This master should be used by designers working on Port of Portland construction projects and by designers working for PDX tenants (“Tenants”). Usage notes highlight a few specific editing choices, however the entire section should be evaluated and edited to fit specific project needs.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

1. GENERAL
	* + 1. DESCRIPTION
				1. This section describes conduit, ducts, duct accessories, handholes, boxes and manholes constructed and installed to form a complete underground raceway system.
			2. RELATED WORK SPECIFIED ELSEWHERE
				1. Section 033000, Cast-In-Place Concrete
				2. Section 312300, Trenching, Backfilling, and Compacting
				3. Section 312319, Dewatering
			3. REFERENCES
				1. AASHTO: American Association of State Highway and Transportation Officials

AASHTO Specification for Highway Bridges

* + - * 1. ACI: American Concrete Institute

ACI 318: Building Code Requirements for Structural Concrete and Commentary

* + - * 1. ASTM: American Society for Testing and Materials

ASTM A48: Standard Specification for Gray Iron Castings

ASTM C478: Standard Specification for Precast Reinforced Concrete Manhole Sections

* + - * 1. NEC: National Electrical Code
				2. UL: Underwriters Laboratories

UL 651: Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings

UL 651A: Standard for Schedule 40, 80, High-Density Polyethylene (HDPE) Conduit and Fittings

* + - 1. SUBMITTALS
				1. Submit product data and cut sheets.
1. PRODUCTS
	* + 1. PRECAST HANDHOLES AND PULL BOXES
				1. Acceptable Manufacturers: Oldcastle, Christy, Hanson, Hubbell, or equal.
				2. Handholes and pull boxes are defined as boxes up to a size of 17"x30".
				3. Construct the box using precast concrete or polymer concrete with an open bottom unless noted otherwise on the drawings.
				4. The box shall be rated for incidental traffic. It shall be suitable for H-20 loading in off-street locations that are not subject to high density traffic.
				5. Engrave the cover to indicate the contents such as “ELECTRIC,” “COMM,” “LIGHTING,” “SIGNALS,” or as noted on the drawings.
				6. The cover shall be a non-skid surface, include lift or pull slots, and be capable of being secured to the body with fasteners.
				7. The manufacturer’s name and model number shall be permanently indicated to an interior wall face.
			2. PRECAST CONCRETE VAULTS
				1. Acceptable Manufacturers: Oldcastle, Hanson, or equal.
				2. Vaults are defined as boxes larger than 17"x30".
				3. Vaults shall be precast concrete, solid bottom with a knocked-out sump to allow for drainage, embedded galvanized channels in each wall, a 1-inch diameter ground rod knockout in the floor, and galvanized pull/lift irons in each corner. Vaults shall have an opening in the bottom to allow drainage.
				4. Construct vaults using concrete that has a minimum 4,000 psi strength at 28 days.
				5. Design:

Design tops and walls of structures for AASHTO H-20 highway loading, with 30 percent loading added for impact.

Design precast structures in accordance with AASHTO Specification for Highway Bridges. Design concrete and reinforcing in accordance with ACI Code 318. Precast units shall conform to ASTM C478.

Design walls to withstand all soil pressures, taking into consideration the soil to be encountered and groundwater level present at the site. Assume ground water level is at ground surface unless a lower water table is indicated in the boring logs.

Precast vaults shall be designed and constructed not to float.

Assembled sections shall have mating edges with tongue-and-groove joints. Design joints to firmly interlock adjoining components, and provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strips installed in accordance with the manufacturer’s instructions.

Slope floor 2 percent in all directions to the sump.

Steel components other than reinforced steel shall be hot-dip galvanized after fabrication.

Identify vaults using the manufacturer’s name embedded in, or otherwise permanently attached to, an interior wall face.

* + - * 1. Vaults located in roadways shall be provided with round high-density H-20 rated traffic covers. Other areas such as sidewalks, parking lots, and landscape areas shall be provided with galvanized steel hatches unless otherwise noted on the drawings.

High density traffic areas shall be provided with H-20 rated cast iron manhole covers. These covers shall be a minimum of 30-inch diameter, with lift holes and provisions to secure into the vault top with fasteners. Round vault covers and frames shall be Class 30B grey cast iron in accordance with ASTM A48.

Sidewalks, parking lots, and landscape areas shall be provided with traffic rated galvanized steel hatches unless noted otherwise on the drawings. Include a locking latch, a recessed lift handle, and a hinging system that allows the cover to open a full 180 degrees. Communication vaults containing fiber optic back bone cables shall be provided with a pad-lock compartment in the cover.

* + - * 1. Permanently label all vaults with the Port-assigned vault number. Vault designations shall be visible from the surface. Communication vaults will be designated “CVLT-xxxx” and electrical vaults designated “EVLT-xxxx,” where xxxx is a vault number assigned by the Port. Cast covers shall have the designation cast into the cover at the casting foundry. If casting the designation into the cover is not an option, the Contractor shall propose other means to permanently label the vault. Galvanized steel hatches shall include the bead welded designation onto the cover. If the cover cannot be bead welded, the Contractor shall propose other permanent marking options.
				2. Conduit entries through vertical vault walls shall be through cast-in-place molded plastic duct connections such as Term-A-Ducts unless otherwise noted on the drawings.
			1. DUCT LINES
				1. Size: Except where otherwise shown on the drawings, ducts and conduits shall not be less than 4-inch trade size.
				2. Ducts (Concrete-Encased): Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 651 and carry appropriate UL listing for below-ground use.
				3. Ducts (Direct-Buried):

Rigid Non-Metallic Conduit: Type II PVC Schedule 40, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 651 and carry appropriate UL listing for above- and below-ground use.

Rigid Non-Metallic Polyethylene Conduit: HDPE Schedule 40, 80, suitable for use with 90°C rated wire. Conduit shall conform to UL Standard 651A and shall have appropriate UL listing for below-ground use.

Rigid Metal Conduit: UL 6 galvanized rigid steel. Where metal conduit transitions from concrete to soil, provide supplementary corrosion protection (20 MIL corrosion protection tape half-wrapped) a minimum of 4 inches on each side of the point where the raceway emerges.

* + - * 1. Manufactured bends shall be not less than 36 inches in radius for conduits 4 inches in diameter or larger. Fiberglass manufactured bends are acceptable.
			1. INNERDUCT
				1. Acceptable Manufacturers: Carlon Riser-Guard, or equal.
				2. Innerduct shall be a UL-listed non-metallic flexible raceway for use with riser or general-purpose fiber and communication applications. The innerduct shall be fabricated from extruded PVC resin and provided in a coilable tubing for use as a single or multiple raceway. The product shall be available in 3/4-inch through 2-inch diameters. The raceway shall include a pre-installed pull tape. The innerduct shall be capable of being direct buried, encased in concrete, and used to provide multiple raceways within an existing conduit system.
			2. SPACERS
				1. Acceptable Manufacturers: Carlon, or equal.
				2. Factory-fabricated rigid PVC vertical and horizontal interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum of 3 inches separation between ducts while supporting ducts during concreting or backfilling.
			3. GROUND RODS
				1. Ground rods shall be copper-clad steel, 3/4-inch diameter, and 10 feet long.
			4. GROUND WIRE
				1. Ground wire shall be stranded bare copper No. 6 AWG minimum.
			5. CONDUIT EXPANSION/DEFLECTION FITTINGS
				1. Acceptable Manufacturers: Crouse-Hinds, O-Z/Gedney, or equal.
				2. Conduit expansion/deflection fittings in embedded runs shall be rated for indoor use, outdoor use, buried underground, or embedded in concrete in non-hazardous areas.
				3. Fittings shall allow axial expansion or contraction up to 3/4 inch and angular misalignment of the axes of the coupled runs in any direction to 30 degrees. Inner sleeves shall maintain constant inside diameter in any position and provide smooth insulated wireway for protection of wire insulation.
				4. Fittings shall have a watertight flexible neoprene outer jacket and tinned copper flexible braid grounding strap.
				5. Use with galvanized rigid steel conduit or PVC Schedule 40 conduit utilizing rigid metal conduit nipples and rigid metal to PVC adapters.
			6. HDPE CONDUIT COUPLINGS
				1. Acceptable Manufacturers: Dura-Line Shur-Lock II, or pre-bid approved equal.
				2. Couplings and fittings used for transitioning between HDPE conduit and PVC conduit shall be designed for that purpose and shall be UL listed.
1. EXECUTION
	* + 1. CONDUIT ENCASEMENT OR EMBEDMENT (STRUCTURES AND DUCT BANKS)
				1. Concrete shall be class 3500-3/4 with red dye. Red dye may be installed onto the top of the concrete encasement.
				2. Concrete-embedded conduit shall be separated from the earth by at least 3 inches of concrete. Clearances shall be equal to the conduit diameter, but not less than 1 1/2 inches. Maintain clearances between conduits encased in slabs. Clearances of less than 1 1/2 inches at conduit crossing and terminating locations are acceptable.
				3. Provide conduit expansion/deflection fittings where embedded conduit crosses building expansion joints, passes between two adjacent structures, or passes between a duct bank and structure. Locate conduit expansion/deflection fittings between duct bank and manholes or pull boxes where noted on the drawings.
				4. Place duct banks on an undisturbed soil base wherever possible. Where duct banks pass through backfilled areas, the soil base shall be as specified elsewhere in the contract documents. Duct banks that run under traffic areas shall be steel reinforced.
				5. Locate plastic spacers 5 feet to 8 feet on center as recommended by the manufacturer. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Secure spacers to earth and to ducts to prevent conduit flotation during concreting. Conduit runs shall be watertight.
				6. Protect conduit ends from damage during construction. When using plugs for protection, a 1/4‑inch hole shall be drilled in the lower portion of the plug to provide drainage.
				7. Where a conduit is specified “spare” or for future use, install a nylon cord in conduit and fasten at each end.
				8. Pull leather-washer-type duct cleaner, with graduated washer sizes through full lengths of ducts immediately after concrete is poured. After the concrete has set but before backfilling, pull a 4‑inch-long mandrel having a diameter equal to the conduit’s inside diameter minus 1/2 inch through each conduit. The mandrel shall be lead-covered or painted white so that it will indicate any protrusion on the inside of the conduit.
			2. PRECAST HANDHOLES AND PULL BOXES INSTALLATION
				1. Install precast handholes and pull boxes on a solid ring of base material such as concrete around the outer edge to prevent settlement. The base material shall include openings that allow drainage from the box into the soil. Set boxes plumb and elevate slightly above surrounding grade to prevent them from becoming the water collection points. Seal conduit ends to prevent debris from entering the raceway.
			3. PRECAST VAULTS INSTALLATION
				1. Locate vaults at the approximate location shown on the drawings with due consideration given to other utilities, grades, duct lines, obstructions, and paving.
				2. Install on a level bed of well-tamped gravel or crushed stone, well-graded from the 1-inch to 2‑inch sieve. Compact rock to prevent settlement, and then install drainage fabric over the area where the vault sump will be located. The sump shall be a clear opening from the vault interior to the surrounding surface to provide a pathway for water.
				3. In paved areas, set top of vault plumb and flush with finished surface. In unpaved areas, set vault top slightly higher than surrounding area to prevent the vault from collecting surrounding water.
				4. Install a ground rod in each vault through the ground rod knockout in the floor.
				5. Install a bonding conductor along the perimeter of the interior walls. Bond all metallic parts including all embedded channels, frames, ladders, etc. Connect the ground rod to this bonding conductor.
				6. In cases where Term-A-Ducts were not provided at conduit entries, fill the breakout windows with concrete or non-shrink grout after all ducts have been installed. Provide conduit entries with a smooth bell end to prevent cable damage.
				7. Affix a laminated plastic label to the vault wall adjacent to each conduit entry/exit. The label shall indicate the conduit number and its destination. For example, “#1 to CVLT-1234” indicates that conduit #1 extends to vault CVLT-1234. Labels shall be engraved phenolic that is suitable for the environment. Acceptable attachment methods include stainless steel fasteners and permanent epoxy.
				8. Install a Port-furnished Confined Space Identification sign to the underside of the vault lid or affix the sign to near the top of the vault wall with stainless steel screws.
			4. TRENCHING
				1. Excavate trenches in accordance with Section 312300.
				2. Work with extreme care near existing utilities to avoid damaging them. Cut the trenches neatly and uniformly.
				3. For Concrete-Encased Ducts:

After excavation of the trench, drive stakes in the bottom of the trench at 4-foot intervals to establish the grade and route of the duct bank.

Pitch the trenches uniformly toward manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching the ducts towards buildings.

The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that the concrete envelope can be poured without soil inclusions. Use forms where the soil is not self-supporting.

After the concrete-encased duct has sufficiently cured, backfill the trench in accordance with Section 312300.

* + - 1. DUCT LINE INSTALLATIONS
				1. General:

Duct line shall be in accordance with the NEC, as shown on the drawings and as specified.

Slope duct to drain toward manholes and away from building and equipment entrances. Pitch shall be not less than 4 inches in 100 feet. Curved sections in duct lines shall consist of long sweep bends with a minimum radius of 50 feet in the horizontal and vertical directions unless noted otherwise on the drawings. The use of manufactured bends is limited to building entrances and stub-ups to equipment.

Underground conduit stub-ups to equipment inside buildings shall be galvanized rigid steel and shall extend at least 10 feet outside the building foundation. Stub-ups to equipment, mounted on outdoor concrete slabs, shall be galvanized rigid steel and shall extend at least 5 feet from edge of slab. Install insulated grounding bushings on the terminations. Couple the steel conduits to the ducts with suitable adapters, and encase with 3 inches of concrete.

Upon completion of the duct bank installation, pull a standard flexible mandrel through each duct. The mandrel shall be at least 12 inches long, and shall have a diameter 1/2 inch less than the inside diameter of the duct. After mandreling, pull a brush with stiff bristles through each duct to remove the loosened particles. The diameter of the brush shall be equal to or slightly larger than the diameter of the duct.

Seal the ducts and conduits at building entrances and at outdoor equipment terminations with a suitable non-hardening compound.

Conduits shall be joined, terminated and sealed with fittings, materials and methods recommended by the manufacturer. Supply all necessary fittings and materials for a complete conduit/duct system.

* + - * 1. Concrete-Encased Ducts:

Duct lines shall consist of single or multiple duct assemblies encased in concrete, and installed with top of duct bank not less than 36 inches below established grade unless otherwise indicated. Ducts shall be uniform in size and material throughout the installation.

Rigid base and intermediate spacers shall securely support and maintain uniform spacing of the duct assembly at least 3 inches above the trench bottom during pouring of concrete. Spacer spacing shall not exceed 8 feet. Use a minimum of 3 spacers for each 20-foot length of duct.

Clearances between individual ducts:

For like service, clearance shall be not less than 3 inches.

For high voltage power and telephone services, clearance shall be not less than 6 inches.

For high voltage and 600 volt services, clearance shall be not less than 3 inches.

Provide tie wires to prevent displacement of the ducts during pouring of concrete. Tie wires shall not act as substitutes for spacers.

Terminate duct lines at window openings in manhole walls as shown on the drawings. Adjust window openings to correspond with duct line inverts. All ducts shall be fitted with end bells.

Couple the ducts in staggered rows and layers to ensure maximum strength and rigidity of the duct bank.

Extend the concrete envelope encasing the ducts at least 3 inches beyond the outside walls of the outer ducts and conduits.

Install reinforcing steel bars within the top and bottom of each concrete envelope within 5 feet of the building, at manhole wall penetrations, under roadways, and between concrete pours. Where shown on the drawings, incorporate additional steel reinforcing in the duct envelopes.

Keep ducts clean of earth, sand, or gravel during construction, and seal with tapered plugs upon completion of each portion of the work.

Where new ducts, conduits, and concrete envelopes are to be joined to existing manholes, make the joints with the proper fittings and fabricate the concrete envelopes to ensure smooth, durable transitions.

* + - * 1. Direct Burial Duct and Conduits:

Install direct burial ducts and conduits only where shown on the drawings.

Ducts and conduits shall be joined and terminated with fittings recommended by the conduit manufacturer.

Tops of ducts and conduits shall be not less than 24 inches below grade.

Do not kink the ducts or conduits.

* + - * 1. Slab on Grade:

Ducts and conduits shall not be installed in slab on grade, unless otherwise shown on the drawings.

Install ducts and conduits a minimum of 6 inches below slabs as measured to top of raceway.

* + - 1. UTILITY WARNING TAPE AND LOCATE WIRE
				1. Place a continuous strip of utility warning tape approximately 12 inches above ducts or conduits before backfilling trenches. See Section 312300, for tape description and installation requirements.
				2. Provide utility locate wire as described in Section 312300.
				3. Extend locate wire to near vault top and secure with an additional 2 feet of spare loop. Additional conductor length allows equipment used by locators to be positioned outside the vault, thereby eliminating a confined space entry.

END OF SECTION 260543