTM F593 and ASTM 594, Type 304.

C. Internal gasket or its appurtenances shall not extend into the manhole opening to restrict entry into or exit from the manhole.

D. Gasket shall be made only of materials that have been proven to be resistant to the following exposures and conditions:

1. Sanitary sewage.
2. Corrosion or rotting under wet or dry conditions.
3. Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at the sites of installation.
4. Biological environment in soils and sanitary sewers.
5. Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
6. Temperature ranges, variations, and gradients in the area of construction.
7. Variations in moisture conditions and humidity.
8. Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
9. Vibrations due to traffic loading.
10. Fatigue failure due to repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression.
11. Any combination of the above.

E. Materials used shall be compatible with each other and with manhole materials.

F. Design gasket to meet the following requirements:

1. Continuously prevent leakage of water from outside the manhole into the manhole at the joints between the manhole frame and the cone section.
2. Seal shall remain flexible, allowing repeated vertical movements of frame from 0 to 2 inches or repeated horizontal movements of frame with respect to top of extension or cone from 0 to 1/2 inch due to pavement movements or other causes, or both types of movement occurring simultaneously at rates not exceeding 1/10 inch per minute.

## 2.04 MORTAR

A. Standard premixed in accordance with ASTM C387, or proportion one part portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures: May be included but do not exceed the following percentages of weight of cement:

1. Hydrated Lime: 10 percent.
2. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

## 2.05 CLEANOUT FRAMES AND COVERS

A. Castings:

1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
2. Cast Iron: ASTM A48, Class 30B.
3. Ductile Iron: ASTM A536, Grade 65-40-12.
4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Covers: True and seat within frame at all points.

## 2.06 IMPORTED PIPE BASE

A. Furnish as specified in Section 31 23 23.15, Trench Backfill. Use bedding material, as approved by Engineer.

2.07 FLEXIBLE JOINTS

A. Manufacturers:

1. “Kor-N-Seal” flexible rubber boot with stainless steel accessories as manufactured by NPC, Inc., Milford, New Hampshire.
2. “Z-LOK XP” or “A-LOK” flexible connectors as manufactured by A-LOK Products, Inc., Tullytown, PA.

## PART 3 EXECUTION

3.01 GENERAL

A. Remove and keep all water clear from the excavation during construction and testing operations.

B. Place imported pipe base material on undisturbed earth; thoroughly compact with a mechanical vibrating or power tamper.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Cast-in-Place:
   a. Vibrate to densify concrete and screed so first precast manhole section to be placed has a level, uniform bearing for full circumference.
   b. Deposit sufficient mortar on base to assure watertight seal between base and manhole wall, or place first precast section of manhole in concrete base before concrete has set. Properly locate and plumb first section.
2. Precast:
   a. Place on compacted imported base material.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:

1. Carefully inspect precast manhole sections to be joined.
2. Thoroughly clean ends of sections to be joined.
3. Do not use sections with chips or cracks in the tongue.

4. Locate precast steps in line with each other to provide a continuous vertical ladder.

C. Mortar Joints:

1. Thoroughly wet joint with water prior to placing mortar.
2. Place mortar on groove of lower section prior to section installation.
3. Fill joint completely with mortar of proper consistency.
4. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joints.
5. Prevent mortar from drying out and cure by applying an approved curing compound or comparable approved method.
6. Do not use mortar mixed for longer than 30 minutes.
7. Chip out and replace cracked or defective mortar.
8. Completed Manholes: Rigid and watertight.

D. Preformed Plastic Gaskets (In lieu of mortar joints):

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer's instructions.
3. Completed Manholes shall be rigid and watertight.

E. Rubber Gasketed Joints: Install in accordance with manufacturer's instructions.

F. Extensions:

1. Provide on manholes in streets or other locations where a subsequent change in existing grade may be likely.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections, and make watertight.

## 3.04 MANHOLE INVERT

A. Construct with smooth transitions to ensure an unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

B. Where full section of pipe is laid through manhole, break out top section as shown and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

## 3.05 MANHOLE FRAMES AND COVERS

A. Set frames in bed of mortar with mortar carried over flange as shown.

B. Set tops of covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

3.06 MANHOLE PIPING

A. Drop Assembly:

1. Extend pipe from the drop to a minimum of 3 feet beyond the manhole excavation into the trench, and connect to sewer pipe with an adapter.
2. Support lower drop elbow with concrete monolithically-placed with manhole base.

B. Flexible Joints:

1. Provide in pipe not more than 1-1/2 feet from manhole walls.
2. Where last joint of pipe is between 1-1/2 and 6 feet from manhole wall, provide flexible joint in manhole wall.

3.07 FIELD QUALITY CONTROL

A. Hydrostatic Testing:

1. Procedure: Plug inlets and outlets and fill manhole with water to total height of manhole (or wetwell).
2. Each manhole (or wetwell) shall be filled with clean water 24 hours prior to time of testing to permit normal absorption into the pipe walls to take place.
3. No measureable leakage is allowed over the testing period.
4. Repair manholes, manhole section joints, etc. that do not meet the leakage test, and/or do not meet specified requirements from visual inspection.

B. Testing Cast-in-Place Manhole Steps (If Applicable):

1. Test each step for a horizontal pullout load of 400 pounds with the load applied over a width of 3-1/2 inches and centered on the rung.
2. Apply the load at a uniform rate until the required test load is reached.
3. Provide suitable hydraulic jacks and gauges to perform the test.
4. Steps will be considered acceptable if they remain solidly embedded after application of test load and if no cracking or fracture of the step nor spalling of the concrete, masonry, or mortar is evident.
5. Replace, or reset and retest, steps failing to withstand required load.

**END OF SECTION**

**SECTION 33 13 00**
**DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. B302, Ammonium Sulfate
   d. B303, Sodium Chlorite.
   e. C651, Disinfecting Water Mains.
2. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

### 1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this Section.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
7. Method of disposal for highly chlorinated disinfecting water.
8. Independent Testing Agency: Certification that testing agency is qualified to perform chlorine concentration testing and bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.
9. Certified Bacteriological Test Results:
   a. Facility tested is free from coliform bacteria contamination.
   b. Forward results directly to Engineer.

### 1.03 QUALIFICATIONS

A. Independent Testing Agency: Certified in the State of Washington, with 10 years' experience in field of water sampling and testing. Agency shall use

calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

## PART 2 PRODUCTS

2.01 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable. Use potable well water once tested and approved.

2.02 CONTRACTOR'S EQUIPMENT

A. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2.03 DISINFECTANT

A. Coordinate with Engineer or Owner for type of disinfectant to be used.

## PART 3 EXECUTION

3.01 GENERAL

A. Conform to AWWA C651 for pipes and pipelines, except as modified in these Specifications.

B. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pumps: Used for pipeline cleaning and disinfection.
2. Pipelines: Disinfect pipelines.
3. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

C. Prior to application of disinfectants, clean pipelines of loose and suspended material.

D. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 SEQUENCING AND SCHEDULING

A. Commence disinfection after completion of following:

1. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
2. Disinfection of pumps and associated system piping.

3.03 PIPING AND PIPELINES

A. Cleaning:

1. Before disinfecting, clean all foreign matter from pipe in accordance with AWWA C651.
2. If the continuous feed method or the slug method of disinfection, as described in AWWA C651 are used, flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
3. Flush pipe through flushing branches and remove branches after flushing is completed.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 PUMPS (SYSTEM TESTING AND DISINFECTION PUMPS)

A. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.

B. Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.
2. Operate valves and pump appurtenances during disinfection to ensure that disinfecting solution is dispersed into all parts of pump and lines.
3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush water from pump until water through the unit is chemically and bacteriologically equal to permanent source of supply.

3.05 DISPOSAL OF HEAVILY CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. See the appendix of AWWA C651 for acceptable neutralization methods.

3.06 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this Section.
2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from an independent testing laboratory.

C. Chlorine Concentration Sampling and Analysis: Collect and analyze Samples in accordance with AWWA 651.

D. After pipelines have been cleaned, disinfected, and refilled with potable water, an independent laboratory hired by Contractor will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.

1. Samples shall be collected in accordance with applicable AWWA Standard.
2. Samples shall be analyzed for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.

E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

**END OF SECTION**

**SECTION 33 44 13.13**
**CATCH BASINS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Welding Society (AWS): Code for Welding in Building Construction.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48, Standard Specification for Gray Iron Castings.
   c. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   f. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.

## PART 2 PRODUCTS

2.01 CONCRETE

A. Concrete shall be ready-mixed, conforming to ASTM C94/C94M, Alternate 2. Compressive field strength shall be not less than 2,500 psi at 28 days. Maximum size of aggregate shall be 1-1/2 inch. Slump shall be between 2 and 4 inches. Field strength shall be assumed as equal to 85 percent of strength of laboratory-cured cylinders.

2.02 FORMS

A. Exposed surfaces shall be plywood. Others shall be steel, matched boards, plywood, or other acceptable material. Form vertical surfaces. Provide fillets on re-entrant angles. Trench walls, large rock, or earth will not be acceptable form material.

2.03 REINFORCING STEEL

A. Reinforcing steel shall conform to ASTM A615/A615M, Grade 60, deformed bars.

2.04 PRECAST UNITS

A. Precast units shall conform to ASTM C478 Concrete risers for extensions shall be a maximum of 6 inches high and of same quality as sections. Risers shall be reviewed by Engineer before installation.

2.05 MORTAR

A. Standard premixed mortar conforming to ASTM C387, Type S, or proportion 1 part portland cement to 2 parts clean, well-graded sand which will pass a 1/8-inch screen. Admixtures may be used not exceeding the following percentages of weight of cement: Hydrated lime, 10 percent; diatomaceous earth or other inert materials, 5 percent. Consistency of mortar shall be such that it will readily adhere to concrete.

2.06 FRAMES AND GRATES

A. Frames and grates for catch basins and storm drain inlets shall be fabricated of steel conforming to ASTM A36/A36M in accordance with details shown. Connections shall be welded. Welding shall conform to requirements of current Code For Welding in Building Construction of the American Welding Society. Frames and grates shall be properly cleaned and hot-dip galvanized after fabrication.

2.07 FRAMES AND GRATINGS

A. Cast iron frames and gratings for catch basins and storm drain inlets shall be as indicated. Bearing surfaces shall be clean and shall provide uniform contact. Castings shall be tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects, and shall conform to ASTM A48, Class 30.

**PART 3 EXECUTION**

3.01 EXCAVATION AND BACKFILL

A. Excavate as required to accomplish construction. Backfill shall be as specified for adjoining pipe trench.

3.02 CONSTRUCTION OF CATCH BASINS AND INLETS

A. Construct inlets and catch basins at locations shown and in accordance with Drawings. Construct forms to dimensions and elevations required. Forms shall be tight and well braced. Chamfer corners of forms.

B. Prior to placing concrete, remove water and debris from forms. Moisten forms just prior to placing concrete. Handle concrete from transporting vehicle to

forms in a continuous manner as rapidly as practical without segregation or loss of ingredients. Immediately after placing, compact concrete with mechanical vibrator. Limit duration of vibration to time necessary to produce satisfactory consolidation without causing segregation.

C. Screed top surface of exposed slabs and walls. When initial water has been absorbed, float surfaces with wood float and lightly trowel with steel trowel to smooth finish free from marks or irregularities. Finish exposed edges with steel edging tool. Remove forms and patch defects in concrete with mortar mixed in same proportions as original concrete mix.

D. Cure concrete by preventing loss of moisture for a period of 7 days. Accomplish with a membrane-forming curing compound. Apply curing compound immediately after removal of forms or finishing of slabs. Protect concrete from damage during 7-day curing period.

3.03 PLACING PRECAST UNITS

A. If material in bottom of trench is unsuitable for supporting unit, excavate and backfill to required grade with 3-inch minus, clean, pit-run material. Set units to grade at locations shown.

3.04 EXTENSIONS

A. Install extensions as required. Lay risers in mortar with sides plumb and tops to grade. Joints shall be sealed with mortar, with interior and exterior troweled smooth. Prevent mortar from drying out and cure by applying a curing compound. Extensions shall be watertight.

3.05 INSTALLATION OF FRAMES AND GRATES

A. Set frames and grates at elevations indicated or as determined in field and in conformance with Drawings.

B. Frames may be cast in, or shall be set in mortar.

3.06 CLEANING

A. Upon completion, clean each structure of all silt, debris, and foreign matter.

**END OF SECTION**

**SECTION 40 27 02**
**PROCESS VALVES AND OPERATORS**

## PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society of Mechanical Engineers (ASME): B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
2. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves.
   d. C507, Ball Valves, 6 in. Through 48 in. (150 mm Through 1200 mm).
   e. C508, Swing-Check Valves for Waterworks Service, 2-in. through 24-in. (50 mm Through 600 mm) NPS.
   f. C509, Resilient-Seated Gate Valves for Water Supply Service.
   g. C510, Double Check Valve, Backflow Prevention Assembly.
   h. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   i. C540, Power-Actuating Devices for Valves and Slide Gates.
   j. C550, Protective Interior Coatings for Valves and Hydrants.
   k. C606, Grooved and Shouldered Joints.
   l. C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   d. B61, Standard Specification for Steam or Valve Bronze Castings.
   e. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   f. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
   g. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
   h. B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
   i. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.

j. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
k. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
l. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
m. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

4. International Association of Plumbing and Mechanical Officials (IAPMO).

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.

B. Informational Submittals:

1. Tests and inspection data.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

**PART 2 PRODUCTS**

2.01 GENERAL

A. Valves to include operator, extension stem, operating nut, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight)

in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Valve to open by turning counterclockwise.

G. Factory mount operator, actuator, and accessories.

H. Valve parts not lined/coated and in contact with leachate shall be Type 304 stainless steel.

2.02 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139 (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
2. Stainless steel Alloy 18-8 may be substituted for bronze.

2.03 FACTORY FINISHING

A. Epoxy Lining and Coating:

1. Use where specified for individual valves described herein.
2. In accordance with AWWA C550 unless otherwise specified.
3. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
4. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.04 VALVES

A. Plug Valves:

1. Type V420 Nonlubricated Plug Valve:
   a. Ductile iron body, PTFE-lined plug with straight-way rectangular ports, flanged ends, 2-inch AWWA nut operator.
   b. Class: 150.
   c. Rating: 275 psi WOG.
   d. Manufacturers and Products: Flowserve Durco Model T 41.

B. Check Valves:

1. Type V608 Swing Check Valve:
   a. Class 150 flanged ends, stainless steel body.
   b. For vertical or horizontal installations.
   c. Manufacturers and Products: Powell Co., Corrosion-resistant Swing Check; Model 2000.

C. Gate Valves:

1. Type V120 Gate Valve:
   a. ANSI/AWWA C515, ductile iron body; wedge bronze encapsulated with EPDM rubber; bolting stainless steel, Type 304; working water pressure 250 psi.
   b. Ductile iron square operating nut.
   c. Stem sealed by three O-rings. The top O-ring shall be replaceable. O-rings set in a cartridge shall not be allowed.
   d. All internal and external surfaces of the valve body and bonnet shall have fusion-bonded epoxy coating.
   e. Manufacturers and Products: American Flow Control; Series 2500 Ductile Iron Resilient Wedge Gate Valve (RWGV).

## 2.05 OPERATORS

A. Manual Operators:

1. General:
   a. Operator force not to exceed 40 pounds under any operating condition, including initial breakaway.
   b. Operator self-locking type or equipped with self-locking device.
   c. Position indicator on quarter-turn valves.
2. Exposed (Vault) Operator: 2-inch AWWA operating nut.
3. Buried Operator:
   a. Buried service operators shall have a 2-inch AWWA operating nut. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Design buried service operators for quarter-turn valves to withstand 450 foot-pounds of input torque at the FULLY OPEN or FULLY CLOSED positions, grease packed and gasketed to withstand a submersion in water to 10 psi.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.

2.06 ACCESSORIES

A. Tagging: 1-1/2-inch diameter stainless steel tag attached with stainless steel jack chain for each valve, bearing valve tag number. Coordinate tag numbering scheme with Engineer.

B. T-Handled Operating Wrench:

1. One galvanized operating wrench, 4 feet long.
2. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Clow No.; F-2520.

C. Cast Iron Valve Box: Designed for traffic loading, sliding type, with minimum 6-inch ID shaft.

1. Box: Cast iron with minimum depth of 9 inches.
2. Lid: Cast iron, minimum 3 inches, marked LEACHATE.
3. Extensions: Cast iron.

**PART 3 EXECUTION**

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Valve Installation and Orientation:

1. General:
   a. Install valves to operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance. All valves in vault shall be installed such that they can be operated from the surface using T-handled operating wrench.
   c. Install valves per manufacturer’s recommendations.
2. Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
3. Check Valves: Install swing check valve with shaft in horizontal position.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Count and record number of turns to open and close valve; account for any discrepancies with manufacturer's data.

D. Set, verify, and record set pressures for relief and regulating valves.

**END OF SECTION**

**SECTION 41 14 36.01**
**COMMERCIAL TRUCK SCALE**

## PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section covers the Work necessary to furnish and install, complete and ready for operation, a low-profile commercial truck scale.

B. Refer to other Specification sections or the electrical drawings for the telecommunication system, CCTV system, power system, and other elements and features of the commercial truck scale system as shown on Drawings.

C. Performance Requirements:

1. Truck scale will be used to weigh commercial delivery garbage trucks as its primary function, and to weigh loaded long-haul waste transfer trailer and trucks for purposes of calibration as its secondary purpose. The truck scale will be automated by means of a card-reader system that identifies the truck and its tare weight, allows communication with the scale house through vendor-supplied data cable, voice and CCTV systems, and provides a printed receipt of the transaction and the scale for the commercial garbage truck driver.
2. Truck scale will be installed on concrete foundation supports above-grade.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revisions of the following documents. They are part of this section insofar as specified and modified herein. In case of conflict between the requirements of this section and the listed documents, the Contractor shall point out the conflict to the project representative; lacking a definitive answer otherwise, the requirements of the contract specifications shall prevail.

| Reference | Title |
|---|---|
| NIST H-44 | National Institute of Standards and Technology Handbook H-44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices |

B. Factory Tests:

1. Custom-programming in digital scale controller. Provide documentation of custom-designed input screens.
2. Test assembled control panel. Provide test documentation.

C. Qualification of Scale Manufacturer: The manufacturer of the new scale shall have been in the business of design and manufacturing of similar type scales for at least 10 years, and have been represented in the State of Washington by a properly licensed sales and service organization for the preceding 5 years. Local parts and service must be available on a 24-hour-day, 7-day-week basis. A service list of customers with similar type scales, covering at least the past 5 years, and a list of the servicemen with their experience record must be submitted to assure that adequate, skilled manpower is available at all times to provide timely scale repair service.

D. Scale shall be built in accordance with standards of the American Society of State and Highway Officials and the Scale Manufacturers Association.

E. Performance: The scale, new and adjusted, shall perform automatically as specified, with all components compatible to suit the intended use. The performance requirements and tolerance values shall be as set forth for vehicle scale in the Scale Code of National Bureau of Standards Handbook H-44 and shall be met in every respect. The scale manufacturer shall provide a Certificate of Conformance to the standards. The installation shall be completed and tested under the Contractor's direction to meet the approval of and to obtain the Seal of Certification from the State of Washington regarding automatic weight indicators.

F. The scale in its entirety (except for Data Management System) shall be manufacturer's standard design, without modification for this Project, and shall have been proven in similar installations and shall have NTEP (National Type Evaluation Program) certificate for scale and load cells.

G. Scale foundation and approach slabs shall comply with the requirements set forth for vehicle scales in the Scale Code of National Bureau of Standards Handbook H-44.

1.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified shall be present at the Job Site for 2 days for certification of the installation, startup assistance, and training of Owner's personnel. Travel time shall not be included in the 2 days at the Job Site.

1.04 SUBMITTALS

A. Action Submittals:

1. Manufacturer provided documentation pertaining to installation and standard setting, and foundation plans.
2. Complete detailed construction drawings for one new concrete platform commercial truck scale, scale foundations, list of conduit requirements between the scale and the existing Scale House, cabling to be provided between the scale and the existing Scale House, and manufacturer's brochures for the new scale and associated equipment to be furnished. Contractor must provide above Shop Drawings within 30 days of contract award and must be approved by the Engineer prior to starting scale foundation construction.
3. Complete schematic diagrams and Operating and Maintenance Manuals and Maintenance Summary Sheets for the equipment specified herein shall be furnished.

B. Informational Submittals:

1. Certificate of conformance with the Scale Code of National Bureau of Standards Handbook H-44.
2. Washington State Seal of Certification.

3. O&M Manuals.

1.05 WARRANTY

A. Guarantee in writing the operating performance of the adjusted scale and all related equipment and components for a period of 2 years upon certified completion of the entire Contract (but no sooner than Final Completion). In the event of any defect during this period attributable to workmanship under this Contract, make corrective repairs within 5 days of written notice by the Owner so specifying the nature of the defect.

**PART 2 PRODUCTS**

2.01 MANUFACTURER

A. Materials, equipment, components and accessories specified in this Section shall be products of Unitec, Tukwila, WA, telephone, 206/575-1100.

2.02 SCALE FOUNDATION

A. Low-profile aboveground foundation with 10-foot long approach slab at each end, in compliance with requirements of NBS Handbook H-44.

B. Concrete for scale foundation shall comply with requirements of Section 03 30 00, Cast-in-Place Concrete. Refer also to Drawings. Concrete for the scale deck is as specified by the scale manufacturer and shall be the minimums as specified herein.

## 2.03 COMMERCIAL TRUCK SCALE

A. General: Contractor shall coordinate with the scale manufacturer for products and materials that the scale manufacturer will provide preassembled, those that will be provided and require Contractor installation, and those that will be provided and installed by the Contractor. This includes, but is not limited to, the scale, all conduits, wires, cables, card reader system, and all other ancillaries to provide a complete, fully operational and automated scale system.

B. Concrete platform truck scale, electronic full load cell type, 80 feet long overall, in maximum of three sections and eight load cells by 10 feet wide with a 120,000-pound capacity and designed to support a 60,000-pound dual axle, with axles on 4-foot centers and offset to one side of the module, or worst case loading conditions. Under the specified load, the maximum deflection shall not exceed 1/500th of span and the bending stress in any member shall not exceed 20,000 psi. The deck design shall be for 120-psi minimum tire pressure. Provide scales as shown on Drawings. Details of scale deck and load cell support locations and depth shall be as required by the scale manufacturer.

C. Systems or components that require proprietary/sole source service or maintenance by the manufacturer, or their service division, are not acceptable.

D. The scale shall have the following minimum features and capacities:

1. Fully electronic in design and shall not incorporate any mechanical weighing elements, check rods, or check stays.
2. Designed to perform as single weighing platforms, of low-profile aboveground design. With side rails that are integral with the weighbridge.
3. Junction boxes shall be NEMA 4 rated.
4. Weighbridge, load cells, scale instrument, and associated accessories, shall be furnished by the same supplier to maximize compatibility and availability of components and design.
5. Platforms shall be constructed of steel framing with concrete slab surface and shall be designed and constructed to withstand sudden truck stops. Scale system shall be self-checking without check rods, and scale shall not use load cell as a checking device.
6. Load cells shall be approved by NTEP and meet the specifications as set forth by the National Institute of Standards and Technology

Handbook 44 for Class IIIL, 10,000d Devices. A Certificate of Conformance to these standards shall be provided by the Contractor.

7. The scale shall be fully electronic and be equipped with heavy-duty surge voltage protection for the electronic system, and be electrically grounded.
8. Provide T-Grip closure strips between edge of scale and scale pit walls.
9. Metal Parts: All metal parts shall be galvanized or epoxy coated for corrosion protection. The corrosion protection coating of all the steel members shall be prepared and painted in accordance with Section 09 90 00, Painting and Coating, requirements. The final color shall be selected by the Owner.
10. Electrical: All wiring and conduits shall be concealed and protected within the scale. All control wiring shall be installed in galvanized steel metal conduits and rated for wet underground conditions. The Contractor shall provide RFI (radio frequency interference) and EMI (electromagnetic interference) protection for weighing instrumentation. Junction boxes shall be mounted by each section, located in an accessible area for inspection and maintenance. The sectional junction boxes shall be rated NEMA 4 and the main junction boxes shall be rated for NEMA 12 suitable for push mounting. All electrical works including wiring, conduits, and panels shall meet the requirements of Division 26, Electrical.
11. Grounding System: Each structural panel shall have all metal parts bonded to one another. A ground rod shall be installed for each panel and bonded to structural steel of the panel. All ground rods shall be bonded together using compression lugs. Ground rods shall be copper, minimum 10 feet long, 3/4-inch in diameter. All grounding shall be in accordance with Article 250 of the National Electrical Code. Minimum ground conductor size shall be No. 1/0 copper. Ground rods shall be mounted near the access plates of each of the structural panels.
12. Environmental Condition: Scale system shall operate satisfactorily over the full range of weather conditions. The scale's structural members, load cells, and electrical wiring shall not be susceptible to the influence of the extraneous environmental conditions.
13. The deck surface shall be concrete to provide high-impact resistance, high-abrasion resistance, and low permeability from infiltration of water and road salts. Install the deck in accordance with the scale manufacturer's instructions.
    Deflection in the scale module length must not subject the concrete to tension forces and the associated deterioration. All concrete must be above the neutral axis of the structure when the scale structure is at maximum specified deflection.
14. Adjustable screw bearings will be located above each load support point to provide vertical adjustment of each module; shimming to elevation is not acceptable.

15. The scale shall be completely self-checking. No check rods shall be used. Scale shall not use the load cell as a checking device.

E. The load cell stands and load cell suspension components shall be designed for the Sensortronics, Model 65058-50K Double ended, center loaded, shear beam load cell. Load cell must be available from more than one supplier and must be interchangeable. Load cells shall be mounted no less than 12 inches above concrete pier and shall be mounted outside of the weighbridge for ease of maintenance.

2.04 SCALE INSTRUMENTATION AND

A. General: The new scale along with the card reader system hardware and software shall integrate seamlessly with the existing scale house's software system, including any hardware and/or software upgrades to the County's current system. Conduits, cables, conductors, etc. shall be furnished and installed to accommodate all necessary telecommunications and electrical systems between the existing scale house and the new commercial truck scale, including, but not limited to, the CCTV and the new card reader system (with intercom and ticket printer).

B. Scale instrument and associated equipment shall be supplied by the scale manufacturer.

C. The scale instrument shall have the following minimum features and capabilities:

1. NTEP approved and meet or exceed the specifications set forth by the National Bureau of Standards Handbook 44 for Class II, III, and IIIL Devices.
2. Housed in an enclosure which is suitable for desktop mounting.
3. RS-232 output for computer.
4. Variable baud rates and serial port parameters.
5. "On-Demand" function (PC prompts for weight when requested).
6. 10- to 15-foot cable with 26-pin "female" end to connect to PC/Easy-Share setup indicator.
7. Setup indicator with parameters per ISI spec sheet.
8. Lightning arrestor (SP7) package for scales.
9. Surge protection on R8-232 line between indicator and PC/Easy-Share.
10. Automatic zero function.

2.05 CARD READER SYSTEM

A. The card reader system shall be fully functional for inbound scaling of commercial garbage trucks and interfaced with the County's software system. The card reader system shall provide for a fully automated weighing operation whereby commercial garbage trucks are identified in the system (with tare

weights) by scanning a proximity (RFID) card. The card reader system shall be housed in a weather-proof enclosure and mounted on a kiosk or pedestal-type arrangement, as approved by the Engineer, with window access by the truck driver in seated position. The kiosk pedestal mount shall be embedded in the ground and concrete, plumb and stable, as approved by the Engineer.

B. The card reader system shall include a ticket printer that provides a receipt for the commercial garbage hauler's delivery weight and an intercom system. The ticket shall display the vehicle identification number, date and time, tare weight, delivery weight, and net weight. The card reader system shall include devices required to program reader cards, 50 programmable reader cards, and any required hardware and software upgrades to the County's system. The ticket printer shall be as provided along with the card reader system by the scale manufacturer. The ticket reader shall provide a print speed of three lines per second, bi-directional dot matrix, 40 characters per line at 12 CPI, and a printing width of 3.33 inches.

## PART 3 EXECUTION

### 3.01 INSTALLATION

A. General: The scale shall be installed by the Contractor in accordance with the scale manufacturer's instructions and approved Shop Drawings. Contractor shall cover painted surfaces with tape or other means during concrete placement to avoid damage to paint surface and to minimize touchup requirements.

B. A straight approach of half the scale deck length must be provided with the first 10 feet on both ends of the scale being a concrete apron (pad) level with the deck.

C. Site-Poured Deck: Refer to the scale manufacturer's instructions and coordinate with the scale manufacturer for products and materials that they will and will not be providing to the Contractor.

D. The scale modules shall be center-supported while pouring the deck.

E. The scale must be installed level, plumb and in a straight line with itself and the foundation.

F. The load cell stands, once leveled, must be grouted using a high quality, nonmetallic, non-shrinking-type grout as approved by the scale manufacturer.

G. The Contractor shall accomplish installation, calibration, and testing under the direction of the scale manufacturer.

H. Contractor shall have scale certified by the State of Washington.

I. Install card reader system for accessibility by driver in a seated position.

3.02 MANUFACTURER'S INSPECTION AND CERTIFICATION

A. Following installation by the Contractor and certification by the State of Washington, a manufacturer's representative shall inspect and certify that the scale has been installed in full compliance with the manufacturer's instructions. Furthermore, the manufacturer shall instruct the Owner's operators in proper operation of the equipment. A minimum of one of the 2 days the manufacturer's representative is onsite shall be dedicated to training of Owner's personnel.

3.03 TESTING

A. Preoperational Test Phase: Perform factory tests in accordance with manufacturer's requirements. Factory tests shall include factory testing of custom-programmed scale controller and testing of inputs for all County provided input fields.

B. Component Test Phase: Test scale controller, card reader system, and load cells for proper installation, and interface with the Owner's software system. Obtain State of Washington Certification of Scale following check-out of equipment and system. Arrange for registration of the scale in accordance with State of Washington requirements. Contractor shall pay all fees for registration.

3.04 SERVICE

A. In addition to the required warranty, the scale manufacturer shall provide complete service of the new scale for a period of 2 years in a manner that keeps the equipment in continuous and legal operation. This shall be accomplished at no additional cost to the Owner.

B. At a minimum provide two inspections and calibrations per year.

3.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials in manufacturer's original, unopened, undamaged containers.

B. Handle materials in such a manner as to prevent damage to products or finishes.

**END OF SECTION**

**SECTION 41 14 36.02**
**AXLE PIT SCALES**

## PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section covers the Work necessary to furnish and install, complete and ready for operation, the axle pit scales to be located in the lower level of the new waste transfer building.

B. Refer to other specification systems for power systems and other elements and features of the axle pit scales.

C. Performance Requirements:

1. The axle pit scales will be used to weigh a transfer trailer connected to the Owner's yard goat in the lower level loading space of the new waste transfer building. The scales must be set to allow flexibility for parking the trailer with up to 4 feet of movement in either direction and still provide axle alignment on the scales for accurate weighing. The scales shall be of the dimensions and sizes shown on Drawings. 10-foot wide scales will not be acceptable. The axle scales shall be connected to weight indicators on the tipping floor level that display three separate readings; front scale weight, rear scale weight, and total weight. The display shall also be the tare weight of the trailer and connected yard goat after it has pulled on the scale for an accurate display of refuse weight placed in the trailer. The scales shall also be connected to a ticket printer mounted in the lower level trailer loading space that provides triplicate receipt printing of the transaction.
2. Truck scale will be installed in concrete pits and coordinated with the concrete work for the lower level pit construction.

1.02 QUALITY ASSURANCE

A. Referenced Standards: This Section incorporates by reference the latest revisions of the following documents. They are part of this Section insofar as specified and modified herein. In case of conflict between the requirements of this section and the listed documents, the Contractor shall point out the conflict to the Project representative; lacking a definitive answer otherwise, the requirements of the contract specifications shall prevail.

| Reference | Title |
|---|---|
| NIST H-44 | National Institute of Standards and Technology Handbook H-44 Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices |

B. Factory Tests:

1. Custom-programming in digital scale controller. Provide documentation of custom-designed input screens.
2. Test assembled control panel. Provide test documentation.

C. Qualification of Scale Manufacturer: The manufacturer of the new scales shall have been in the business of design and manufacturing of similar type scales for at least 10 years, and have been represented in the State of Washington by a complete sales and service organization for the preceding 5 years. Local parts and service must be available on a 24-hour-day, 7-day-week basis. A service list of customers with similar type scales, covering at least the past 5 years, and a list of the servicemen with their experience record must be submitted to assure that adequate, skilled manpower is available at all times to provide timely scale repair service. The vendor that provides the axle pit scales shall be the same vendor that supplies the commercial truck scale.

D. Scales shall be built in accordance with standards of the American Society of State and Highway Officials and the Scale Manufacturers Association.

E. Performance: The scales, new and adjusted, shall perform automatically as specified, with all components compatible to suit intended use. The performance requirements and tolerance values shall be as set forth for vehicle scales in the Scale Code of National Bureau of Standards Handbook H-44 and shall be met in every respect. The scale manufacturer shall provide a Certificate of Conformance to the standards. The installation shall be completed and tested under the Contractor's direction to meet the approval of and to obtain the Seal of Certification from the State of Washington regarding automatic weight indicators.

F. The scale in its entirety (except for Data Management System) shall be manufacturer's standard design, without modification for this Project, and

shall have been proven in similar installations and shall have NTEP (National Type Evaluation Program) certificate for scale and load cells.

G. The scale pits shall comply with the requirements set forth for vehicle scales in the Scale Code of National Bureau of Standards Handbook H-44.

1.03 MANUFACTURER'S SERVICES

A. A manufacturer's representative for the equipment specified shall be present at the Job Site for 2 days for certification of the installation, startup assistance, and training of Owner's personnel. Travel time shall not be included in the 2 days at the Job Site.

1.04 SUBMITTALS

A. Actions Submittals:

1. Manufacturer provided documentation pertaining to installation and standard setting, and pit/foundation plans.
2. Complete detailed Shop Drawings for the two axle pit scales; list of conduit requirements between each of the scale pits and the wall-mounted remote displays and ticket printer unit; ticket printer unit, and installation requirements for the new scales and associated equipment to be furnished. Contractor must provide above Shop Drawings within 30 days of contract award and must be approved by the Engineer prior to starting scale foundation/pit construction.
3. Furnish complete schematic diagrams and Operating and Maintenance Manuals and Maintenance Summary Sheets for the equipment specified herein.

B. Informational Submittals:

1. Certificate of Conformance with the Scale Code of National Bureau of Standards Handbook H-44.
2. State of Washington Seal of Certification.
3. O&M Manuals.

1.05 WARRANTY

A. Guarantee in writing the operating performance of the calibrated scales and all related equipment and components for a period of 2 years upon certified completion of the entire Contract (but no sooner than Final Completion). In the event of any defect during this period attributable to workmanship under this Contract, make corrective repairs within 5 days of written notice by the Owner so specifying the nature of the defect.

## PART 2 PRODUCTS

2.01 MANUFACTURER

A. Materials, equipment, components and accessories specified in this Section shall be products of Unitec, Tukwila, WA, telephone, 206/575-1100.

2.02 SCALE PITS

A. Shallow-type scale pits in compliance with NBS Handbook 44.

B. Concrete for scale pits shall comply with requirements of Division 3, Concrete. Concrete for the scale decks are as specified by the scale manufacturer and shall be the minimums as specified herein.

2.03 AXLE PIT SCALES

A. General: Contractor shall coordinate with the scale manufacturer for products and materials that the scale manufacturer will provide preassembled, those that will be provided and require Contractor installation, and those that will be provided and installed by the Contractor. This includes, but is not limited to, the scale, all conduits, wires, cables, card reader system, and all other ancillaries to provide a complete, fully operational and automated scale system.

B. The axle pit scales shall be the electronic full load cell type with a concrete deck. Each axle scale shall be 20-ton capacity, 9 wide and length as shown on Drawings. Provide one set of scales where shown in the trailer bay of the new waste transfer building.

C. Systems or components that require proprietary/sole source service or maintenance by the manufacturer, or their service division, are not acceptable.

D. The axle pit scales shall have the following minimum features and capacities:

1. Fully electronic in design and shall not incorporate any mechanical weighing elements, check rods, or check stays.
2. Each scale to perform as a single weighing platform, of flat top design. Side rails are not acceptable.
3. Junction boxes shall be NEMA 4 rated.
4. Weighbridge, load cells, scale instrument, and associated accessories, shall be furnished by the same supplier to maximize compatibility and availability of components and design.
5. Platforms shall be constructed of steel framing with concrete slab surface and shall be designed and constructed to withstand sudden truck stops. Scale system shall be self-checking without check rods.

6. Provide full-length center access hatches for each scale to permit access for cleaning and maintenance in the pits as approved by the Engineer.
7. Load cells shall be approved by NTEP and meet the specifications as set forth by the National Bureau of Standards Handbook 44 for Class IIIL, 10,000d Devices. A Certificate of Conformance to these standards shall be provided by the Contractor.
8. Scales shall be fully electronic and be equipped with heavy-duty surge voltage protection for the electronic system, and be electrically grounded.
9. Load cells have full access from the top of the weighbridge for maintenance and replacement. Side access is not acceptable.
10. Exposed metal surfaces shall be painted with manufacturer's standard corrosion-resistant paint system.
11. Provide T-Grip closure strips between edge of scale and scale pit walls.
12. Metal Parts: All metal parts shall be galvanized or epoxy coated for corrosion protection. The corrosion protection coating of all the steel members shall be prepared and painted in accordance with Section 09 90 00, Painting and Coating, requirements. The final color shall be selected by the Owner.
13. Electrical: All wiring and conduits shall be concealed and protected within the scale. All control wiring shall be installed in galvanized steel metal conduits and rated for wet underground conditions. The Contractor shall provide RFI (radio frequency interference) and EMI (electromagnetic interference) protection for weighing instrumentation. Junction boxes shall be mounted by each section, located in an accessible area for inspection and maintenance. The sectional junction boxes shall be rated NEMA 4 and the main junction boxes shall be rated for NEMA 12 suitable for push mounting. All electrical works including wiring, conduits, and panels shall meet the requirements of Division 26, Electrical.
14. Grounding System: Each structural panel shall have all metal parts bonded to one another. A ground rod shall be installed for each panel and bonded to structural steel of the panel. All ground rods shall be bonded together using compression lugs. Ground rods shall be copper, minimum 10 feet long, 3/4-inch in diameter. All grounding shall be in accordance with Article 250 of the National Electrical Code. Minimum ground conductor size shall be No. 1/0 copper. Ground rods shall be mounted near the access plates of each of the structural panels. Manufacturer shall be Blackburn; or approved equal.
15. Environmental Condition: Scale system shall operate satisfactorily over the full range of weather conditions. The scale's structural members, load cells, and electrical wiring shall not be susceptible to the influence of the extraneous environmental conditions.
16. The deck surface shall be concrete to provide high-impact resistance, high-abrasion resistance, and low permeability from infiltration of water

and road salts. Install the decks in accordance with the scale manufacturer's instructions.

17. Deflection in the scale module length must not subject the concrete to tension forces and the associated deterioration. All concrete must be above the neutral axis of the structure when the scale structure is at maximum specified deflection
18. Adjustable screw bearings will be located above each load support point to provide vertical adjustment of each module; shimming to elevation is not acceptable.
19. The scale shall be completely self-checking. No check rods shall be used. Scale shall not use the load cell as a checking device.

E. The weighing elements of the scale shall have the following minimum features:

1. The load cell stands and suspension components shall be designed for the Sensortronics 65058-50K, double ended, center loaded, shear beam load cell, or approved equal. Each load cell shall have an adjacent foot jack to allow jacking of the scale for maintenance. The load cells shall be independently removable and easily accessible. The load cells shall be mounted a minimum of 12 inches above concrete pedestals and no less than 6 inches below the top of scale. The load cells shall be available for more than one manufacturer and shall be interchangeable without modification of the load cell suspension.
2. All load cells, junction boxes, and scale checking system must be accessible through removable covers held in position by stainless steel hardware.
3. Load cells shall be mounted to and securely supported on the foundation to prevent any movement of the cell.
4. The load cell capacity shall be 50,000 pounds each, and each cell must have a stainless steel braided covering in the load cell cable.
5. All load cells must be protected from corrosion by utilizing galvanic protection. Zinc or an approved equal is to be used as the sacrificial anode.
6. The design will permit the individual load cells to be electronically matched and the scale sections to be electronically calibrated.

## 2.04 SCALE INSTRUMENTATION

A. General: The axle pit scales along with the ticket printer (and the display boards) shall integrate seamlessly. Conduits shall be provided to provide provisions for future connection of the system with the scale house. Conduits, cables, conductors, etc. shall be furnished and installed to accommodate all necessary electrical systems and ancillaries.

B. Scale transmitter and remote displays, including associated equipment shall be supplied by the scale manufacturer.

C. The scale transmitter shall have the following minimum features and capabilities:

1. NTEP approved and meet or exceed the specifications set forth by the National Bureau of Standards Handbook 44 for Class II, III, and IIIL Devices.
2. Housed in stainless steel NEMA 4X wall mount enclosure.
3. Have subtotal and total weight accumulators.
4. Capable of being programmed and calibrated in pounds or tons.
5. Have standard communication port selectable for on demand or continuous communications. The communications port shall be configured to drive the remote indicator. The port shall be capable of receiving a remote print command via serial communication or hard wire input.
6. Scale instrument shall provide an output to drive three remote displays (two axle platform weights, and total). The instrument will be enclosed in a stainless steel wall-mount enclosure with a display of all three weights.
7. The scale transmitter shall be UL/CSA listed.
8. The scale transmitter shall operate on 120-volt, 15-amp, single-phase, 60-Hz power.
9. Provide data communications cable between transmitter and remote indicator.

## 2.05 REMOTE DISPLAYS

A. Provide three remote displays (scoreboards) located above the trailer load chute openings on the upper (tipping floor) level of the new waste transfer building with the following minimum features and capabilities:

1. Weather-resistant housing with U-bracket for mounting on wall that allows for a minimum 180-degree swivel.
2. Electromechanical display with 6-inch high, white numerals and contrasting background, minimum six digits.
3. Three scoreboards shall be provided as follows:
   a. Display axle 1 platform continuously.
   b. Display axle 2 platform continuously.
   c. Display total weight continuously.
4. 120-volt power.

2.06 TICKET PRINTER

A. Scale printer system shall be supplied by the scale manufacturer, providing triplicate copies of weight tickets inside the trailer bay. Coordinate with Owner for location.

B. As supplied by the scale manufacturer with the following minimum requirements:

1. Print Speed: Three lines per second.
2. Type: Bidirectional dot matrix.
3. Characters per Line: 40 characters at 12 CPI.
4. Printing Width: 3.33 inches.
5. Housed in an all-weather enclosure suitable for the space and as approved by the Engineer.

## PART 3 EXECUTION

3.01 INSTALLATION

A. General: Axle pit scales shall be installed by the Contractor in accordance with the scale manufacturer's instructions and approved Shop Drawings. The ticket printer shall be installed on the wall of the trailer bay. Install the remote displays above the push wall on the upper level at locations approved by the Engineer. The Contractor shall submit details for mounting of the scale instrument. Interconnecting cables shall be installed in conduits provided by the Contractor and be located outside of traffic and operations zones that could damage the cables.

B. Site-Poured Deck: Refer to the scale manufacturer's instructions and coordinate with the scale manufacturer for products and materials that they will and will not be providing to the Contractor.

C. The scale modules shall be center-supported while pouring the deck.

D. The scale must be installed level, plumb and in a straight line with itself and the foundation.

E. The load cell stands, once leveled, must be grouted using a high quality, nonmetallic, non-shrinking-type grout as approved by the scale manufacturer.

F. The Contractor shall accomplish installation, calibration, and testing under the direction of the scale manufacturer.

G. Contractor shall have scale certified by the State of Washington weights and measures.

3.02 MANUFACTURER'S INSPECTION AND CERTIFICATION

A. Following installation by the Contractor and certification by the State of Washington, a manufacturer's representative shall inspect and certify that the scale has been installed in full compliance with the manufacturer's instructions. Furthermore, the manufacturer shall instruct the Owner's operators in proper operation of the equipment. A minimum of one of the 2 days the manufacturer's representative is onsite shall be dedicated to training of Owner's personnel.

3.03 TESTING

A. Preoperational Test Phase: Perform factory tests in accordance with manufacturer's standards. Factory tests shall include factory testing of custom-programmed scale controller and testing of inputs for all County provided input fields.

B. Component Test Phase: Test scale controller, ticket printer, display boards, and load cells for proper installation, and interface with the Owner's software system. Obtain State of Washington Certification of Scale following check-out of equipment and system. Arrange for registration of the scale in accordance with State of Washington requirements. Contractor shall pay all fees for registration.

3.04 SERVICE

A. In addition to the required warranty, the scale manufacturer shall provide complete service of the new scales and readout equipment for a period of 2 years in a manner that keeps the equipment in continuous and legal operation. This shall be accomplished at no additional cost to the Owner.

B. At a minimum provide two inspections and calibrations per year.

3.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store materials in manufacturer's original, unopened, undamaged containers.

B. Handle materials in such a manner as to prevent damage to products or finishes.

**END OF SECTION**

**SECTION 44 42 56.04**
**CONTACT WATER LIFT STATION SUBMERSIBLE PUMPS AND ACCESSORIES**

## PART 1 GENERAL

### 1.01 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. ASTM International (ASTM):
   a. A48, Standard Specification for Gray Iron Castings.
   b. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
2. Hydraulic Institute Standards (HIS).
3. National Electrical Manufacturers Association (NEMA).
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code.
   b. 497, Recommended Practice for the Classification of Flammable Liquids, Gases or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.
5. Underwriters Laboratories Inc. (UL).

### 1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to ratings and nomenclature of Hydraulic Institute Standards.

### 1.03 SUBMITTALS

A. Action Submittals:

1. Make, model, weight, and horsepower of each equipment assembly.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction, including cable seal details.
3. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump, from shutoff to maximum capacity. Indicate separately head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
4. Power and control wiring diagrams, including terminals and numbers.
5. Factory-finish system.

B. Informational Submittals:

1. Special shipping, storage and protection, and handling instructions.
2. Manufacturer’s printed installation instructions.

3. Field Performance Test Reports and Log.
4. Suggested spare parts list to maintain equipment in service for period of 5 years. Include list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
5. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
6. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps: One complete set of special tools required to dismantle pumps.

## PART 2 PRODUCTS

2.01 GENERAL

A. Submersible, vertical shaft, centrifugal nonclog type, for pumping wastewater.

B. Pump and Electrical Driver: Meet requirements for class, group, and division location in accordance with NFPA 70.

C. All components of the lift station shall be appropriate for Class 1, Division 1 Group D hazardous areas.

D. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

A. Specific requirements are attached to this Section as Supplements.

B. No “or-equal” or substitute products will be considered.

2.03 COMPONENTS

A. Equipment consists of contact water pump station complete with the pumps and motors, pressure switches (floats), control cables, power cables, pump lifting cables, and complete control panel with dual operation control of the pumps and local alarm system (audible and visual beacon). Control logic shall alternate pump operation under normal conditions. High level conditions shall run both pumps simultaneously. Alarm shall trigger under high water level conditions. Refer to Drawings for level control.

B. Motor nameplate horsepower not to be exceeded at head-capacity point on pump curve.

C. Pump motor and sensor cables shall be suitable for submersible pump application and cable sizing shall conform to NFPA 70 specifications for pump motors. Cables shall be of sufficient length to reach junction boxes without strain or splicing.

D. Pump control panel and box shall be corrosion resistant material, NEMA 4X suitable for outdoor exposure. It shall be equipped with an alarm light and audible alarm for signaling high level in the pump station.

E. Float System for signaling pump on and off shall be mini-floats designed for small diameter sumps. The float system shall be UL listed. The cable shall be 18-2 SJOW/A and the float shall be polypropylene. The clamps shall be stainless steel.

2.04 FACTORY FINISHING

A. All metal surfaces coming into contact with leachate (contact water), other than stainless steel or brass, shall be protected by a factory-applied spray coating of acrylic dispersion zinc phosphate primer resin paint finish.

## PART 3 EXECUTION

3.01 INSTALLATION

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

B. Connect piping without imposing strain to flanges.

C. No portion of pumps shall bear directly on floor of sump.

D. When installed, pumps will be able to be removed or placed in the lift station with a dedicated lift chain and lift-out rail system. Pitless adaptors shall be provided so that the pumps can be placed or removed without entering the lift station.

3.02 FIELD QUALITY CONTROL

A. Functional Test: Conduct on each pump.

1. Test for continuous 2-hour period.
2. Test Report Requirements: In accordance with Hydraulic Institute Standards for submersible pump tests HIS 1.6 and 11.6.
3. Tests shall be conducted with clean water under simulated conditions. Clean water shall not be discharged to the lined pond except for a very short period for final performance testing, and as approved of Owner.

B. Performance Test: Conduct on each pump.

1. Perform under actual or approved simulated operating conditions. Throttle discharge valve to obtain pump data points on curve at 2/3, 1/3, and shut-off conditions.
2. The bulk of the test shall be done under simulated conditions with just a short period of actual test discharging into the lined pond, at the approval of the Owner.

3.03 SUPPLEMENT

A. The supplement listed below, following "End of Section," is part of this Specification.

1. Lift Station Grinder Pumps Data Sheet.

**END OF SECTION**

**LIFT STATION GRINDER PUMPS DATA SHEET**

Tag Numbers: LS-1, LS-2

Pump Name: Lift Station Grinder Pumps

Manufacturer and Model Number: (1) Contractor to Submit
(2)

**SERVICE CONDITIONS**

Liquid Pumped (Material and Percent): Transfer Station Contact Water

Pumping Temperature (Fahrenheit): Normal: 60 Max 75 Min 35

Specific Gravity at 60 Degrees F: 1.01

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

**PERFORMANCE REQUIREMENTS**

Capacity (US gpm): Rated: 20

Total Dynamic Head (Ft): Rated: 28

**DESIGN AND MATERIALS**

Design: Each pump shall be capable of pumping contact water derived from water contact with municipal solid waste (also referred to as leachate).

Major Components: Cast iron

Fasteners: 300 series stainless steel

Shaft: Type 416 stainless steel

Impellers: Type 440 stainless steel

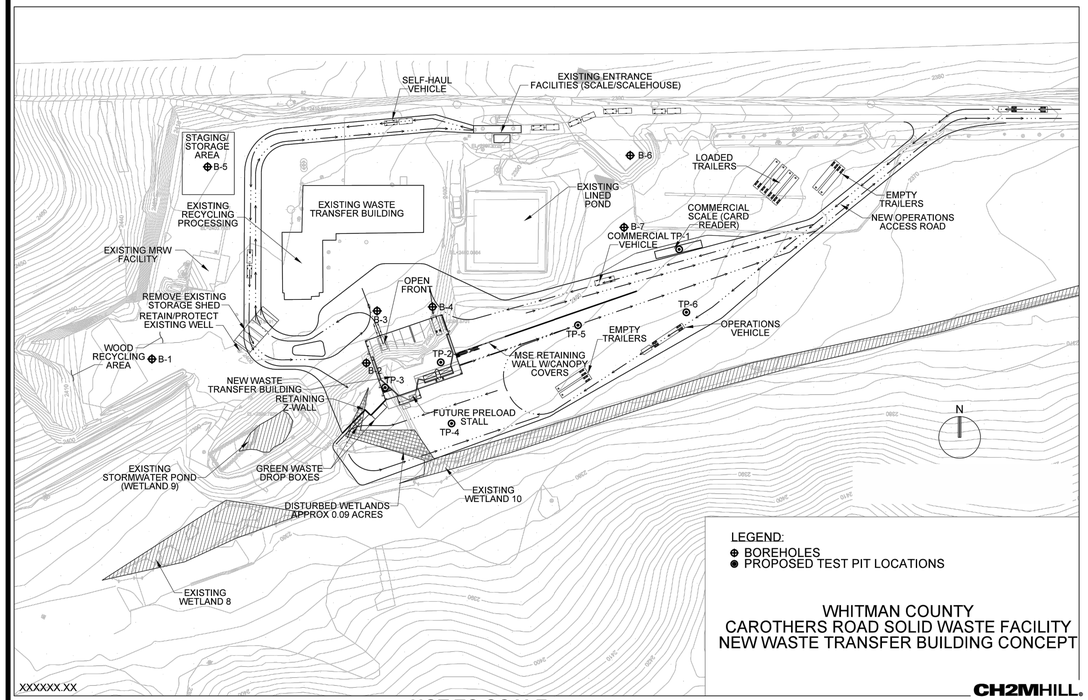
**DRIVE MOTOR**

Horsepower: 1.0 Voltage: 200 Phase: 3

CLASSIFICATION: Class I, Division 1 Group D Explosion Proof

# ATTACHMENT A - STRATA'S GEOTECHNICAL DESIGN DRAWING SHEETS

# PROPOSED WASTE TRANSFER FACILITY




NOT TO SCALE

# ④ IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL DELIVERABLE

**(Adapted from ASFE, The Geoprofessional Business Association)**

**Geotechnical Deliverable Use**

These documents are prepared for the proposed Whitman County Transfer station in Whitman County, Washington. These documents include STRATA's geotechnical design, soil engineering design characteristics, recommendations, and design criteria. The project team must read, understand, and implement the geotechnical recommendations in their entirety. Whitman County and the design team should regularly consult with and include the geotechnical consultant in design meetings to verify the intentions of our recommendations are fully understood and properly incorporated into final project design. Should design modifications, project concepts, or project locations change, we must be notified so that our recommendations can be re-evaluated and modified accordingly.

These geotechnical deliverables are intended for use only by Whitman County, project owner, and their retained design consultants, and are valid only for the project type, description, and location as presented in the *Project Understanding.* If the project concept changes from our understanding, we must be notified.

**Geologic Impacts**

Unknown or unanticipated subsurface conditions are a principal cause of construction delays, cost overruns and disputes. The following information is provided to help you manage your risk associated with subsurface conditions.

**STRATA's Services Are Performed for Your Specific Project**

STRATA structures our services to meet your and the project's specific needs. For example, a geotechnical engineering evaluation conducted for a civil engineer or architect may not fulfill the needs of a construction contractor or even another civil engineer or architect. Because each geotechnical engineering evaluation is unique, each geotechnical engineering deliverable is unique, prepared solely for you, the client. No one except you and your designated team should rely on STRATA's geotechnical engineering deliverable without first conferring with the geotechnical engineer who prepared it. And no one - not even you - should apply the deliverable for any purpose or project except for the one for which it has been prepared.

**Read the Full Deliverable**

Serious problems have occurred because those relying on geotechnical engineering deliverables did not read it all. Do not rely on an executive summary or cursory review. Do not read selected elements only and do not detach exploration logs from the remainder of the document.

**STRATA's Deliverables are Based on a Unique Set of Project-Specific Factors**

STRATA considers a number of unique, project-specific factors when establishing the scope of our geotechnical services. Typical factors include: your goals, objectives and risk management preferences; the general nature of the structure involved, its size and configuration; the location of the structure on the site; and other planned or existing site improvements such as access roads, parking lots and underground utilities. We also consider various material or construction efficiencies, LEED, and/or recyclable material initiatives. Unless STRATA specifically indicates otherwise, do not rely on a geotechnical engineering deliverable that was:

- Not prepared for you,
- Not prepared for your project,
- Not prepared for the specific site explored, or completed before important project design changes were made.

Typical changes that can reduce the reliability of an existing geotechnical engineering deliverable include those that affect:

- The function of the proposed structure(s).
- Elevation, configuration, location, orientation, loading, or weight of the proposed structure.
- Composition of the design team or project ownership.
- Site grades and drainage features.
- Other factors that have the potential to impact our analysis or recommendations.

As a general rule, *always* inform STRATA of project changes - even minor ones - and request an assessment of their impact. Therefore, if our *Project Understanding*, as outlined in these documents, is not correct, please notify STRATA immediately. *STRATA cannot accept responsibility or liability for problems that occur because our documents do not consider developments of which we were not informed.*

**Subsurface Conditions Can Change**

Site exploration identifies only a small portion of the site's subsurface conditions and subsurface conditions can change significantly between exploration locations. STRATA reviews field and laboratory data and then applies our professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ - sometimes significantly - from those identified in our document. Retaining STRATA to provide construction observation is the most effective method of managing the risks associated with unanticipated or changed site conditions.

STRATA's geotechnical engineering evaluation is based on specific surface and subsurface conditions that existed at the time the study was performed, and applied specifically to the proposed construction. *Do not rely on a geotechnical engineering deliverable* whose adequacy may have been affected by: man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, changes in soil moisture or groundwater fluctuations. *Always* contact STRATA before applying the geotechnical documents to determine if they are still reliable. Additional consultation, testing or analysis could prevent major problems.

**STRATA's Deliverables can be Subject to Misinterpretation**

Other design team members' misinterpretation of STRATA's deliverables may result in costly problems. You can lower that risk by having STRATA confer with appropriate members of the design team during the entire design process. Also, retain STRATA to review pertinent elements of the design team's plans and specification. Contractors can also misinterpret a geotechnical engineering deliverable. Again, this risk can be reduced by having STRATA participate in pre-bid, pre-construction and pre-installation conferences and by providing construction observation.

**Geotechnical Recommendations are not Final**

Do not over-rely on the construction recommendations included in STRATA's deliverables. *Those recommendations are not final,* because STRATA engineers develop them principally from judgment and opinion. Construction continuity is a requirement and critical element of the geotechnical design process. STRATA can confirm our recommendations only by observing actual subsurface conditions revealed during construction. If a firm or individual other than STRATA is retained to observe, test, or interpret actual field conditions, they must assume the role of geotechnical engineer-of-record. It is your responsibility to notify this entity of their role and responsibility. *STRATA cannot assume responsibility or liability for our document's recommendations if STRATA does not perform construction observation.*

**Do Not Redraw STRATA's Logs**

STRATA prepares final exploration logs based upon our interpretation of soil profiles described during exploration and laboratory data. To prevent errors or omissions, the logs included in our deliverable should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the final deliverable can elevate risk of misinterpreting our geotechnical recommendations.*

**Give Contractors a Complete Deliverable and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering deliverable, but preface it with a clearly written transmittal letter. In that letter, advise contractors that the document was not prepared for purposes of bid development and that the document's accuracy is limited; encourage them to confer with STRATA and/or to conduct additional study to obtain the specific types of information they need or prefer. Pre-bid or specific pre-installation conferences can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the responsibilities stemming from unanticipated conditions.

**Read Responsibility Provisions Closely**

Some clients, design professionals and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims and disputes. To help reduce the risk of such outcomes, STRATA includes a "Limitations" section herein to indicate where STRATA's responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions.* Ask questions. STRATA will respond fully and frankly.

**STRATA is a member of ASFE. Rely on STRATA for Additional Assistance**

Membership in ASFE, The Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. The above information is based upon an ASFE document and has been modified with their permission to meet STRATA's and this deliverable's intent. Confer with STRATA for more information.

**ISSUED FOR**
- ☒ DESIGN USE
- ☐ PRELIMINARY REVIEW
- ☒ YOUR APPROVAL
- ☒ REFERENCE
- ☒ CONSTRUCTION
- ☒ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |
| | | |

DRAWN: DMS

DESIGN: BN

CHECK: TW

ORIGINATION DATE: 7/23/2012

FILE: WHICOU PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
MR. MARK STOREY P.E.
PUBLIC WORKS DIRECTOR
WHITMAN COUNTY
310 NORTH MAIN STREET
COLFAX, WASHINGTON 99111

Attn: marks@co.whitman.wa.us

ENGINEER STAMP

TRAVIS J. WAMBECK
STATE OF WASHINGTON
24396
REGISTERED
PROFESSIONAL ENGINEER
8/29/2012

STRATA
A PROFESSIONAL SERVICES CORPORATION
Integrity From the Ground Up

# ① PROJECT UNDERSTANDING

**General**

Whitman County will construct a second transfer structure on a portion of property adjacent the existing transfer building and recycling center. This second structure will allow Whitman County residents and regional waste handlers to dispose of additional waste which will eventually be transferred to permanent disposal locations contracted by the County. This facility is expected to be constructed in 2013. CH2MHill is providing civil, programming, and structural design for the project. Because the County has access to excavation equipment for exploration and the County's site familiarity and access to aggregate materials, some preliminary earthwork and grading will be performed by County staff in 2012.

**Existing Conditions**

The proposed waste transfer building site is underlain by thick fill deposits which form a level bench varying from 10 to 20 feet in height. This bench was constructed to park equipment and store materials to support the landfill. From exploration the fill is primarily silt and clay mixed with moderate to significant organics and varying amounts of sand, gravel, concrete, masonry, asphalt and other inert construction debris mixed into the matrix. The fill slope down to the natural draw exposes a variety of these materials. Most of this fill was placed 10 to 20 years ago over a low lying agricultural area. The natural soil in this area varies from soft silt and clay loess to remobilized loess deposited as alluvium during flooding from the adjacent Spring Flat Creek. In essence, the subgrade is anticipated to be relatively soft and wet.

The site has sparse to moderate vegetation primarily consisting of localized weeds, except around the perimeter where agriculture activities continue to grow wheat and legumes annually. An existing, unlined stormwater pond is just west of the planned building with a lined pond to the east for the existing transfer structure to handle effluent. Wetlands exist south and east, adjacent the fill slope toe.

**Proposed Construction**

The transfer structure will be 2 levels; main tipping floor and lower load out. From our interaction with you and CH2MHill and from reviewing preliminary site and structural plans, we understand facility users will enter on the top side of the facility at or near the existing bench elevation (approximate elevation 2398) and will deposit waste on a thick, reinforced concrete tipping floor. The tipping floor will be the main level; enclosed on 3 sides with a pre-engineered, metal building. The waste will be accumulated with front end loaders and deposited into a loading chute near the facility's center and finally into highway legal vans staged on the lower load out level which will transport the waste to its ultimate disposal point. At the lower level load out floor, axle scales will be constructed in a shallow pit which allow a crane operator to view the load weight during loading. The current project grading plan requires 3- to 20-foot cuts and fills to achieve the transfer station's tiered site grades. A 18 to 20-foot tall "z" wall and a tapering 20 to 2-foot high MSE wall will create exterior grade transitions along the west and east sides, respectively. Each will have a consistent base/foundation elevation. Just east of the MSE wall, a remote scale will be installed.

The structure itself will have an approximate 10,000- to 12,000-square-foot footprint. The lower load out level will be below grade and comprised of thick, reinforced concrete walls and foundations on 3 sides. Structural loads are estimated by the building manufacturer at 150 kips per column and 5 kips per lineal foot along continuous footings. A crane will be situated atop the load out wall creating point loads along the retaining system. The foundation system is planned to utilize conventional spread and continuous footings bearing on granular soil improvements after the site has been preloaded for 10 to 12 months.

A small wood recycling collection facility may eventually be constructed in the sites southwest corner to collect and transfer wood waste from local residents. A recycling drop off facility will be located just east of the scale house and will have 2 shallow unload platform founded on a short cast in place retaining wall, or a segmental retaining wall, in the sites northwest corner, an eventual maintenance shed may be constructed.

There are no offices or other finished spaces associated with the transfer station. Because floor coverings are not planned, vapor retarders will not be used. However, a restroom and safety shower will be provided at the tipping floor. Water for this facility will be plumbed from existing lines from other facilities in the area. The County is considering future asphalt pavement to provide the travel surface from Carothers Road to the facility. Eventual asphalt must support a variety of waste handling vehicles including typical residential pickups (GVW typically 6,000) up to large, loaded semis (GVW 80,000). CH2MHill is performing pavement design for Whitman County. Minor electrical and possibly water utilities will be extended from the nearest locations adjacent the shop. CH2MHill's civil design will route stormwater to existing channels and towards swales and detention basins that already exist. Collected effluent will be routed to an existing, lined settling pond. No new stormwater improvements are expected for this project.

# ② REFERENCES

Our field investigation and laboratory testing are based upon our proposed geotechnical scope dated May 2, 2012 and subsequent engineering analyses based on the preliminary drawings and concepts presented by the project team; CH2MHill and Whitman County and finally; the latest version of the following *ASTM International* (ASTM) standards:

**Field Exploration**

- D420 Guide to site characterization for engineering, design, and construction
- D1452 Practice for soil investigation and sampling by auger boring
- D1586 Test method for penetration test and split-barrel sampling of soil
- D2487 Test method for classification of soils for engineering purposes (USCS)
- D2488 Practice for description & identification of soil (Visual-manual procedure)

**Laboratory Investigation**

- D422 Test method for particle-size analysis of soil
- D1140 Test method for amount of materials in soil finer than No. 200 (75 micron)
- D1557 Test method for laboratory compaction characteristics of soil, modified method
- D1883 Test method for CBR (California Bearing Ratio) of laboratory compacted soil
- D2216 Test method for laboratory determination of water content of soil and rock
- D2435 Test method for one-dimensional consolidation properties of soil (A+B)
- D4318 Test method for liquid limit, plastic limit and plasticity index of soils
- D2166 Test method for unconfined compression testing for soils

Construction Guidelines

Washington Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Highway Construction (standard).

# ③ GEOTECHNICAL DESIGN BASIS

**General**

- Conceptual site plans provided by CH2MHill dated May 10, 2012
- International Building Code, 2009
  - IBC section 16.1507
- STRATA's field exploration, reference sheets G5 through G7
  - Test pits performed on June 19, 2012
  - Boings performed on May 4, 2012
- STRATA's laboratory testing, reference sheet G7
- Foundation frost depth - 30 inches
- Structural loads per Varco Prudent Buildings dated ***July 29, 2012***
  - Maximum isolated total column loads: 150 kips
  - Maximum conventional strip footing loads: 5 klf
- Displacement tolerances reported by CH2MHill
  - Maximum settlement: 1.2 inches total, ¾-inch differential (30-ft span)
- Bearing capacity failure, factor of safety (FOS) = 3 or greater
- Settlement estimates are unfactored

# ⑤ EVALUATION LIMITATIONS

**General**

Our deliverables are prepared to assist the planning, design and construction for the proposed Transfer Station located in Whitman County, Washington. Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices, as they exist at the time and in the area of this report. The geotechnical recommendations provided herein are based on the premise that an adequate program of tests and observations will be conducted by STRATA during construction in order to verify compliance with our recommendations and to confirm conditions between exploration locations. This acknowledgement is in lieu of all express or implied warranties.

**Geoenvironmental Concerns Are not Covered**

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, geotechnical engineering documents do not relate geoenvironmental findings, opinions or recommendations: e.g. the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask STRATA for risk management guidance. Finally, do not rely on an environmental report prepared for someone else.

# ⑥ ADDITIONAL RECOMMENDED SERVICE

**Geotechnical Design Continuity**

We base the information contained in this report on static loading conditions, structural loads provided by the building manufacturer and site development plans provided by the project team. The final floor elevations, floor and footing configurations, loading conditions as well as site geometry can significantly alter our opinions and design recommendations. Specifically, changes in structural design loads and the site geometry may require additional analyses specific to the actual anticipated construction conditions. Therefore, it is critical STRATA provide geotechnical continuity through final planning and design for the planned construction as individual aspects become available during design phases. Specifically, we recommend that Whitman County retain STRATA to review geotechnical-related sections of the project plans and specifications to verify the plans and specifications are commensurate with our geotechnical recommendations. It has been our experience that having consultants from the design team review the construction documents prior to bidding helps reduce the potential for errors, and also reduces costly changes to the contract during construction. We also recommend STRATA, in support of the County's construction personnel, be retained on Whitman County's behalf to be on site during earthwork, mass grading, preloading and reviewing preload measurements, foundation and slab subgrade preparations to verify the conditions encountered during exploration are encountered during construction.

Verifying the subsurface conditions during construction is an important part of the geotechnical design process. If we are not provided such opportunities, we cannot be responsible for soil-related design or construction related errors, omissions, delays or increased costs that are identified during construction. If a firm other than STRATA is selected to observe and interpret the subsurface conditions during construction, they will become the geotechnical engineer of record; we request that Whitman County notify the selected firm of these responsibilities and require the firm to interpret and implement our report for the project. This can be accomplished by requiring the selected material testing firm to issue to Whitman County a statement that they understand and agree with the geotechnical report used for design and that they agree to implement it in its entirety as the geotechnical engineer-of-record. We recognize that Whitman County has qualified staff to perform material testing and inspection of various construction related processes and that STRATA's role may be limited to engineering observations and verifications which we consider to meet the intent of the standard of geotechnical care at this time and in the area.

# ⑦ EARTHWORK

**7 - EARTHWORK**

**Site Stripping**

1. Topsoil containing vegetation and organics must be removed from proposed building, wood recycling facility, surcharge, pavement, and parking areas and stockpiled for use as landscaping or removed from the area.
2. Extend stripping laterally to the extents shown in the Surcharge Section 9 to accommodate the aerial extents of the preload embankment.
3. We anticipate the surface-stripping depth will range from approximately 12 to 18 inches below the existing ground surface.
4. Isolated thicker topsoil or landscaping material deposits are possible and must be removed during site stripping operations.
5. Whitman County reportedly has a stockpile or disposal area delineated for excess strippings. Contractor shall confirm prior to bidding.
6. As part of the site stripping process, relocate the exploratory test pit location. If they are within the building foot print, they must be excavated and the spoils replaced with granular structural fill.

**Uncontrolled Fill Removal**

1. Remove all uncontrolled fill to firm native soil, wherever it is encountered within the building footprint, and surcharge area, and maintain exposed native soil in an undisturbed condition.
2. Achieve final excavation levels with smooth blade equipment or moisture condition and recompact to at least 90 percent of ASTM D 1557, (Modified Proctor).
3. Allow exposed native soil to aerate and dry for a minimum of 3 to 5 days.
4. Uncontrolled fill is not suitable for reuse and must be removed from the site and properly disposed.

**Subgrading**

1. Once fill and topsoil is removed and the exposed native soil has aerated and dried for 3 to 5 days, achieve final foundation subgrade elevations in the lower load out area and for retaining walls.
2. All lower load out level and retaining wall foundations must be laid out with detail and accuracy to ensure that soil improvements are properly positioned below foundations which will be constructed nearly a year later. The lateral extents of foundation soil improvements are delineated in the Foundation Section on Sheet G-3.
3. Over-excavate the native soil to the foundation subgrade level including soil improvement vertical and lateral dimensions.
4. Perform over-excavations with smooth blade equipment to ensure an undisturbed condition. Native soil with a pocket penetration measurement of at least 2 tons per square foot is acceptable. If the subgrade does not exhibit this consistency, allow further aeration and drying, attempting compaction per table 2a) directed by the county.
5. Place geogrid continuously across the undisturbed native subgrade. Geogrid shall be draped into the foundation soil improvements simultaneously. Reference geogrid material requirements and placement in Section 8, Geosynthetics.
6. STRATA shall review all site preparations, geosynthetics materials, and over-excavations prior to granular structural fill placement.
7. Given the site conditions and expected substrate during earthwork, accomplish work at or near final subgrade using equipment that imparts low bearing pressures, track-mounted, drum and low tire pressure equipment. Using high bearing pressure equipment such as dump trucks and scrapers can readily pump and rut the subgrade and their application should be carefully considered.
8. Final building subgrades in the upper level (tipping floor) and soil improvements exposed in the lower load out and retaining wall areas will be granular structural fill compacted to the requirements presented herein. Upon excavation for foundation forms, recompact the exposed granular surface to 95 percent of Modified Proctor.
9. If soft soil is encountered which does not meet the geotechnical criteria herein; it must be over-excavated.
10. Soft soil over-excavation criteria shall be determined during construction with STRATA, the contractor, and the County, but is anticipated to extend at least 1.5 to 2 feet below the subgrade.
11. After achieving subgrade, the contractor must take precautions to protect the subgrade from becoming disturbed or saturated. The contractor must limit construction traffic to any prepared subgrades and reduce the subgrades' exposure to precipitation and water.

**Excavation Characteristics**

1. Site soil is expected to be excavatable using conventional excavation techniques and equipment.
2. Bedrock is not expected within the planned vertical construction limits (10 to 20 feet).
3. Temporarily excavate, slope, shore or brace excavations in accordance with *Washington Industrial Safety and Health Act* (WISHA) and *Washington Administrative Code* (WAC) guidelines. Regulations outlined in WAC Section 296-155 provide temporary construction slope requirements for various soil types and slopes less than 20 feet tall.
4. Uncontrolled fill is classified as *Type C* soil referencing WAC Section 296-155, and must be temporarily sloped back at least 1.5H:1V. Native clay loess in a firm, undisturbed and dry condition will classify as a *Type B* soil and can be sloped at 1H:1V.
5. Construction vibrations, seepage, or surface loading can cause excavations to slough or cave and should be avoided.
6. Ultimately, the contractor is solely responsible for site safety and excavation configurations and maintaining WISHA approved personnel for excavation monitoring.
7. Plan excavations carefully, allowing water collection points and utilizing conventional sumps and pumps to remove nuisance water from runoff, seeps, springs or precipitation.
8. Coordinate construction activities and excavation backfilling as rapidly as possible following excavation to reduce the potential for subgrades to degrade under construction traffic.
9. Subgrades must be graded to aggressively direct surface water away from subgrades to avoid infiltration.
10. Maintain dewatering systems to facilitate good drainage during construction and reduced over-excavation.

**Wet Weather/Soil Construction**

1. Ideally, perform earthwork construction during dry weather conditions.
2. The site soil is susceptible to pumping or rutting from heavy loads such as rubber-tired equipment or vehicles any time of the year.
3. Complete earthwork by track-mounted equipment that reduces vehicular pressure applied to the soil if construction commences in wet areas or before soil can dry.
4. Depending on precipitation, runoff and perched groundwater conditions, the site soil will be over optimum moisture content. Contractor shall expect these conditions and be prepared to install runoff management facilities and to replace wet or disturbed soil with granular structural fill.

# ⑧ GEOSYNTHETICS

**8 - GEOSYNTHETICS**

1. Geosynthetic fabrics are applicable when constructing on soft or wet soil, for soil improvement applications, or any area where coarse fill must be separated from the fine-grained subgrade.
2. Where required for foundation support, at the surcharge subgrade, to aid construction or increase long-term performance, apply geosynthetics directly on approved subgrades, taut, free of wrinkles and over-lapped at least 12 inches.
3. Consult STRATA to review geosynthetic applications or other subgrade improvement alternatives.
4. We recommend woven geosynthetic fabrics conform to *Section 9-33 - Construction Geosynthetic* and specifically meet or exceed the properties presented in *Table 3, Section 9-33.2(1) - Geotextile Properties* from (WSDOT Standards*)*.
5. Geogrid is required at the surcharge embankment subgrade and extending laterally at least 20 feet from the building edges. Geogrid is also required at the planned retaining wall's soil improvements. These walls protrude from the building.
6. Geogrid shall consist of extruded, polypropylene, biaxial or triaxial geogrid with the following minimum properties:
   - 1,300 pounds per foot ultimate tensile strength (ASTM D 6637-01)
   - 93 percent junction efficiency (GRI-GG2-05)
   - 750,000 mg-cm flexural stiffness (ASTM D 5732-01)

# ⑨ SURCHARGE EMBANKMENT

**Surcharge Process**

1. Once topsoil stripping is complete, uncontrolled fill removed, lower level and retaining wall foundation soil improvements have been excavated, place geogrid on undisturbed or recompacted, native subgrades according to Section 8. Reference Figures 1 - 3. Extend geogrid 30' beyond building perimeters and below wall surcharges. Place 4 - 6 inches of crushed surfacing over geogrid prior to placing shotrock.
2. After the geogrid and the subgrade have been reviewed and approved by Whitman County and STRATA, place foundation drains and apply granular structural fill to the lines and grades shown below in Figures 2 and 3. Foundation drains must daylight during surcharging.
3. During initial embankment construction, construct 3 settlement monitoring plates in close proximity to the locations shown in Figure 3. Construct settlement plates according to Figure 4.
4. Place and compact granular structural fill according to the requirements in Section 10.
5. Fill placement shall meet granular structural fill requirements to elevation 2398. By placing fill to structural requirements to this elevation, increased unit weight is achieved for surcharge and compaction effort at the time of foundation forming will be reduced. Remaining fill to final surcharge elevations may be placed and track walked.
6. It may be desirable to place 12 inches of crushed surfacing at the actual foundation and slab bearing surfaces, thus making preparations easier for the contractor and increasing consistency along the bearing surface. Should the County and project team desire to have this surface prepared, accurate and timely surveying is required during initial surcharge embankment construction.

**FIGURE 1: Section B - B**

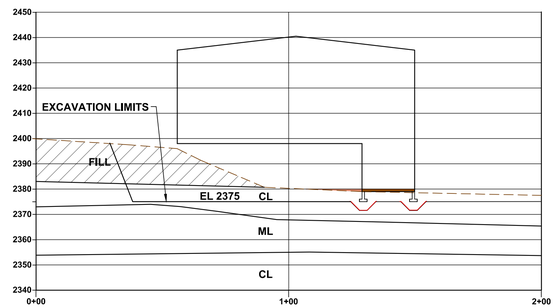
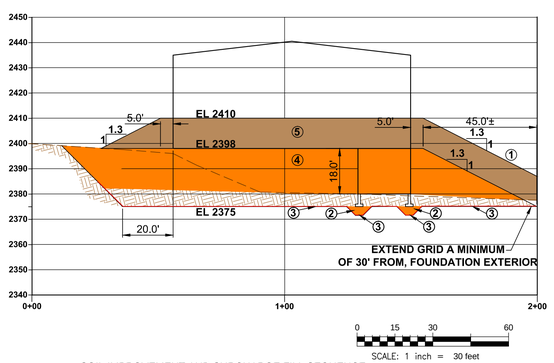



**FIGURE 2: Section B - B Showing Surcharge**




SOIL IMPROVEMENT AND SURCHARGE FILL SEQUENCE

① EXCAVATE BENEATH BUILDING TO 2375 ±

② EXCAVATE SOIL IMPROVEMENT TRENCHES 3 FEET DEEP BENEATH LOWER LEVEL FOOTINGS

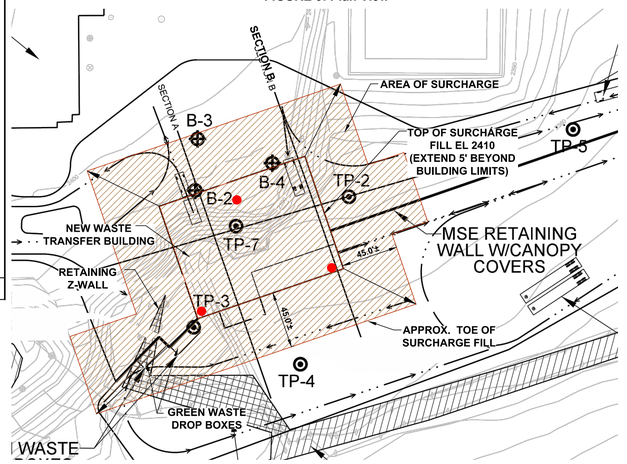
③ PLACE GEOGRID & GRANULAR STRUCTURAL FILL IN SOIL IMPROVEMENTS TRENCHES AND CONTINUOUSLY ACROSS SURCHARGE SUBGRADE.

④ PLACE GRANULAR STRUCTURAL FILL TO EL. 2398

⑤ PLACE SURCHARGE EMBANKMENT TO EL. 2410

# ⑨ SURCHARGE EMBANKMENT

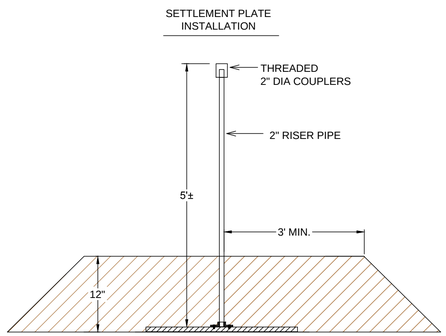
**FIGURE 3: Plan View**




SETTLEMENT MONITORING PLATE LOCATIONS

**FIGURE 4: Settlement Plate**




1. PLACE DIRECTLY ON UNDISTURBED NATIVE SOIL 12 - INCHES BELOW SUBGRADE
2. SEAT PLATE WITH 12 - INCHES CRUSHED SURFACING
3. IN SEATING THE PLATE, THE CRUSHED SURFACING SHALL BE COMPACTED WITH HAND OPERATED VIBRATORY COMPACTION EQUIPMENT.
4. BACKFILL AROUND RISER CAREFULLY TO FINISH GRADE. MAINTAIN VERTICAL POSITION OF RISER.
5. PLACE CAP ON TOP PIPE SEGMENT TO PREVENT DEBRIS ENTERING RISER.

# ⑩ STRUCTURAL FILL

**Structural Fill**

1. Structural fill is required for pre-loading the site, to achieve site grades and to help support foundations, concrete slabs-on-grade and pavement sections.
2. Our opinion is that site soil should not be relied on for reuse as structural fill in the building footprint or 20 feet laterally.
3. Our recommended material requirements for structural fill reference the latest (WSDOT Standards).
4. Project structural fill products are described in Table 1 below.

**TABLE 1: Structural Fill Specifications and Allowable Use**

| Soil Fill Product | Allowable Use | Material Specifications |
|---|---|---|
| **General Structural Fill** (Site grading) | All site grading and fill placement at least 20-feet outside the building, wood recycling facility, access drive, and parking areas | • Soil must be classified as GP, GM, GW, SP, SM, SW, MI or CL according to the USCS.<br>• Soil consisting of inert earth materials with less than 3 percent organics or other deleterious substances (wood, metal, plastic, waste, etc).<br>• Soil with particles less than 12 inches in diameter. |
| **Granular Structural Fill** (Building or structural areas) | Construction entrances, soil improvements, surcharge embankment, over-excavations, general structural fill 12 or more inches below finish floor | • Soil meeting General Structural Fill requirements.<br>• Well graded mixture of sand, cobbles and boulders with less than 5% passing the number 200 sieve.<br>• Creates a dense and interlocking matrix with a minimum in place unit weight of 130 pounds per cubic foot (pcf).<br>• Shotrock is an acceptable material when it meets these criteria. |
| **Crushed Surfacing** (Soil Improvements, Pavement/slab aggregate) | Asphalt and concrete support aggregate, final 12 inches of soil improvements at bearing grades, general structural fill, over-excavations | • Soil meeting General and Granular Structural Fill requirements.<br>• Soil meeting *Section 9-03.9(3) – Crushed Surfacing* of WSDOT Standards[1]. |
| **Pipe Bedding** | Utility trench pipe bedding | • Soil meeting requirements stated in *Section 9-03.12(3) – Gravel Backfill for Pipe Zone Bedding* of WSDOT Standards[1]. |
| **Unsatisfactory Soil** | No structural applications; landscaping per landscape engineer | • Soil classified as CL, ML, CH, MH, OH, OL or PT may not be used at the project site for structural fill.<br>• Soil not maintaining moisture contents within 3 percent of optimum.<br>• Any soil containing more than 3 percent organics by weight or other deleterious substances (wood, metal, plastic, waste, etc) is unsatisfactory soil. |

1. WSDOT Standard Specification for Road, Bridge and Municipal Construction, 2010 (WSDOT Standards)

**Compaction**

Backfill to support any structure, embankment or improvement must be compacted to structural fill requirements presented in Table 2 below.

**TABLE 2: Required Compaction Products for Designated Project Areas**

| Project Area | Required Structural Fill Product | Compaction Requirement[1] |
|---|---|---|
| Structural Subgrades | Native Soil | Undisturbed (>2 tsf) or 90% |
| Within 20 feet of building structural or pavement footprints, surcharge embankment, and all finished subgrades | General, Granular, and Crushed Surfacing Structural Fill | 95% |
| Utility Trench Backfill Below Pavements, Slabs, and Buildings | Utility Trench Fill | 95% |
| All Other Fills (more than 20 feet outside the building or deeper than 2 feet below finished surfaces) | General Structural Fill | 92% |
| Landscape Areas Sloped Flatter than 5H:1V | General Structural Fill | 88% |

1. Relative compaction requirement compared to the maximum dry density of the soil as determined by ASTM D 1557 (Modifi Proctor).

1. Fill placed in excess of 20 feet outside any building, retaining wall or pavement envelope can be placed as non-structural fill (i.e. landscape fill) providing there are no structures (sidewalk, curbs, utilities, signs, etc.) or embankment planned directly above the landscape fill. Landscape fill compaction requirements also apply to stem- and retaining wall backfill that do not support overlying structures such as asphalt, slabs or other improvements free of no structures.
2. Structural fill products must be moisture conditioned to near optimum moisture content.
3. Compact structural fill 12 to 16-inch-thick, loose lifts providing compaction equipment weighs a minimum of 10 tons. If smaller or lighter compaction equipment is provided, reduce the lift thickness to meet the compaction requirements presented herein. Small compaction equipment is not suitable for compacting shotrock.
4. The site soil is expected to be suitable for reuse as general structural fill at least 20 feet outside building areas providing it can meet the criteria presented in Table 1 above.

**Coarse Fill (Shotrock)**

1. Any material with greater than 30 percent retained above the ¾-inch sieve is too coarse for Proctor density testing, but may be used as General or Granular Structural Fill. Coarse fill must be compacted using a "method specification" developed during construction that is based on the material characteristics and the contractor's means and methods.
2. Method specifications will be developed during construction, specific to the materials, compaction equipment and conditions encountered.
3. At a minimum, place all oversize material in maximum 18-inch lifts and compact with 5 complete passes of a 10-ton, vibratory or grid roller.
4. Vibratory rollers must have a dynamic force of at least 30,000 pounds per impact per vibration and at least 1,000 vibrations per minute. Coarse fill must be compacted to a dense, interlocking and unyielding surface.
5. Coarse fill is expected to generate an in place, moist unit weight of 135 pcf.

**Utility Trench Backfill**

1. Remove all saturated, loose or disturbed soil from the bottom of the utility trenches prior to placing pipe bedding.
2. Accomplish bedding for pipes and utility trenches in accordance with Division 7 of the latest edition of the *WSDOT Standard Specifications.*
3. Backfill the remainder of utility trenches in accordance with the *Structural Fill* specification.

**ISSUED FOR**

- ☒ DESIGN USE
- ☐ PRELIMINARY REVIEW
- ☒ YOUR APPROVAL
- ☒ REFERENCE
- ☒ CONSTRUCTION
- ☒ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |

DRAWN: DMS

DESIGN: BN

CHECK: TW

ORIGINATION DATE: 7/23/2012

FILE: WHICOU PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
MR. MARK STOREY P.E.
PUBLIC WORKS DIRECTOR
WHITMAN COUNTY
310 NORTH MAIN STREET
COLFAX, WASHINGTON 99111
Attn: marks@co.whitman.wa.us

ENGINEER STAMP

TRAVIS J. WAMBEKE
STATE OF WASHINGTON
38908
REGISTERED
PROFESSIONAL ENGINEER
8/29/2012

STRATA
A PROFESSIONAL SERVICES CORPORATION
Integrity From the Ground Up

# ⑪ FOUNDATION DESIGN CRITERIA

**Specific Criteria**

The transfer building area will be preloaded with a granular structural fill embankment as delineated in Section 9. The surcharge will be applied for approximately 10 to 12 months and settlement monitored by Whitman County forces. Once primary consolidation is realized & confirmed by STRATA, the structure will be constructed by a commercial contractor. The text below delineates general and specific criteria for implementing granular soil improvements and foundation drainage at the time the surcharge embankment is constructed. Constructing these now with County forces reduces contractor rework and facilitates uniform subgrade construction for foundations. These geotechnical recommendations are oriented towards improving the long term performance of the foundation system. These recommendations may be applied from a preliminary and conceptual standpoint to future structures such as the planned maintenance shed located in the site's northwest corner and the eventual recycling drop off facility to be located east of the current scale shack. However, the recommendations below are specific to the transfer building and relying on them through final design and construction of these yet unplanned structures is done so at the County's sole risk.

1. Exterior foundations must extend at least 30 inches below the final, exterior ground surface to help protect against frost action.
2. Interior foundations shall bear at least 18 inches below finish slab elevations and maintain at least 4 inches of gravel between slabs and the top of the footing to reduce the potential for reflective cracking
3. Foundations should be a minimum of 24 inches wide and structurally conform to the latest edition of the *International Building Code (*IBC).
4. The reported allowable bearing criteria can be increased 1/3 to account for transitory live loads.
5. Foundation bearing surfaces must be free of loose soil and debris.
6. STRATA shall observe foundation and slab subgrades in combination with County forces. Reviewing the subgrade during site and foundation preparation allows verification that vegetation, organics and significant debris have been removed to the required elevation and that excavations have been accomplished according to these recommendations.
7. Construct foundation soil improvements as shown in Figure 1 for the Transfer Building and retaining walls. See Figure 1 below.
8. Avoid structurally connecting the Z - wall and MSE wall to the foundation wall.
9. Granular soil improvements for the Z - wall and MSE wall shall be 3 feet vertically and 1.5 feet laterally for walls 10 to 20 feet in height. Reduce soil improvements to 1.5 feet for walls less than 10 feet in total height.
10. Final MSE wall design will provide additional details associated with wall foundation construction.

**Design Criteria**

Allowable bearing pressure for dead and sustained live loads:

- 4,000 psf for foundations bearing on granular structural fill over native clay soil
  Allowable bearing pressure can be increased by 1/3 for transient load such as wind or seismic.

Modulus of Subgrade Reaction (Native Soil Profile)

- 110 pci

Coefficient of sliding friction:

- 0.5 for foundations bearing on granular structural fill

Foundation Settlement

- Estimated primary consolidation due to site preloading: 6 to 10 inches
- Estimated total settlement after primary consolidation: 1.25 inches
- Estimated differential settlement: 0.75 inches

Foundation Surcharge

Granular backfill will be placed as structural fill behind the transfer building interior retaining wall and the exterior Z-wall. Granular fill will rest atop the retaining wall heel and is expected to have an in place unit weight of 135 pcf or higher. This fill will vertically surcharge the foundation heel and must be accounted for in structural design.

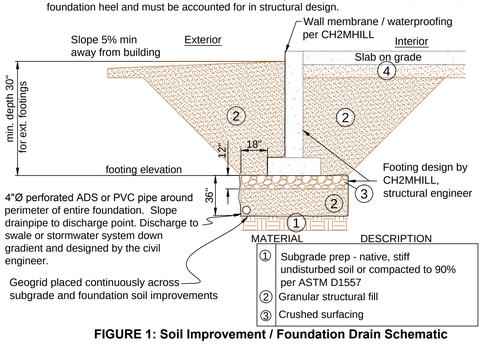



**FIGURE 1: Soil Improvement / Foundation Drain Schematic - Applies to Continuous or Column Foundations**

**Seismicity**

1. The seismic site soil profile is Class C.
2. A site-specific study seismic response was not performed.
3. The potential for vertical settlement due to liquefaction is low.
4. Seismic parameters in Table 1 (below).

**TABLE 1: Seismic Design Parameters**

| Parameter | Value (g)[1] |
|---|---|
| Mapped Spectral Acceleration at 0.2 sec ($S_S$) | 0.307 |
| Mapped Spectral Acceleration at 1.0 sec. ($S_1$) | 0.097 |
| Site Coefficient Fa | 1.200 |
| Site Coefficient Fv | 1.700 |
| Design Peak Ground Acceleration (Site Class C) | 0.098 |

Notes: [1]Values from 2009 IBC.
[2] Values for location Latitude 46.7635° and Longitude -117.2791°

**Corrosion Potential**

1. Corrosion of buried metallic structures is an electrochemical process and is dependent on many factors, including type of metal or alloy, galvanic effects, and soil properties such as resistivity, pH and oxygen content. Generally, soil that has low resistivity and low pH is more corrosive than soil with high resistivity and high pH.
2. Our experience with the site soil and aggregate in the Pullman area suggests these materials maintain a relatively neutral pH and moderate to low resistivity indicating a heavy to potentially severe corrosion potential.
3. Consider steel loss due to corrosion with respect to selecting pipes and other buried or underground structures.
4. Maintain maximum clearances for reinforcing concrete.

# ⑫ CONCRETE SLAB-ON-GRADE FLOORS

**Slab Substrate**

1. Place crushed surfacing structural fill, as defined in Table 1 on sheet G2, over compacted granular structural fill soil as described in the *Earthwork* section.
2. Subgrade areas that become soft, wet or disturbed during slab subgrade preparations must be moisture conditioned and recompacted, or over-excavated to dense structural fill and replaced with crushed surfacing.
3. Compact crushed surfacing below slabs to structural fill requirements as defined in Table 2, sheet G2.
4. The slab's supporting aggregate course must be constructed once the majority of underslab plumbing and utilities are completed.
5. Floor and exterior slabs and supporting base section thicknesses must be structurally designed for the anticipated use and equipment or storage loading conditions.
6. Concrete slab design may utilize an allowable modulus of subgrade reaction (k) of 350 pounds per cubic inch (pci) (Figure 2) for slab sections constructed over compacted, granular structural fill. Structural design will designate final crushed surfacing thickness.

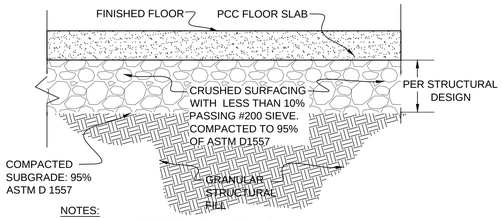



**FIGURE 2: Floor Slab Schematic**

USE MODULUS OF SUBGRADE REACTION OF 350 pci FOR SLAB DESIGN.

**Exterior Slab Considerations**

The below information is intended to support structural design for exterior slabs/pavements.

***General***

1. Portland Cement Concrete (PCC) pavements and slabs shall meet WSDOT Standards and have a minimum 5,000 psi compressive strength, 750 psi modulus of rupture, and 4 to 7 percent entrained air.
2. Per structural apply curing compounds specified by structural design on all exterior concrete surfaces prior to winter. Due not apply salts or salt solutions to the pavement surface.
3. Sawcut the concrete per structural design pattern as soon as possible following placement to reduce the potential for shrinkage cracking.
4. Joint and cure exterior concrete referencing ACI requirements to help reduce random cracking, shrinkage cracking and to facilitate construction and concrete curing.
5. Structurally design joints to occur through contraction joints, construction joints and isolation joints accounting for the concrete surface geometry and paving plan.
6. Joint details, fixture details, sealant details and other appropriate design and construction practices are illustrated in the ACI 330R-08 document and should be incorporated into project plans.

***Frost***

1. ACI 330R-08 states that frost softening during thaw periods of the year are not a substantial design concern and slabs and pavements can typically accommodate such soil softening during spring freeze and thaw cycles.
2. Frost jacking/frost heave are rigid pavement design concerns, particularly where abrupt changes in soil frost susceptibility occur.
3. Abrupt changes may occur where rigid pavements meet flexible pavements or at building entrances and foundations. Soil subgrades will exist in areas where exterior slabs are planned and about the building.
4. To accommodate these locations, we recommend that 2/3 of the frost depth (20 inches) be excavated and removed extending 10 feet from the building or at any trash enclosure.
5. Replace these over-excavations with granular structural fill or crushed surfacing.
6. Consult the structural engineer regarding additional measures to help resist frost action.

# ⑬ SITE DRAINAGE

**Foundations**

1. Place exterior fill around stem walls as general or granular structural fill.
2. Place interior fill as granular structural fill.
3. Install perimeter foundation drains at the base of soil improvements as shown on *Figure 1, Soil Improvement/Foundation Drain Schematic*.
4. Install foundation drains at a slope and dispose of collected water in a stormwater system away from structures and slopes given site grades, it may be necessary to direct collected water in foundation drains to sumps planned in the scale pit.
5. Never connect roof drain pipes to foundation drain pipes.

**Exterior Grading**

1. Site grading design and construction must allow for positive drainage of surface runoff water away from the proposed structure and not be allowed to infiltrate slopes or foundation and slab subgrades.
2. Runoff or water migrating along the ground surface must be conveyed away from structures by an appropriately designed series of ditches, swales or other surface water management procedures.
3. Divert runoff along the adjacent drainage away from the transfer building. Where granular structural fill daylights at the drainage, consider placing a 2-foot thick cap of clay to reduce infiltration into the fill profile
4. Slope all hardscapes within 10 feet of the structure away at 5 percent except were ADA requirements must be met.
5. The remaining sidewalks and paved surfaces should slope at least 2 percent away from the structures. This reduces the risk of subsurface soil near the foundation wall becoming saturated due to water ponding near the structure.
6. Connect roof downspouts to a solid pipe placed away from structures and do not allow to infiltrate into the soil underlying the structure.
7. Divert stormwater to an appropriate disposal system specified by site civil design.
8. The soil encountered in test pits was classified as clay loam within the depths and locations explored. This soil is not suitable for dry well or other subsurface disposal methods of stormwater.
9. If civil design or other issues will not allow appropriate collection and disposal points away from structures, the design team must evaluate alternate stormwater disposal plans.

# ⑭ SLOPE CONSTRUCTION

1. Construct permanent cut and fill slopes no steeper than 2.5H:1V.
2. Construct fill slopes as structural fills.
3. Provide appropriate erosion control measures such as hydroseeding, erosion control blankets or other landscaping to reduce the potential for sloughing and erosion.
4. At a minimum, re-seed slopes with an appropriate seed blend at the completion of construction. Vigorously maintain slopes until vegetation has the opportunity to establish itself. Minor sloughing should be expected along slopes until vegetation is established. Where snow is stockpiled above slopes it has the potential to drain over slopes and instability and large scale sloughing potential drastically increases.
5. Design walls for the appropriate internal and external stability and bear wall foundations on soil improvements placed over native soil.
6. Properly drain walls (Figure 3).
7. Surface grading must not allow water to drain over slopes or wall faces.

# ⑮ LATERAL EARTH PRESSURES

**Static Earth Pressure**

The project will use concrete, cast in-place walls (Z-wall) and segmental black retaining walls (MSE). Retaining systems must resist lateral earth pressures, which are realized from retained soil behind the structure as well as any surcharge from equipment, slopes or vehicles adjacent to walls. Apply lateral earth pressures for wall system design using the following equivalent fluid pressures (EFP) from Table 1 below.

**TABLE 2: Static Equivalent Fluid Pressures (EFP)**

***Granular backfill in the active zone (Φ=42°)***

| Lateral Earth Pressure Case | Equivalent Fluid Pressure (EFP) |
|---|---|
| At-rest case (no wall movement) | 45 pcf |
| Active case (wall movement away from soil mass) | 26 pcf |
| Passive case (wall movement toward soil mass)* | 650 pcf |

*Assumes ¾ inch lateral movement to fully mobilize passive resistance

1. The equivalent fluid pressures in table 1 assume fully drained conditions and no hydrostatic forces acting on the wall.
2. For walls that cannot tolerate movement, design utilizing at-rest equivalent earth pressures. we understand some off the walls on this project cannot tolerate lateral movement.
3. The above EFP's also assume the top surface of backfill adjacent to walls slopes down and away from the wall a minimum of 5 percent for drainage.
4. Lateral surcharge pressures due to equipment, slopes, storage loads, etc. are not included in the above lateral earth pressure recommendations. Use the lateral earth pressure coefficient of 0.5, acting over the entire below-grade wall height to estimate the lateral surcharge loads from equipment, adjacent foundations and slopes behind and above walls.
5. Figure 3 below illustrates the equivalent fluid pressure distributions

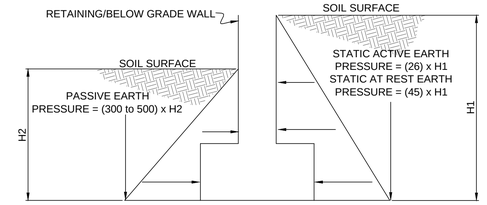



**FIGURE 3: Static Earth Pressures - (EFP)**

**Dynamic Earth Pressure**

Dynamic lateral earth pressures are a function of several factors including the presence of groundwater, magnitude of ground shaking, soil strength and soil permeability. Dynamic lateral earth pressures are *additive* to the above static lateral earth pressures, but act as an inverted triangle. *Hydrodynamic* forces also need to be accounted for in wall design and occur in 2 primary situations; 1) water "sloshing" back and forth between the soil matrix and exerting inertial forces, and 2) water being mobilized with the soil matrix as it is laterally forced against the structure. These situations have low to moderate probability for the operations building component project due to the proximity of groundwater to the finish floor and wall elevations. Additionally, these situations are not expected to impact the south side improvements.

1. Where soil backfill exists behind walls, design should account for dynamic load influences.
2. Dynamic EFPs must be added to the static EFPs (Table 2), but as an inverted triangle distribution for active and at-rest cases.
3. For the passive condition the dynamic pressure decreases the available static passive resistance acting in a conventional triangular distribution.
4. Table 3 presents equivalent fluid pressures during dynamic loading (excludes static loads) for unsaturated soil.
5. The seismic component of active and at-rest pressure is assumed to have its resultant acting at 0.66 times the wall height measured from the base of the wall.

**TABLE 3: Mononobe-Okabe Dybamic Equivalent Fluid Pressures (granular fill)**

| Coulomb Lateral Earth Pressure Case | Equivalent Fluid Pressure (EFP) |
|---|---|
| At rest case (no wall movement) | +26 pcf[1] |
| Active case (wall movement away from soil mass) | +5 pcf[1] |
| Passive case 2 (wall movement toward soil mass) | -90 pcf [1,3] |

[1]Includes soil moist unit weight.
[2]Passive resistance has been provided for 1 inch of lateral movement.
[3]Passive resistance should be reduced by 90 pcf acting as a conventional triangle against the wall.

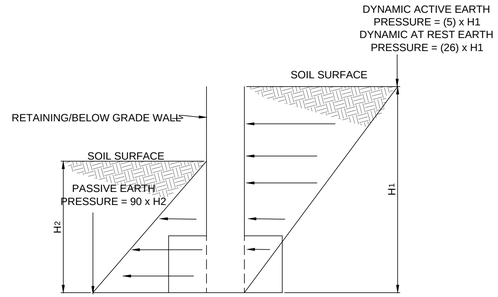



**FIGURE 4: Dynamic Earth Pressure**

**Wall Drainage**

1. Design and construct retaining walls with adequate drainage systems to reduce the potential for instability, leakage or seepage. See Figure 4.
2. Never connect roof or other drains to wall or foundation drainage pipes.

**NOTE:**

THIS DRAWING INTENDED FOR USE FOR BELOW GRADE WALLS OR AT-GRADE FOUNDATIONS (I.E. STEM WALL HEIGHT WILL VARY). THIS IS NOT A STRUCTURAL DETAIL.

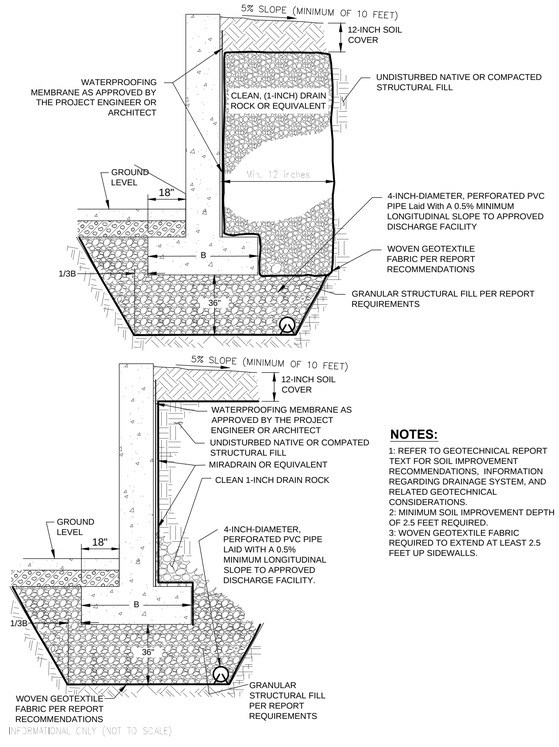



**FIGURE 4: Foundation and Wall Drain Schematic With Soil Improvements**

**NOTES:**

1: REFER TO GEOTECHNICAL REPORT TEXT FOR SOIL IMPROVEMENT RECOMMENDATIONS, INFORMATION REGARDING DRAINAGE SYSTEM, AND RELATED GEOTECHNICAL CONSIDERATIONS.
2: MINIMUM SOIL IMPROVEMENT DEPTH OF 2.5 FEET REQUIRED.
3: WOVEN GEOTEXTILE FABRIC REQUIRED TO EXTEND AT LEAST 2.5 FEET UP SIDEWALLS.

**ISSUED FOR**

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| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |

DRAWN: DMS

DESIGN: BN

CHECK: TW

ORIGINATION DATE: 7/23/2012

FILE: WHICOU PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
MR. MARK STOREY P.E.
PUBLIC WORKS DIRECTOR
WHITMAN COUNTY
310 NORTH MAIN STREET
COLFAX, WASHINGTON 99111
Attn: marks@co.whitman.wa.us

ENGINEER STAMP

TRAVIS J. WAMBEKE — STATE OF WASHINGTON — 21600 — REGISTERED PROFESSIONAL ENGINEER
8/29/2012

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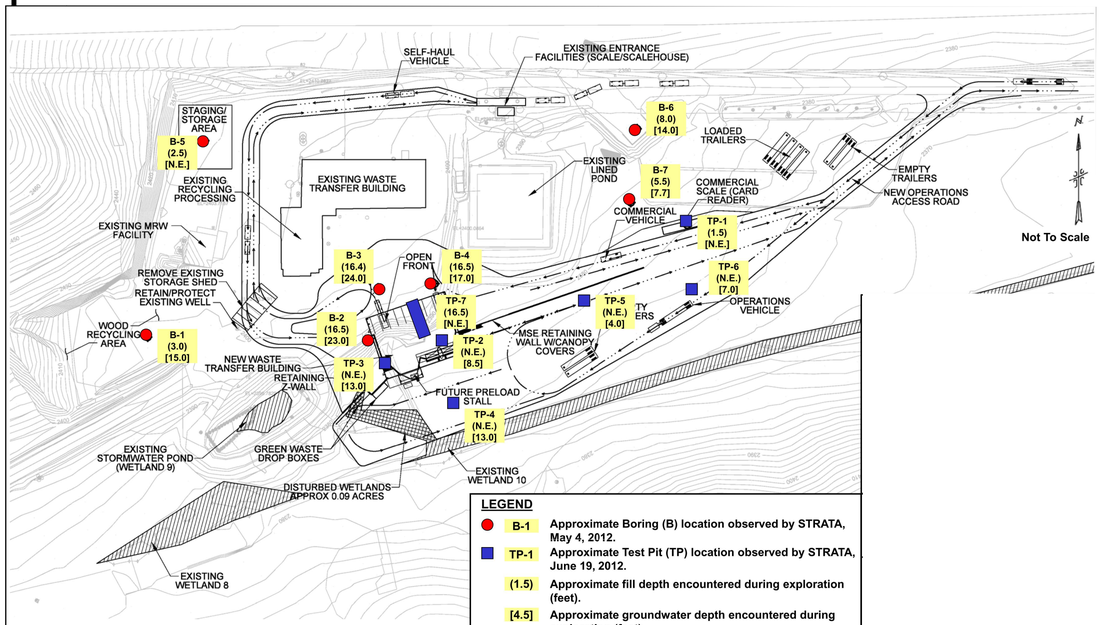
## 15 SITE PLAN




**LEGEND**

| | | |
|---|---|---|
| ● | B-1 | Approximate Boring (B) location observed by STRATA, May 4, 2012. |
| ■ | TP-1 | Approximate Test Pit (TP) location observed by STRATA, June 19, 2012. |
| | (1.5) | Approximate fill depth encountered during exploration (feet). |
| | [4.5] | Approximate groundwater depth encountered during exploration (feet). |
| | N.E. | Not Encountered |

## 16 TEST PIT LOGS

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL - SILT, (ML) dark brown to black, stiff to very stiff, moist | 0.0 | ML | | | | | | | | Moderate vegetation and organics to about 2 foot BGS. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist | 2.5 | | | RG | | | | | 2-2.5 | |
| | 5.0 | CL | | RG | | | 90.8 | 25.5 | 3-3.5 | |
| | 7.5 | | | | | | | | | Orange brown mottling. |
| | 10.0 | | | | | | | | | |
| LOESS - CLAY, (CL) gray, firm to stiff, moist | 12.5 | 06-19-12 CL | | | | | | 24.7 | 1-1.5 | ASTM D-4318: LL = 28, PI = 9 |
| Test Pit Terminated at 13.5 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-3 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 13' | **Logged By:** TJW | | |

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL - SILT, (ML) dark brown to black, stiff to very stiff, moist to wet | 0.0 | ML | | | | | | | | Moderate vegetation and organics to about 2 foot BGS. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist to saturated | 2.5 | | | | | | | | | |
| | 5.0 | CL | | BG | | | 94.9 | 28.2 | | |
| | 7.5 | 06-19-12 | | | | | | | | |
| Test Pit Terminated at 9.0 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-5 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 4' | **Logged By:** TJW | | |

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| FILL - SILTY GRAVEL WITH SAND, (GM) gray, loose, dry to to moist | 0.0 | GM | | | | | | | | No vegetation and organics at the ground surface. |
| (TOPSOIL) - SILT, (ML) black to dark gray, soft, moist to wet | | ML | | | | | | | | Woven geotextile fabric at base of gravel, organics observed below fabric. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist to wet | 2.5 | | | BK | | | | | | |
| | 5.0 | CL | | | | | | | | |
| | 7.5 | | | | | | | | | |
| Test Pit Terminated at 9.5 Feet. | | | | | | | | | | Loosely backfilled upon completion with site soil. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-1 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** N.E. | **Logged By:** TJW | | |

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL - SILT, (ML) dark brown to black, stiff to very stiff, moist | 0.0 | ML | | | | | | | | Moderate vegetation and organics to about 2 foot BGS. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist | 2.5 | | | BG | | | 96.8 | 26.6 | 1-1.5 | |
| | 5.0 | CL | | | | | | | | |
| | 7.5 | 06-19-12 | | BK | | | | | 2-2.5 | Orange brown staining. |
| | 10.0 | | | | | | | | 2.5-3.0 | |
| | 12.5 | | | | | | | | | |
| Test Pit Terminated at 12.5 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-2 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 8.5' | **Logged By:** TJW | | |

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL - SILT, (ML) dark brown to black, stiff to very stiff, moist | 0.0 | ML | | | | | | | | Moderate vegetation and organics to about 2 foot BGS. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist | 2.5 | | | | | | 93.3 | 24.4 | 2.5-3.0 | |
| | 5.0 | CL | | | | | | | | |
| | 7.5 | | | | | | | | 3-3.5 | |
| | 10.0 | | | | | | | | | Orange brown mottling. |
| | 12.5 | 06-19-12 CL | | | | | | | | |
| LOESS - CLAY, (CL) gray, firm to stiff, moist to wet | | | | | | | | | | |
| Test Pit Terminated at 13.5 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-4 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 13' | **Logged By:** TJW | | |

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Textural Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| TOPSOIL - SILT, (ML) dark brown to black, stiff to very stiff, moist to wet | 0.0 | ML | | | | | | | | Moderate vegetation and organics to about 2 foot BGS. |
| LOESS - CLAY, (CL) reddish brown, firm to stiff, moist to saturated | 2.5 | | | | | | | | | |
| | 5.0 | CL | | | | | | | | |
| | 7.5 | 06-19-12 | | | | | | | | |
| Test Pit Terminated at 8.5 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-6 | STRATA | EXPLORATORY TEST PIT LOG |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | A Professional Services Corporation Integrity from the Ground Up | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 7' | **Logged By:** TJW | | |

**ISSUED FOR**
- ☒ DESIGN USE
- ☐ PRELIMINARY REVIEW
- ☒ YOUR APPROVAL
- ☒ REFERENCE
- ☒ CONSTRUCTION
- ☒ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |

DRAWN: DMS

DESIGN: BN

CHECK: TW

ORIGINATION DATE: 7/23/2012

FILE: WHICOU PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
MR. MARK STOREY P.E.
PUBLIC WORKS DIRECTOR
WHITMAN COUNTY
310 NORTH MAIN STREET
COLFAX, WASHINGTON 99111
Attn: marks@co.whitman.wa.us

ENGINEER STAMP

TRAVIS J. WAMBEKE
STATE OF WASHINGTON
REGISTERED
PROFESSIONAL ENGINEER
8/29/2012

STRATA
A Professional Services Corporation
Integrity from the Ground Up

R:\Projects\W\WHITMAN COUNTY\Pu12053a\PU12053A DESIGN PLAN.dwg, G5, 8/29/2012 8:49:30 AM, DSasso, DWG To PDF.pc3

## 16 TEST PIT LOGS

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | USDA SOIL Classification | % Passing No. 200 Sieve | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| UNCONTROLLED FILL - CLAY, (CL) dark brown with black mottling, very soft, moist | 0 | | | | | | | | | Significant organics and debris observed through fill profile. |
| | 5 | CL | | RG | | | 88.9 | 27.6 | | ASTM D 4318 LL = 38, PI = 17 |
| LOESS - CLAY, (CL) gray to reddish brown, firm to stiff, moist | 15 | | | | | | | | | |
| | 20 | CL | | RG | | | | | | |
| Test Pit Terminated at 20.0 Feet. | | | | | | | | | | Loosely backfilled upon completion with site cuttings. Test pit and backhoe tracks were leveled and smoothed with the backhoe bucket. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Test Pit Number:** TP-7 | STRATA | **EXPLORATORY TEST PIT LOG** |
| **Project:** PU12053A | **Date Excavated:** 06-19-2012 | | |
| **Backhoe:** John Deere | **Bucket Width:** 30 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** N.E. | **Logged By:** TJW | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:48:41 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WASTE TRANSFER CENTER TEST PITS.GPJ

## 17 BORING LOGS

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| UNCONTROLLED FILL - LEAN CLAY, (CL) mottled black to reddish brown, soft, moist to wet | 0 | | | | 1 2 2 | 4 | | | | Concrete debris encountered |
| | 5 | CL | | | 0 1 1 | 2 | | | | Trace gravel |
| | 10 | | | | 1 1 2 | 3 | | | | |
| ALLUVIUM - CLAY, (CL) dark grayish brown to black, soft to firm, moist to wet | 15 | CL | | | 15 24 25 | 31 | | | | Trace gravel |
| LOESS LEAN CLAY, (CL) reddish brown, soft to firm, moist | 20 | | | | 2 3 4 | 7 | | | | |
| | 25 | CL | | | 0 2 3 | 5 | | | | |
| LOESS SILT, (ML) reddish, very soft, saturated | 30 | | | | 0 0 0 | 0 | | | | Trace sand |
| | 35 | ML | | | 0 0 0 | 0 | | | | |
| | 40 | | | | 0 0 0 | 0 | 33.9 | | | ASTM D422: 85.6% passing #200 screen ASTM D4318: LL = 26, PI = 2 |
| LOESS LEAN CLAY, (CL) reddish brown, soft to firm, saturated | 45 | CL | | | 4 6 10 | 16 | | | | |
| Borehole Terminated at 46.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-2 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 23' | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| (FILL) - SILTY GRAVEL, (GM) black to dark gray, loose, moist, (5") | 0 | GM | | | | | | | | |
| UNCONTROLLED FILL - LEAN CLAY, (CL) reddish brown, soft to stiff, moist | 5 | CL | | | 2 2 3 | 5 | | | | |
| | 10 | | | | 2 4 6 | 6 | | | | |
| | 15 | | | | 2 2 3 | 5 | | | | |
| TOPSOIL SILT, (ML) black to dark gray, soft to firm, moist to saturated | 20 | ML | | | 4 7 11 | 18 | | | | Organics and vegetation observed. |
| LOESS LEAN CLAY, (CL) reddish brown, firm to stiff, saturated | | CL | | | | | | | | |
| LOESS SILT, (ML) reddish brown to gray, stiff to very soft, saturated | 25 | | | | 3 5 4 | 9 | | | | |
| | 30 | ML | | | 2 2 3 | 5 | | | | Trace sand |
| | 35 | | | | 0 0 0 | 0 | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, firm to stiff, saturated | 40 | | | | 2 2 3 | 5 | | | | |
| | 45 | CL | | | 4 8 11 | 19 | | | | |
| Borehole Terminated at 46.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-4 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 17' | **Logged By:** TJW/CWS | | |

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## FUTURE RECYCLING DROP OFF AREA

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| ASPHALT PAVEMENT, (AC) (4") | 0 | AC | | | | | | | | |
| BASE COURSE - SILTY GRAVEL, (GM) dark brown, medium dense, moist, (11") | | GM | | | | | | | | |
| SUB BASE - COARSE GRAVEL, WITH SAND AND COBBLES, (GM) dark gray to gray, medium dense, moist | | GM | | | | | | | | |
| UNCONTROLED FILL - LEAN CLAY, (CL) reddish brown, soft to firm, moist | 5 | CL | | | 4 7 11 | 11 | 108.9 | 17.0 | | |
| (TOPSOIL) - SILT, (ML) black, soft, moist | 10 | ML | | | 4 4 6 | 10 | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, firm to stiff, moist | | CL | | | | | | | | |
| | 15 | | | | 2 4 4 | 8 | | | | |
| Borehole Terminated at 16.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug, recieved a cold asphalt patch. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-6 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 14' | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

## 17 BORING LOGS
## FUTURE WOOD RECYCLING AREA

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| (FILL) - SILTY GRAVEL, (GM) black to dark gray, loose, moist, (8") | 0 | GM | | | | | | | | Organics and Vegetation |
| UNCONTROLED FILL - LEAN CLAY, (CL) reddish brown, soft to stiff, moist | | CL | | | | | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, firm to stiff, moist | 5 | | | | 3 3 3 | 6 | | | | |
| | 10 | CL | | | 3 4 5 | 9 | | | | |
| | 15 | | | 05-04-12 | 3 3 6 | 9 | | | | Some mottling |
| LOESS LEAN CLAY, (CL) light mottled brown to gray, firm, moist | | | | | | | | | | Increasing clay content |
| | 20 | CL | | | 3 3 6 | 9 | | | | |
| Borehole Terminated at 21.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-1 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 15' | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| (FILL) - SILTY GRAVEL, (GM) black to dark gray, loose, moist, (8") | 0 | GM | | | | | | | | |
| UNCONTROLED FILL - LEAN CLAY, (CL) reddish brown, soft to firm, moist | | CL | | | 2 2 3 | 5 | | | | |
| | 5 | | | BK | | | | 22.1 | | ASTM D1557: Max D. D. = 111.0 pcf Opt. M. C. = 13.0 pcf ASTM D422: 93.5% passing #200 screen ASTM D4318: LL = 38, PI = 17 |
| | 10 | CL | | | 1 2 1 | 3 | | | | |
| | 15 | | | | 2 3 4 | 7 | | | | |
| TOPSOIL SILT, (ML) black to dark gray, soft, moist | | ML | | | | | | | | Organics and vegetation observed. |
| LOESS LEAN CLAY, (CL) reddish, firm to stiff, moist to saturated | 20 | | | | 4 6 9 | 15 | | | | |
| | | CL | | | | | | | | |
| | 25 | | | | 2 2 5 | 7 | | | | |
| LOESS SILT, (ML) reddish brown, soft to very soft, saturated | | | | | 2 2 2 | 4 | | | | |
| | 30 | | | | | | | | | |
| | 35 | ML | | | 0 0 2 | 2 | | | | Trace sand |
| | 40 | | | | 0 0 0 | 0 | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, firm to stiff, saturated | 45 | CL | | | 4 6 10 | 16 | | | | |
| Borehole Terminated at 46.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-3 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 24' | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

## FUTURE MAINTENANCE SHED AREA

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| (FILL) - SILTY GRAVEL, (GM) black to dark gray, loose, moist | 0 | GM | | | | | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, firm, moist | | CL | | | 2 2 3 | 5 | | | | |
| | 5 | | | BK | | | | 24.4 | | ASTM D422: 93.7% passing #200 screen ASTM D4318: LL = 28, PI = 9 |
| | 10 | CL | | | 2 2 4 | 6 | | | | |
| | 15 | | | | 2 2 4 | 6 | | | | |
| Borehole Terminated at 16.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-5 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** N.E. | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

| USCS Description | DEPTH (ft) | U.S.C.S. CLASS | SYMBOL | Sample Type | SPT Blows Per 6 Inches | SPT $N_{60}$ | Dry Density (pcf) | Moisture Content (%) | Pocket Pen. (tsf) | REMARKS Note: BGS = Below Ground Surface |
|---|---|---|---|---|---|---|---|---|---|---|
| BASE COURSE - SILTY GRAVEL, (GM) light to dark gray, loose, moist | 0 | GM | | | | | | | | 5/8" minus crushed gravel surfacing. |
| (TOPSOIL) - SILT, (ML) dark gray, soft, moist | | ML | | | | | | | | |
| LOESS LEAN CLAY, (CL) reddish brown, soft to firm, moist to saturated | 5 | | | | 2 4 10 | 14 | | | | |
| | 10 | CL | | | 3 4 5 | 9 | | | | |
| | 15 | | | | 2 2 2 | 4 | | | | |
| Borehole Terminated at 16.5 Feet. | | | | | | | | | | Loosely backfilled with site cuttings and bentonite plug. |

| | | | |
|---|---|---|---|
| **Client:** WHICOU | **Boring Number:** B-7 | STRATA | **EXPLORATORY BORING LOG** |
| **Project:** PU12053A | **Date Drilled:** 05-04-2012 | | |
| **Drill Rig:** BK-81 | **Borehole Diameter:** 8 | | Sheet 1 Of 1 |
| **Depth to Groundwater:** 7.7' | **Logged By:** TJW/CWS | | |

STRATA BH / TP / WELL - STRATA.GPJ - 7/20/12 09:41:1 - S:\2012\DWT\PROJECTS\WHICOU PU12053A WHITMAN CO. LANDFILL.GPJ

**ISSUED FOR**
- ☒ DESIGN USE
- ☐ PRELIMINARY REVIEW
- ☒ YOUR APPROVAL
- ☒ REFERENCE
- ☒ CONSTRUCTION
- ☒ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |
| | | |

DRAWN: DMS

DESIGN: BN

CHECK: TW

ORIGINATION DATE: 7/23/2012

FILE: WHICOU PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
MR. MARK STOREY P.E.
PUBLIC WORKS DIRECTOR
WHITMAN COUNTY
310 NORTH MAIN STREET
COLFAX, WASHINGTON 99111

Attn: marks@co.whitman.wa.us

Whitman County

ENGINEER STAMP

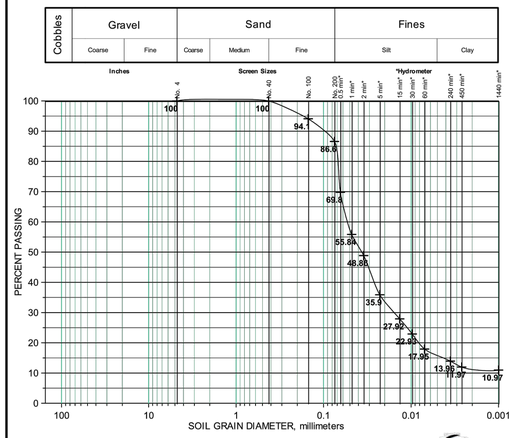
TRAVIS J. WAMBECK
STATE OF WASHINGTON
36896
REGISTERED
PROFESSIONAL ENGINEER
8/29/2012

STRATA
A PROFESSIONAL SERVICES CORPORATION
Integrity From the Ground Up

## (17) LABORATORY TEST

# GRADATION ANALYSIS
ASTM D-422

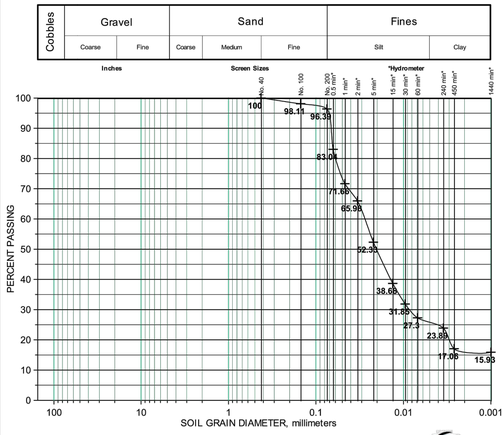
Project: Whitman County Landfill Transfer Station
Client: Whitman County
File Name: WHICOU - PU12053A
Lab Number: M12-030C
Sample Location: B-2 at 40 to 41.5 feet BGS
Sample Classification: Silt (ML)
ASTM D 4318: LL = 26, PI = 2
Date Sampled: 5/4/12 By: TJW




Reviewed by: _____

# GRADATION ANALYSIS
ASTM D-422

Project: Whitman County Landfill Transfer Station
Client: Whitman County
File Name: WHICOU - PU12053A
Lab Number: M12-030B
Sample Location: B-5 at 5 to 6.5 feet BGS
Sample Classification: Lean Clay (CL)
ASTM D 4318: LL = 28, PI = 9
Date Sampled: 5/4/12 By: TJW

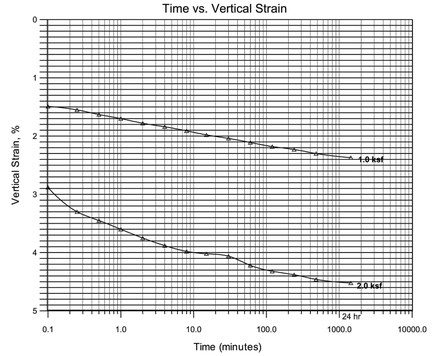



Reviewed by: _____

# CONSOLIDATION TEST RESULTS
## ASTM D 2435
## (Method B - Time Rate)

Project: Whitman County Waste Transfer Station
Client: Whitman County
File Name: WHICOU PU12053A
Lab Number: B12L0753
Sample Identification: TP-7 @ 3.5 ft
Sample Classification: Lean Clay
Sample: In-Situ Tube (Condition: Good)
Date Tested: 6/22-29/12 By: IR
Sample Dry Unit Weight: 88.9 pcf
Moisture Content: 27.6%
Atterberg Limits: LL = 38, PI = 17

Time vs. Vertical Strain




Reviewed By: _____

## UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | | GRAPH SYMBOL | LETTER SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|---|
| COARSE GRAINED SOIL | GRAVEL | CLEAN GRAVELS | | GW | Well-Graded Gravel, Gravel-Sand Mixtures. |
| | | | | GP | Poorly-Graded Gravel, Gravel-Sand Mixtures. |
| | | GRAVELS WITH FINES | | GM | Silty Gravel, Gravel-Sand-Silt Mixtures. |
| | | | | GC | Clayey Gravel, Gravel-Sand-Clay Mixtures. |
| | SAND | CLEAN SANDS | | SW | Well-Graded Sand, Gravelly Sand. |
| | | | | SP | Poorly-Graded Sand, Gravelly Sand. |
| | | SANDS WITH FINES | | SM | Silty Sand, Sand-Silt Mixtures. |
| | | | | SC | Clayey Sand, Sand-Clay Mixtures. |
| FINE GRAINED SOIL | SILT AND CLAY LIQUID LIMIT LESS THAN 50% | | | ML | Inorganic Silt, Sandy or Clayey Silt. |
| | | | | CL | Inorganic Clay of Low to Medium Plasticity, Sandy or Silty Clay. |
| | | | | OL | Organic Silt and Clay of Low Plasticity. |
| | SILT AND CLAY LIQUID LIMIT GREATER THAN 50% | | | MH | Inorganic Silt, Micaceous Silt, Plastic Silt. |
| | | | | CH | Inorganic Clay of High Plasticity, Fat Clay. |
| | | | | OH | Organic Clay of Medium to High Plasticity. |
| | | | | PT | Peat, Muck and Other Highly Organic Soil. |

**BORING LOG SYMBOLS**
- Standard 2-Inch OD Split-Spoon Sample
- California Modified 3-Inch OD Split-Spoon Sample
- Rock Core
- Shelby Tube 3-Inch OD Undisturbed Sample

**GROUNDWATER SYMBOLS**
- Groundwater After 24 Hours
- (7-3-07) Indicates Date of Reading
- Groundwater at Time of Drilling

**TEST PIT LOG SYMBOLS**
- BG Baggie Sample
- BK Bulk Sample
- RG Ring Sample

Shorthand Notation:
BGS = Below Existing Ground Surface
N.E. = None Encountered

# CALIFORNIA BEARING RATIO
ASTM D-1883

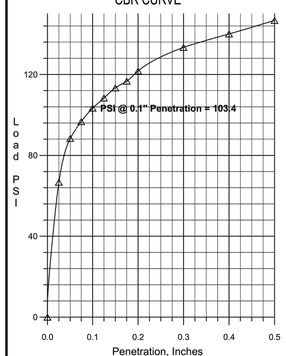
Project: Whitman County Landfill Transfer Station
Client: Whitman County
File Name: WHICOU - PU12053A
Sample Location: B-3 at 8 to 10 feet BSG
Sample Description: Lean Clay (CL)

Lab Number: M12-030A
Date Sampled: 5/4/12
Date Received: 5/8/12
Sampled By: TJW

**SOIL CONSTANTS**

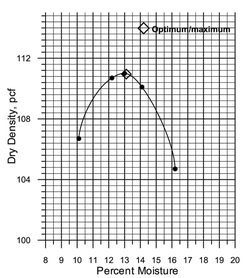
CBR = 10.3
Test Dry Density= 99.9 PCF (90% ASTM D 1557)
Test Specimen Molded @ 13.0% Moisture
Test Performed @ 18.3% Moisture
Percent Swell = 1.4 %
Surcharge (psf) = 75 psf
Soil pH: 6.4
Resistivity: 1115 ohm/cm
Liquid Limit: 38, Plasticity Index: 17

CBR CURVE




**MOISTURE-DENSITY CURVE**
ASTM D1557

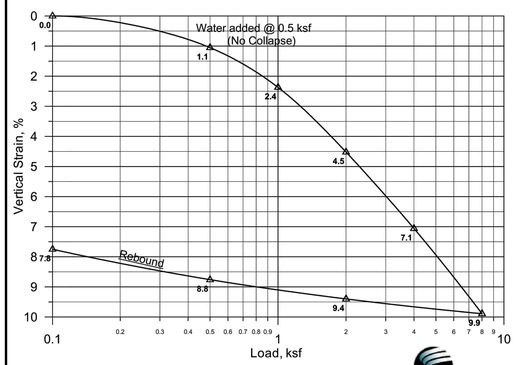
Method: A
Maximum Dry Density, Pcf: 111.0
Optimum Moisture Content, %: 13.0




Reviewed by: _____

# CONSOLIDATION TEST RESULTS
## ASTM D 2435 (Method A)

Project: Whitman County Waste Transfer Station
Client: Whitman County
File Name: WHICOU PU12053A
Lab Number: B12L0753
Sample Identification: TP-7 @ 3.5 ft
Sample Classification: Lean Clay
Sample: In-Situ Tube (Condition: Good)
Date Tested: 6/22-29/12 By: IR
Sample Dry Unit Weight: 88.9 pcf
Moisture Content: 27.6%
Atterberg Limits: LL = 38, PI = 17

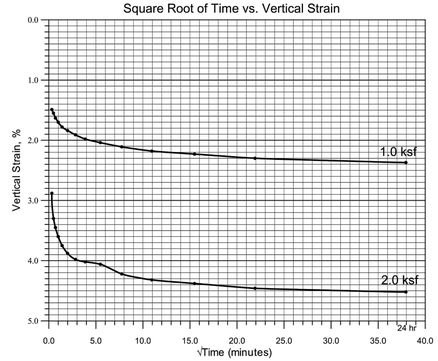



Reviewed By: _____

# CONSOLIDATION TEST RESULTS
## ASTM D 2435
## (Method B - Time Rate)

Project: Whitman County Waste Transfer Station
Client: Whitman County
File Name: WHICOU PU12053A
Lab Number: B12L0753
Sample Identification: TP-7 @ 3.5 ft
Sample Classification: Lean Clay
Sample: In-Situ Tube (Condition: Good)
Date Tested: 6/22-29/12 By: IR
Sample Dry Unit Weight: 88.9 pcf
Moisture Content: 27.6%
Atterberg Limits: LL = 38, PI = 17

Square Root of Time vs. Vertical Strain




Reviewed By: _____

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- ☒ REFERENCE
- ☒ CONSTRUCTION
- ☒ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 7/23/12 | DRAFT 50% |
| 2 | 8/1/12 | DRAFT 80% |
| 3 | 8/9/12 | FINAL DRAFT |
| 4 | 8/29/12 | FINAL DRAFT |

DRAWN: DMS
DESIGN: BN
CHECK: TW
ORIGINATION DATE: 7/23/2012
FILE: WHICOU PU12053A

PROJECT:
WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
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8/27/2012

STRATA
A PROFESSIONAL SERVICES CORPORATION
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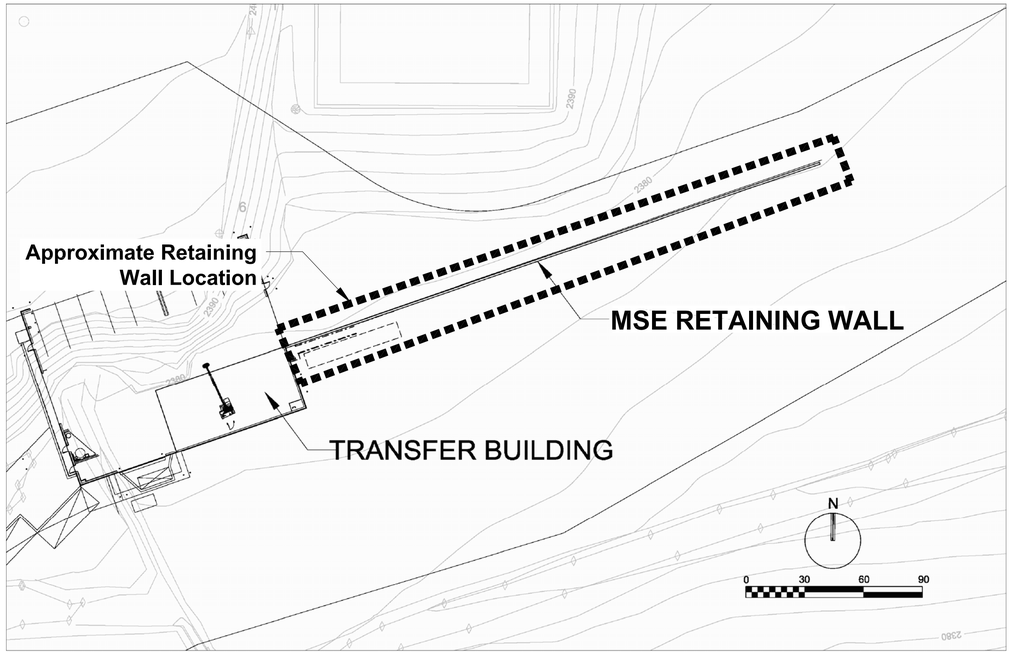
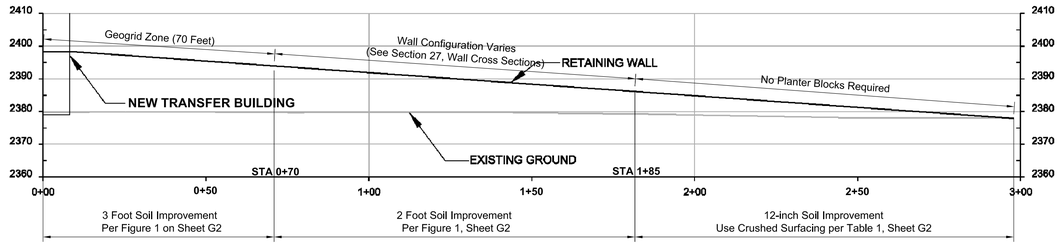
## 18 RETAINING WALL - SITE PLAN




Reference: Base Plan prepared by CH2MHill, dated May 10, 2012, Whitman County, Carothers Road Solid Waste Facility New Waste Transfer Building Concept Version 2. No Scale Intended.

## 19 RETAINING WALL - PROFILE VIEW




## 20 MSE RETAINING WALL CONCEPT

**Proposed Construction**

We understand our retaining wall comprising Mechanical Stabilized Earth (MSE) will be constructed on the east side of the planned transfer station as separation between upper and lower levels. Wall construction will begin in 2013. Whitman County has elected to utilize Redi-Rock™ segmental wall blocks as wall facing units. The wall profile will transition from nearly at grade to approximately 16.8 feet in exposed height along its length. The wall will be backfilled with coarse granular structural fill (shotrock). From our foundation evaluation for the transfer station, we know the wall will be founded on granular soil improvements. Planter blocks which provide horizontal offset, flattening the batter angle for wall heights greater that 5 rows (i.e. 7.5 feet) will be incorporated to reduce geosynthetic reinforcement requirements in wall sections. Jersey barriers will be placed immediately behind the wall for traffic safety.

**Existing Conditions**

The site has sparse to moderate vegetation primarily consisting of localized weeds, except around the perimeter where agriculture activities continue to grow wheat and legumes annually. An existing, unlined stormwater pond is just west of the planned transfer building with a lined pond to handle effluent north of the planned retaining wall.

The transfer station building area has been stripped of uncontrolled fill, vegetation, organics,and topsoil. Some of the proposed MSE wall alignment has also been stripped. The eastern 2/3 of the MSE wall remains to be stropped of vegetation, organics, and topsoil. The area within the planned MSE wall is relatively flat.

## 21 REFERENCES

Our field investigation and laboratory testing are based upon our proposed geotechnical scope dated May 2, 2012, and the latest version of ASTM International (ASTM) Standards listed below. Subsequent engineering analyses based on the preliminary drawings and concepts presented by the project team; CH2MHill and Whitman County.

**Field Exploration**

- D420 Guide to site characterization for engineering, design, and construction
- D1452 Practice for soil investigation and sampling by auger boring
- D1586 Test method for penetration test and split-barrel sampling of soil
- D2487 Test method for classification of soils for engineering purposes (USCS)
- D2488 Practice for description & identification of soil (Visual-manual procedure)

**Laboratory Investigation**

- D422 Test method for particle-size analysis of soil
- D1140 Test method for amount of materials in soil finer than No. 200 (75 micron)
- D1557 Test method for laboratory compaction characteristics of soil, modified method
- D1883 Test method for CBR (California Bearing Ratio) of laboratory compacted soil
- D2216 Test method for laboratory determination of water content of soil and rock
- D2435 Test method for one-dimensional consolidation properties of soil (A+B)
- D4318 Test method for liquid limit, plastic limit and plasticity index of soils
- D2166 Test method for unconfined compression testing for soils

Construction Guidelines

Washington Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Highway Construction (standard).

## 22 GEOTECHNICAL DESIGN BASIS

**General**

- International Building Code (IBC), 2009
- STRATA's field exploration, reference sheets G5 through G6
  - Test pits performed on June 19, 2012
  - Borings performed on May 4, 2012
- STRATA's laboratory testing, reference sheet G7
- Global stability analysis performed by STRATA using the Morgenstern-Price Method of Slices. (Retained in STRATA files).
  - Minimum Global Stability Safety Factor = 1.5 based on current project understanding and these plan sheet recommendations
  - Minimum Safety Factor against sliding = 1.5 based on current project understanding and these plan sheet recommendations
  - Minimum Safety Factor against overturning = 2.0 based on current project understanding and these plan sheet recommendations
  - Minimum Safety Factor against bearing failure = not analyzed based on current project understanding and these plan sheet recommendations
- Traffic Load: 250 psf
- Jersey Barrier Load: 230 psf
- Entire active zone backfilled with shotrock structural fill

**Civil Design**

- Conceptual site plans provided by CH2MHill dated May 10, 2012

## 23 ANALYSIS

**Geotechnical Material Properties**

The site soil is clay Loess and in its native, undisturbed state had measured natural unit weight typically in the range from 111 to 121 pcf during our field exploration in May and June of 2012. Crushed surfacing designated as Granular Structural Fill (See Table 1, Sheet G2) is recommended for the compacted fill that forms the wall foundation pad. Structural fill placed directly behind the wall will be 8-inch minus shotrock (basalt) available from Whitman County source(s). Estimated geotechnical engineering properties for the imported materials are summarized in Table G8.1.

**Table G8.1. Geotechnical Material Properties Used for Stability Analysis**

| Material | Friction Angle Φ, degrees | Cohesion c, psf | Moist Unit Weight γ, pcf | Assumed Soil Type |
|---|---|---|---|---|
| Granular Wall Backfill | 42 | 50 | 142 | 8-Inch Minus Shotrock, per *Table 1*, Sheet G2. |
| On-Site Soil | 28 | 200 | 125 | Native |

**Stability Analysis of the Gravity Wall**

To design the gravity retaining wall, which relies solely on its weight and not any geogrid-reinforced zone behind the blocks, we used the Allowable Stress Design (ASD) method based on Coulomb Earth Pressure Theory to compute factor of safety values (FOS). We evaluated external stability analysis for base sliding (design FOS = 1.5) and for overturning (design FOS = 2.0). Bearing capacity is not a critical design issue at this site. The gravity wall requires a granular leveling pad and foundation comprised of well-graded, Crushed Surfacing and Granular Structural Fill as shown on Figure 1, Sheet G2 Soil Improvement Schematic (See Table 1, Sheet G2 for Granular Structural Fill Requirements, and Table 2, Sheet G2 for Required Compaction). However, thicknesses of the soil improvements vary along the wall length per Wall Design below, Section 19, *Retaining Wall - Profile View*, and Figures G9.2 - G9.4. On-site soil is not to be used for Structural Fill behind the retaining wall alignment.

**Wall Design**

The gravity-block Redi-Rock™ wall proposed for STA 0+00 to 0+70 will have a maximum finished height of 16.8 feet with 1.2 feet of bury (i.e., 12 rows of block). To meet the FOS design criteria for sliding and overturning for such heights, our analysis showed the wall will require 2 base rows of blocks 60 inches wide and planter blocks at rows 5 and 9 (See Figure G9.2). Also, a geogrid-reinforced zone of 3 layers separated by 8-inches of gravel and 10-feet wide is needed with 11 or more blocks section (approximately STA 0+00 to 0+70) of this wall to provide a pad to spread the load from the concrete jersey barrier (See Figure G9.2). Soil improvements for this wall section must extend 3 feet below the wall bearing elevation.

The gravity-block Redi-Rock™ wall proposed for STA 0+70 to 1+10 will have a maximum finished height of 13.8 feet with 1.2 feet of bury (i.e., 10 rows of block). To meet the FOS design criteria for sliding and overturning for such heights, our analysis showed the wall will require one row of base blocks 60 inches wide and planter blocks at rows 5 and 9 (See Figure G9.3). When the wall height is limited to 9 total rows of blocks, the planter block at row 9 can be replaced with top block. Soil improvements for this wall section must extend 2 feet below wall bearing elevation.

The gravity-block Redi-Rock™ wall proposed for STA 1+10 to 2+80 will have a maximum finished height of 11.0 feet with 1.0 feet of bury (i.e., 8 rows of block). To meet the FOS design criteria for sliding and overturning for such heights, our analysis showed the wall will require a base blocks 41 inches wide and planter blocks at row 5 (See Figure G9.4). When the wall height is limited to 5 total rows of blocks, the planter block at row 5 can be replaced with top block. Soil improvements for this wall section must extend 2 feet below wall bearing elevation from STA 1+10 to STA 1+85 and 12 inches below wall bearing elevation from STA 1+85 to end of the wall.

## 23 ANALYSIS

**Table G8.2 Summary of Gravity Retaining Wall Stability Analysis**

| Gravity Wall | Exposed Height (ft) | Wall Analysis Height (ft) | Number of Planter Blocks | Base Block Width (in.) | No. of Block Rows[1] | Soil Improvement Depth | Computed FOS Sliding/ Overturning |
|---|---|---|---|---|---|---|---|
| Redi-Rock™ | 6.8 | 7.5 | 0 | 41 | 1-5 | 12 - inches | 1.95 / 2.48 |
| Redi-Rock™ | 11.0 | 12.0 | 1 | 41 | 6-8 | 2 - feet | 1.82 / 2.11 |
| Redi-Rock™ | 13.8 | 15.0 | 2 | 60 | 9-10 | 2 - feet | 1.83 / 2.27 |
| Redi-Rock™ | 16.8 | 18.0 | 2 | 60 | 11-12[2] | 3 - feet | 1.76 / 2.03 |

Notes:
1. Analysis results are for the greatest number of rows (i.e., highest wall in this range).
2. When 11 or more rows of block are used 3 layers of geogrid extending 10 feet from the back of the wall are required (See Figure G9.2)

**Slope Stability Analysis**

We used computer program SLOPE/W developed by GEO-STUDIO, Inc., to analyze global slope stability and calculate a minimum global FOS value, which is the ratio of resisting forces to driving forces. Thus, a FOS value of 1.0 indicates a slope that is at limiting equilibrium, or on the verge of failure. For constructed slopes along major roads, highways, or commercial/residential developments, the standard-of-care FOS for design purposes typically is 1.5 when input values are reasonably well-known.

Our computations were based on the Morgenstern-Price method of slices for slope stability analysis and using the geotechnical properties presented in Table G8.1. We estimated geometry and spatial relationships of subsurface geologic units based on field observations, test pit logs, and our experience with similar terrains. The computer analysis investigated about 4,000 potential failure paths and then identified the minimum-FOS path. The minimum computed FOS value was 1.64 so the planned wall geometry meets the FOS design criterion.

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- ☐ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 9/15/12 | DRAFT 50% |
| 2 | 9/29/12 | DRAFT 90% |
| 3 | 10/31/12 | FINAL |
| | | |
| | | |

DRAWN: CWS

DESIGN: SM

CHECK: TJW

FILE: WHICOU - PU12053A

PROJECT:
WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
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11-1-2012

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6 O'DONNELL ROAD, PULLMAN, WA 99163
Phone No.: (509) 339-2000

## 24 RETAINING WALL EARTHWORK

**Alignment Preparation**

1. Topsoil containing vegetation and organics must be removed from the proposed retaining wall alignment and stockpiled for use as landscaping or removed from the area.

**Excavation Characteristics**

1. Site soil is expected to be excavatable using conventional excavation techniques and equipment.
2. Bedrock is not expected within the planned construction limits (10 to 20 feet).
3. Temporarily excavate, slope, shore or brace excavations in accordance with *Washington Industrial Safety and Health Act* (WISHA) and *Washington Administrative Code* (WAC) guidelines. Regulations outlined in WAC Section 296-155 provide temporary construction slope requirements for various soil types and slopes less than 20 feet tall.
4. Uncontrolled fill is classified as *Type C* soil referencing WAC Section 296-155, and must be temporarily sloped back at least 1.5H:1V. Native clay loess in a firm, undisturbed and dry condition will classify as a *Type B* soil and can be sloped at 1H:1V.
5. Construction vibrations, seepage, or surface loading can cause excavations to slough or cave and should be avoided.
6. Ultimately, the contractor is solely responsible for site safety and excavation configurations and maintaining WISHA approved personnel for excavation monitoring.
7. Plan excavations carefully, allowing water collection points and utilizing conventional sumps and pumps to remove nuisance water from runoff, seeps, springs or precipitation.
8. Coordinate construction activities and excavation backfilling as rapidly as possible following excavation to reduce the potential for subgrades to degrade under construction traffic.
9. Subgrades must be graded to aggressively direct surface water away from subgrades to avoid infiltration.
10. Maintain dewatering systems to facilitate good drainage during construction and reduced over-excavation.

**Subgrade Preparation**

1. Prepare subgrades beneath the planned retaining wall and in all areas of structural fill placement by excavating to the necessary lines and grades with smooth blade equipment per *Earthwork* section, Sheet G2.
2. See Figure 1, Sheet G2 for soil improvements schematic, reference sections 19, 23, and 27 for specific soil improvement depths.
3. Once prepared and approved by the Geotechnical Engineer, it is the contractor's sole responsibility to protect subgrades from degradation from traffic, poor drainage, precipitation or other sources.

**Wet Weather/Soil Construction**

1. Ideally, perform earthwork construction during dry weather conditions.
2. The site soil is susceptible to pumping or rutting from heavy loads such as rubber-tired equipment or vehicles any time of the year.
3. Earthwork should not be performed immediately after rainfall or until soil can dry sufficiently to allow construction traffic without disturbing the subgrade (See *Site Drainage*, Section 13, Sheet G3).
4. Complete earthwork by track-mounted equipment that reduces vehicular pressure applied to the soil if construction commences in wet areas or before soil can dry. Stage hauling traffic to avoid multiple traverses in the same path.
5. If the subgrade is firm, but may be easily disturbed, the contractor may place an initial structural fill lift between 12 and 18 inches to help reduce the compaction energy on the sensitive subgrade. Thicker structural fill lifts can only be installed over sensitive subgrades at STRATA's direction during construction. Initial thicker fill lifts and over-excavations to remove soft, wet soil shall only be placed after the contractor has attempted to moisture condition and recompact the native soil and was unsuccessful.
6. Depending on precipitation, runoff and perched groundwater conditions, the site soil will be slightly over optimum moisture content. The contractor shall expect these conditions and be prepared to install runoff management facilities and to replace wet or disturbed soil with granular structural fill.

**Over-Excavation**

1. If construction takes place during wet weather conditions (not recommended), or the soil cannot achieve the required compaction following adequate efforts to moisture condition the soil; over-excavate to undisturbed, firm soil.
2. Additionally, over-excavations are required to complete shallow, granular soil improvements for retaining wall leveling pads as shown on sheet G2 (Figure 1).
3. Complete over-excavations with smooth blade equipment.
4. Replace excavation with geotextile fabric and granular structural fill. Soft soil over-excavation criteria shall be determined during construction with STRATA and Whitman County, but is anticipated to extend at least 1 foot below the subgrade.
5. Retaining wall foundation excavation dimensions are specified on sheet G9 (Figures G9.2-G9.4).

**Groundwater Considerations**

1. Groundwater was encountered during exploration at between 4.0 and 24.0 feet below the feet below the existing ground surface in all borings and test pits except B-5, TP-1, and TP-7.
2. Groundwater in the area can occur as minor or significant seeps or springs at any elevation as water infiltrates the soil profile and migrates along micro fissures in the soil structure or along boundaries between different soil types.
3. Groundwater will have a high probability to migrate along the bedrock surface below the site.
4. Groundwater may be encountered at any time of the year and contractors must have contingencies to rapidly remove water from all excavations with appropriately sized and maintained sumps or pumps. Recommendations for foundation drains and other measures to reduce groundwater infiltration are included in the subsequent report text.

## 25 FOUNDATION PAD DESIGN

1. The wall foundation subgrade beneath the soil improvements and gravel leveling pad must be prepared referencing the *Subgrading* report section (Section 7, Sheet G2).
2. Prior to gravel leveling pad construction, a non-woven geotextile fabric should be placed as a lining in the shallow trench to separate the subgrade soil from the gravel used for the foundation/leveling pad and to wrap the 4-inch perforated drain pipe laid at the rear of the trench (see Figures G9.1,G9.2, and G9.3).
3. We recommend the fabric be a non-woven, needle-punched filter fabric with characteristics specified in the *Geosynthetics* section, Sheet G2.
4. The gravel levelling pad must comprise 12 inches of 3/4-inch minus crushed surfacing per the *Structural Fill* report section (Section 10, Sheet G2), extending laterally 8 inches, soil improvements beyond 12 inches should utilize shotrock, reference sections 19, 23, and 27 for shotrock thicknesses.
5. The backfill immediately behind the facing blocks must comprise 8-inch minus Granular Structural Fill per the *Structural Fill* report section (Section 10, Sheet G2).
6. The foundation drain pipe must grade at least 1 percent to a daylight outlet, such as a riprap outfall area, subsurface stormwater drainage network, or existing drainage at least 50 feet from the wall. STRATA or a qualified representative from Whitman County should review all wall preparations prior to wall construction.
7. Geosynthetic Specification are presented in Section 8, *Geosynthetics*, Sheet G2.

## 26 REDI-ROCK™ SPECIFICATIONS

**General**

1. Redi-Rock blocks are typically delivered to the construction site using a flat bed trailer or boom truck.
2. Rubber tired backhoes, loaders, skid steers, or excavators are used to set the retaining wall blocks.
3. Redi-Rock blocks weigh 3,500 lbs or more. Make sure to use the proper sized equipment to handle the blocks. All lifting chains, rigging, or slings must be OSHA compliant and safety rated for proper working loads.

**Block Installation**

1. Properly mark the location of the retaining wall. Offset stakes should be placed at least 5 feet but no more than 10 feet in front of the face of the retaining wall. A stake should be provided at every elevation change and at a maximum of 50 feet apart.
2. Place a complete row of blocks on the prepared leveling pad (See *Foundation Pad Design*, Section 25). Blocks shall be placed tight together.
3. Block alignment should be established by lining up the "form line" where the face texture meets the steel form finished area at the top of the block, approximately 5 inches back from the front face.
4. Check all blocks for level and alignment as they are placed. Small adjustments to the block location can be made with a large pry bar. Set the bottom row properly so installation of the upper rows of blocks is much easier and more efficient.
5. Place non-woven geotextile fabric in the vertical joint between the blocks as needed to hold the backfill material between the blocks in place and prevent material from "washing out" through the joints between blocks. At Whitman County's discretion geotextile fabric in the vertical joints between blocks can be omitted.
6. Place and compact backfill in front of the bottom row of blocks to help hold them in place. Place granular structure fill between blocks.
7. Place the next row of blocks on top of the bottom row.
   - If needed, a half block can be used at the end of every other row to establish a running bond in the wall where a Redi-Rock block straddles the two blocks below it.
8. Push the Redi-Rock blocks forward until the groove on the bottom of the block comes in full contact with the knobs on the blocks below.
9. Place non-woven geotextile fabric in the vertical joint between the blocks (geotextile fabric in the vertical joints can be omitted at Whitman County's discretion), and place and compact the granular structure fill the same way as the bottom row.
10. Do not install more than one course of blocks without placing and compacting stone and backfill.
    - Having more than one course of blocks without backfill will prevent you from being able to properly place and consolidate the granular structure fill between blocks.
11. Repeat these steps with each course of blocks to the top of the wall.

**Steps in the Top of a Wall**

1. End blocks or garden corner blocks may be used to make a step-down.
   - If desired, the inside lip can be removed to allow the topsoil to fill to the edge of the block.
   - To remove the lip, make one cut with a concrete saw and knock the lip off with a sledgehammer.
2. Top blocks may be placed in a radius to provide a scalloped look.
   - 2 to 4 half blocks should be used.
   - Remove the outside knob on the last middle block of the bottom course before beginning scallop. A concrete saw and sledgehammer can be used to remove the knob in the field.
   - Freestanding corner blocks can be used inline to step-down or finish the end of a wall.
   - A Redi-Rock Step block or Cap Block can be used to provide a more finished look.

**Steps in the Bottom of a Wall**

1. Grade changes along the bottom of a wall can be accommodated by stepping the bottom row of blocks.
2. Steps in the bottom of a wall are relatively simple to make with granular structural fill.
   - Use a half bottom block to finish the bottom row before making the step. This continues the running bond between rows of blocks and keeps middle blocks from being used at the bottom of the wall.

**Planter Block Installation**

1. Planter blocks are used to provide for vegetation to break up the face of a wall.
2. Planter blocks can also be used without vegetation to increase the wall batter and help improve stability.
3. The trough in the planter blocks must be filled with soil, stone, or concrete, depending on how the planter blocks are used.
4. In no case shall the trough in the planter blocks be left empty as backfill from behind the wall can wash out through joints between the blocks causing voids to form behind the wall.
5. The planter block has a 16 5/8" setback and is supported partially on the stone backfill material behind the wall. It is important that the stone backfill be leveled and compacted prior to placing the planter blocks.
6. In some cases, planter blocks may be transitioned in or out of a normal middle block course in a wall.
   - This transition is done by removing one or two knobs at the transition, or by using the corner block.
   - Transitioning planter blocks in or out of a middle block course may offset the joints slightly from falling in the middle of the block below.
7. In general, keep all sources of water away from retaining walls.
   - Place geotextile fabric over the joint between planter blocks to eliminate soil from washing out (geotextile fabric between planter blocks joints can be omitted at Whitman County's discretion).
8. Construct the wall up to the elevation of the geogrid layer shown in the design. Before placing geogrid, grind smooth any rough edges on the back of the concrete blocks prior to placement to avoid damage to the geogrid sheets and place a 4-inch bed of crushed surfacing on top of the compacted shotrock to help prevent installation damage to the geogrid.

**Geogrid Placement**

1. Geogrid must extend into the reinforced soil zone approximately 10 feet, measured from the back of the wall to the back of geogrid, when no connection location is available (i.e. top and bottom row of geogrid, See Figure G9.1). Geogrid must extend into the reinforced soil zone approximately 9 feet, measured from the back of the wall to the back of geogrid, when a connection location is available (i.e. middle row of geogrid, see Figure G9.1). Place geogrid sheets from the wall blocks to the design length at the back of the reinforced soil zone.
2. Use Tensar BX1200 or equivalent biaxial geogrid (*Geosynthetics* section, Sheet G2).
3. Geogrid must be placed in a continuous sheet throughout its length from the connection at the Redi-Rock blocks to the back of the reinforced zone.
   - When no connection from the geogrid to the block is present (i.e. lower and upper geogrid layers, see Figure G9.2), roll the geogrid parallel to the retaining wall.
   - When a connection from the geogrid to the block is present (i.e. middle geogrid layer, see Figure G9.2), roll the geogrid perpendicular to the wall to achieve the correct anchored tail and main geogrid reinforcement lengths (See Figure G9.1).
4. Do not splice or overlap the geogrid.
5. Make the appropriate connection to the Redi-Rock blocks. (See text for Geogrid Connection to Blocks).
6. Pull the geogrid sheets taut and pin them down prior to placing and compacting backfill.
7. Perform compaction starting from the back of the wall blocks and working into the reinforced soil zone.
8. Avoid "bunching" the geogrid reinforcement.
9. Do not operate tracked construction equipment directly on the geogrid reinforcement.
10. A minimum crushed surface fill thickness of 6" is required for the operation of tracked vehicles over the geogrid reinforcement.
11. Turning of tracked vehicles should be kept to a minimum to prevent displacement of the Granular Structure Fill and the geogrid reinforcement.
12. Rubber-tired vehicles may pass over the geogrid reinforcement at a slow speed (less than 5 mph).
13. Sudden breaking and sharp turning should be avoided.
14. Place retained soil immediately between the reinforced soil zone and the back of the excavation.
15. Bring the reinforced and retained soil up to grade at the same time.
16. At no time should the elevation of the reinforced soil be more than 1 block higher than the retained soil.

## 26 REDI-ROCK™ SPECIFICATIONS

**Geogrid Connection to Blocks**

1. Connection between geogrid sheets and the Redi-Rock Series blocks is made with the Redi-Rock Type 1AT connection. The connection is made with one 7/16" diameter solid fiberglass rod available from your local Redi-Rock manufacturer.
2. The Type 1AT Connection is made with the following steps:
   - Install a complete row of retaining wall blocks. Sweep the top of the blocks clean.
   - Lay the geogrid across the top of the block and let it hang down to the bottom of the front face.
   - Place one 40" fiberglass rod over the geogrid into the geoconnector slot.
   - Pull the geogrid back over the rod and extend the tail beyond the back of the block to provide a minimum of 3 feet embedment (See Figure G9.1).
   - Install the next course of retaining wall blocks to lock the geogrid connection in place.
   - Pull the geogrid flat and tight. Secure it in place with pins or staples as recommended by the manufacturer.
   - Place 3 inches of crushed surfacing between the anchored tail and the primary geogrid layer.
   - Backfill with crushed surfacing and compact as specified in Table 2, Sheet G2.
3. Geogrid connections shown in Figure G9.2 as coming into the middle of a block (row 11 and row 12) do not require connections.

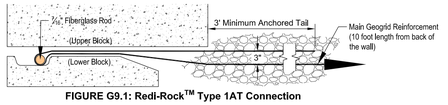


**FIGURE G9.1: Redi-Rock™ Type 1AT Connection**

## 27 WALL CROSS SECTIONS

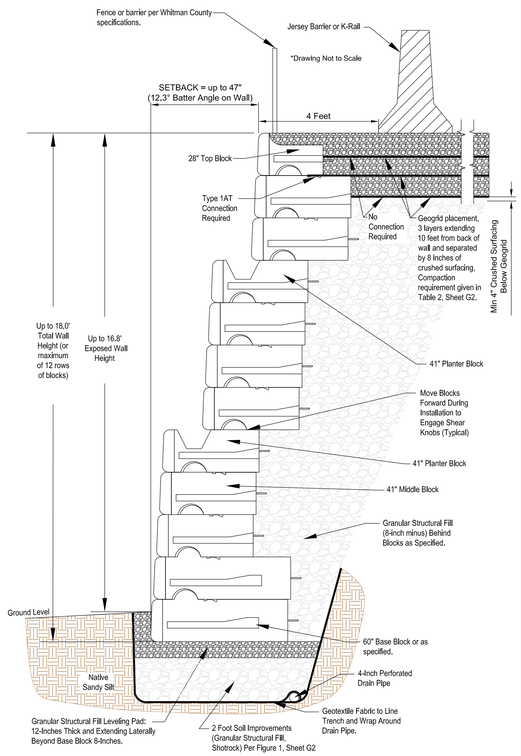


**FIGURE G9.2: Redi-Rock™ Gravity Wall Standard Gravity Blocks up to 17 Feet Exposed Height Station 0+00 to 0+70**

Notes:
1. All wall backfill must be placed as granular structural fill. Wall foundation subgrade preparations and structural fill placement must be observed by STRATA.
2. Where the wall is 11 rows or more high (approximately Station 0+00 to 0+70) geogrid (Tensar™ BX1200 or biaxial equivalent) is required as shown to extend behind the wall for 10 ft, covered in 8-inches of crushed surfacing (Table 1, Sheet G2)
3. Drawing not to Scale.

## 27 WALL CROSS SECTIONS

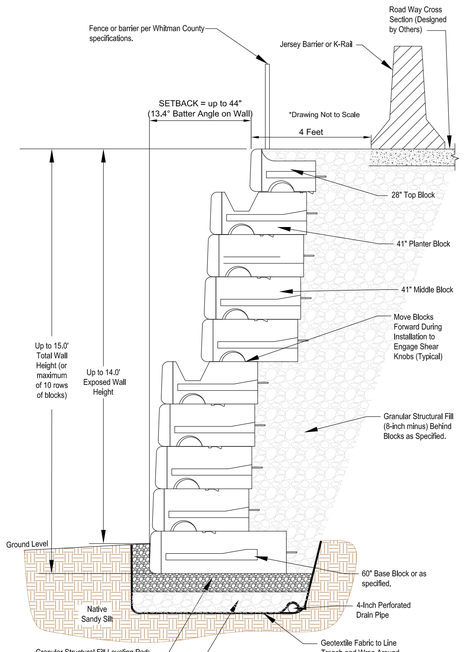


**FIGURE G9.3: Redi-Rock™ Gravity Wall Standard Gravity Blocks up to 14.0 Feet Exposed Height Station 0+70 to 1+10**

Notes:
1. All wall backfill must be placed as granular structural fill. Wall foundation subgrade preparations and structural fill placement must be observed by STRATA.
2. When the wall height is limited to 9 total rows of blocks, the planter block at row 9 can be replaced with top block.
3. Drawing not to Scale.

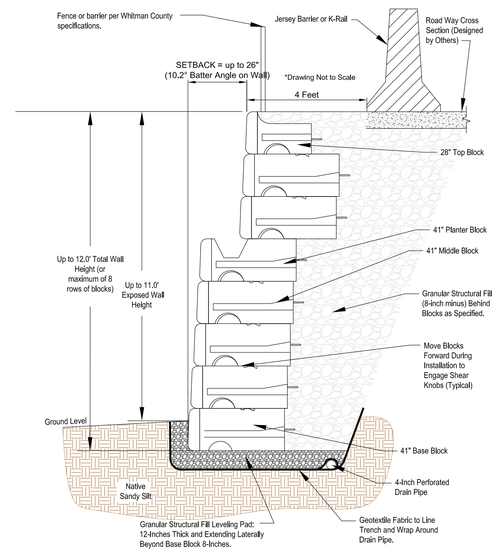


**FIGURE G9.4: Redi-Rock™ Gravity Wall Standard Gravity Blocks up to 11.0 Feet Exposed Height Station 1+10 to 2+80**

Notes:
1. All wall backfill must be placed as granular structural fill. Wall foundation subgrade preparations and structural fill placement must be observed by STRATA.
2. When the wall height is limited to 5 total rows of blocks, the planter block at row 5 can be replaced with top block.
3. Drawing not to Scale.

**ISSUED FOR**
- ☐ DESIGN USE
- ☒ PRELIMINARY REVIEW
- ☒ YOUR APPROVAL
- ☐ REFERENCE
- ☐ CONSTRUCTION
- ☐ DESTROY PREVIOUS PRINTS

| REV | DATE | DESCRIPTION |
|---|---|---|
| 1 | 9/15/12 | DRAFT 50% |
| 2 | 9/29/12 | DRAFT 90% |
| 3 | 10/31/12 | FINAL |
| | | |
| | | |

DRAWN: CWS

DESIGN: SM

CHECK: TJW

FILE: WHICOU - PU12053A

PROJECT:

WHITMAN COUNTY
TRANSFER FACILITY
CAROTHERS ROAD
WHITMAN COUNTY, WA

PREPARED FOR:
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REGISTERED
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