ROCKY MOUNTAIN POWER
A DIVISION OF PACIFICORP

Policy

ROCKY MOUNTAIN POWER CUSTOMER-OWNED EQUIPMENT ROOM DESIGN STANDARDS

Engineering Standards Policy 363

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Table of Contents

List of Tables

List of Figures

ROCKY MOUNTAIN POWER CUSTOMER-OWNED EQUIPMENT ROOM DESIGN STANDARDS

Engineering Standards Policy 363

1 General

This policy outlines customer responsibilities and design requirements for vault and alcove installations housing Rocky Mountain Power (company)-owned electrical equipment (transformers, switchgear, etc.). An overview of the options covered in this design standard is provided below:

- **Alcove:** Equipment located exterior to the structure, recessed into a nook and partially surrounded by building walls, or in a separate walled enclosure in a location remote from the main structure.
- **Grade-Level Vault:** Located at street level and incorporated into the building's footprint. Doorways and roll-up coil doors provide access from the building's exterior for personnel ingress/egress and equipment installation.
- **Below-Grade Vault:** Located in a basement level of the building and extended beneath the adjacent building frontage or sidewalk area. Hatches and lift-out slabs provide access for personnel ingress/egress and equipment installation.

This policy should be distributed and interpreted in its entirety and in conjunction with the referenced codes and standards. Individual pages will not represent all the requirements necessary for an installation. Printed versions of this document may be out of date. Please consult our websites for the most recent version.

1.1 Limitations on Availability

The company's standard construction practice is to install above-grade, pad-mounted equipment in outdoor areas, with only the cables installed below grade. This design aligns with industry best practices and the company's obligation to build a safe, reliable, and cost-effective electric system.

Service requests incorporating vaults should only be made when extenuating circumstances exist that make siting above-grade, pad-mounted equipment impractical or unfeasible.

1.2 Customer Cost Responsibility

Customer responsibilities and financial obligations vary based upon state tariff for line extensions. Construction of facilities that are beyond standard construction may require the customer to pay additional costs that are not funded through the line extension allowance and to pay ongoing monthly maintenance charges for added maintenance of these facilities.

https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/idaho/rules/12_Line_Extensions.pdf

https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/wyoming/rules/12_Line_Extensions.pdf

https://www.rockymountainpower.net/content/dam/pcorp/documents/en/rockymountainpower/rates-regulation/utah/rules/12_Line_Extensions.pdf

2 References, Codes, and Standards

- ACI 302.1, *Guide for Concrete Floor and Slab Construction*
- Electric Utility Service Equipment Requirements Committee, *EUSERC Manual*
- FM Global 5.4, *Property Loss Prevention Data Sheets, Transformers*
- IBC, *International Building Code*
- IEEE C2, *National Electric Safety Code*
- NFPA 70, *National Electric Code*
- NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*
- PacifiCorp *Six-State Electric Service Requirements (ESR) Manual*
- PacifiCorp, *Policy 122 Underground Distribution System Construction*

3 Division of Responsibility

The customer shall be responsible for design, construction, labor, and furnishing of all materials, including but not limited to the following:

- Vault, doorways, ladders, pulling irons, access hatches, lift-out slabs (including brick, tile, or other decorative surfaces)
- Duct bank, cable racking, conduit and sealing of all penetrations (except those associated with primary cables)
- 120 V station service (lighting, convenience receptacles, etc.)
- Ground bus
- Oil containment
- Drainage, sump pits, pumps, and discharge plumbing
- Ventilation
- Fire safety plan (containment, protection, suppression)

The customer will retain ownership of the vault and will be responsible for maintaining the vault structure, preventing water ingress, 120 V station service, ventilation, fire suppression, and drainage systems.

Upon acceptance of the completed installation the company will install and maintain the following:

- Primary switchgear and fusing
- Primary cables and terminations
- Primary cable conduit sealing
- Service transformers
- Service cable from transformers to bus duct termination or service entrance.

  Note: The company will not install, own, or maintain service cables penetrating the buildings foundation or extended outside of a vault.
- Warning and danger signage
- Communication equipment for SCADA

After acceptance and installation of company equipment, the customer will not have access and shall not enter the vault or alcove unless escorted by authorized representatives of the company.

Note: In alcove installations customer access and co-location of equipment may be allowed if the design incorporates equipment and if the customer equipment does not interfere with installation and maintenance of company equipment.

3.1 Design Review and Drawing Submittal

Requests for new service or requiring modifications to existing vault will require an Engineering Service Agreement (ESA) and a System Impact Study (SIS). The SIS will determine the type of electrical equipment required to serve the load and to identify optimal locations for the vault, and design options available for the site.

The customer shall submit to the company for approval a comprehensive package with design plans, drawings, and equipment submittals demonstrating compliance with this specification in accordance with Table 1. Incomplete or unapproved submittals shall be revised by the customer as noted on the returned plans and resubmitted. A minimum of 15 business days is required for the company to review submittals.

Design and construction drawings should be approved by the company before the customer submits a building permit application to the authority having jurisdiction (AHJ). The purpose of this requirement is to reduce the likelihood of delays and costly modifications should design changes be required. Company approval is limited to areas and aspects of the design necessary for the safe, efficient operation and maintenance of company equipment.

Table 1—Design Review Drawing Submittals

Item	Submittal	Description
1	Site plan	Entire property outline showing property boundaries, utility easements, building layout, location of vault, transformers, service equipment, and metering points; primary/service conduit routes, vehicular access routes
2	Per building site plan(s)	*Required for multi-building complexes, the same details are required as in overall site plans
3	Enlarged site plans for all service equipment and transformer locations	Transformer and service equipment locations with working clearance depicted, surface finish details (curbs, parking, landscaping, bollards, etc.), and primary/service conduit routes
4	Electrical one-line	One-line drawings that show service transformer, service conductors (quantity/size), service entrances switchboards, pull sections and metering stacks, service disconnects; metering points shall differentiate between CT style and direct connect
5	Overcurrent protection coordination study	Coordination study for service equipment and primary protective elements interfacing with the distribution system
6	Metering and service entrance equipment submittals	Manufacturer drawings and equipment submittals with reference to applicable EUSERC designs section; this includes all switchboards, pull sections, and metering stacks **Note:** Tamper sealing provisions are required for all unmetered bus and panel sections

Item	Submittal	Description
7	Metering and service entrance equipment elevation drawings	Elevation drawings includes switchboards, pull sections, and metering stacks; show working clearances and meter stack socket height with relationship to final grade
8	Oil containment and spill prevention, control and countermeasure (SPCC) plan	If the site meets requirements of Rule 40 CFR 112, which is implemented by the U.S. Environmental Protection Agency (http://www.epa.gov/oilspill/)
9	Metering rooms	Detailed top view of meter room locations showing working clearances egress paths, access points, and doors' panic hardware
10	Civil/structural drawings vault or alcove	Detailed top view, elevation, fabrication, and construction drawings showing equipment locations, pulling irons, access doors/hatches, working clearances, conduit and cable tray, duct banks, cable tray/bus, troughs sump system, and 120 V station service equipment
11	Ventilation plan	Ventilation system diagram with calculated heat load, drawings showing all vents, ducts, louvers, etc., and design aspects of the electrical/mechanical systems with equipment submittal .
12	Fire rating, protection and detection plans	Drawings and submittals showing all elements of the fire safety plan **Note:** Fire safety plan shall be subject to AHJ review and requires approval from the AHJ.
13	120 V station service and lighting	Electrical one-line and equipment submittal

4 Design General

1. The aggregate sum of transformer capacity, equipment, and distribution feeders contained within a vault should not exceed the limits in Table 2. If a second vault is required, a firewall shall be provided.

Table 2—Vaults Aggregate Limits on Equipment, Capacity and Distribution Feeders

Aggregate Sum of	Limit
Transformer Capacity	5,000 kVA
Equipment Count (Transformers and Switchgear)	3
Distribution Feeders	3

2. The construction and design of vaults and alcove installations shall meet the requirements of NEC Article 450, *Transformers and Transformer Vaults*.
3. Vaults and alcoves shall be designed with adequate security to restrict public access and permit entrance only to personnel authoritzed by the company.
4. Foreign fixtures such as pipes, ducts, wires, or other objects not necessary for the electrical installation shall not be located in or pass through a vault.

   Note: This includes structural support columns for the building.
5. Vaults and alcoves shall be designed to minimize impact to franchise areas, adjacent public and commercial activity, and obstructions to pedestrian/vehicular traffic. When below-grade vaults extend into franchise areas, space should be reserved for additional utilities near grade level, this can be accomplished by using risers at lift-out and access hatch locations as shown in Figure 1.

6. Dedicated easements Dedicated easements shall be recorded restricting obstructions from being placed in access paths, working clearances and equipment staging areas; and providing the company with control over vault access.

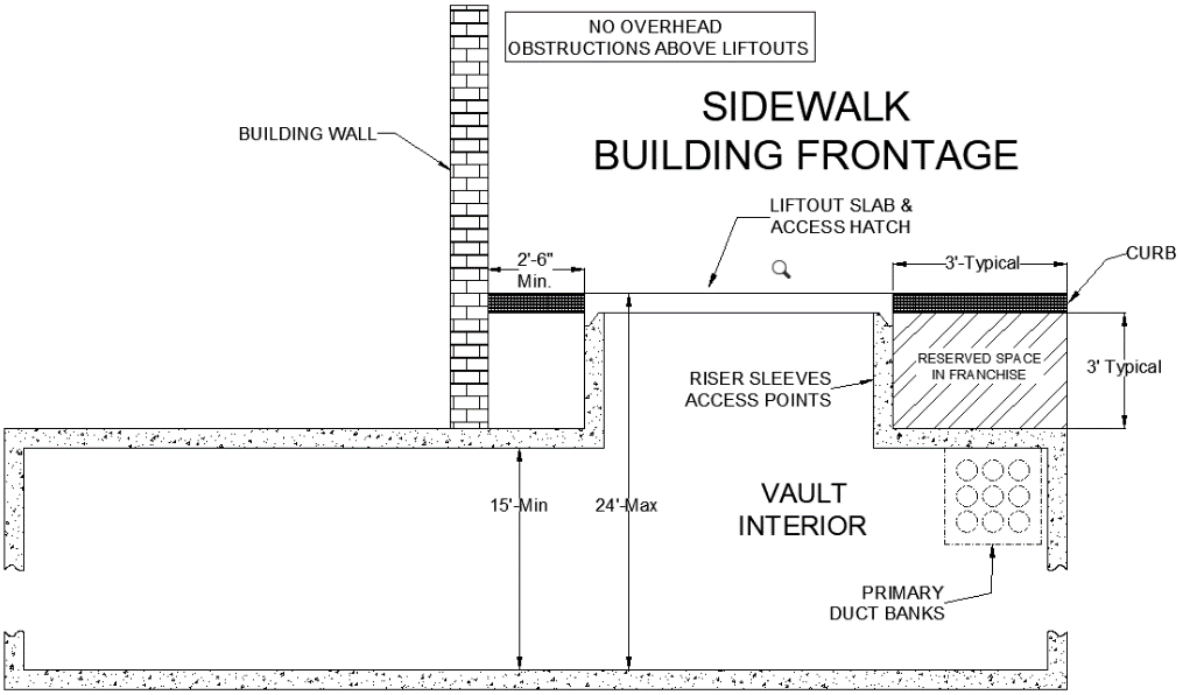


Figure 1—Grade Vault Using or Risers to Minimize Impact to Franchise Space

4.1 Location and Access Requirements

1. The company shall be provided with unencumbered access to company-owned facilities at all times. Access shall not require customer contact, coordination with site management, or be blocked by intermediary gates that are not company keyed.

   Note: Power-operated gates or garage doors do not meet the requirements for unencumbered access.

2. Vaults and alcoves shall be directly accessible from the exterior of the building by heavy equipment such as cranes or boom trucks.
3. Access points and paths shall be provided from a public right-of-way or recorded and dedicated easements that are transferrable with the property.
4. Access points shall not be located in roadways, driveways, or other frequently traveled vehicle paths.
5. Manholes, hatches, frame assemblies, and lift-out slabs shall be watertight and have a minimum American Association of State Highway and Transportation Officials (AASHTO) load rating of H-20.
6. Access points shall be located such that a three-foot clear working space and safety perimeter can be established when in use. Use of the working space and establishment of a safety perimeter should not require closure of public streets or sidewalks.

7. If access points are located in pedestrian thru-zones or other areas subject to pedestrian traffic, manhole and hatch surfaces shall meet requirements of and be approved by the AHJ.
8. Access points shall not be directly in front of building entrances or areas used for outdoor seating or congregation.

4.1.1 Vehicular Access to Site

1. The road surface shall be a paved or well-maintained gravel surface free of large rocks and vegetation.
2. Where applicable, vehicle access will require roll curbs or driveways.
3. Minimum roadway widths, overhead clearances, and maximum distance to access points shall be as defined in Table 3. A clear unobstructed path from parking locations shall be provided to access points.

Table 3—Vehicular Access Roadway Requirements

Access Point Type	Minimum Roadway Width (ft.)	Minimum Vertical Clearance (ft.)	Maximum Distance From Parking Location to Access Point (ft.)
Personnel	12	14	100
Equipment (installation/removal)	23[1]	16	R[2]

1. The purpose of this requirement is to ensure that the company can access equipment at all times with heavy equipment, without blocking fire lanes or being impeded by parked vehicles or other obstructions. Width may be reduced to 16 feet if dedicated routes and parking is provided for staging of equipment within the load handling radius.
2. See Table 4 for equipment load handling radius.

4.1.2 Personnel Access/Egress

1. Vaults require at least two personnel access/egress points, typically one at each end of the vault. Additional egress points may be required to accommodate unique equipment layouts or large vaults.
2. Shall be located such that the egress path does not open directly into roadways, or create other unsafe conditions
3. Shall not be located such that they do not open into or directly above electrical equipment or conductors
4. Should be located in a way that minimizes their impact on adjacent public and commercial activities, should they be blocked or in use for extended periods of time
5. Stairs shall not be permitted inside vaults or alcoves. If stairs are required, they must be located outside the vault with no less than an 8-foot landing.

4.1.3 Equipment (Installation/Removal) Access

Boom trucks, mobile cranes, and telescopic handlers are used for the installation and removal of heavy equipment such as transformers, switchgear, and lift-out slabs. Consideration should be given to overhead obstructions, surface access paths, and space required for boom swing and outriggers.

1. Equipment installation/removal access paths to the site shall be designed to accommodate turning radius/paths of large trucks. A turning path analysis shall be provided using, AASHTO SU-40 Design Vehicle shown in Figure 2. For paths without a vehicular outlet or turn-around point the paths shall be designed to limit blind backing to 50 feet.

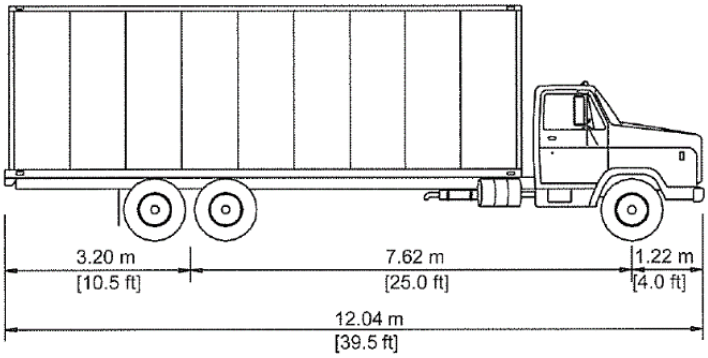


Figure 2—AASHTO Single-Unit Truck (SU-40) Design Vehicle

2. Parking and staging areas for vehicles should be located in such a manner that the impact on adjacent public and commercial activities is minimized.
3. Equipment room layouts and access points shall facilitate the picking and placing of equipment, with the crane or telescopic handler's boom.
4. Typical equipment weights and an example layout for equipment access and installation are provided in Table 4 and Figure 3.

Table 4—Standard Boom Truck and Crane Load Handling Radius

Equipment Weight (lbs.)		Typical Equipment	R' Load Handling Radius (ft.)	Z' Required Overhead Clearance (ft.)
Min	Max			
-	1,500	Sectionalizing cabinets Single-phase pad-mounted transformers (≤ 100 kVA)	30	30
1,501	5,000	Single-phase pad-mounted transformers (167 kVA) Three-phase pad-mounted transformers (≤ 500 kVA) Deadfront switchgear (PME/PSE) Vista switchgear (523)	20	30
5,001	10,000	Three-phase pad-mounted transformers (750–1,000 kVA)	20	35
10,000	15,000	Three-phase pad-mounted transformers (1,500 kVA)	20	35
15,001	20,000	Three-phase pad-mounted transformers (2,500 kVA)	20	35
20,001	+	---	Engineering required	

Notes:
1. Z': Required overhead clearance based on height of main boom at 80˚, rounded up to the nearest 5 feet.
2. R': Load handling radius derived from equipment load charts based on maximum weight.
3. Required lift height to clear ground line obstructions assumed to be ≤10 feet.

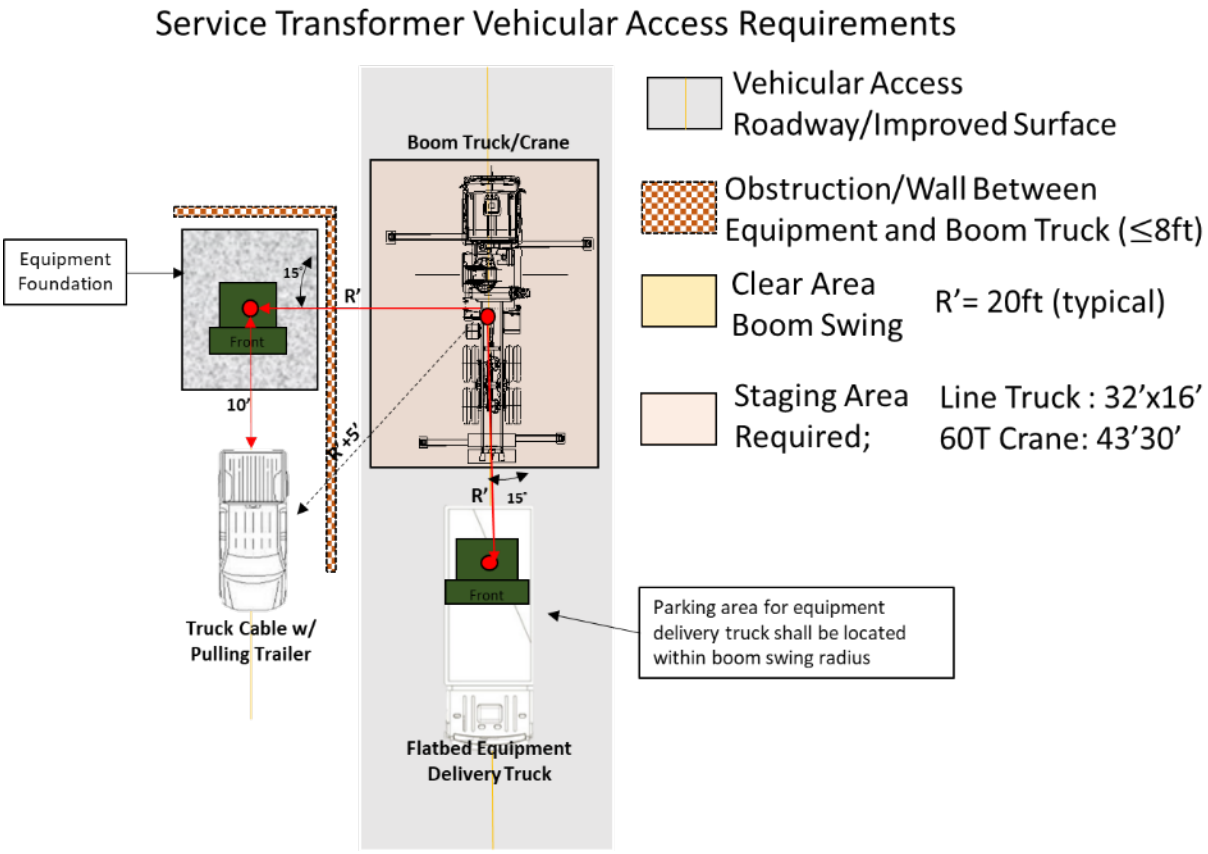


Figure 3—Example Equipment Access and Load Handing Diagram

4.1.4 Doorways

1. Doorways shall have a minimum opening of 36″ W × 80″ H
2. Each doorway shall:
   a) Be provided with a clear unobstructed access and egress path
   b) Open in the direction of egress
   c) Be listed with a minimum Type A, fire rating of three hours
   d) Be supplied with photoluminescent exit signage

      Note: The company will supply exit signage
   e) Be equipped with an automatic door closure device (interior side)
   f) Be equipped with flat bar panic egress hardware (Interior side)
   g) Be equipped with lock set (exterior side); hardware functionality shall be set up as ANSI 09 "storeroom," as described in Figure 4

      Refer to Appendix B for preapproved locksets; lock-core(s) will be keyed by the company.

Note: The customer will not have access to the equipment room after company locks are installed.

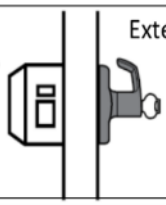
Interior (Panic Bar)  Exterior	Storeroom (Lever Active)	F09	• Entrance by knob or lever only when released by key. Key removable only when locked.

Figure 4—Equipment Room Door Lockset Functionality

h) Be equipped with electrical hazard warning/danger signage, and signage to restrict blocking and assist with locating egress points as shown in Figure 5. The company will supply electrical hazard signage.

Figure 5—Personnel Access Door Warning, Danger, and Egress Signage

4.1.5 Swing Gates and Roll-Up Coil Doors

1. Roll-up coil doors and swing gates shall:
   a) Be manually operated
   b) Be lockable and securable from the interior and exterior using padlocks
   c) Have minimum three-hour fire and smoke rating
   d) Have a minimum clear opening of 15 feet high by 10 feet wide
2. Swing gates and roll-up coil doors may be used to facilitate equipment working clearances, which may allow reduction in vault depth. If used for this purpose they should be located such that the impact on pedestrian and vehicle traffic is minimal.

3. Swing gates used for equipment installation/removal may also serve as a personnel access point, if equipped with appropriate panic hardware for egress.

4.1.6 Hatches and Manholes (Personnel Access/Egress)

1. Hatches and manholes shall have a minimum clear opening of 36-inch-square or 30-inch-round. Refer to Appendix-B for pre-approved assemblies.
2. Hatches and manholes shall have an AASHTO H20 load rating.
3. Hatches and manholes shall be stamped or permanently marked with the text “PACIFICORP” and “ELECTRIC.”
4. Hatches and manholes shall have a minimum weight of 100 lbs. or be securable with a padlock or penta-head security bolts
5. Hatches shall be perpendicular to the flow of pedestrian traffic; hatch doors shall swing toward the building and with their openings facing toward the street

4.1.6.1 Ladders

1. Fixed ladders meeting OSHA 29 CFR 1910.27, shall be provided for all hatches and manholes used for personnel access/egress.

   Note: Maximum vault depth from grade level shall not exceed 24 feet.
2. Ladders shall be constructed of hot-dipped galvanized steel, stainless steel, aluminum, or other company-approved material. Refer to Appendix B for preapproved assemblies.
3. Typical fabrication and layout details are shown in Figure 6. Ladders shall be supplied with a safety extension bare and installed at a 10-inch slope.

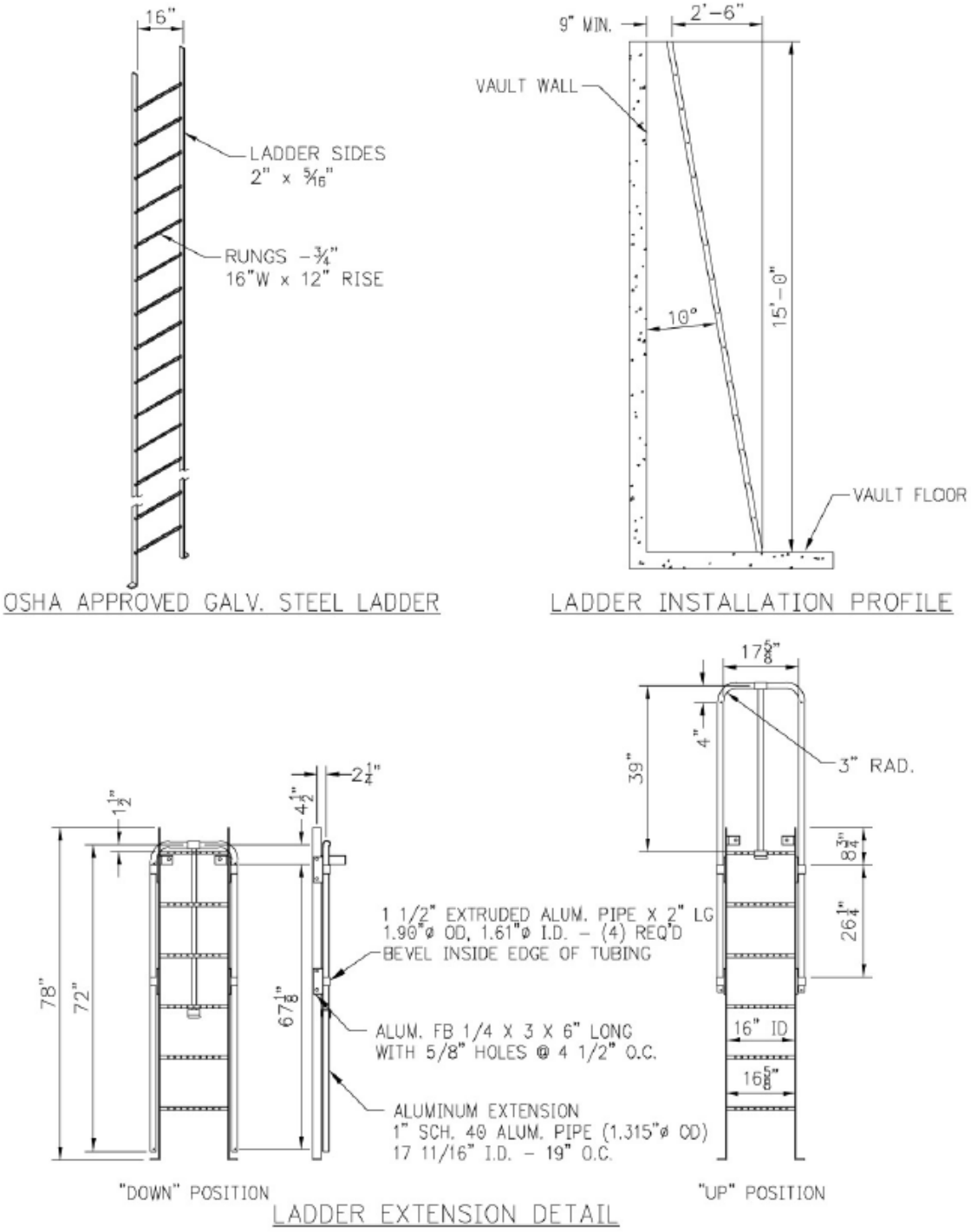


Figure 6—Ladder Fabrication and Orientation Details

4.1.7 Hatches and Lift-Out Slabs (Equipment Install/Removal)

1. The opening shall provide a minimum clearance of 1-foot around all sides of largest piece of equipment to be installed. Minimum dimensions for a lift-out slab shall be 8′ × 12′.
2. Hatches and lift-out slabs shall be designed to meet AASHTO H20 load rating.
3. Surface details shall match surrounding sidewalk area.
4. Hatches and lift-out slabs shall be designed to be watertight and be provided with sealing and drainage as shown in Figure 6 to prevent water ingress into the vault.
5. Hatches and lift-out slabs shall be provided with an engineered lift plan; dedicated easements shall be provided for the required crane staging area and boom swing. The building facade be free of overhead obstructions including removable/temporary canopies that may interfere with removal.
6. Hatches and lift-out slabs shall have a maximum weight of 20,000 lbs.; the weight of the slab shall be permanently marked and visible from inside and outside the vault.
7. Lift-out slabs shall be provided with rigging points and hardware in each corner, positioned approximately 18 inches from the slab edge. Typical rigging point and hardware details are shown in Figure 6.

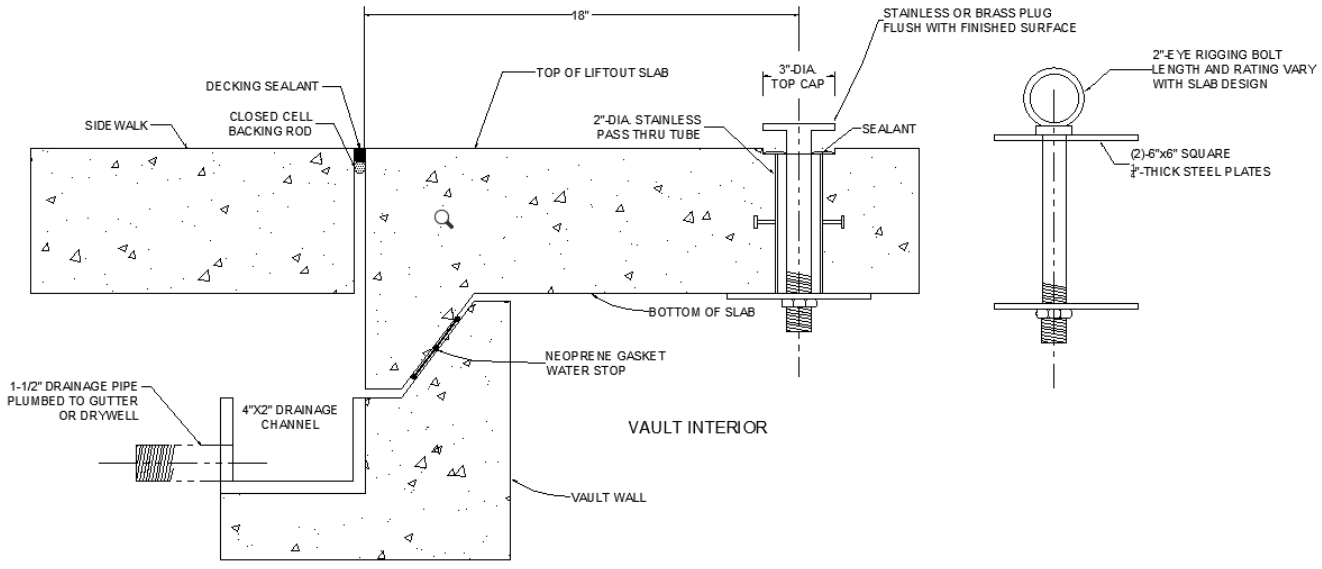


Figure 7—Lift-Out Slab Sealing and Rigging Point Detail

4.2 Equipment Clearances

Clearance requirements for standard equipment types are provided in Table 5 and depicted in Figure 7, additional dimensional information on equipment is provided in Appendix C.

1. For adjacent pieces of equipment, the clearance boundaries may overlap.
2. A clear path or aisleway shall be provided for each piece of equipment such that minimum clearances can be maintained while moving to the installation/removal access point.
3. Equipment shall not be located directly below access hatches or lift-out slabs.

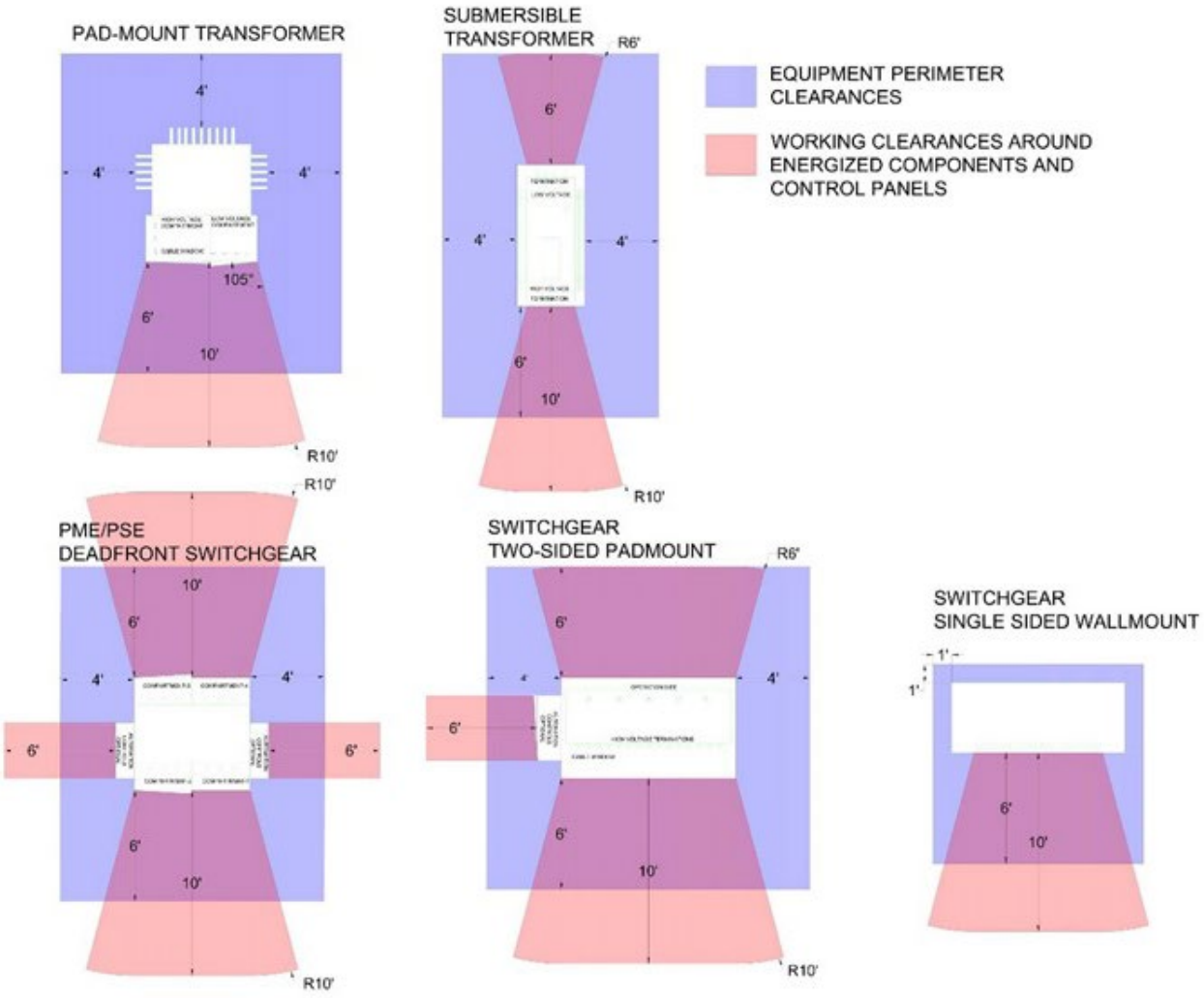


Figure 8—Typical Equipment Working and Perimeter Clearances

Table 5—Equipment Clearances

Pad-Mounted Equipment: Transformer, High-Voltage (HV) Switchgear (all components encased by grounded metal enclosures)	**Minimum Clearance to Walls, Doors, Support Columns, and Other Fixed Objects (ft.)**
Compartment doors, access panels: HV and secondary service terminals[1]	10
Compartment doors, access panels: low-voltage (LV) operating panels and automation controls	6
Equipment sides, radiators, fixed panels	4
Vertical clearance directly above equipment	Vault=6, Alcove=35
Open Rack, Single-Sided HV Switchgear (exposed deadfront cable terminations)	
HV terminations and operating controls[1]	10
Equipment sides, fixed panels	2
Vertical clearance directly above equipment	Vault= 6, Alcove=N/A
Submersible Transformers	
HV terminations and operating controls[1]	10
LV terminations and operating controls	6
Equipment sides, radiators, fixed panels	4
Vertical clearance directly above equipment	Vault=6, Alcove=N/A
[1.] May be reduced to 6 feet if a hinged or roll-up door can be opened to the exterior of building to additional operating clearance	

4.3 Ceiling, Walls and Floors

1. Walls, floors, and ceilings shall be constructed of reinforced concrete with a minimum thickness of 8 inches. Alcove walls not associated with the buildings structure shall be anchored to footings installed below the frostline.
2. Floors shall be constructed to support expected surface loads from electrical equipment and the possibility of flooding.
3. Minimum ceiling height in above- and below-grade vaults shall be 15 feet.
4. The maximum depth of a below-grade vault shall not exceed 24 feet from the finished grade.
5. Floors shall have a minimum Composite Overall Flatness (FF) of 35, when measured in accordance with ACI 302.1.
6. Floors shall have a minimum Composite Levelness Flatness (FL) of 25, when measured in accordance with ACI 302.1

4.4 Pulling Irons

Pulling irons are used as rigging points for equipment installation and cable pulling. Locations and quantity will vary equipment with vault layout. General requirements are provided in Table 6, refer to Appendix B for preapproved assembly. Additional pulling iron locations maybe required during the design review process.

Table 6—Pulling Irons

Pulling Irons		Specification
General	Composition	Stainless steel or hot-dipped galvanized
	Installation notes	Recessed into vault wall; shall not protrude into interior working space
	Minimum design/safety factor	5:1 (Ultimate Strength: Working Load)
	Minimum working load	10,000 lbs.
	Labeling	Stencil or placard stating: “Maximum working load ##### lbs” (####-Per design)
Location/ Application	Vault walls	Corners (upper and lower) located 3 feet out from each wall and offset 3 feet from floor and ceiling
	Floors	Centered below each manhole or access hatch
	Conduit entrances	Wall or ceiling opposite each conduit entrance location
	Transformers	Vault walls centered with each transformer location
	Switchgear	Vault ceiling centered over switchgear lift points

4.5 Oil Containment and Spill Prevention, Control and Countermeasures (SPCC)

Customers who own private property that contains company oil-filled equipment may be required to accommodate a Spill Prevention, Control, and Countermeasure (SPCC) Plan. SPCC plans are required by 40 CFR 112, which is enforced by the U.S. Environmental Protection Agency. The customer shall be responsible for providing oil-containment systems, as specified by the company, to meet the site-specific SPCC plan. See ESR White Paper 9—SPCC for more information.

In addition to the SPCC requirements, all vaults shall be designed to contain or provide gravity drainage (through an oil-water separator) for the aggregate volume from all oil-filled equipment. In grade level applications containment may be accomplished by one or more of the following methods:

1. Sloping floor away access points and towards containment pits or troughs; Floor slope shall not exceed 0.5%, pits and troughs shall be covered with durable gratings and shall not be located under equipment or installation/removal paths
2. Recessing vault floor below exterior grade level by up to 4 inches; the vault floor shall be smoothly sloped to exterior grade level at access points locations; sharp thresholds are not allowed

3. Installation of removable threshold-style berms around all access points with a maximum rise of 2 inches; removeable berms shall be bolt-down style with gasketing; adhesive berms are not allowed

4.6 Drainage, Sump Pits, and Pumps

Vaults and alcoves shall be provided with sufficient gravity drainage and/or a sump system to discharge accumulated water from rainfall, runoff, and infiltration. Gravity drainage to an on-site, customer-maintained oil-water separator is the preferred system. Sump pumps may be used if gravity drainage is unfeasible.

1. Vault floor shall be sloped (pitched) towards sump pits and drainage gutters with a maximum slope of 0.5% from the high point of the room. If a cable trough is incorporated into the design, the trough shall be provided with a drainage path.
2. Gutters shall be covered with durable grating installed flush with the floor.
3. Sump pits should be located on opposite sides of the vault near personnel access doors in above-grade stations or in below-grade stations be adjacent to or behind ladders. Pits should not be located in paths required for equipment positioning.
4. Below-grade vaults shall be provided with a minimum of two sump pits.
5. Above-grade vaults shall be provided withone sump pit if gravity drainage is not provided.
6. Sump pit dimensions shall measure 18″×18″×18″ (L×W×D) and be provided with removable galvanized grating installed flush with the floor.
7. If the design does not incorporate gravity drainage, sump pumps shall be provided with sufficient head capacity to maintain a minimum discharge rate of 15-gallons/minute.
8. Sump pumps shall be float controlled with a manual shutoff switch located near one or more of the vault entrances.

4.7 Fire Ratings

1. Transformer vaults, alcoves, and building elements adjacent to the installations shall be designed for passive fire resistance and containment.
2. Fresh-air intakes, operable windows, doors, and other penetrations leading in the building should not be located adjacent to or directly above vault access points or alcoves.
3. Fire ratings for the vault and protection of the building shall be subject to review and approval of the AHJ. The company requires a minimum three-hour fire rating and sealing of all penetrations to prevent the spread of fire and smoke.
4. Sealants, dampers, and barriers shall be listed for the intended application. In below-grade applications all sealants shall be rated for a minimum 10 feet of water head pressure.

4.7.1 Fire Protection and Detection Systems

1. The customer or the AHJ may require a fire detection and protection system to be installed. The company assumes no responsibility for the permitting or operation of the system.
2. Automatic sprinklers or other water-based fire suppression systems shall not be used within electrical vaults.

Note: Water-based systems are not allowed due the risks of electrical shock with high voltage equipment, ability to spread oil-based fires, and potential for leaks that could cause failure of electrical equipment resulting in additional hazards.

3. When automatic fire suppression (non-water based) systems are installed:
   a) Fire suppression piping, nozzles and equipment shall be located so as not to interfere with electrical cables and equipment. A minimum 4-foot radial clearance shall be maintained.
   b) Prominent warning signage shall be installed at all entrances advising personnel of potential hazards with system operation.
   c) A supervised switch that deactivates the system shall be provided for company personnel within the vault. The switch shall be clearly marked and located adjacent to entrances.
   d) Audible and visual predischarge alarm devices and an emergency abort switch shall be provided.
   e) Control panels, suppression agent cylinders, and containers shall be located outside of the vault.
   f) Control systems, supervisory switches, and alarms shall be tested by the customer on an annual basis.

      Note: For entry into the vault an authorized representative of the company is required to be present.

4.8 Ventilation

1. Vaults shall be directly ventilated to an to an exterior area. Ventilation ducts shall not pass through occupied parts of the structure or mixed with the buildings HVAC systems.
2. Ventilation shall be by means of natural convection, forced-air, or a combination of both. Table 7 and Table 8 shall be used to calculate aggregate equipment-related heat load within the enclosed area.
3. Incoming and exhaust air vents should be positioned to induce drafts across the equipment to be cooled. Cold air intakes should be located near the floor level; hot air exhaust should be located near the ceiling. General ventilation topology and design principals for an electrical vault are depicted in Figure 8. Cross ventilation is necessary to ensure cold intake air drafts across equipment radiators.

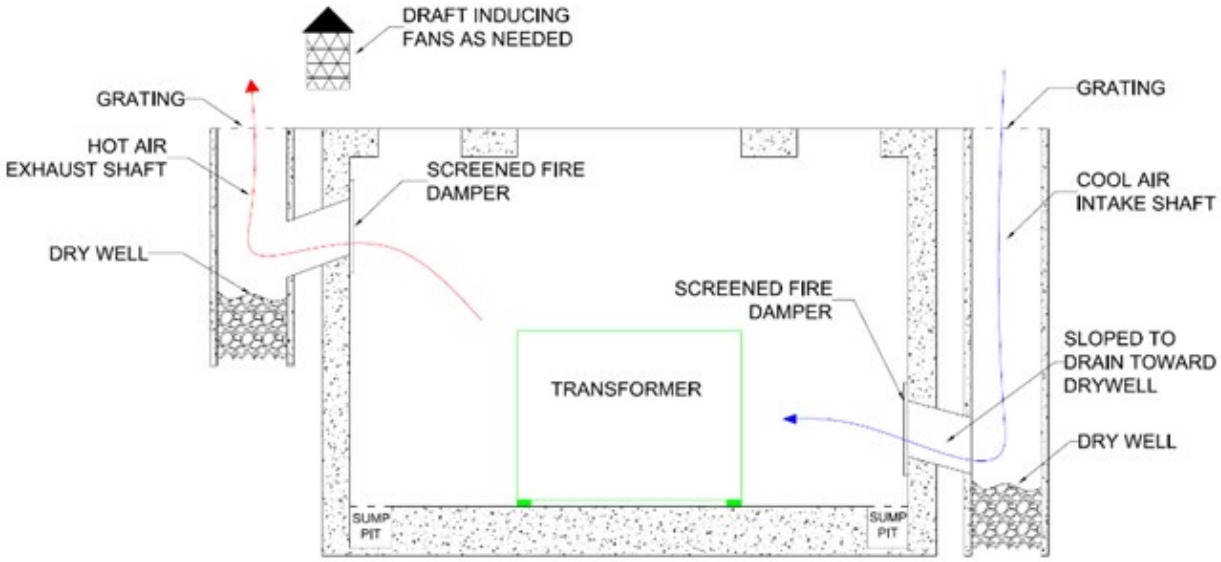


Figure 9—General Ventilation Topology (Below-Grade Vault Example)

4. All ventilation openings shall be provided with durable gratings and screens to prevent ingress of animals and debris.
5. Ventilation openings shall be provided with automatic heat sensing, combination fire, and smoke dampers with a minimum three-hour rating. Activation temperature on fusible links shall not be less than 65 °C (149 °F). If force ventilation is used dampers shall be interlocked to shutdown fans when dampers close.
6. Ventilation capacity shall be designed to maintain a 45 °C (113 °F) maximum equipment room air temperature. All significant heat loads shall be included in the ventilation systems balance diagram.

Table 7—Equipment Heat Loads

Equipment	Heat Load Per Apparatus (kW)
Medium Voltage Switchgear	1
Primary Metering	1
Secondary/Service Conductor Set	1

Table 8—Transformer and Service Conductor Heat Loads

Transformer kVA Rating	Heat Load (kW)	
	Secondary Voltage	
	208 Y/120 V	277 Y/480 V
75	1.1	1.1
150	2.0	1.8
225	2.5	2.5
300	3.1	2.9
500	4.8	4.7
750	8.5	6.4
1,000	9.4	8.4
1,500	---	11.4
2,500	---	17.5

4.8.1 Natural Convection

1. The combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than:
   a) 400 sq-in/kW of nontransformer related heat load; plus
   b) 3 sq-in/kVA of transformer capacity
2. Vaults using natural air convection shall have roughly half of the total required area in one or more openings near the floor and the remainder in one or more openings in or near the ceiling.

   Note: For alcove installations, sufficient air infiltration shall be provided around the groundline elevation to meet the requirements for natural convection.

4.8.2 Forced Ventilation

1. Mechanical equipment (filters, fans, motors) shall not be located within the vault structure; they shall be located such that they can be maintained by the customer from outside the vault.
2. Fans shall be thermostatically controlled with the ON setpoint at 32 °C (90 °F) and OFF setpoint at 21 °C (70 °F).
3. A switch shall be provided in the vault near personnel access points to disable ventilation fans.
4. Fans shall be interlocked to shutdown with activation of automatic louvers or fire suppression systems.
5. Registers/grilles shall not be located directly above electric equipment or within the energized working clearances.

4.9 Electrical Station Service (Lighting, 120 V Receptacles, Auxiliary Loads, Etc.)

Equipment rooms shall be provided with electrical station service for lighting, 120 V receptacles and required auxiliary loads (sump pumps, SCADA cabinets, etc.). The

station service panel board shall be tied into the facility's emergency power system. Typical station service design for a below-grade station is shown in Figure 9, design criteria is provided in Table 9.

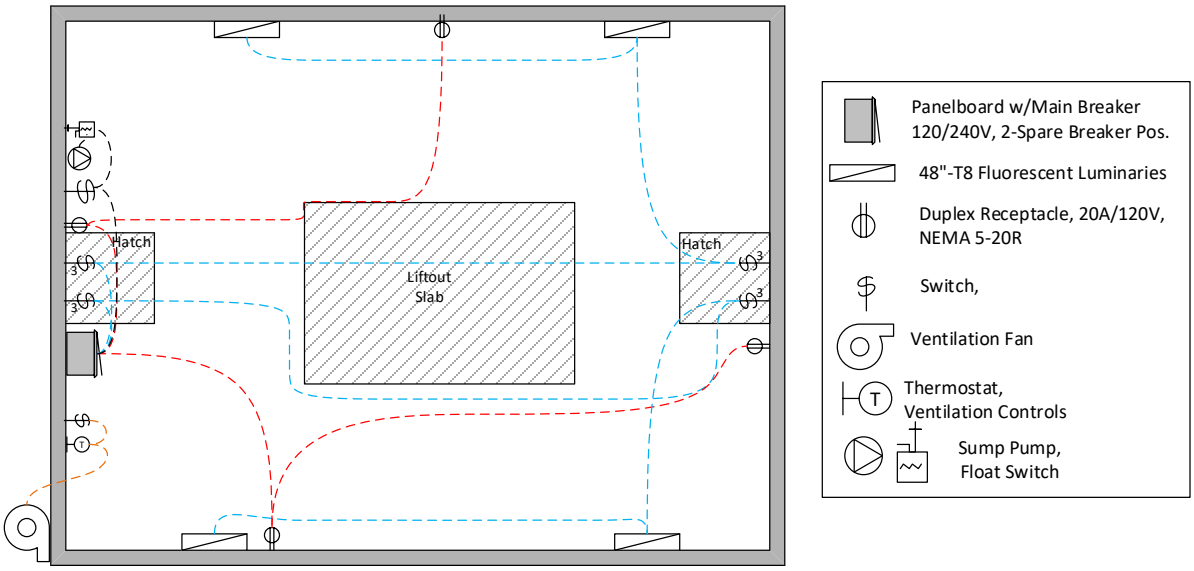


Figure 10—Example Station Service Electrical Plan Below-Grade Vault

Table 9—Electrical 120 V Station Service Design Criteria

Electrical Station Service Wiring Requirements		Above Grade	Below Grade
General	Location classification	Damp	Wet/corrosive
	Conduit types	EMT	EMT/IMC/RMC (stainless steel)
	Component installation	All wiring, conduit, and components shall be surface mounted.	
Panel Board	Enclosure rating	NEMA 3R	NEMA 4X (stainless steel)
	Bus ampacity/short circuit current rating (SCCR)	As required (minimum 100 A/10 kA)	
	Breaker types	GFCI	GFCI
	Spare breaker positions / kVA capacity	Two single pole (20 A–120 V) / 4.8 kVA	
Lighting/ Luminaires	Lighting illumination levels	50 foot-candles or greater	
	Number of circuits	Two independent circuits	
	Luminaire locations	Luminaires shall not be positioned directly above equipment or in a location that would expose personnel performing maintenance to an electrical hazard.	
	Luminaire type	(2x48") T8 fluorescent or LED lamps; fluorescent lamps shall be equipped with cold-start electronic ballasts	
	Luminaire enclosure rating	Damp Locations	NEMA 4X/Watertight
	Luminaire installation height	10 ft. to 12 ft.	
	Switch locations	Adjacent to each personnel access point	
	Switch install height	48"	24" from ceiling
Receptacles	Receptacle type	Duplex 20A/120V, NEMA type 5-20R	
	Receptacle enclosure rating	Damp Locations	NEMA 4X/WaterTight
	Receptacle installation height	36"	60"
	Install locations	Provided on each vault wall with a maximum spacing of 50 feet between receptacles	

4.10 Grounding and Bonding

Vaults shall be constructed with concrete-encased grounding electrodes and a connection to the building's grounding electrode system. The company will install ground bus conductor and ancillary connectors. Typical layout and construction requirements are provided in Figure 11 and Table 10.

1. The ground bus shall also be electrically connected with the building's grounding electrode system.
2. All metallic components within the vault shall be bonded to the ground bus. Metallic door frames, doors, trough covers, and ladders shall be supplied with a NEMA two-hole ground plate. Fabrication details shown in Figure 12.

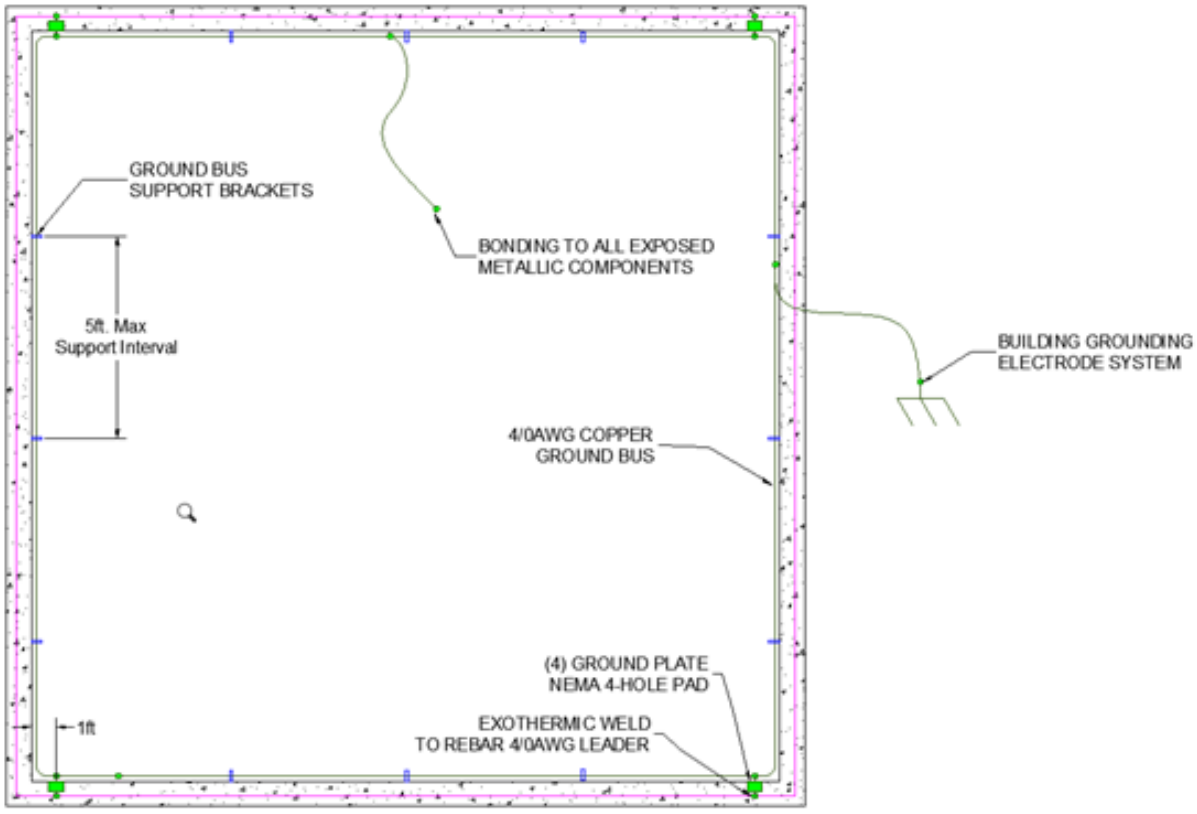


Figure 11—Example Vault Grounding and Bonding Diagram

Table 10—Vault Grounding and Bonding Components

Grounding System Components		Specifications
Perimeter Ground Bus	Conductor size (type)	4/0 AWG, copper soft drawn, Class B stranding
	Installation height	18″ to 36″
	Horizontal offset From wall	2″ to 3″
	Support interval	60″
Bonding Jumpers and Grounding Electrode Conductors	Conductor size (type)	4/0 AWG (Copper)
Concrete Embedded Ground Insert	Quantity	4
	Type	NEMA 4-hole, silicon bronze, concrete embedded Refer to Appendix B for preapproved assemblies
	Installation notes	Cast flush with vault surface, exothermic welds are required for connection to rebar
Weld on NEMA Ground Pad	Notes	Fabricated from 304 stainless steel.
Connector(s)	Connectors	Shall be listed for direct burial and composed of copper or silicon bronze alloy. Refer to Appendix B for preapproved assemblies

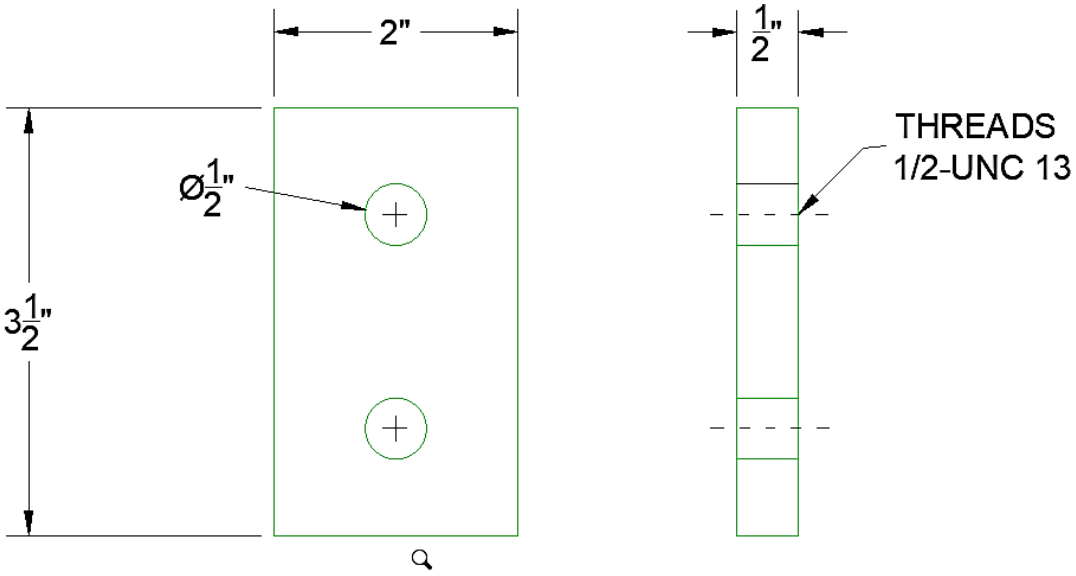


Figure 12—Weld on NEMA Two-Hole Ground Pad

4.11 Primary and Service Cable, Conduit, Cable Trays, and Troughs

The customer shall be responsible to furnish and install all conduit, racking, and troughs necessary for the installation of primary and service cables. The SIS provided by the company will specify the primary conduit size and the quantity of ducts; it will also provide an electrical one-line showing connectivity with cable types.

In alcove installations, wiring methods and service entrance equipment shall comply with the company's Electric Service Requirements Manual. In vaults, the customer shall furnish a secondary bus duct termination. The company will not install, own, or maintain service conductors that exit the vault.

1. Designers should be mindful of equipment position, working space clearances, and access points when routing cables.
2. Conduit shall not be used for routing of primary or service cables within vaults.
3. Within vaults, primary cables shall be routed using a cable tray, stanchion arms, or troughs; service cables shall be routed using cable bus.

4.11.1 Conduits

1. Conduit routes exterior to the vault and alcove installations shall comply with PacifiCorp Policy 122.
2. Conduits and ducts between vaults and within alcove areas shall be concrete encased. Construction of the duct system and materials shall meet the requirements of Section 5 of the company's Electric Service Requirements Manual.
3. Conduits and ducts entering below-grade vaults and alcoves shall not penetrate the building foundation or be located under the building's footprint. In above-grade vaults, conduits shall be routed through to pass through personnel or equipment access points.

4.11.2 Cable Tray and Stanchion Brackets

Cable tray installations shall comply with the requirements of Table 11, stanchion bracket installations shall comply with Table 12.

Table 11—Cable Tray Design Criteria

Cable Tray		Requirement
General	Composition	Aluminum, stainless steel, or other company-approved corrosion material. Refer to Appendix B for preapproved assemblies.
	Style	Open rack, ladder rung
	Side rail / channel depth	4” Min
	Cable support interval	18” Max
	Cable clamping interval	36” Max
	Minimum bend radius	2 ft.
Installation	Minimum clearance to ceiling	2 ft.
	Elevation above floor	10 ft. to 15 ft., except as necessary to align with exterior duct penetrations or maintain clearances around equipment
	Minimum clearance to access points	18”, radial separation to access points and ingress/egress paths
	Clearance between adjacent circuits	6” with vertical channel segregator 12” without vertical channel segregator
	Maximum number circuits per tray	2

Table 12—Stanchion Bracket Design Criteria

Stanchion Brackets		Requirement
General	Composition	Nonmetallic fiber reinforced; refer to Appendix B for preapproved assemblies
	Style	Wall mount
	Cable support interval	24” Max
	Minimum bend radius	2 ft.
Installation	Minimum clearance to ceiling	2 ft.
	Elevation above floor	8 ft. to 15 ft. except as necessary to align with exterior duct penetrations or maintain clearances around equipment
	Minimum clearance to access Points	18”, radial separation to access points and ingress/egress paths
	Vertical clearance between adjacent circuits	18” Min
	Maximum number circuits per arm	1

4.11.3 Cable Bus and Bus Duct

1. Service cables may be directly connected to submersible transformer secondaries if a bus duct termination is provided within 8 feet of the secondary spades.
2. Bus duct and cable bus assemblies are typically engineered and designed on a project-specific basis by the manufacturers. Installations shall comply with the requirements of Table 13.
3. If cable bus is installed in a trough, trough requirements shall apply.

Table 13—Bus Duct Termination Cable Bus Design Criteria

Cable Bus		Requirement	
General	Composition of racking and support Tray	Aluminum, stainless steel, or other company-approved corrosion material. Refer to Appendix B for preapproved assemblies	
General	Ampacity	≥ Service entrance panel rating	
Bus Duct Termination	Phasing	Phasing shall mirror transformer secondary configuration and be clearly marked (see Figure 13)	
Bus Duct Termination	Termination type	Spade, NEMA two-hole connections (see Figure 12)	
Bus Duct Termination	Spade size Number of holes	**Service Panel Ampacity**	**Number of Holes**
		1,200 A or less	10
		1,201 A to 2,400 A	12
		2,401 A to 4,000 A	16
Bus Duct Termination	Phase-to-phase separation	8”-Min	
Bus Duct Termination	Elevation above floor	10 ft. to 15 ft.	
Cable Bus	Service cable	500 kcmil or 750 kcmil, copper Class-B stranding, USE-2 **Note:** Company will supply service cables and connectors	
Cable Bus	Clearance to ceiling	2 ft. – Min.	
Cable Bus	Elevation above floor	10 ft. to 15 ft.	
Cable Bus	Minimum clearance to access points	18”, radial separation to access points and ingress/egress paths	

4.11.4 Troughs

1. Troughs shall be provided with gravity drainage to in accordance with Section 4.6.
2. Troughs shall not be located in paths or aisleways used to transport equipment to installation and removal access points.
3. Trough gratings shall be installed flush with the finished floor.
4. Trough construction and design shall meet the requirements of Table 14. Example trough cross section for two primary circuits is shown in Figure 13.
5. Metallic racking and gratings shall be bonded to the ground bus. Refer to Appendix B for preapproved assemblies.

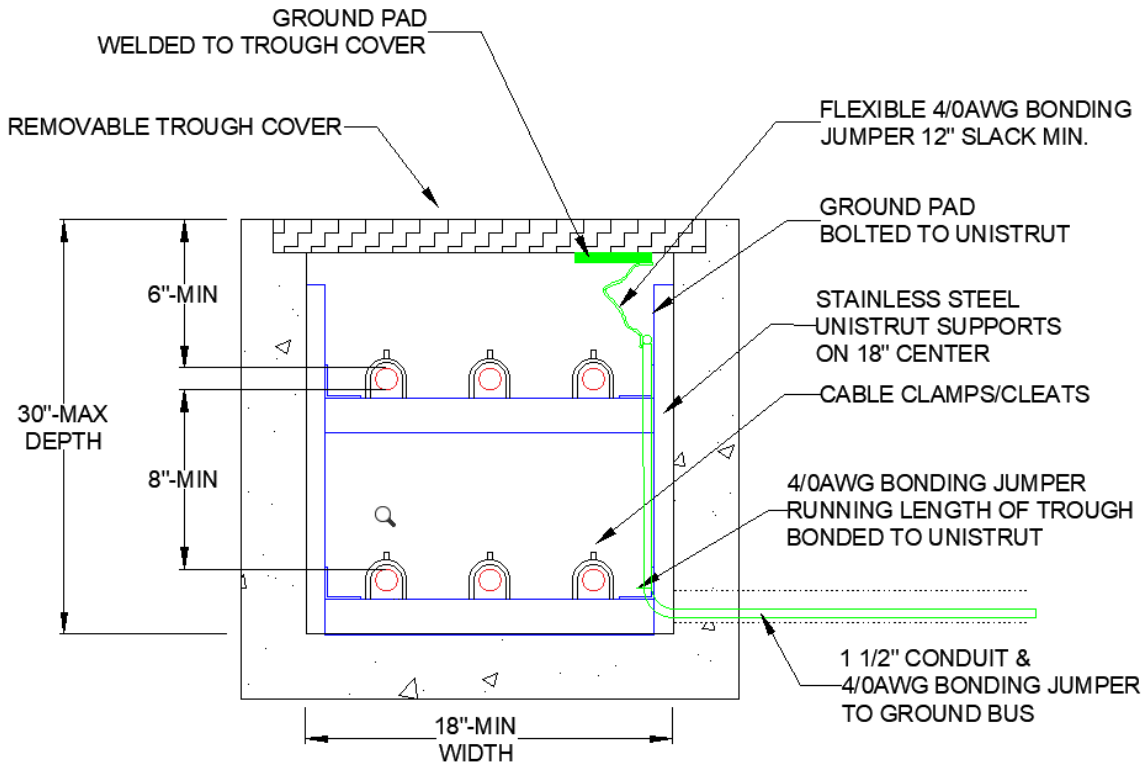


Figure 13—Example Primary Cable Trough Two Circuits

Table 14—Trough Gratings

Troughs and Gratings		Requirement
Troughs	Minimum width	16″
	Maximum depth	30″
Gratings	Composition	Hot-dipped galvanized steel, stainless steel or other company approved corrosion material
	Maximum weight/assembly	75 lbs.
	Minimum open area	50%
	Max. gap between bearing bars	¼″
	Load rating	
Primary Cable Installation	Cable support interval	18″ Max
	Cable clamping interval	36″ Max
	Minimum bend radius	2 ft.
	Vertical clearance between circuits	8″ Min
	Min. Clearance from finished grade to cables or cable bus	6″

Appendix A—Example Layouts

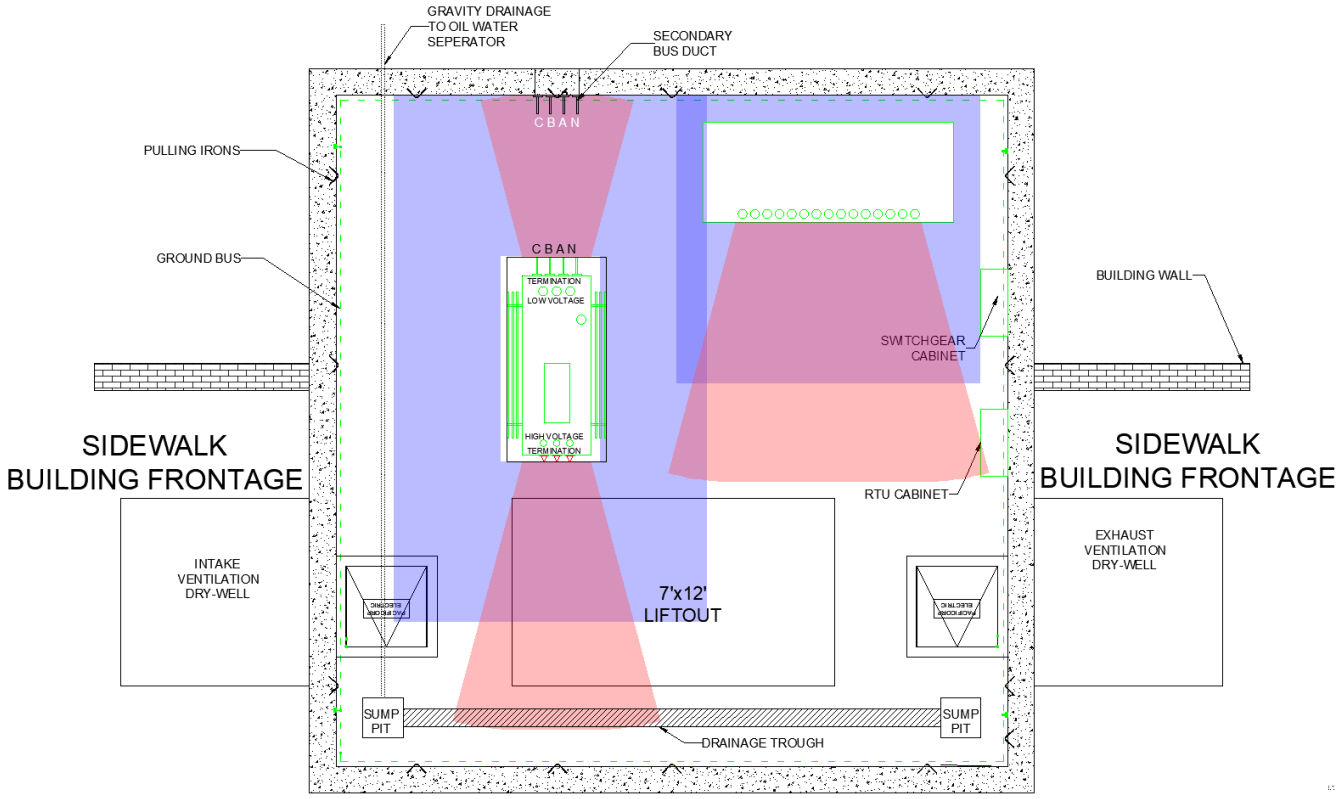


Figure 14—Below-Grade Vault, Top View

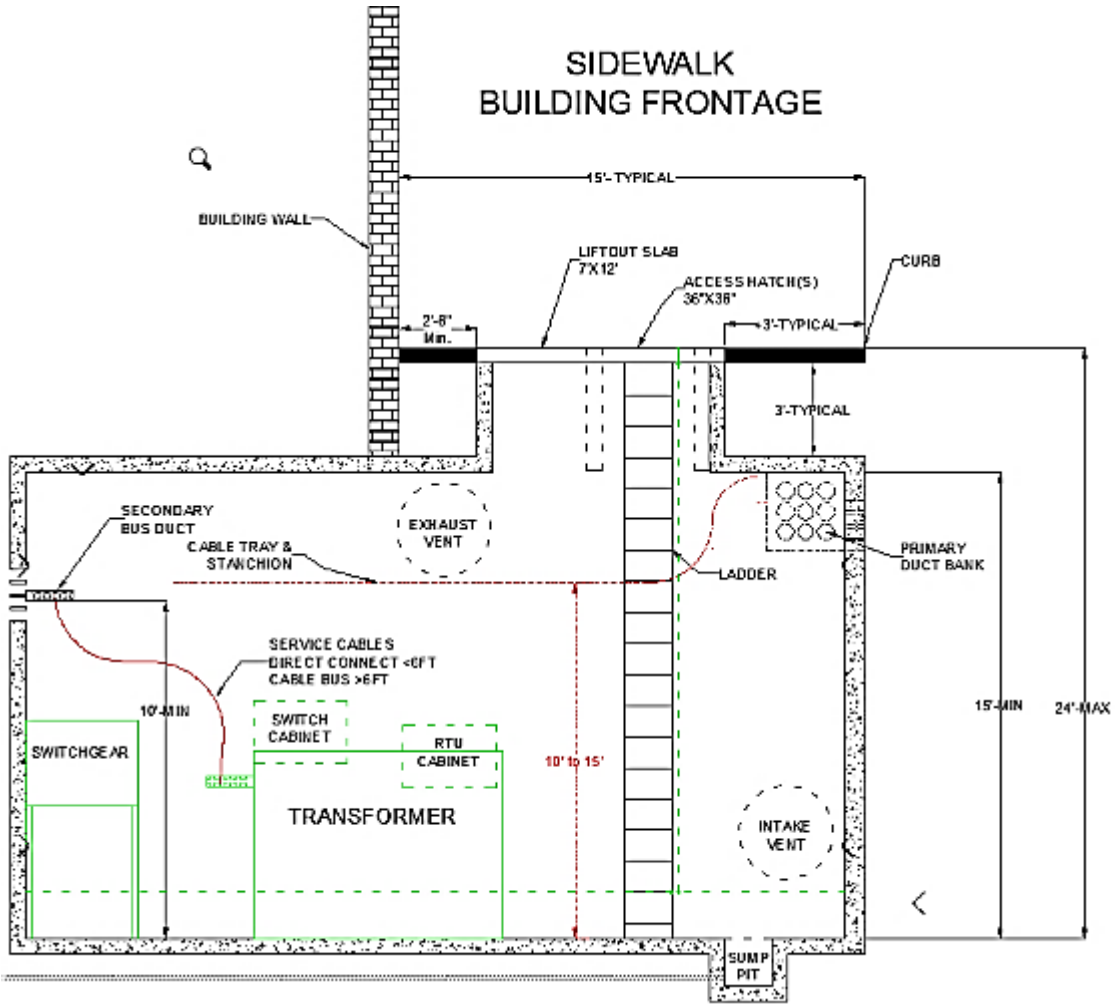


Figure 15—Below-Grade Vault, Side View

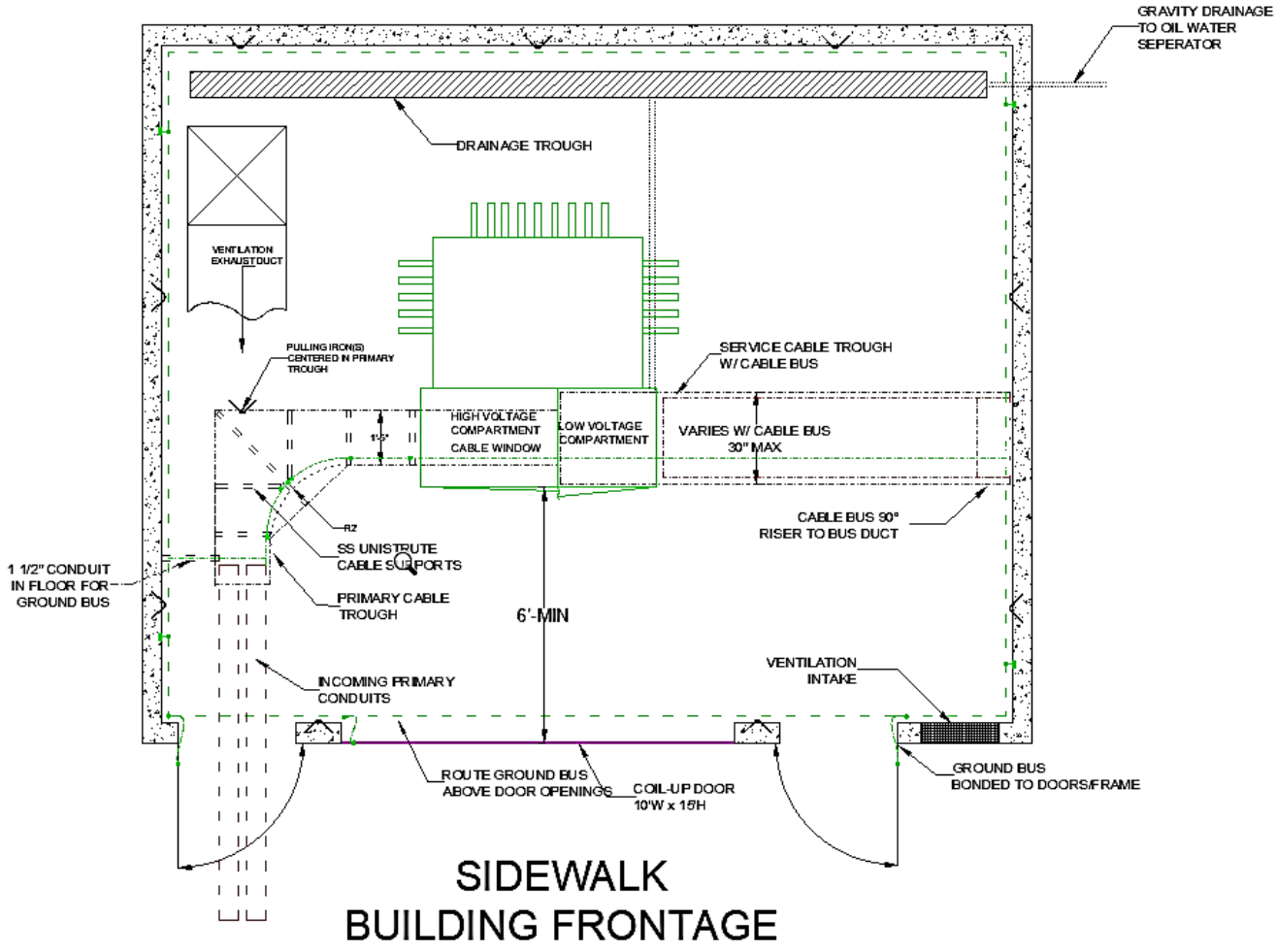
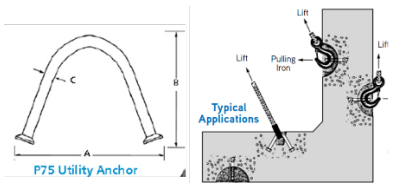
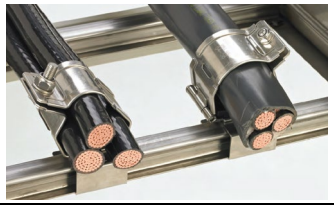


Figure 16—Above-Grade Vault, Top View

Appendix B—Required Hardware (Preapproved Supplier)

Component	Manufacturer	Catalog Number	
Doorway Lockset	Yale	7150F (series flat bar exit device) 626F (series handle, set for storeroom function)	
Access Hatch	East Jordan (EJ)	NPR21-002651-29358 (36″×36″, ductile iron, top frame, h20 non-roadway, gasketed)	
Access Hatch **(Preferred)**	East Jordan (EJ)	NPR21-202106-29469 (36″×36″, aluminum, channel frame, H20 non-roadway)	
Ladders			
Manhole Cover	East Jordan (EJ)	NPR20-002148-18796	
Manhole Frame	OldCastle	3010-PCORP-COVER-A1366106	
Pulling Irons	Dayton Superior	#129169 (P75 Galvanized, 8UA671, 10,830 lbs. SWR in tension)	
Ground Plates	Harger	#EGPBSD4/0X12 (concrete encased, 4/0 AWG lead wire, exothermic weld to rebar required)	
Ground Plate Clamps	Burndy	#GB29 (QTY-2 per ground plate) 2/0 AWG–250 kcmil	

Component	Manufacturer	Catalog Number	
Ground Bus Connections	Hubbell	#GC5040 (QTY-2 per connection) 4/0 AWG–4/0 AWG	
Bonding Grounding Straps	Harger	#BGS52B18D2D (18″, 2-hole, 2-braid, bonding strap)	
Bonding Unistrut Clamps	Harger	SCBC158 (#6–250 kcmil)	
Stanchion Brackets	Underground Devices, Inc	CR36-B (36″ stanchion bracket) RA14 (14″ stanchion arm)	
Cable Tray (MV-Cables > 1,000 V)	Eaton/Cooper B-line	Series-34A1212xxxxx	
Cable Tray and Trough (Clamps, Cleats)	Eaton/Cooper B-Line	9SS6-CCTxxxx (Trefoil) 9SS6-CCSxxxx (Single Conductor)	
Cable Bus (Service Cables < 600 V)	Superior	600V-Series Cable Bus	

Appendix C—Typical Equipment Dimensions

C.1. Cables

Table 15—Typical Cable Dimensions

Cable Type	Overall Diameter (in.)	Weight/ft. (Single Conductor)
600 V–500 kcmil (Cu)	1.00	1.73
600 V–750 kcmil (Cu)	1.22	2.57
15 kV–1/0 AWG (Al)	1.07	0.48
15 kV–4/0 AWG (Al)	1.29	0.70
15 kV–1000 kcmil (Al)	2.03	2.12

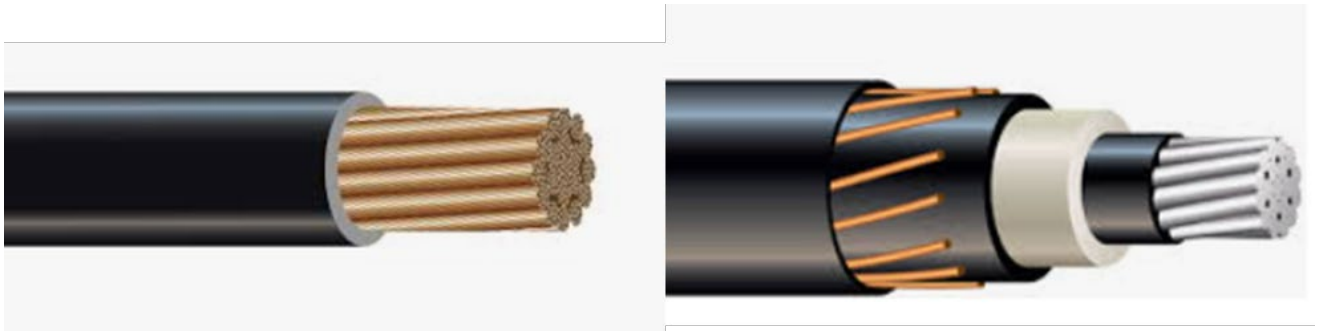


Figure 17—Service (600 V) and Primary (15 kV) Cables

C.2 Single-Phase Submersible Transformers

Table 16—Typical Single-Phase Submersible Transformer Dimensions

kVA Rating	Max Dimensions (in.)		Oil Volume (gal.)	Weight (lbs.)
	D	H		
25	30	52	41	700
50	30	52	45	850
75	30	52	'---	'---
100	30	52	'---	'---
167	33	52	'---	'---

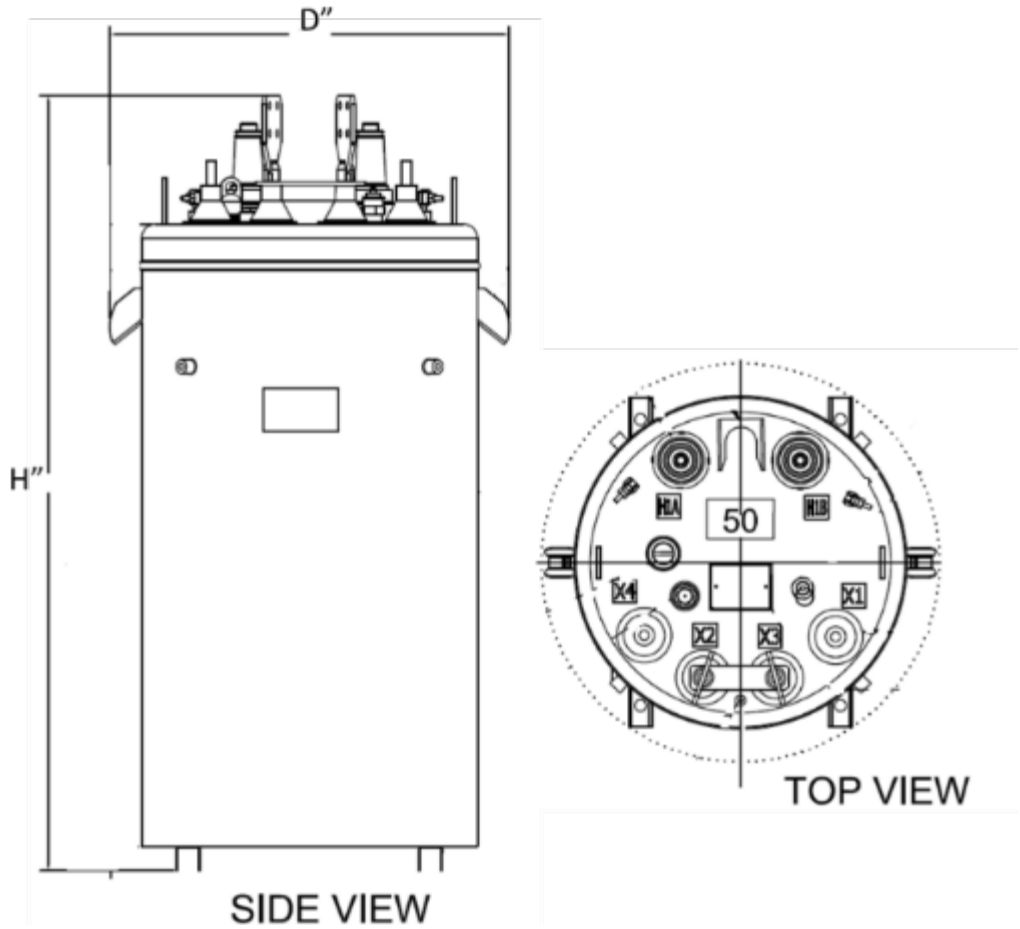


Figure 18—Single-Phase Submersible Transformers

C.3 Three-Phase Submersible Transformers

Table 17—Typical Three-Phase Submersible Transformer Dimensions

kVA Rating	Max Dimensions (in.)			Oil Volume (gal.)	Weight (lbs.)
	W	L	H		
300–1,000	48	78	66		
1,500	60	96	72		
2,000	66	96	72		
2,500	66	96	72		

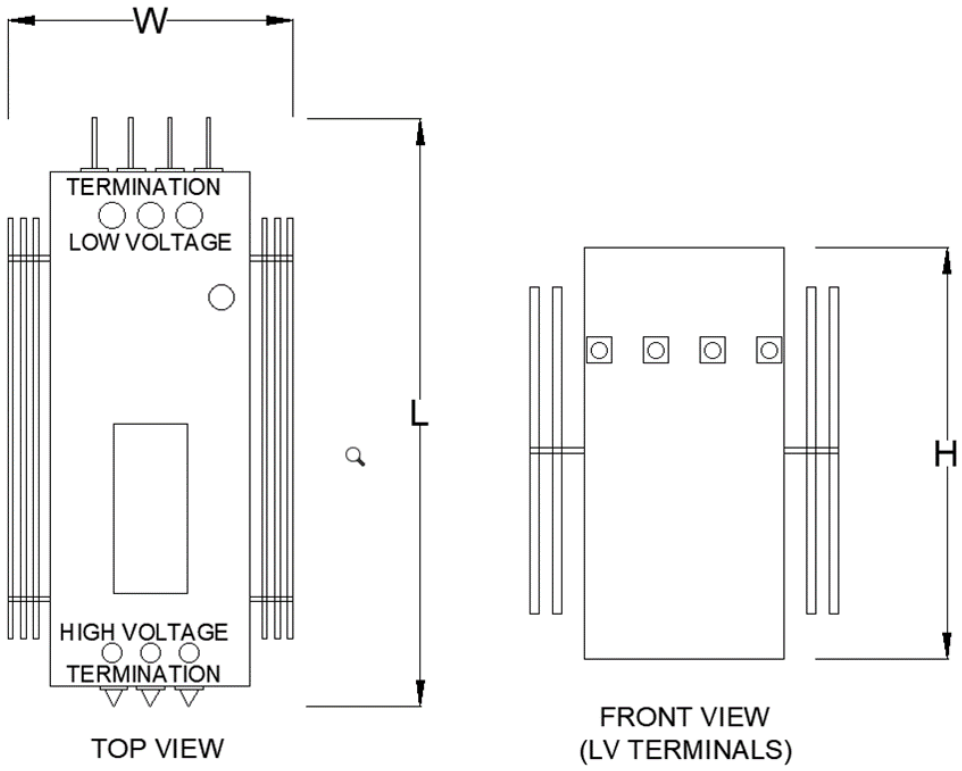


Figure 19—Three-Phase Submersible Transformers

C.4 Single-Phase Pad-Mounted Transformers

Table 18—Typical Single-Phase, Pad-Mounted Transformer (15 kV) Dimensions

kVA Rating	Max Dimensions (in.)			Oil Volume (gal.)	Weight (lbs.)
	A	B	C		
25	33	42	36	30	650
50	33	42	36	35	750
75	36	42	36	50	1,000
100	36	42	36	60	1,150
167	36	42	36	75	1,650

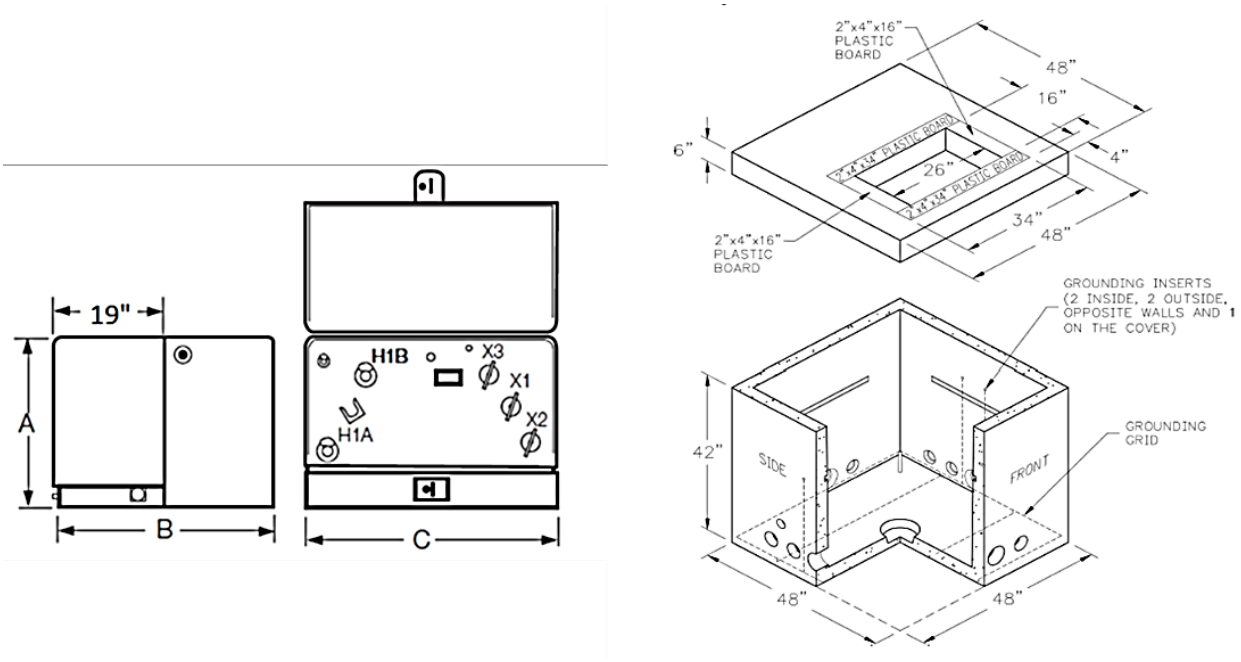
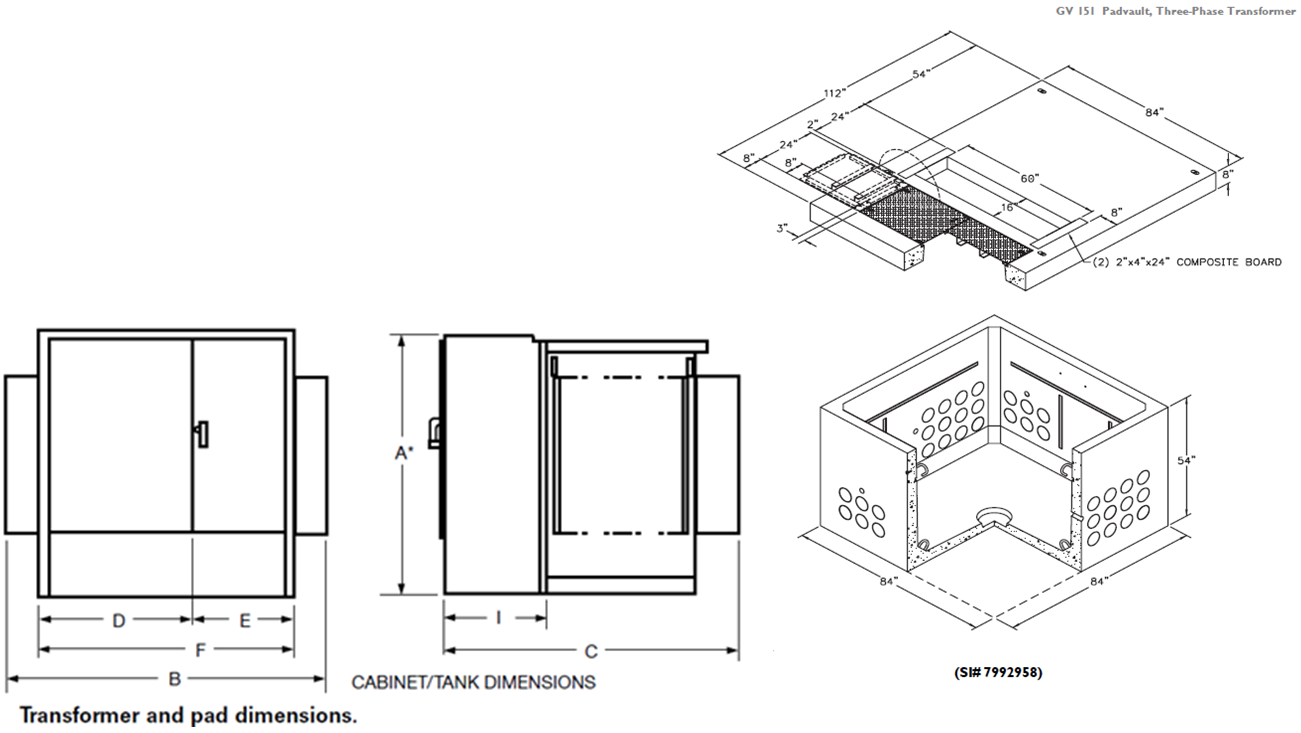


Figure 20—Single-Phase, Pad-Mounted (15 kV) and Cable Pulling Vault

C.5 Three-Phase Pad-Mounted Transformers

Table 19—Typical Three-Phase Pad-Mounted Transformer Dimensions

kVA Rating	Dimensions (in.)					Oil Volume (gal.)	Weight (lbs.)
	A	B	C	D	E		
75	59	68	45	42	26	115	2,250
150	59	68	55	42	26	125	2,700
225	59	72	57	42	30	140	3,150
300	59	72	57	42	30	160	3,650
500	59	89	59	42	30	190	4,650
750	73	89	63	42	30	270	6,500
1,000	73	89	65	42	30	350	8,200
1,500	73	89	92	42	30	410	10,300
2,000	73	89	93	42	30	490	12,500
2,500	73	89	105	42	30	530	14,500



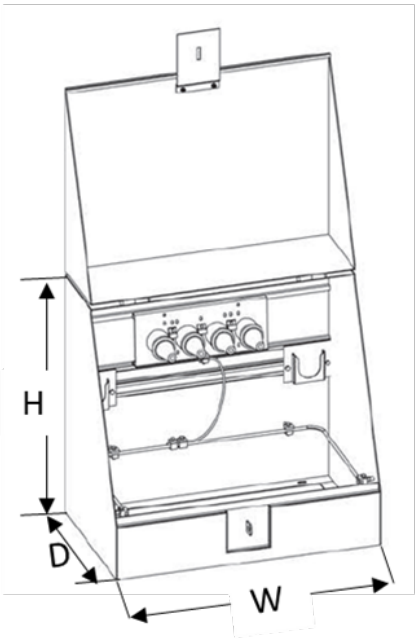
Transformer and pad dimensions.

Figure 21—Three-Phase, Pad-Mounted Transformer Vault

C.6 Single-Phase Sectionalizing Cabinets

Table 20—Typical Single-Phase Sectionalizing Cabinet Dimensions

Voltage	Height (in.)	Width (in.)	Depth (in.)
15 kV	33	36	22
25 kV	33	36	22
35 kV	36	36	30



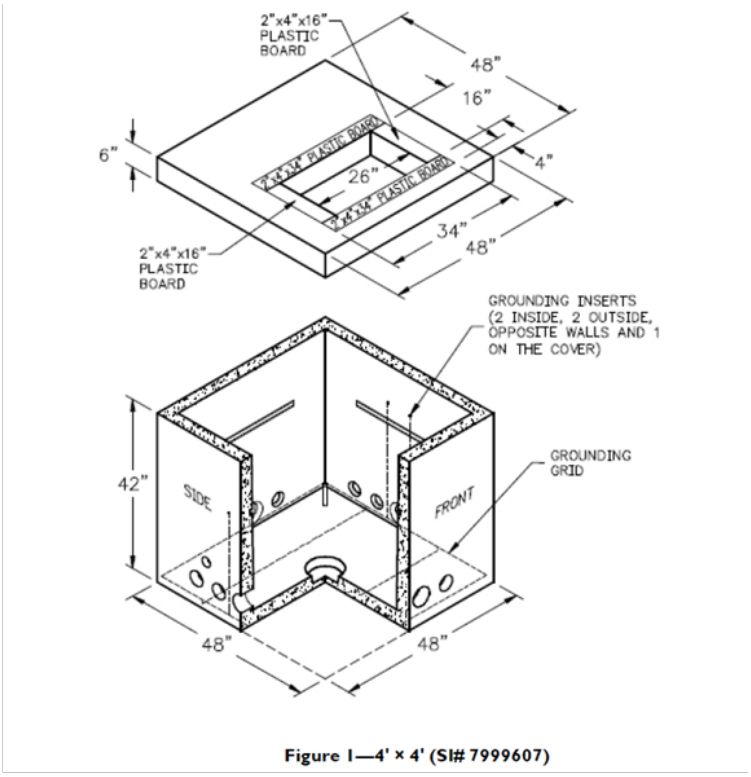


Figure 22—Single-Phase Sectionalizing Cabinet and Vault

C.7 Three-Phase Sectionalizing Cabinets

Table 21—Typical Three-Phase Sectionalizing Cabinet Dimensions

Voltage	Height (in.)	Width (in.)	Depth (in.)
15 kV	33	66	22
25 kV	33	84	22
35 kV	36	84	30

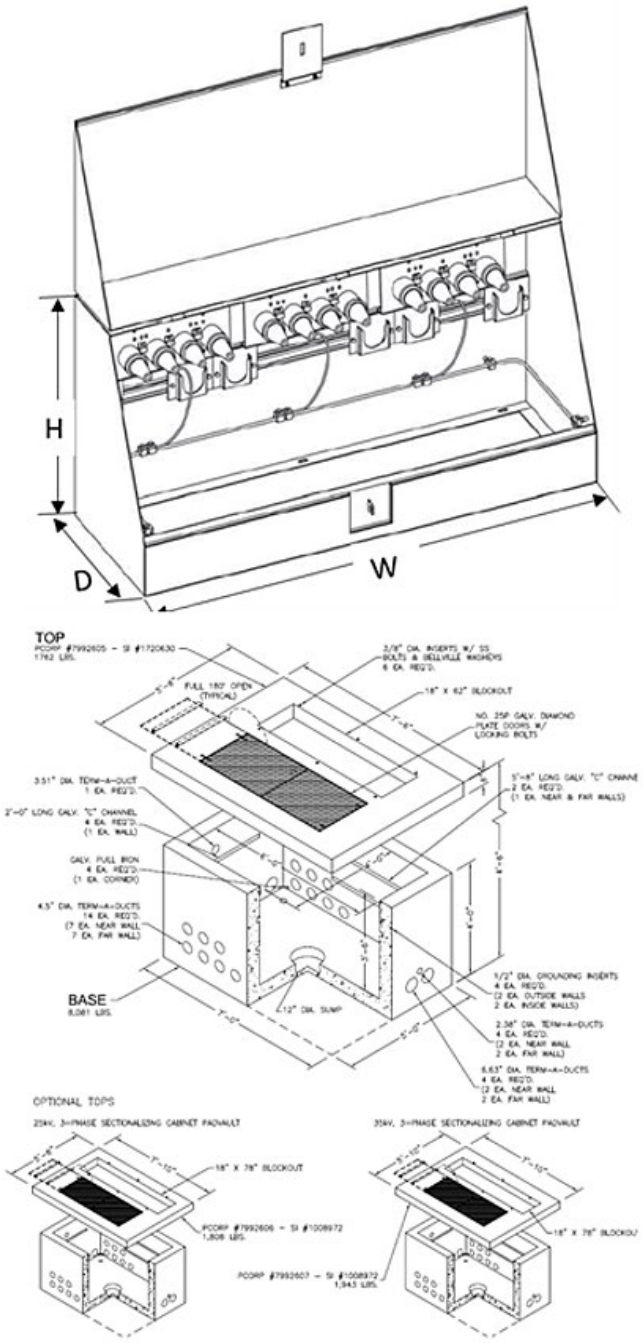


Figure 23—Three-Phase Sectionalizing Cabinet and Vault

C.8 Switchgear Pad-Mounted Air-Insulated (PME/PSE Style)

Table 22—Typical Switchgear, Pad-Mounted, Air-Insulated Dimensions

Voltage	Type	Height (in.)	Width (in.)	Depth (in.)
15 kV	3	45	41	70
15 kV	9,12	45	75	70
15 kV	10,11	45	75	73

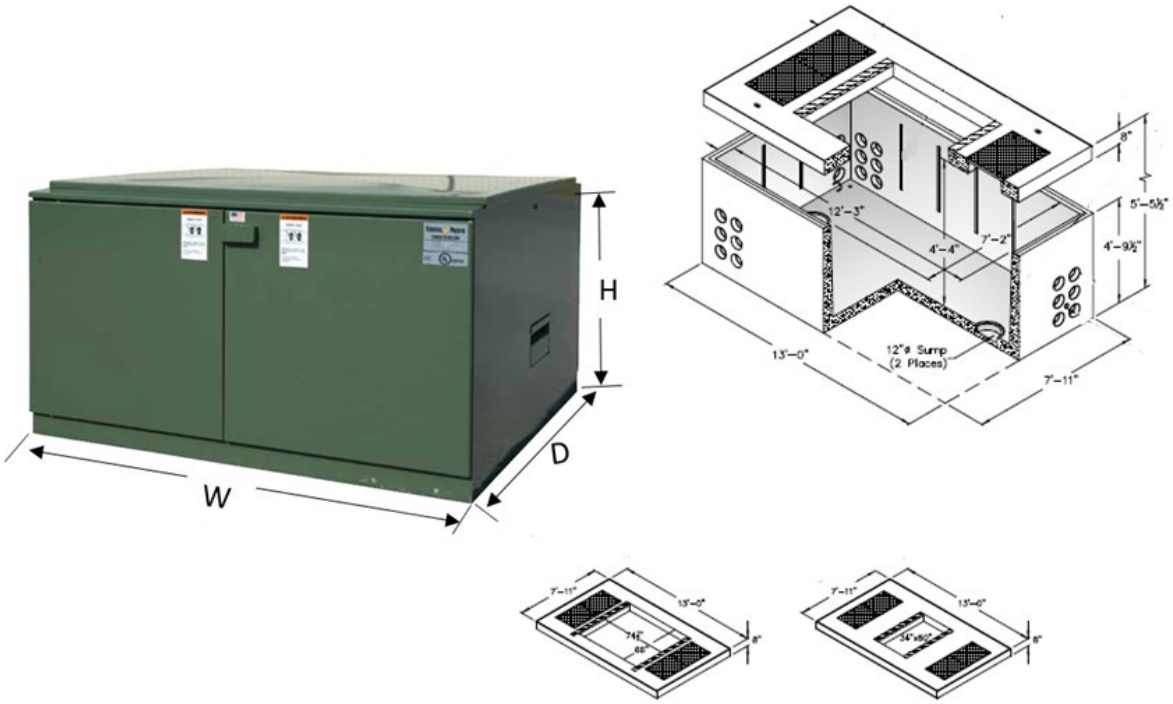


Figure 24—Pad-Mounted, Air-Insulated Switchgear

C.9 Switchgear S&C Vista SF6 Insulated

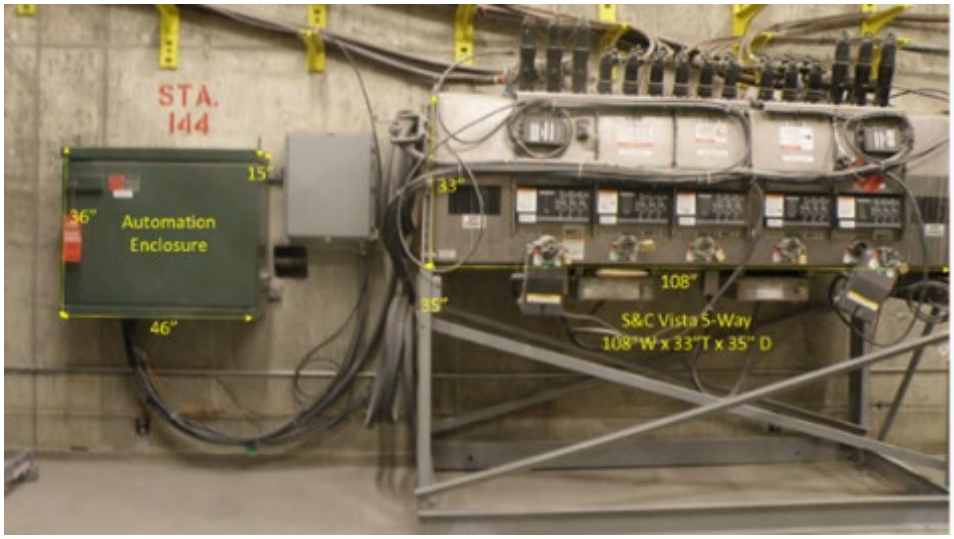


Figure 25—Submersible S&C Vista 5-Way Switchgear and Automation Controller

C.10 Switchgear Elastimold MVI/MVS Rack Mount

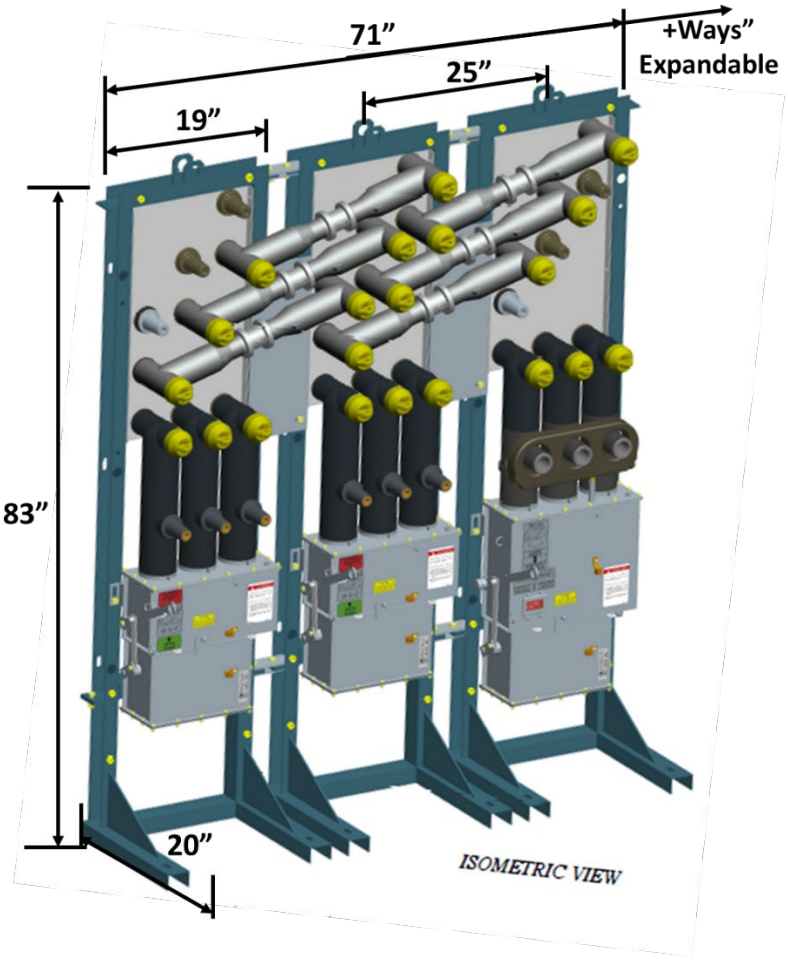


Figure 26—Switchgear Elastimold MVI/MVS Rack Mount