

## Precast Reinforced Concrete Structures, General Requirements



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## 2. Scope

This standard covers the general requirements for precast reinforced concrete structures used at Seattle City Light (SCL).

This standard applies to the following SCL reinforced concrete products:

- Vaults
- Vault cover
- Pads

Specific requirements shall be according to the detailed material standards and purchase orders issued subsequent to competitive solicitations.

This standard does not apply to panel vaults.

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## 3. Application

Precast concrete structures are used to construct the underground electric system.

Precast concrete structures may be used to house equipment, cables, service connections and splices for the distribution system.

For non-network vaults, a fixed ladder is required when the vault floor exceeds 12 feet 6 inches below finished grade. For network vaults, a fixed ladder is required when the vault floor exceeds 14 feet 5 inches below finished grade.

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## 4. Definitions

**Vault (as defined by NESC)** - A structurally solid enclosure, (including all sides, top, and bottom), above or below ground, where entry is limited to personnel qualified to install, maintain, operate, or inspect the equipment or cable enclosed. The enclosure may have openings for ventilation, personnel access, cable entrance, and other openings required for operation of equipment in the vault.

**Vault (as defined by SCL)** - An enclosure that is used for primary service. Enclosures 444 or larger.

**Vault Assembly/Assemblies (as defined by SCL)** - A vault that is composed of multiple components assembled together to form a single unit.

**Ring Vault (as defined by SCL)** - A vault that is composed of multi-sections, i.e. base, mid-section, and a top section. These vaults may also have various risers to achieve the proper height and access openings. Enclosures 818 and 814.

**Concrete Encased Electrode (as defined by NESC)** - A metallic wire, rod, or structural shape, meeting Rule 93E5 and encased in concrete, that is not insulated from direct contact with earth, shall constitute an acceptable ground electrode. The concrete depth below grade shall be not less than 1 foot, and a depth of 2.5 feet is recommended. Wire shall be no smaller than AWG No. 4 if copper, or 3/8-inch diameter or AWG No. 1/0 if steel. It shall be not less than 20 feet long and shall remain entirely within the concrete except for the external connection. The conductor should be run as straight as practical.

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## 5. Industry Standards

Precast reinforced concrete structures shall meet the applicable requirements of the latest revision of the following industry standards:

**ACI 318**, "Building Code Requirements for Structural Concrete and Commentary"

**ANSI/AWS D1.4/D1.4M**, "Structural Welding Code – Reinforced Steel"

**ASTM A123/A123M**, "Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products"

**ASTM A615/A615M**, "Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement"

**ASTM A706/A706M**, "Standard Specification for Low-Alloy Deformed and Plain Bars for Concrete Reinforcement"

**ASTM A1064/A1064M**, "Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement Plain and Deformed, for Concrete"

**ASTM C39/C39M**, "Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens"

**ASTM C150/C150M**, "Standard Specification for Portland Cement"

**ASTM C478**, "Standard Specification for Precast Reinforced Concrete Manhole Sections"

**ASTM C857**, "Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures"

**ASTM C858**, "Standard Specification for Underground Precast Concrete Utility Structures"

**AWS D1.4**, "Structural Welding Code— Reinforcing Steel"

**National Electrical Safety Code (NESC) C2-2012, Rule 094B6**;  
"Concrete-Encased Electrodes"

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## 6. Conflict

Where conflict exists, the following order of precedence shall apply:

1. SCL purchase order
2. SCL General Terms and Conditions
3. This standard
4. SCL detailed material standards
5. ASTM standards
6. Other industry standards

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## 7. Purchase Order Information

Purchase orders will include the following minimum information:

- Vault size and description
- SCL general material standard number including revision date
- SCL detailed material standard number including revision date
- SCL stock number
- Total order quantity
- Price
- Delivery date
- Ladder requirement

Design changes shall require the prior written approval of an SCL Org 321 Standards Engineer.

## 8. Requirements

### 8.1 Reinforced Concrete

Minimum compressive strength of concrete shall not be less than 4,500 pounds per square inch in 28 days as determined by the ASTM Method C39.

Cement shall conform to ASTM C150.

No additives containing calcium chloride or any other material that will produce corrosive ions shall be used in the concrete.

Welded wire fabric shall conform to ASTM A1064.

Steel Reinforcing Bars shall conform to ASTM A615, Grade 60 or ASTM A706, Grade 60.

Welding of reinforcing steel shall conform to the Structural Welding Code, Reinforcing Steel (AWS D1.4) of the American Welding Society.

The concrete cover (measured from the surface of the concrete to the outside surface of the reinforcement) for reinforcement shall be 1-1/2 inches minimum for main reinforcing bars and 3/4 inch for stirrups and ties.

The concrete finish shall be free of rock pockets and honeycombed areas.

The interior walls, ceiling and exterior surfaces exposed shall be smooth.

Rock pockets over 3/8 inch deep and other imperfections on all surfaces shall be patched and troweled to match the surrounding surface.

### 8.2 Structural Design

Structural design of the precast vault shall conform to ACI 318 and ASTM C857 with the following clarifications:

- Reinforced concrete vaults shall be designed and constructed to be watertight.
- Top of vault shall be assumed to be at a minimum of 2 ft and maximum (unless noted on drawings) 5 ft below grade.
- Live Load: AASHTO HS-20 truck, P=16 kips. Traffic can approach the structure from any direction.
- 30% live load impact load factor for soil cover less than or equal to 3 ft.
- No live load surcharge for soil cover greater than 8 ft.
- Soil density shall be 120 lb force per cubic ft.
- 40 lb force per cubic ft Equivalent Fluid Pressure Lateral Soil Pressure Above Water Table.
- 80 pounds force per cubic foot Equivalent Fluid Pressure Lateral Soil Pressure Below Water Table.
- 80 pounds per square ft Live Load Surcharge.
- Buoyancy: Vault weight (without equipment) plus weight of soil cover shall be greater than 1.1 times the hydrostatic uplift force on the base of the vault. It cannot rely on skin frictional resistance between backfill and vault wall surfaces. If the gravity load is insufficient, then the vault shall be designed with restraints to withstand the buoyant force. Buoyancy calculations shall be submitted for each vault and a restraint design as required. See Section 12.
- The groundwater table shall be assumed to be 5 ft below grade.

## 8.3 Grounding

### 8.3.1 Electrodes

Concrete-encased electrodes shall comply with NESC 094B6.

Electrodes shall be:

- No smaller than #4 AWG if copper or 3/8-inch diameter (1/0) if steel.
- No less than 20 ft long and shall remain entirely within the concrete except for the external connections.
- Installed as straight as possible.
- Encased in a minimum of 1-1/2 inches of concrete.
- Positioned a minimum of 2-1/2 ft below the top of the vault.

### 8.3.2 Ground Insert Connector

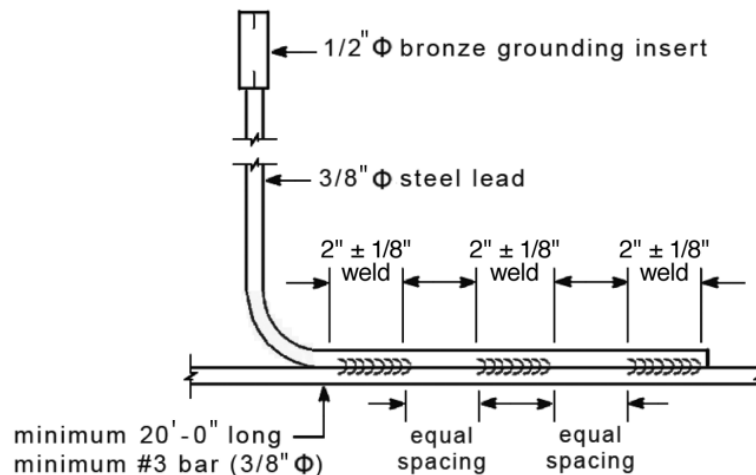
Ground insert connectors shall be installed flush (neither recessed nor protruding) with the vault wall.

Bronze inserts shall be tapped for 1/2-13 UNC bolts, and located on two opposite walls.

The nominal thread depth of the bronze insert shall be 1-1/8 inches.

The lead rod, a 3/8-inch steel or bronze rod, shall be connected to the ground electrode with arc weld or Cadweld (exothermic connection) at a minimum of three points as shown in Figure 8.3.2.

**Figure 8.3.2. Lead Rod and Concrete-Encased Electrode Weld Details**



Inserts shall be plugged to prevent contamination from entering.

Insert faces shall be exposed and marked prior to pick-up or delivery.

On multi sectioned vaults (3 or more sections):

- The inserts shall be aligned vertically.
- Only the middle section will have the inserts that face inside and outside of the vault.
- All other inserts in the vault shall be placed in accordance with the drawing of the specific vaults on manufacturer's specifications and approved by SCL.

## **8.4 Knockouts and Vault Openings**

### **8.4.1 Vault Openings**

Vaults 7 ft x 12 ft (inside dimensions) and larger shall have two 42-in diameter access entries, unless specified otherwise in the detailed material standards.

All vaults shall have cable knockouts located in each lower corner of the enclosure according to the manufacturer's standard and SCL's requirements.

Knockout and duct openings shall be beveled on the exterior surface.

Each enclosure with a floor shall have a ground-rod knockout at two corners of the base of the enclosure. Size, shape, quantity and location of knockouts shall be as specified in the detailed material standards.

### **8.4.2 Duct Bank Knockout Threaded Inserts**

For 712 and larger vaults, provide four minimum 1/2-in diameter ferrule-threaded insert at perimeter of each duct bank knockout. These threaded inserts are to allow the duct bank rebar to dowel into the vault wall.

Threaded inserts shall be spaced 12 in (nominal) apart along the height of each knockout panel.

## **8.5 Lifting Methods**

Lifting provisions shall be provided per manufacturer's and SCL requirements.

### **8.5.1 Covers**

All vault covers, pads or slabs, or risers weighing less than 9,000 pounds shall have 3/4-in lifting inserts on each corner of the top surface, or as described in the detailed material standards.

### **8.5.2 Burke Fittings**

All vault covers or structures over 9,000 pounds shall have either a 2-ton or a 4-ton Burke fitting placed in each corner of the top surface or on the four walls, as described in the detailed material standards.

### **8.5.3 Lifting Inserts**

Lifting inserts shall be provided as shown in the detailed material standards.

All metal lifting devices cast into the internal or external surfaces of vaults for handling purpose shall be hot-dipped galvanized or made from stainless steel.

## **8.6 Vault Accessories**

Structural components shall be provided with vault section components. Structural components include, but are not limited to, grout, seals, or mastics, and joint hardware.

Items in the following sections to be included with all vaults.

### **8.6.1 Cable Pulling Irons**

Vaults larger than 577 shall have 7/8-in diameter cable pulling irons mounted on each corner of the vault and be suitable as anchors for cable pulling operations.

7/8-in diameter cable pulling iron mounts shall withstand 10 kips maximum working tension and 20 kips ultimate strength.

577 and smaller vaults shall have 1/2-in diameter cable pulling irons mounted on each corner of the vault and be suitable as anchors for cable pulling operations.

1/2-in diameter cable pulling iron mounts shall withstand 5 kips maximum working tension and 10 kips ultimate strength.

Pulling irons shall be stainless steel or hot dipped galvanized steel.

The maximum working tension for pulling irons shall be stenciled on the wall surface near two of the roof pulling irons.

Burke lifting devices are not suitable for cable pulling purposes.

#### **8.6.2 "C" Channels**

Vault shall be provided with a cast-in-place channel.

"C" channels shall be included on each of the four interior walls unless stated otherwise in the detailed material standards.

"C" channel strut size shall be 1-5/8 in by 13/16 in for the following vaults: 504, 507, 644, 577, 687, and 5106, unless stated otherwise in the detailed material standards.

"C" channel strut size for vaults sized 712 and larger shall be 1-5/8 inches by 7/8 inches unless stated otherwise in the detailed material standards.

#### **8.6.3 Drainage and Sump**

All vaults shall have a drain sump.

Vaults that are 7 ft x 12 ft (inside dimensions) and larger shall have a rectangular sump at one end wall. Sump shall be equipped with galvanized grating.

Vaults smaller than 7 ft x 12 ft shall have a circular sump with cover located near the center of the vault.

The floor shall be sloped to drain to the sump in 577 or larger vaults.

#### **8.6.4 Ladders**

Where a ladder is required, it shall conform to the following requirements:

- Ladders shall be corrosion resistant.
- Ladders shall be made according to SCL Drawing D-28304, Rev 5, "Retractable Ladder, Vault and Manhole Access," with the following clarifications:
  - Retractable upper ladder length shall be 7 ft-8 in
  - The upper ladder's 3/4-in square rungs shall extend 5/16-in minimum beyond the outer rail wall to ensure it will not come loose if the weld fails.
  - Both the upper and lower ladder sections shall be permanently marked with the fabricator name and production date

Ladder substitution shall be submitted to SCL civil engineer for approval.

#### **8.6.5 Joint Sealant**

Vault sections shall be provided with butyl rubber joint sealant material or gasket mastic to be used between vault keyways and sections, including hatch riser rings.

#### **8.7 Metal Doors, Access Cover Plates, and Hatches**

All lids, hatches, and frames shall be provided with a grounding site.

##### **8.7.1 Frames and Hatches**

All frames and hatch covers shall be designed for at least 20.8 kips wheel load (HS20 + 30% impact) applied in any direction.

All frames and lids shall have a non-slip surface.

The 42-inch round cover and frames shall also comply with requirements in SCL Material Standard 7204.70, Frames and Covers, 42-in Round, Iron.

### 8.7.2 Hatches

All hatches shall:

- Include one 5/8-in diameter bonding hole located in an underside bearing bar, approximately centered in the door, and 2-1/2 to 3-1/2 in from the hinged edge.
- Be designed for at least 20.8 kips wheel loading (H20 + 30% impact).
- Be hinged and shall fully open to 180 degrees.
- Not exceed 65 pounds equivalent lift.
- Have a non-slip surface.
- Have a locking mechanism, such as a Penta head bolt, to prevent unsolicited access. Locking mechanism shall not protrude above the door surface.

Aluminum hatches for 36-in x 36-in and 36-in x 72-in opening access shall be designed for at least 26 kips wheel loading (H25 + 30% impact or equivalent H30 + 8% impact).

All steel hatches and access cover plates shall be hot dipped galvanized in accordance with ASTM A123, unless otherwise approved in accordance with Section 8.1.

Square or rectangular doors shall open along the lengthwise of the access opening.

### 8.8 Non-Slip Surfaces

All non-slip surfaces shall have:

Minimum coefficient of friction	0.8
Bond strength to the plate	3000 psi or greater
Surface hardness	55 minimum on the Rockwell "C" scale
Non-slip coating	SlipNot Grade 3 or Thermion TH604

The type of non-slip surface and the year of manufacture shall be identified on the underside of the door (for example, "S3 2005" or "TH604 2016" for SlipNot or Thermion respectively). The identification shall be bead welded or clearly stamped into a metal surface on the underside of each lid, or labeled with an adhesive, metallic foil-backed label.

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## 9. Delivery Requirements for Assemblies

Vault assemblies shall be delivered fully assembled unless otherwise requested in the purchase order. For specific delivery requirements, see detailed standards.

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## 10. Marking

All lids and doors shall be permanently marked "Electric," in 3-inch high letters clearly visible on the top where distribution cables occupy the enclosure.

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## 11. Causes for Rejection

Precast concrete vaults shall be manufactured in accordance with ASTM C858.

A vault may be rejected if it fails to conform to ASTM C858 construction and dimensional tolerances except for concrete cover over reinforcing shall not be less than listed above.

A vault may also be rejected if it does not meet SCL 7201.00, "Acceptance Criteria for the Installation of New Precast Concrete Distribution Facilities."

Corrections of minor defects shall meet the requirements of this material standard. Such work shall be done in accordance with SCL U2-6/NVH-20, "Inspection and Repair Procedures for Precast Vaults and Manholes."

Vaults shall be warranted for one year against design and manufacturing defects including those resulting from poor workmanship and materials.

## 12. Product Approval

Manufacturers interested in having their precast concrete vaults and accessories approved for purchase by SCL shall participate in the process summarized below.

- Provide evidence of National Precast Concrete Association (NPCA) plant certification.
- Provide a shop drawing indicating adherence to the NPCA's Quality Control Program in accordance with the NPCA plant certification.
- Provide product specifications and/or a cut sheet.
- Conduct sample concrete enclosure field trial.
- Provide review and evaluation of field trial.
- Conduct a prototype pulling iron test to demonstrate that the pulling iron could withstand 40 kips ultimate load without failure.
- Submit the certified report for the pulling iron test.
- Submit buoyancy calculations for each vault and a restraint design as required.

Manufacturers shall have a local representative or agent who will provide technical support and authorized to allow returns and repairs to be conducted by SCL or contractors.

Manufacturers are encouraged to plan accordingly. The approval process can take up to six months to complete.

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## 13. Issuance

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## 14. Approved Manufacturers

Approved manufacturers are identified in the detailed material standards.

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## 15. References

**SCL Construction Guideline U2-6/NVH-20**; "Inspection and Repair Procedures for Precast Vaults and Manholes"

**SCL Drawing D-28304**; "Retractable Ladder, Vault and Manhole Access,"  
SCL Engineering internal document, Rev. 5, April 2020

**SCL Material Standard 7201.00**; "Acceptance Criteria for the Installation of New Precast Concrete Distribution Facilities"

**SCL Material Standard 7204.70**; "Frames and Covers, 42-inch Round, Iron"

## 16. Sources

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**Ng, Sharon**; SCL Senior Civil Engineer and subject matter expert for 7203.21

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