September 2021

UNDERGROUND CONDUIT SYSTEMS

for Primary and Secondary Conductors (Rev. 2)

Standards Engineering and T&D Operations Policy No. 343

This policy and related documents are posted on the web at:
http://www.pacificpower.net/con/ucsi.html

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Policy 343—Underground Conduit Systems for Primary and Secondary Conductors

1. General

1.1. Purpose

This manual is intended to guide Pacific Power customers in the installation of primary and secondary underground conduit systems based on an approved design and/or the Electric Service Requirements Agreement (ESRA). This document covers most applications, but cannot address every possible situation. Consult the Power Company for solutions to unique circumstances.

Following application for service (other than for services inside of a predesigned subdivision), an estimator will provide construction design details with a sketch and/or ESRA. If additional information is required, contact the estimator directly or the Pacific Power New Construction Hotline at 1-800-469-3981 or via the internet at www.pacificpower.net/con/index.html.

1.2. Changes or Conflicts in Requirements

The intent of this manual is to comply with all applicable codes, ordinances, and tariffs, as well as to implement common practices throughout the Power Company's service territory. Common practices are implemented to:

- meet or exceed minimum safety codes and municipal building ordinances
- ensure fair and impartial requirements for all customers
- facilitate the privacy and security of current and future customers and occupants
- use safe work procedures by following established Power Company standards

If a requirement in this manual conflicts with an applicable tariff, code, or ordinance, a solution shall be designed that meets (or exceeds) those requirements. The Power Company will provide standards, and should be consulted with questions on the applicability of any item in this manual.

Where this document differs from the Power Company's *Electric Service Requirements Manual* regarding primary and secondary installations this document shall prevail.

1.3. Definitions

1.3.1. Conduit Systems

Closed Conduit Design: A closed conduit design consists of conduit in a trench terminating in a vault. All underground systems require a closed conduit design.

1.3.2. Underground System Conductors

Primary Conductors: Underground conductors between the Power Company's substation and the Power Company's distribution transformers.

Secondary Conductors: Underground conductors between the Power Company's distribution transformers and secondary boxes.

Service Entrance Conductors: Underground conductors between the customer's service equipment terminals and the Power Company's source. For more information regarding service entrance conductors and conduit please refer to the Power Company's *Electric Service Requirements Manual* at www.pacificpower.net/con/esr.html.

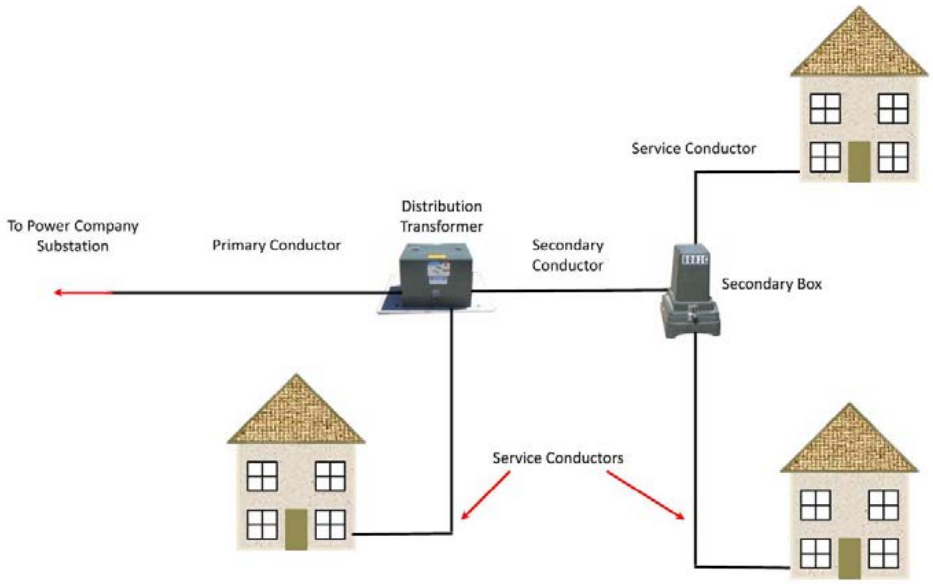


Figure 1—Primary, Secondary, and Service Conductor Schematic

1.3.3. Primary and Secondary Equipment Associated with Conduit Systems

Distribution Transformer: A voltage device that converts power from the primary voltage to a secondary voltage. The secondary side of the transformer serves individual customers either directly or via a secondary box.

Sectionalizing Cabinet: A primary voltage device used as a junction for two or more primary cables. A sectionalizing cabinet cannot be used to serve a customer.

Switchgear: A primary voltage device used as either a switch point or protection point for two or more primary cables. Switchgear cannot be used to serve a customer.

Secondary Box: A secondary voltage device used as a junction for two or more secondary or service cables. A secondary box can be used to serve a customer.

1.4. Customer Responsibilities

The customer shall meet the requirements described in this document to complete construction for underground installations.

The customer is typically responsible for providing all trenches, backfill, compaction, conduit, padvaults, and final grade design. The customer is responsible for boring if that method is used.

Before installing any primary and/or secondary conduit system, the customer may enter into a contract with the Power Company and obtain a job sketch and/or ESRA from a Power Company representative. The customer is typically responsible for ensuring that all conduit system installations comply with Power Company requirements and the provided job sketch and/or an ESRA.

Any conduit system or any part of a conduit system installed before receiving a job sketch and/or ESRA from the Power Company will be subject to Power Company rejection.

1.5. Underground Infrastructure Signs and Markers

Above-grade signage, buried radio frequency (RF) markers, and buried caution tapes assist utility location services. Their presence may also provide a supplemental level of protection against service interruptions from dig-ins. General requirements are provided below:

Requirements:

1. Caution tape shall be installed 12 to 18 inches above all electrical conduits and duct banks, if trenching or other open excavation methods are used.
    a. Caution tape shall be red in color with black text "CAUTION BURIED ELECTRIC LINE BELOW," tape shall be a minimum of 6 inches wide by 0.004 inches thick. (3M Scotch #368 or equivalent).
2. Red-dyed concrete shall be used if concrete encasement is used to encase electrical conduits or duct banks.
3. Radio frequency (RF) markers shall be installed above 4- to 8-inch electrical conduits at stub-outs and transition points between bored and trench installations. (3M #1256 Passive Mid-Range Marker Power Encoded or equivalent). If these markers are required, they will be provided by the Power Company with locations specified on the job sketch.
4. Above-grade signage, if required, will be provided by the Power Company with locations specified on the job sketch.
5. Additional signs or markers may be required for unique installations.

2. Trench and Backfill

2.1. Call Before You Dig (8-1-1)

State laws require the customer/excavator call 8-1-1 for underground utility cable locations at least two (2) full business days prior to any excavation. Excavation shall not start until facilities have been marked by an underground locator service, or until the service confirms that no facilities exist in the area.

811 Know what's below. Call before you dig.

2.2. Trench and Backfill Requirements

2.2.1. Trenching Requirements

The customer shall provide all trenching, meeting or exceeding the Occupational Safety and Health Administration (OSHA) requirements at the time of digging. As of the time of the publication of this document OSHA requires the trench be shored when the combination of trench plus the spoil exceeds five feet (5'). To comply with OSHA rules when not shoring a trench, the customer shall keep the spoil at least two feet (2′) away from the open trench.

The National Electrical Safety Code (NESC) states in Rule 321.A, "The bottom of the trench should be undisturbed, tamped, or relatively smooth earth. Where the excavation is in rock, the conduit should be laid on a protective layer of clean tamped backfill."

To the extent possible, trench bottoms shall be level and made of well-tamped earth without sharp rises and drops in elevation. Rock spurs or ridges shall not project into the trench. If trenching is left open overnight, the customer is responsible for cleaning prior to conduit installation. Per NESC Rule 321.A. the Power Company may require the conduit be laid on a protective layer of clean tamped backfill.

Figure 2—Spoil

When the customer is trenching to existing (energized) equipment, the customer shall stop trenching with mechanical methods and continue hand trenching the final two feet (2') to the energized equipment unless otherwise requested by the Power Company. Do not trench under/past the base of, or otherwise expose, the energized equipment (see "Figure 3" on the facing page). Do not enter any Power Company owned equipment without a company representative on site.

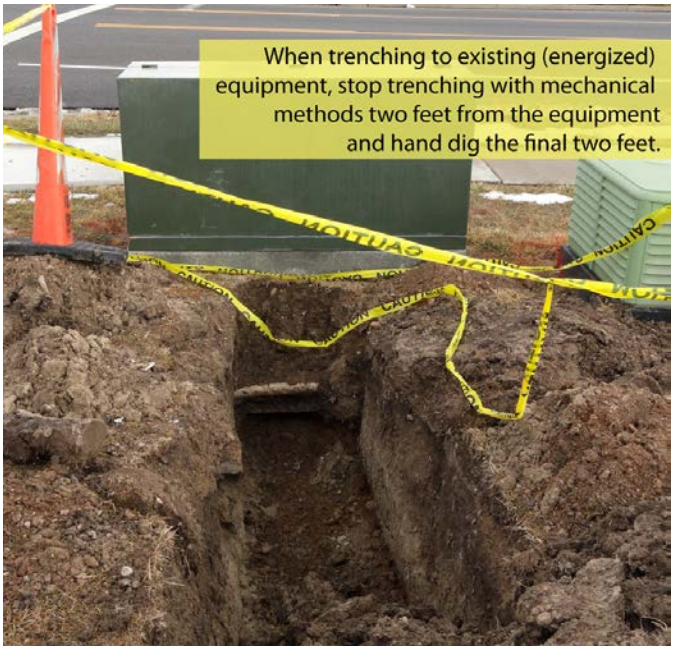


Figure 3—Trench to Energized Equipment

2.2.2. Backfill Requirements

The National Electrical Safety Code states in Rule 321.B, "All backfill should be free of materials that may damage the conduit system. Backfill material should be adequately compacted to limit settling under the expected surface usage."

The following list of requirements applies to all installations requiring backfill:

1. The customer shall provide trench backfill and site restoration.
2. Backfill must be free of materials that may damage the conduit system. Backfill material within six inches (6″) of the conduit shall pass through a three-quarter-inch (¾″) sieve frame. Backfill in the remainder of the trench shall be free of rocks larger than four inches (4″) in diameter.
3. Backfill shall be adequately compacted to prevent future settling.
4. Prior to backfilling over the conduit, the Power Company shall inspect the backfill material and conduit installation.

The Power Company will not schedule work until the customer completes the backfill to Power Company satisfaction.

Extra caution should be taken when backfilling trenches. The customer is responsible for repairing crushed or damaged conduit, including any costs for crews to return to the job site.

2.3. Trench and Backfill Installation

The customer is typically responsible for providing all trenches, boring, backfill, compaction, conduit, and padvaults. The customer shall meet the requirements described in this procedure to complete construction for underground installation.

Before installing any conduit system, the customer shall enter into a contract with the Power Company and obtain a job sketch and/or ESRA from a Power Company representative. The customer is responsible for ensuring that all conduit system installations comply with Power Company requirements and with the provided job sketch and/or ESRA. Any conduit system or any part of a conduit system installed before receiving a job sketch and/or ESRA from the Power Company may be subject to rejection or revision.

During development/construction, the customer is responsible for ensuring that all subsequent contractors working in the vicinity of Power Company facilities exercise care to maintain the integrity of the conduit system (conduit and padvaults). If the Power Company is required to return to the site to repair the conduit system, the customer will be held liable.

Winter conditions may not allow a customer to adequately build to company specifications regarding compaction. The customer shall be responsible for the cost if the Power Company is required to return later to correct settling issues.

Figure 4—Tamping the Conduit Trench

Figure 5—Typical Conduit Trench

2.4. Trench Types

2.4.1. Primary Conduit Trench

The primary conduit trench is normally in the Public Utility Easement (PUE) or an established right-of-way (ROW). This trench may include both secondary and primary cable. When digging only a primary trench, the customer shall follow the dimensions shown in "Figure 6" below.

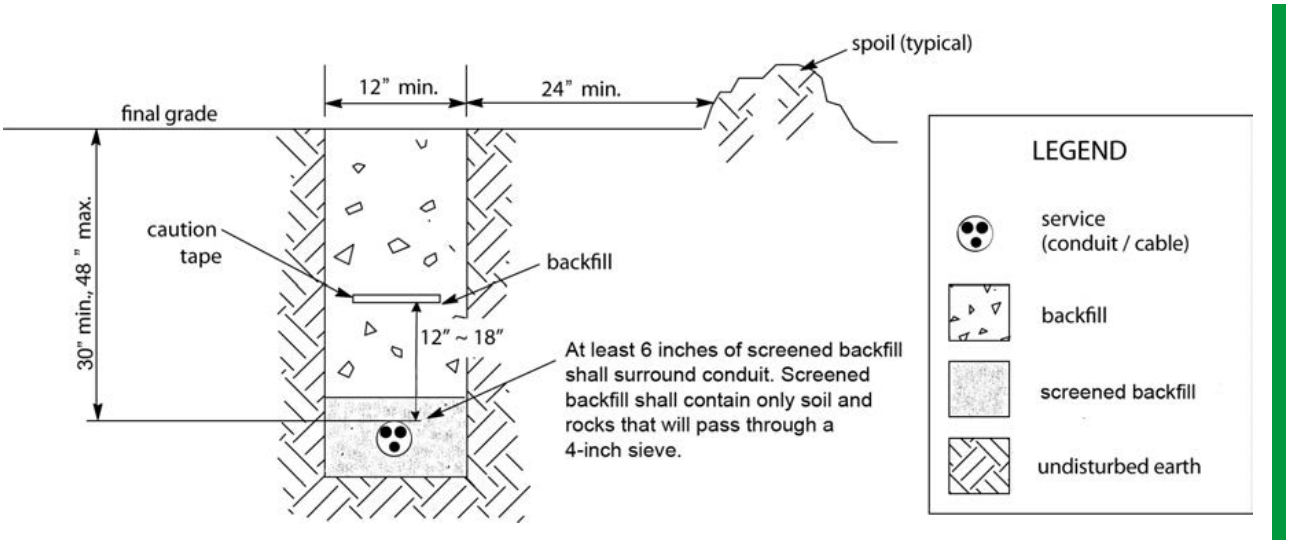


Figure 6—Primary Trench

2.4.2. Secondary Conduit Trench

When installing only secondary conduit in a trench, follow the dimensions and requirements in "Figure 7" below.

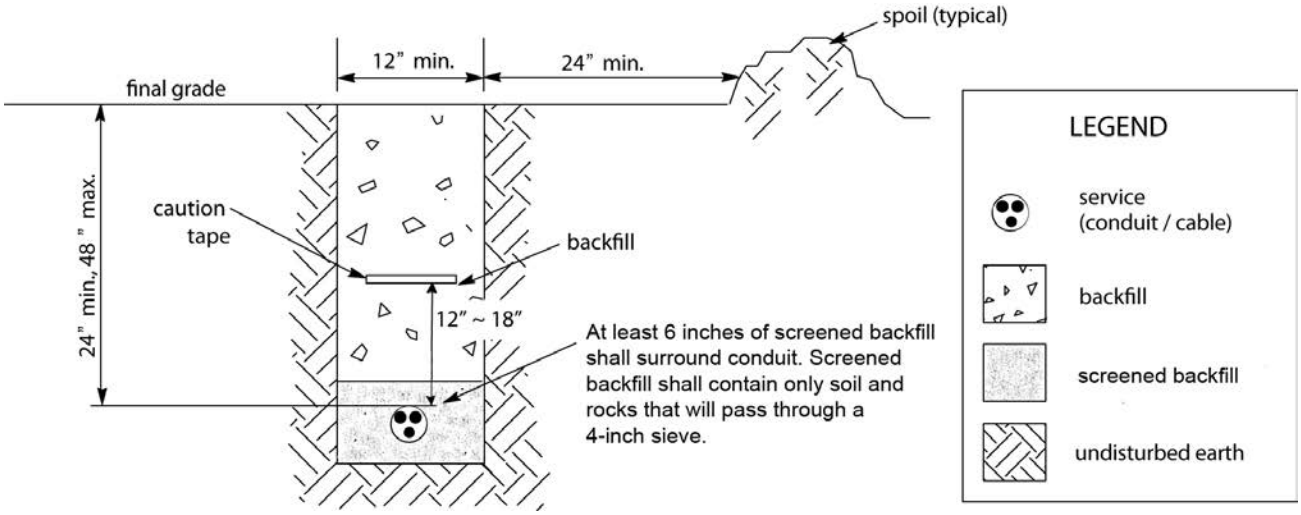


Figure 7—Secondary Trench

2.4.3. Joint Use Trench

Joint use trenching requirements may vary by area; consult the Power Company for requirements before installation. The customer may be allowed to place communication, signal, and other electrical supply conductors in the same trench as Power Company conductors, provided that the installation meets Power Company policy, and all concerned parties agree on the placement.

Communications: A minimum horizontal distance of 12 inches (12") shall exist between the electrical conduit and other utility lines, unless superseded by the requirements of other utilities involved (and/or unless local requirements differ). See "Figure 10" on page 11.

Gas: The minimum horizontal distance between the electrical conduit and gas lines must be greater than 12 inches (12") unless both the Power Company and the joint use gas utility have reached a separate operational agreement requiring a greater distance.

Other electric utilities: The Power Company requires that other electric utilities be located in different trenches that have a minimum separation of six feet (72"); however, the Power Company may allow a joint trench agreement with another electric utility.

Water, sewer, and drainage: The Power Company will not install electrical conductors in a common trench with main water lines, sewer lines, or other drainage lines. Conduit should be installed as far as practical to protect it from being undermined if the water main breaks.

Note: "Table 1" on page 10, "Figure 8" on the facing page, and "Figure 11" on page 11 provide information and examples for joint use trench applications.

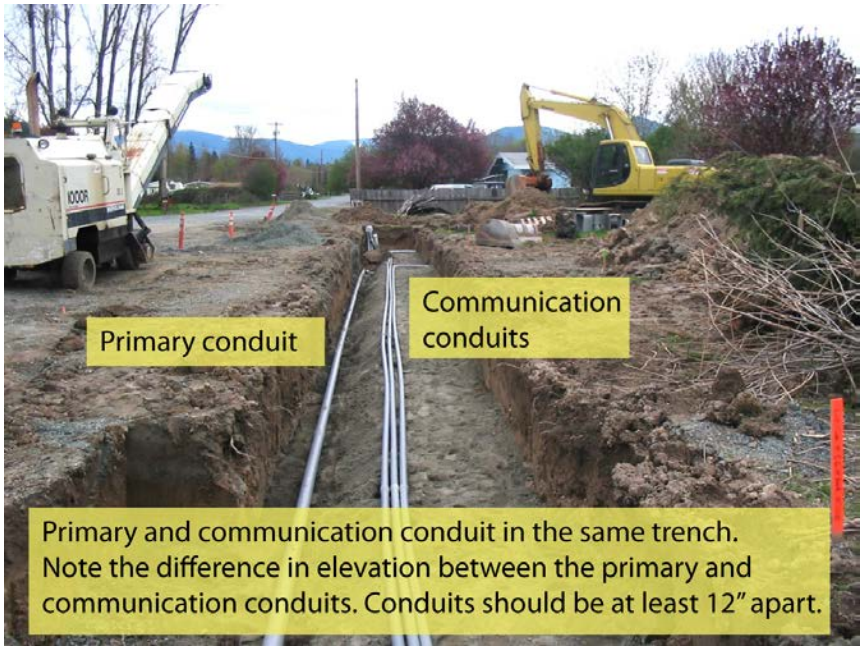


Figure 8—Power and Communication Conduits in Trench

Note: Communication and gas lines should be over 12″ and up 12″ from power conduit.

Table 1—Radial Separation from Foreign Utilities and Structures

Location	Foreign Utility or Structures Permitted	Minimum Separation	
		Paralleling	Crossing
Zone 1	No foreign lines or structures allowed	N/A	N/A
Zone 2	Communication (telephone, fiber, cable)	12″ (Horizontal)	12″ (Vertical)
	Streetlights		
	Minor structures (vaults, manholes, poles foundations, fence footings)		
	Gas (mains and services)		
Zone 3[a]	Water lines (pressurized)	36″ (Horizontal)	12″ (Vertical)
	Sewer (sanitary and sewer)		
	Steam and cryogenic		
—	Building foundations	60″ (Horizontal)	Prohibited
—	Retaining walls	60″ (Horizontal)	Engineering required
—	Gas transmission	Engineering required	Engineering required
	Other lines transporting flammable materials		
	Railroads		

[a] Lines shall not be parallel directly above or below electric supply lines.

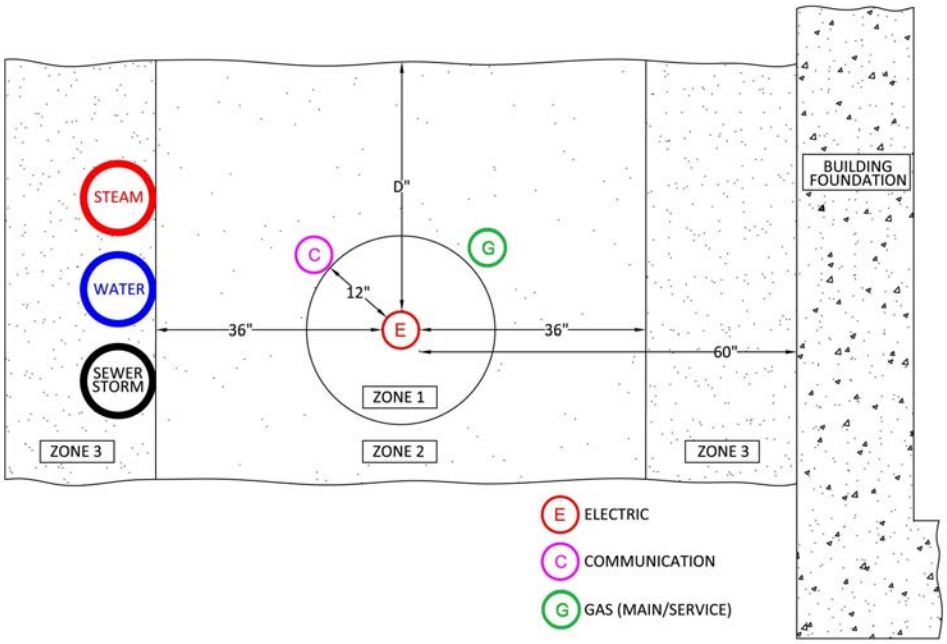


Figure 9—Minimum Separation of Paralleling Lines and Structures

Note: Distance exceptions may be granted on a case-by-case basis by the Power Company.

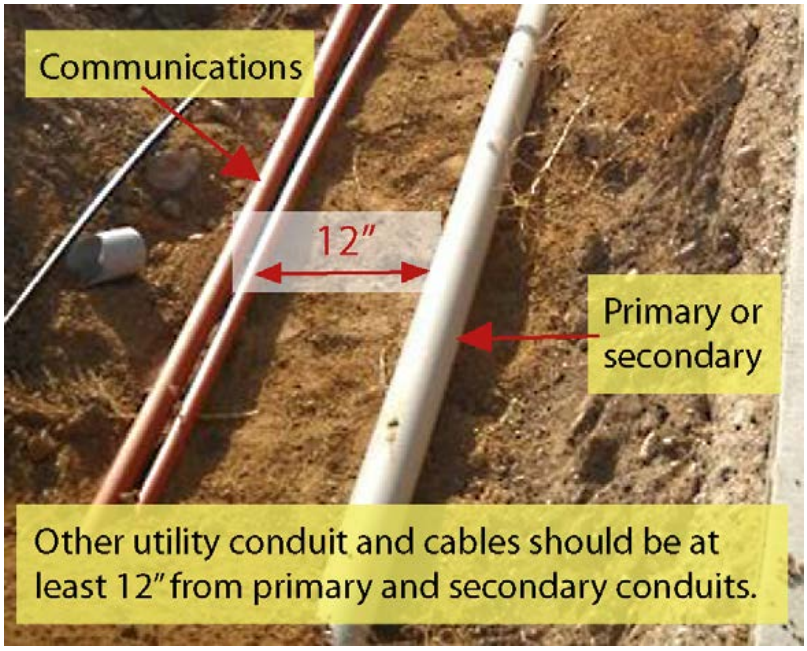


Figure 10—Joint Trench for Primary/Secondary with Communication

When installing power conduit in a joint use trench, follow the dimensions in "Figure 11" below, which shows the primary, secondary, and joint use installed in a horizontal configuration. Please contact the Power Company for details.

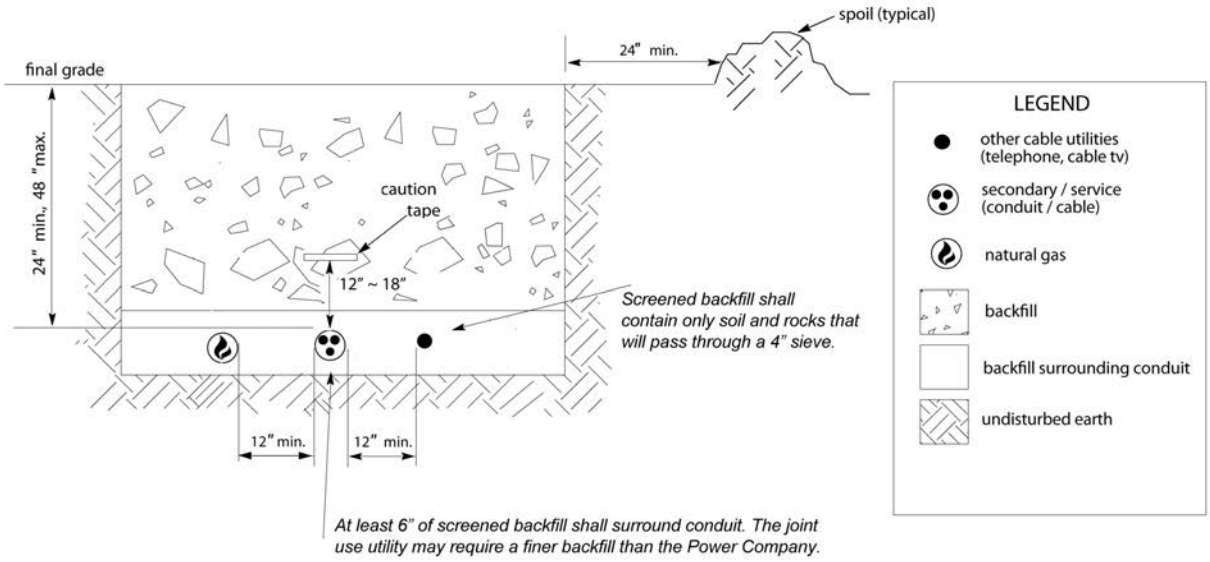


Figure 11—Joint Use Primary Trench

2.5. Backfill

For trenching requirements see Section 2.2. , *Trench and Backfill Requirements*. "Figure 12" below shows acceptable backfill and "Figure 13" below shows unacceptable backfill.

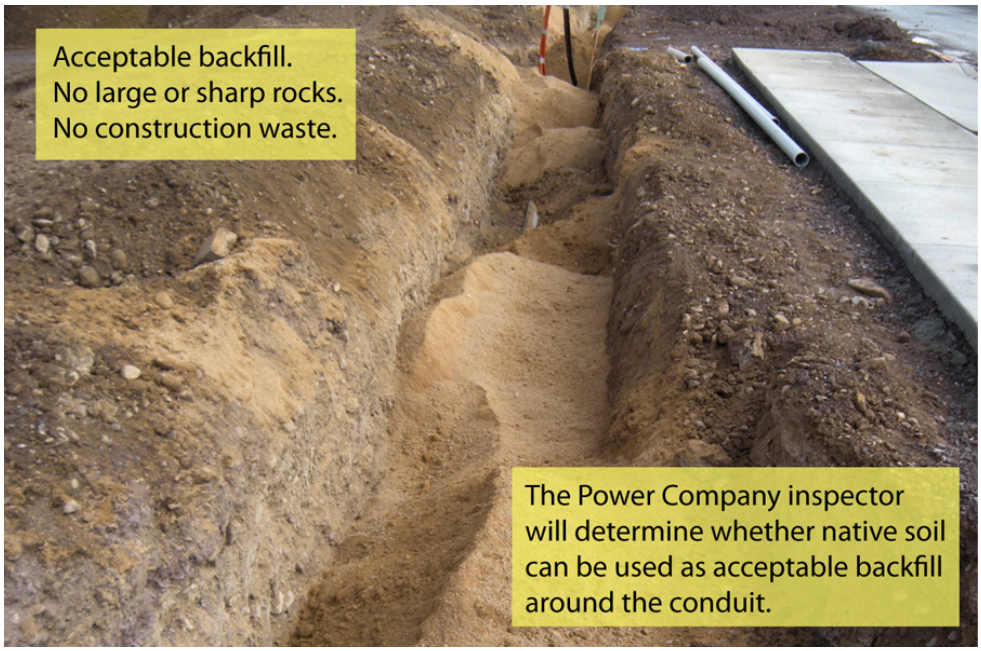


Figure 12—Acceptable Backfill

Figure 13—Unacceptable Backfill

3. Conduits

3.1. Conduit Installation Requirements

The following list of requirements applies to all primary and secondary conduit installations.

3.1.1. Location

The customer shall ensure that conduit is located away from (and never underneath) buildings, building foundations, or other structures.

Conduit shall not be run in a parallel direction under a retaining wall. Conduit may be run at a right angle under a retaining wall. If the retaining wall is greater than three feet (3') in height a steel sleeve shall be used to protect the conduit.

3.1.2. Water Flow

The customer is responsible for recognizing potential surface and subgrade water flows and coordinating with the Power Company to minimize potential runoff problems. Potential surface and subgrade water flows are relevant where water infiltration is problematic because of proximate river flooding, the presence of a high water table, or the lay of the land.

3.1.3. Dirt and Debris

The customer shall keep the inside of the conduit free of dirt and debris during installation. Once the conduit is installed, it shall be temporarily sealed (plugged or capped) to prevent infiltration of water and dirt. An unglued conduit cap or plug is required for keeping the conduit free of debris. The customer is responsible for clearing accumulated debris.

3.1.4. Pull Rope

The customer shall provide a flat pull line (preferred) or poly rope (alternative) rated to withstand 1,000 lbs. of tension, installed with six feet (72″) of extra line extending from each end of the conduit. The pull line shall be secured inside the ends of the conduit and both conduit ends shall be capped. The customer shall contact the Power Company to install the pull line into energized equipment.

3.1.5. Final Grade

Final grade design must be established and a physical measure confirmed by the presence of curb, gutter, and grading stakes placement.

3.2. Conduit and Sweeps – Material

"Table 2" below identifies the appropriate types of conduit, materials, and sweeps for below-ground applications. HDPE is only accepted for below-grade applications when installed by directional boring or cable plowing. "Table 3" below specifies the sweep specifications. Field bends are not permitted.

The company accepts electrical grade schedule 40 PVC (or better). Fiberglass (ZG 033), and high-density polyethylene (HDPE) (ZG 031) conduit materials can also be used with prior company approval; these material specifications are available at www.pacificpower.net/con/esr.html.

The Power Company shall provide prior approval for the use of rigid metal conduit (RMC), which is only to be used in above-grade special applications.

Table 2—Below-Ground Conduit Applications

Application	Type of Conduit[1]	Sweep Material[1]
Three-phase primary	PVC	Fiberglass
Single-phase primary	PVC	Fiberglass
Secondary	PVC	Fiberglass or PVC[2, 3]

1. Steel conduit, casings, and sweeps may be required for special applications.
2. Fiberglass can tolerate higher sidewall pressures than PVC.
3. Conduit runs greater than 150 feet require fiberglass.

Table 3—Sweep Specifications

Acceptable Elbow Sweeps[1]				When PVC is Used[1]	When Fiberglass is Used[1]
Conduit Diameter (in.)	Secondary Conductor Conduit (in.)	Primary Conductor Conduit (in.)		PVC Schedule	Minimum Fiberglass Wall Thickness (in.)
		In Trench	Riser		
3″	36″	36″	36″	40	0.09″
	48″	48″			
4″	36″	36″	36″	40	0.09″
	48″	48″			
6″	48″	48″	48″	40	0.11″
		60″			

1. Long radii sweep elbow sizes are based on cable sidewall pressure-bearing limitations. Depending on pulling calculations, the Power Company may require a larger radius sweep or specify which material the sweep should be made of.

Note: Two-inch (2") conduit is prohibited for secondary use unless prior approval from the Power Company is granted.

Figure 14—Electrical Grade PVC

Figure 15—Fiberglass Sweeps with PVC Ends

Figure 16—Field-Installed Elbow

Additional conduit and sweep requirements:

- PVC shall be electrical grade Schedule 40 or better
- Fiberglass conduit shall meet or exceed the Power Company's material specification ZG 033, *Fiberglass Conduit*
- Each fiberglass sweep requires two factory-attached PVC, extra-deep, fabricated, expanded bell-ends as shown in "Figure 15" on the previous page.
- Fiberglass sweeps must be certified by a Nationally Recognized Testing Laboratory (NRTL)
- HDPE conduit may be used upon approval of the Power Company. HDPE conduit can be installed by plowing and short-directional boring methods. Primary and secondary conductors can be pulled into this type of conduit. HDPE conduit shall meet the Power Company's specification ZG 031, *High-Density Polyethylene (HDPE) Conduit*, which can be found at http://www.pacificpower.net/con/esr.html.

3.3. Conduit and Sweeps – Installation

The customer is responsible for providing all conduit and sweeps. The customer shall meet the requirements described in this procedure to complete construction for underground installation. The customer is responsible for ensuring that all conduit system installations comply with Power Company requirements.

During development/construction, the customer is responsible for ensuring that all subsequent contractors in the vicinity of Power Company facilities exercise care to maintain the integrity of the conduit system (conduit and padvaults). If the Power Company is required to return to the site to repair the conduit system, the customer will be held liable.

1. The customer shall provide and install conduit, including long-radius sweeps.
2. All PVC joints shall be glued and compressed to the depth of the coupling system.
3. **Manufactured sweeps shall not be altered. Field form sweeps are not permitted.**

Figure 17—Field-Altered Sweep – Damaged PVC

3.4. Conduit Proofing Requirements

All installed underground conduit (including stub-outs) shall be proofed with a mandrel to remove obstructions, and to confirm at least 80% of the nominal conduit diameter. When requested by the Power Company, the customer shall perform a Power Company-witnessed proofing of conduit systems. See "Table 4" below, *Required Mandrel Sizes for Conduit Proofing* and "Figure 18" below showing such mandrels.

Table 4—Required Mandrel Sizes for Conduit Proofing

Conduit Nominal Diameter (in.)	Mandrel Diameter (in.)	Minimum Mandrel Length (in.)	Maximum Mandrel Length (in.)	Proof (%)
2″	1.62″	2.4″	6″	81%
3″	2.5″	3.25″	8″	83%
4″	3.5″	4.25″	8″	87%
6″	5.5″	6.25″	10″	92%

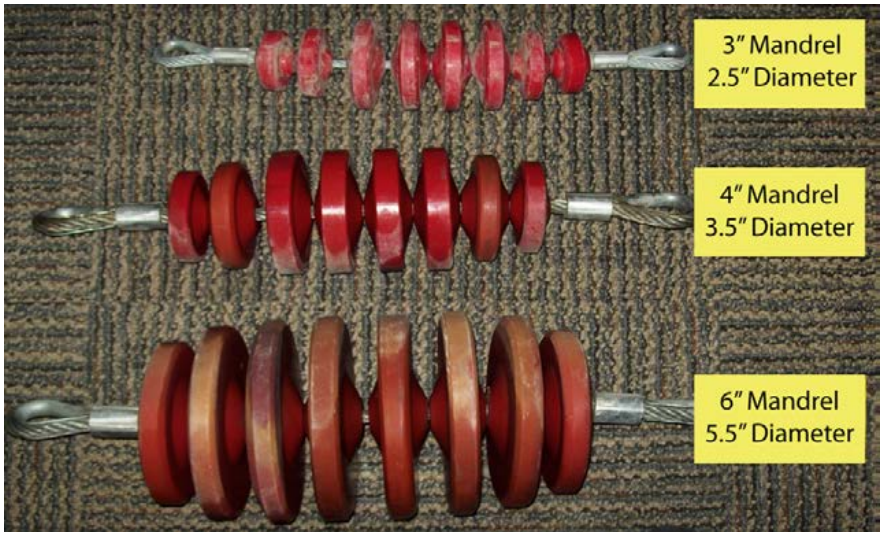


Figure 18—Typical Mandrels

3.5. Change in Conduit Size

No change in conduit size within a conduit run is allowed.

3.6. Conduit to Existing Equipment

When the customer is installing conduit to existing (energized) equipment, the customer shall stop installation of the conduit two feet (2′) from the Power Company facility, unless otherwise requested by the Power Company. The customer shall provide a sweep and extra conduit for use by Power Company employees.

Figure 19—Installing Conduit to Existing (Energized) Equipment

Figure 20—Typical Conduits Attached to a Padvault and Communication Conduit Next to Padvault

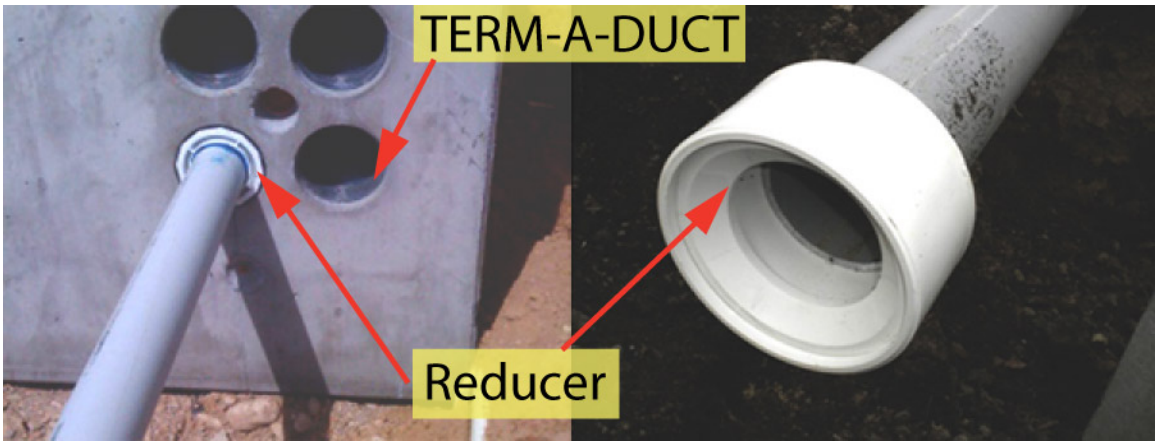


Figure 21—Reducer Used for Conduit Entering the Padvault

Figure 22—Proper Installation of Conduit into Term-A-Duct

3.7. Conduit to New Padvaults

Customer installation of conduit to new padvaults, secondary boxes, or secondary pedestals shall be done according to sections 6. and 1. of this document.

3.8. Conduit through Pavement

When conduit extends vertically through a paved or concrete surface, a sleeve or permanent opening shall be placed around the conduit to prevent direct contact with the pavement to help prevent damage to conduit caused by soil settling. Consult with Power Company.

Figure 23—Installing Conduit through Concrete

3.9. Easements

The customer must ensure all conduits, padvaults, and equipment are placed within the Public Utility Easement (PUE) or within the limits of the granted right-of-way for Power Company.

3.10. Gluing and Sealing PVC Conduit

"Figure 24" below and "Figure 25" on the facing page illustrate the process of gluing and sealing PVC conduit. As described in these two figures: To glue PVC conduit together, apply glue to both the outside (male) and inside (female) ends of the conduit. If you are installing pull rope a conduit section at a time, use caution to ensure that the rope doesn't become dried into any residual glue. Push conduits together until they are seated.

Figure 24—Applying Glue to Conduit

Figure 25—Seating the Conduit

3.11. Pull Line, Proofing, and Sealing the Conduit

For conduit sealing and pull line requirements, see sections 3.1.3., *Dirt and Debris* and 3.1.4., *Pull Rope*. For conduit proofing requirements, see Section 3.4. , *Conduit Proofing*.

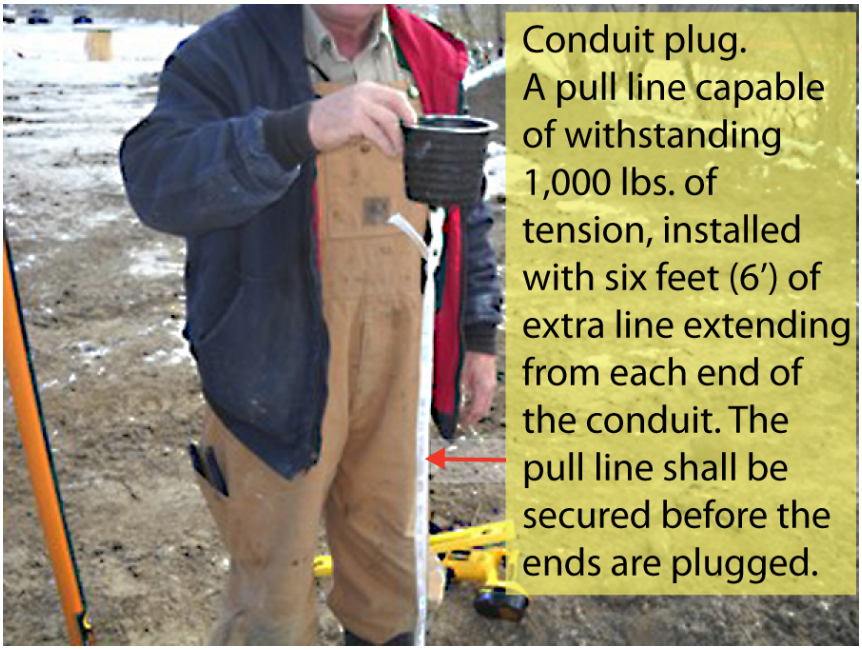


Figure 26—Conduit Plug and Pull Line

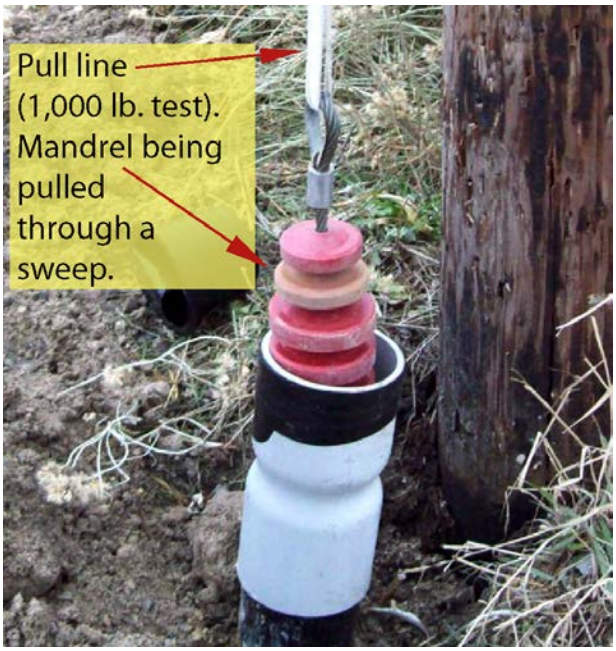


Figure 27—Conduit Proofing

Figure 28—Plugging the Conduit

3.12. Transition from Overhead to Underground

When transitioning from overhead conductors to underground conductors, the Power Company will identify the appropriate location where the conduit riser shall be, relative to the pole. The nearest edge of the conduit sweep should be seven and a half inches (7.5″) from the pole. If a riser already exists on the pole, the new riser shall be attached such that the new riser is parallel to the existing riser. Contact the Power Company if there is no bracket on the pole before installing conduit.

Figure 29—Riser When No Pole is in Place

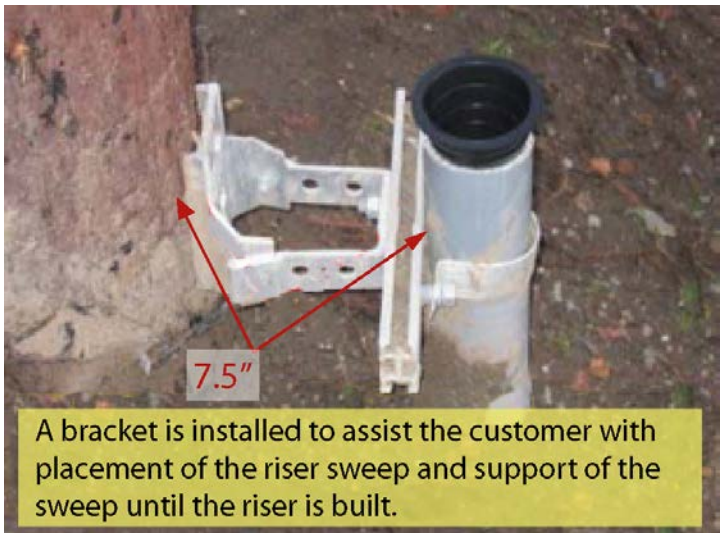


Figure 30—Riser 7.5″ from Pole, Bracket

Figure 31—Riser/Sweep Too Close to Pole

3.13. Conduit into Metering Equipment and Foundations

Locate the sweeps on the building so that the meter will be placed within the first 10' of the closest corner to the power company source. With a minimum of 36" clearance from a gas meter, any gas coupling valve, or any gas connections; and a 36" minimum clearance to a window. The meter must be located directly above the sweep.

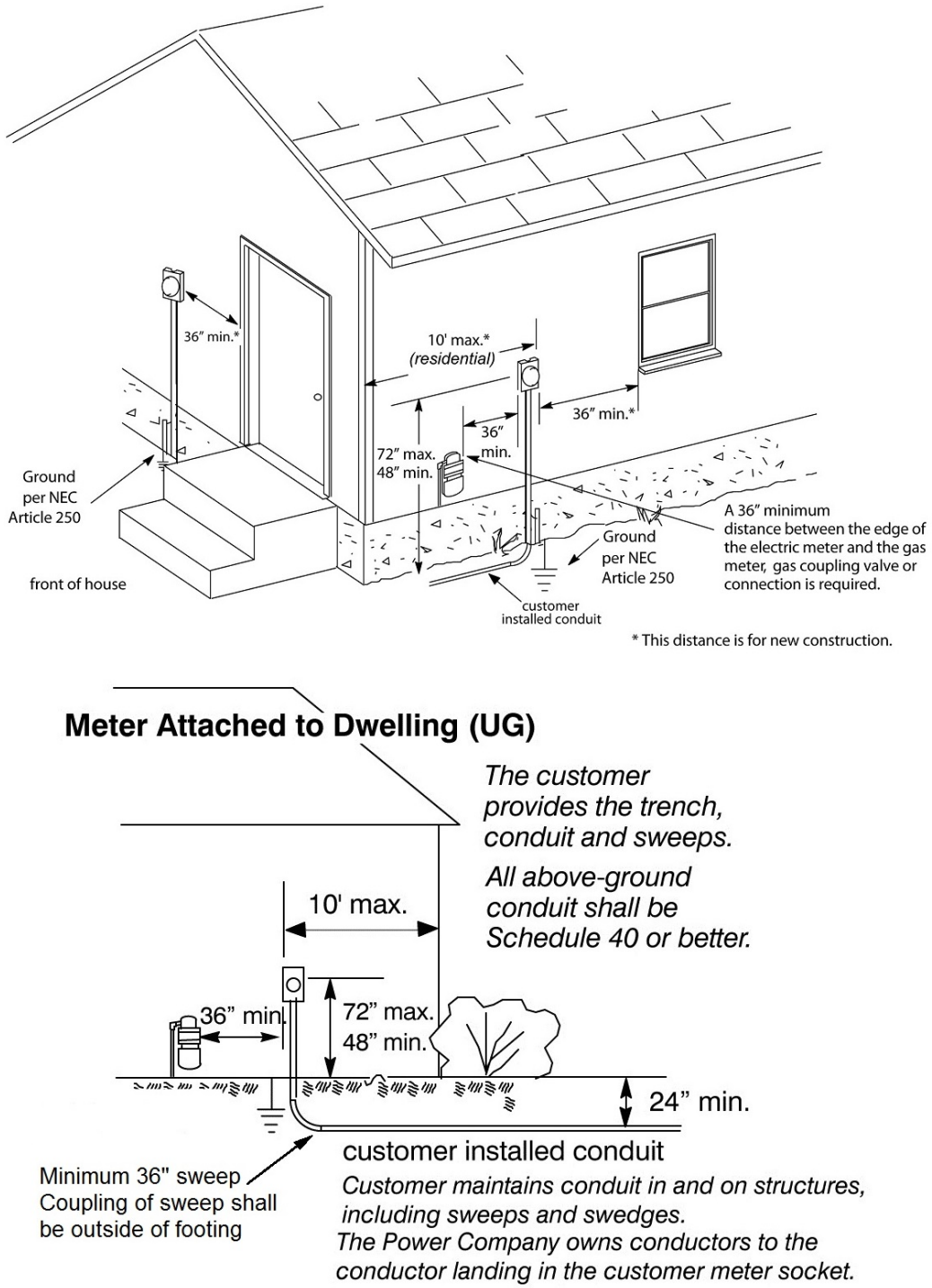


Figure 32—Wall-Mounted Meter Socket Location for Underground Service

3.13.1. Flush-Mount Installation

When installing the sweep into a footing of a building for a flush-mount installation only the sweep is allowed in the footing. Make sure the sweep is pointed towards the power source. The coupling of the 36” sweep must be outside of the footing. Conduit(s) shall be located away from (and never underneath) the building pad and foundation.

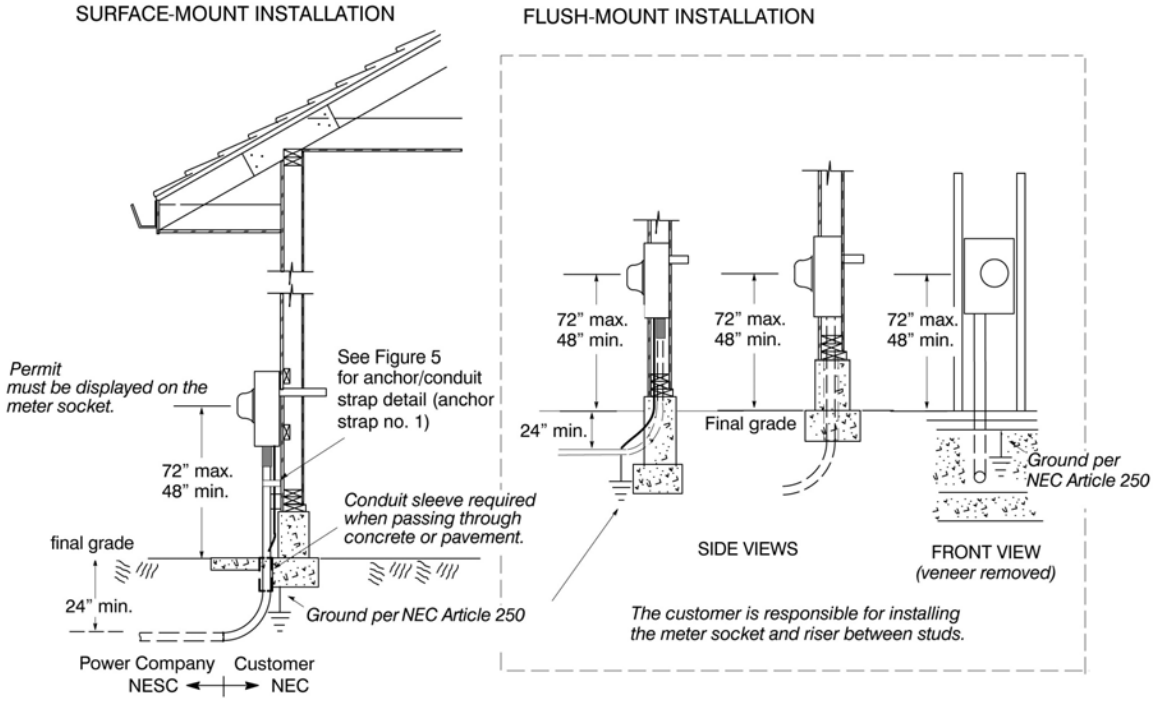
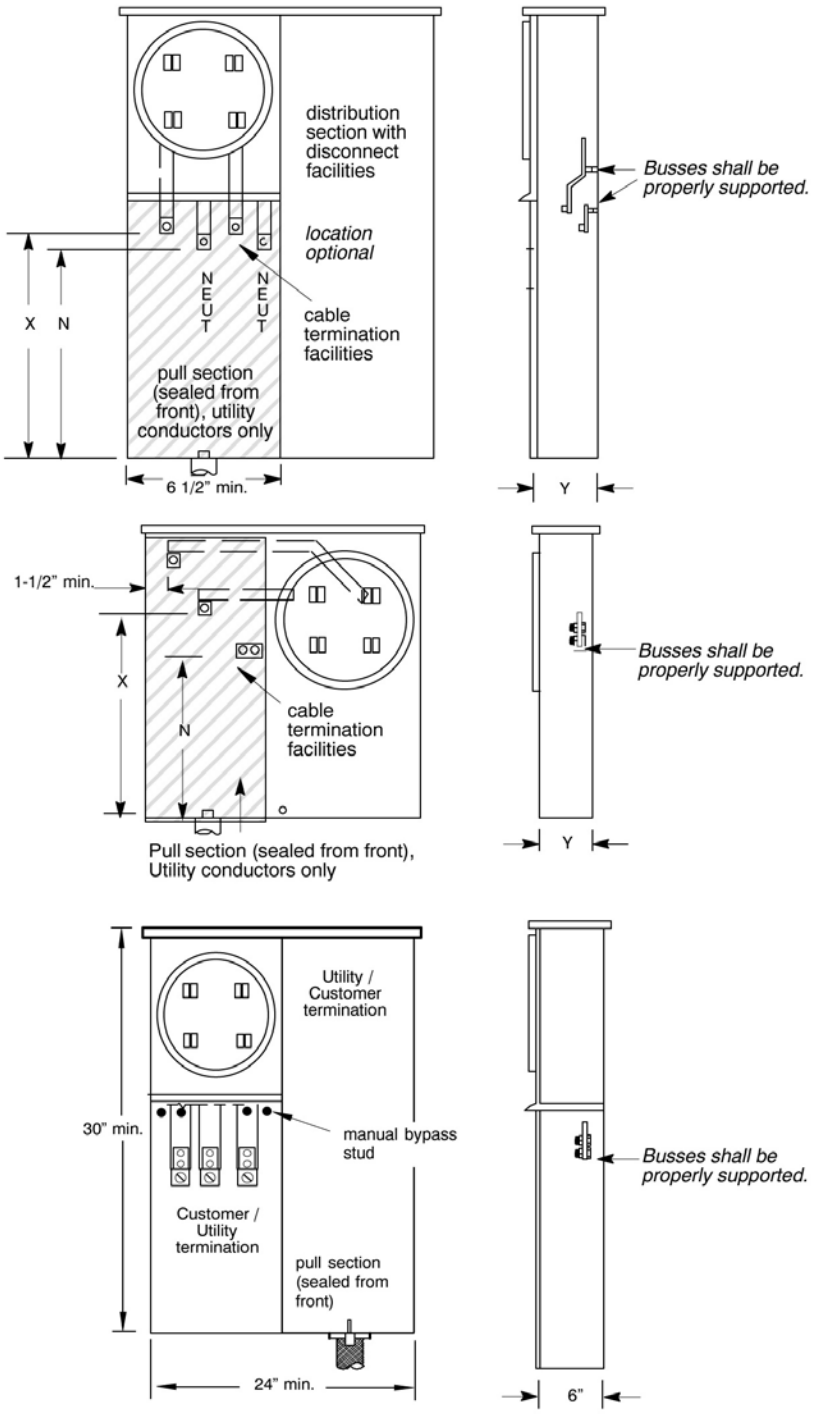


Figure 33—Underground Service to Wall-Mounted Meters

Conduits should be installed on the left hand side of the meter base. A reducing swedge, to no less than two inches (2”), may be used on the vertical riser only if a three-inch (3”) meter socket knockout is not available.



(A) *100, 200 A maximum single-phase underground service combination meter socket. (EUSERC 301)*

Table A: 100, 200 A max.

Amps (max.)	N	X	Y
100	6"	8"	4"
200	8 1/2"	11"	5"

Minimum Dimensions

= Utility area

(B) 200 *A maximum single-phase underground service meter socket. (EUSERC 301A)*

Table B: 200 A max.

Amps (max.)	N	X	Y
200	8 1/2"	11"	5"

Minimum Dimensions

(C) *400 A maximum (320 amps continuous) single-phase underground service combination meter socket with manual link bypass. Customer and utility wires shall not be pulled in the same section. (Consult the manufacturer for load side wiring positions.)*

Figure 34—Residential Underground Approved Meter Sockets

Lists of acceptable meter sockets are available online at www.pacificpower.net/metersockets.

3.13.2. CT Metering

When the line side is in the bottom half of the cabinet and the load wires are on the top half, the conduit(s) should enter at the center of the cabinet. Contact your estimator to determine the number of conduits required.

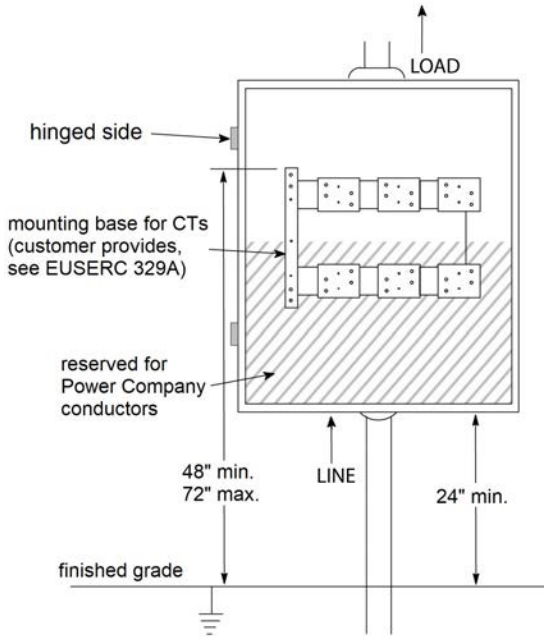


Figure 35—Example of Workspace in CT Cabinet with Top-Half Load

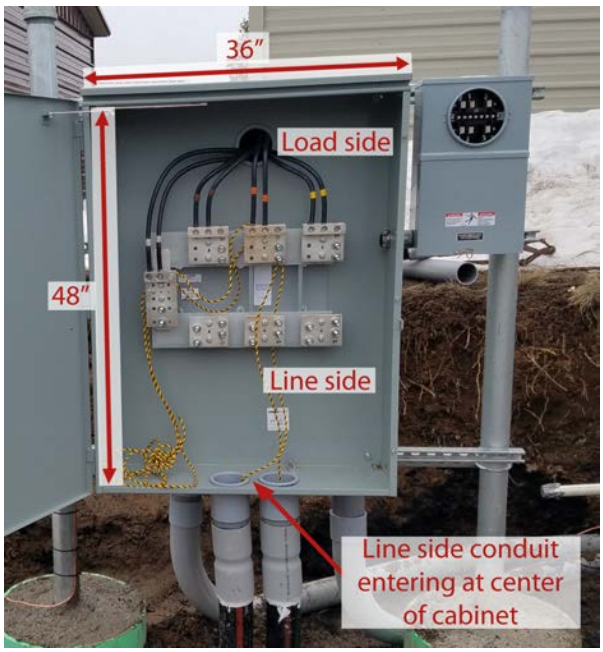


Figure 36—Example of Correct Cable Pulling into Top-Half Load CT Cabinet

When the line side and load are both on the bottom of the CT cabinet the cabinet needs to be bigger (48″ W x 48″ H x 14″ D), and the conduits need to enter on the line side of the cabinet. Contact your estimator to determine the number of conduits required.

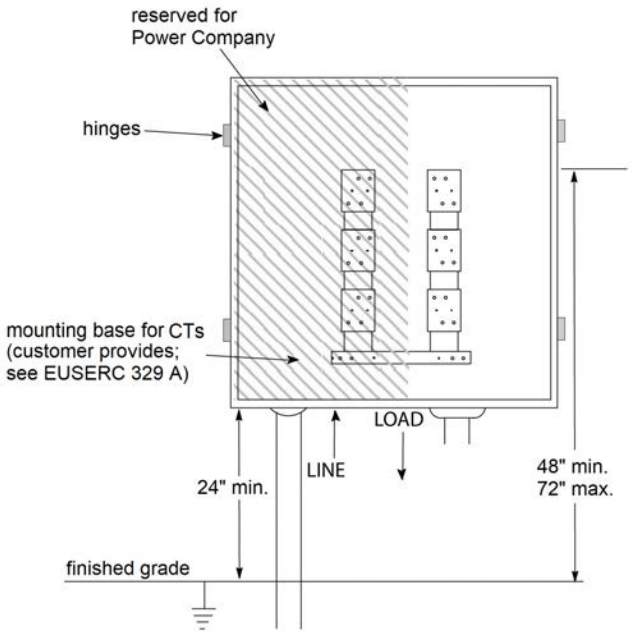


Figure 37—Example of Workspace in CT Cabinet with Bottom-Entry Line and Load

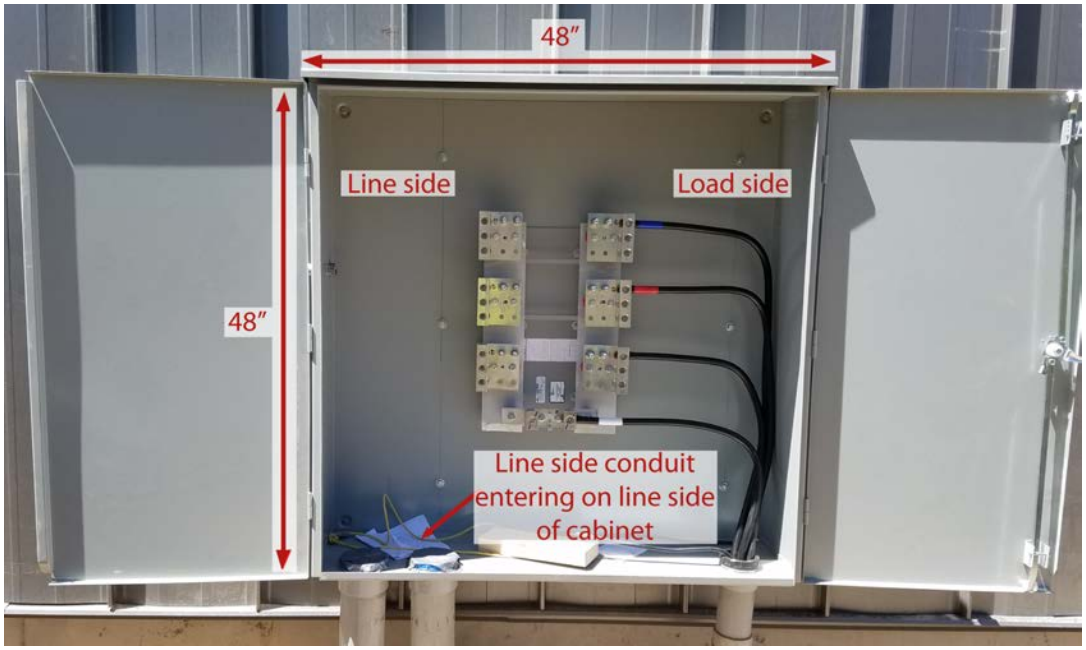


Figure 38—Example of Correct Cable Pulling into Bottom-Entry Line and Load CT Cabinet

3.13.3. Switchboard Metering

A concrete mounting pad is required and a flat permanent surface (such as a concrete pad) must extend a minimum of 36" in front of the CT compartment or multiple meter section. The conduits should be installed at or just above the concrete and should have a sleeve. The minimum termination height will be measured from the top of the conduit.

Figure 39—Example of Unacceptable Conduit Installation, Conduits Too High

Figure 40—Example of Correct Conduit Installation

4. Clearances, Firewalls, and Enclosed Spaces

4.1. Working Clearances

The Power Company needs working clearances to maintain equipment once it is installed. The customer shall comply with the distances shown in "Figure 41" below and "Table 5" below.

Additional requirements to keep the work area safe:

1. Depending on the base, the customer may not know exactly where the equipment will sit on the padvault. As a rule of thumb assume the clearances will be from the edge of the padvault. If these rule-of-thumb clearances cannot be achieved, contact the Power Company. Distances are from the edge of the equipment pad.
2. No vegetation over six inches (6″) in height shall be present in the clear workspace.
3. Trip hazards such as gutters, spigots, etc., shall not exist within the clear workspace.
4. Curbs may be acceptable in the clear workspace; contact the Power Company during site scoping.

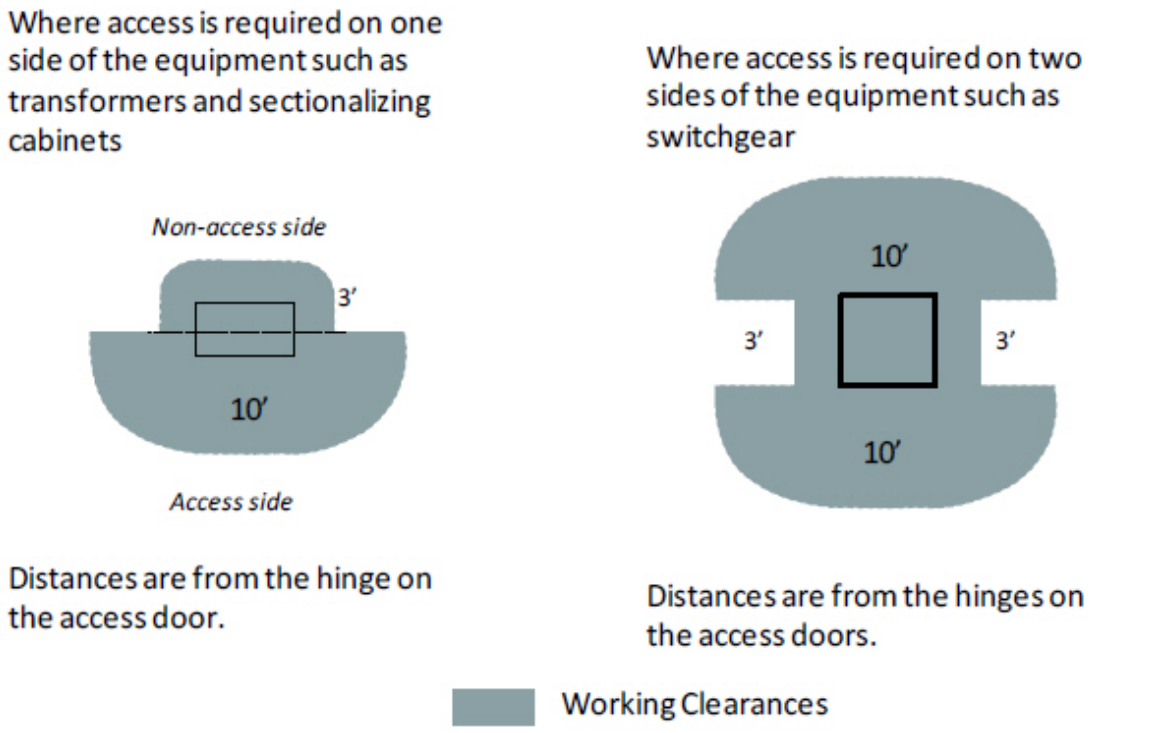
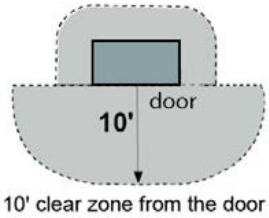
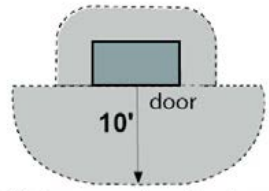


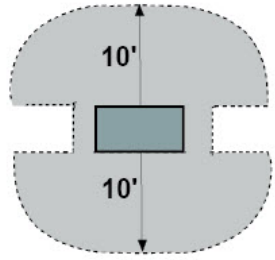
Figure 41—Working Clearances to Pad-Mounted Equipment

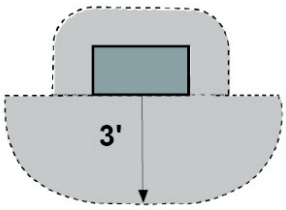
Table 5—Working Clearances

Symbol	Size	Equipment	Working Clearance

<table>
<tr><td rowspan="2">Transformer
Δ</td><td>single-phase</td><td> 
</td><td rowspan="2"> 

10' clear zone from the door</td></tr>
<tr><td>three-phase</td><td>  </td></tr>
<tr><td>Sectionalizing Cabinet
E</td><td>single-phase/ three-phase</td><td>  </td><td> 

10' clear zone from the door</td></tr>
<tr><td>Switchgear
S</td><td>three-phase</td><td>  </td><td> 

10' clear zone both sides</td></tr>
<tr><td>Pedestal
</td><td>single-phase</td><td>  </td><td> 

3' clear zone on one side</td></tr>
</table>

4.2. National Code Clearances

National codes require minimum clearances to equipment. The clearances shown in "Figure 42" below and "Table 6" on the next page are required for all pad-mounted equipment.

Additional notes:

1. Distances are from the edge of the equipment pad.
2. If the building has an overhang, the distance is measured from the outside edge of the overhang to the edge of the equipment pad.
3. Outside walkways or stairs attached to the building are considered part of the building. Minimum clearances must also be maintained from walkways used for exiting to a place of safety.
4. Distances less than those specified in Table 6 (but not less than the required working space) may be allowed if approved by the appropriate code enforcement authority. This may require alternate means of fire protection per NEC Section 450.27 and NESC Section 152(A) (2), including fire barriers, fire-rated walls, sprinkler systems, oil-containment means, or other measures. Use of alternate means of fire protection must be approved by the authority having jurisdictionAuthority Having Jurisdiction (AHJ).
5. The final grade at the location of the transformer should provide oil drainage away from the building. Otherwise, an adequate oil containment means is required
6. The customer shall conform to all local building codes, insurance regulations, and/or ordinances affecting the equipment location.
7. Combustible/non-combustible construction types are defined by respective state building codes.
8. Any deviations shall be approved in writing by the AHJ.

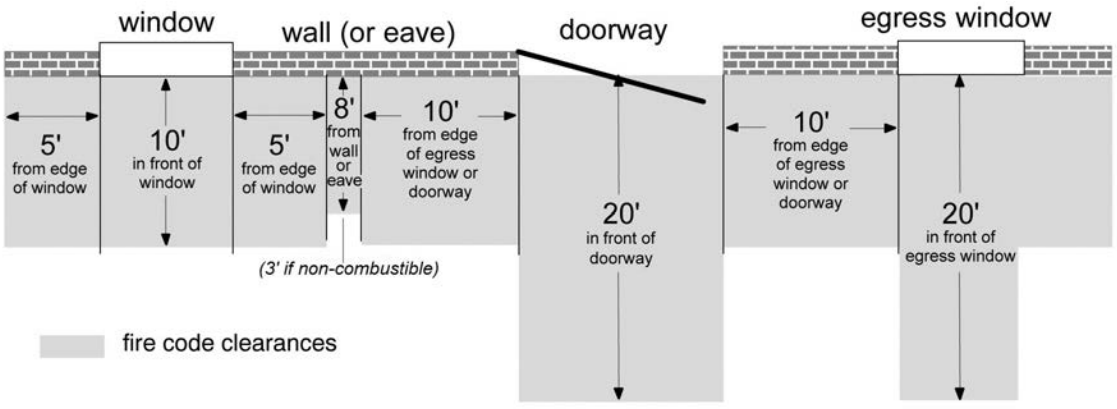


Figure 42—Clearances Between Equipment and Structures

Table 6—Clearances between Equipment and Structures

Clearance from	Clearance in Front of (ft.)	Clearance to Side of (ft.)	Vertical Clearance from (ft.)
Fire escape	20	10	n/a
Doorway	20	10	n/a
Window that can be opened (egress window)	20	10	n/a
Window that cannot be opened	10	5	10
Air vent intake	20	10	25
Air vent exhaust	10	10	25
Combustible surface	8	n/a	n/a
Non-combustible surface	3	n/a	n/a
Fire hydrant (non-metallic equipment)	4	4	n/a
Fire hydrant (metallic equipment)	6	6	n/a

4.3. Conduit Clearances to Foundations

There shall be a minimum of 60" horizontal distance between the building foundation and conduit. When the conduit is installed before the foundation it is recommended that the clearance be 120″ from the planned foundation, see "Figure 9" on page 10

4.4. Firewalls (Blast Walls)

For oil-filled equipment at locations where the required clearance cannot be met, a firewall may be constructed. The firewall shall be constructed such that the heat and flame from a dynamic event are deflected away from a combustible surface or a storage tank.

The firewall shall be approved by the authority having jurisdiction. Consult the Power Company for information on firewalls. Also see ESR White Paper 4—*Firewalls* at http://www.pacificpower.net/esr.

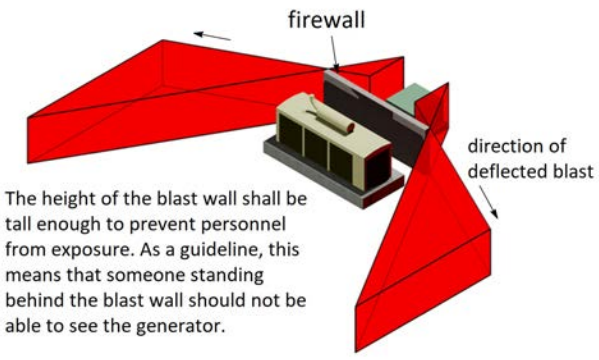


Figure 43—Typical Firewall

4.5. Power Company Equipment in Enclosed Spaces

The Power Company requires 24-hour access to equipment in gated and enclosed spaces. If a single- or three-phase transformer, pad-mounted piece of equipment, or pedestal is to be placed in a gated or enclosed space, the Power Company shall be granted proper access prior to installation. For more information, see ESR White Paper 4, *Gated and Enclosed Spaces* at http://www.pacificpower.net/esr.

4.6. Road Clearances

Per the American Association of State Highway and Transportation Officials (AASHTO), a minimum clear zone of ten (10′) feet from all obstructions is required on roads and streets without curbs. Where these distances cannot be obtained, protective barrier posts and/or barricades, as designated by the Power Company, shall be installed by the customer. Working clearances as described earlier in Section 4. must be maintained.

Clearances from the barrier posts and/or barricades to the equipment must be maintained per Section 5.4.

5. Sites and Locations

5.1. Site Selection

The job sketch and associated documents should clearly identify each padvault and location. The Power Company is responsible for designing the job and determining the location of the equipment; however, input from the customer is valuable. Customer input will be reviewed and, if possible, incorporated into the design prior to the final design. The following items should be included in the inspection and accounted for in the job design:

- **Soil class.** Soil stability shall be determined and recommendations made on shoring or sloping requirements.
- **Water table.** Precautions should be taken to prevent any flooding affecting customer-owned equipment in adjacent structures or properties.
- **Runoff.** Recognize potential surface and subgrade water flows. Consult the Power Company to minimize potential runoff problems.
- **Frost considerations.** Consideration shall be given to local ground and frost conditions such that the installation remains structurally sound.
- **Final grade.** If the final grade has not yet been established, measures shall be made to allow for anticipated grade changes. Where radical changes in grade are anticipated, installation should be delayed until near-final grade has been achieved.
- **Site accessibility.** The site location for any equipment should be within 15 feet (15′) of gravel or paved surfaces. Future access requirements for operation and maintenance of equipment shall be considered when determining equipment location.

5.2. Site Preparation

Excavations should be no deeper than necessary to install conduit and set the padvault.

Disturbed soil beneath the padvault shall be compacted in six-inch (6″) lifts, and leveled to within a 2% slope prior to setting or pouring at the site.

The customer shall supply:

- a six-inch (6″) deep base of ¾-inch-minus gravel compacted to 90% of dry density under padvaults;
- when required by the Power Company a six-inch (6″) base of ¾-inch-minus gravel compacted to 90% of dry density under box pads and secondary boxes; and
- an 18-inch (18″) deep base of compacted ¾-inch-minus gravel compacted to 90% of dry density under flat pads.

In marshy areas, where an adequate foundation cannot be created through normal methods, pilings may be required.

5.3. Height Above Final Grade

Concrete vault lids should be set flush with the final grade in pedestrian and traffic areas. Concrete vault lids should be set three to six inches (3″–6″) above final grade in all other areas.

A retaining wall, approved by the AHJ, shall be installed on the uphill side of any installation when the grade deviates by more than six inches (6″) in an elevation within two feet (2′) of the equipment foundation. The final construction shall accommodate working clearances identified in Section 4.

A retaining wall may also be necessary on the downhill side of the installation to ensure a level working surface is maintained.

Additional easement considerations may be required.

5.4. Padvault Location – Barrier Post Protection

Barrier post protection is required by the Power Company in the following situations:

- where equipment is within seven feet (7') of parking lots or developed travel paths around facilities (paved or unpaved)
- where equipment is within seven to ten feet (7'–10') of the roadway pavement without curbs
- where equipment is within one and a half feet (1.5′) of roadways with curbs

5.4.1. Barrier Post Requirements

Each barrier post shall meet the following requirements:

- Barrier posts shall be placed so as not to obstruct the opening of the equipment doors, nor to impede the operation of the equipment. If this is not possible, removable posts shall be used in the obstructive location(s).
- Enough barrier posts shall be installed to adequately protect the pad-mounted equipment from vehicular traffic. If the distance between two posts, or between a post and a non-traffic area, is greater than six feet (72″), an intermediate post shall be installed as shown in "Figure 44" below.
- Each barrier post shall be set in a concrete foundation at least 12 inches in diameter and 24 inches in depth, below grade, as shown in "Figure 45" on the next page.
- In areas where construction equipment traffic poses a temporary threat to equipment, barrier posts shall be provided by the customer, and shall remain in place until the threat has been eliminated.

- Barrier posts shall be six-inches (6") in diameter, have a domed top, be free of burs and sharp edges, and be made of:

  a. painted or galvanized steel, and should be filled with concrete; or

  b. concrete that is painted or encased in plastic

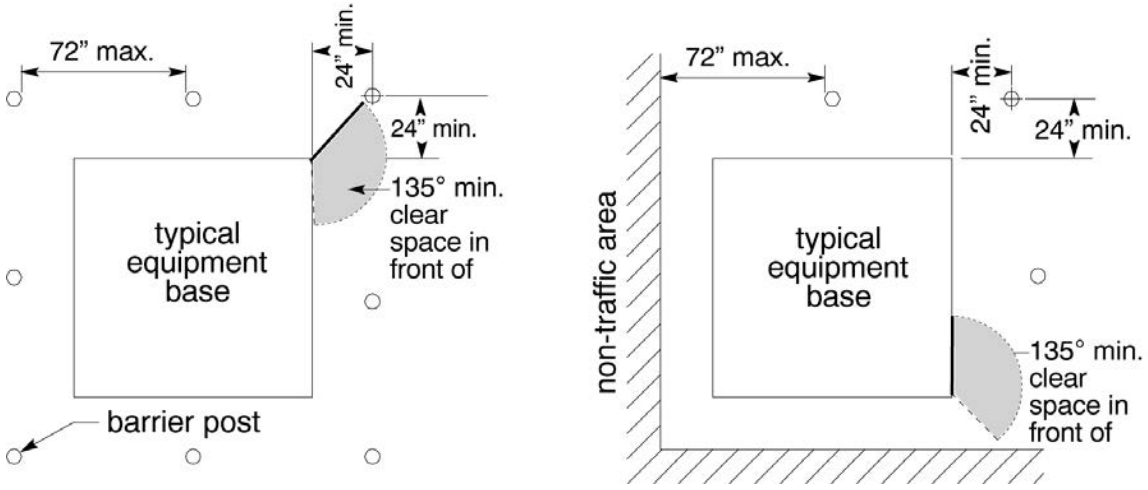


Figure 44–Barrier Post Layout and Clearances

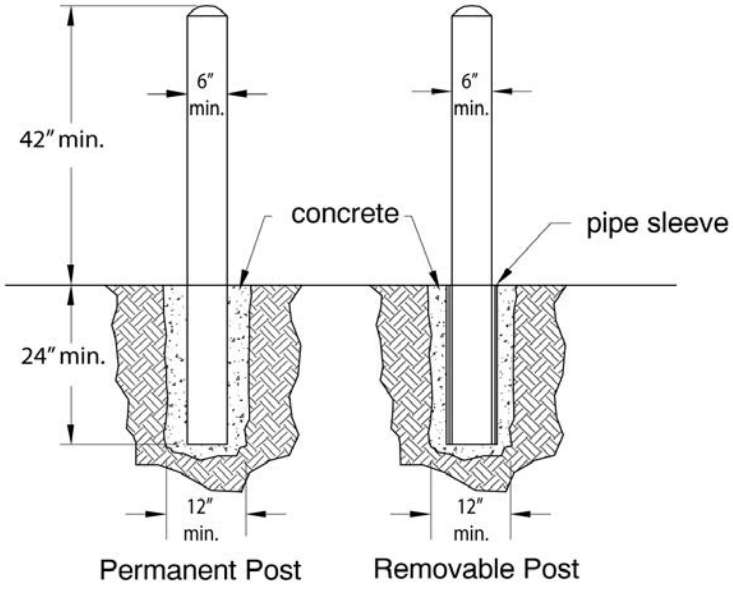


Figure 45–Barrier Post Details

Figure 46–Barrier Posts, Example

6. Pad-Mounted Equipment Installations

Padvaults are designed to be set such that the top of the pad lid is three inches (3") above the final grade in non-pedestrian areas and flush with the final grade in pedestrian areas. Padvaults should be level and supported by six inches (6") of ¾-inch-minus gravel backfill, compacted to 90% of dry density, placed over undisturbed earth.

Padvault and conduit installation is shown in "Figure 47" below through "Figure 49" on the next page. Note that the number of conduits may vary depending on the infrastructure design. When the lid extends past the back wall of the vault, backfill of ¾"-minus material must be compacted so as to support the overhanging lid.

All openings in the vault lid must be covered or barricaded to prevent accidents.

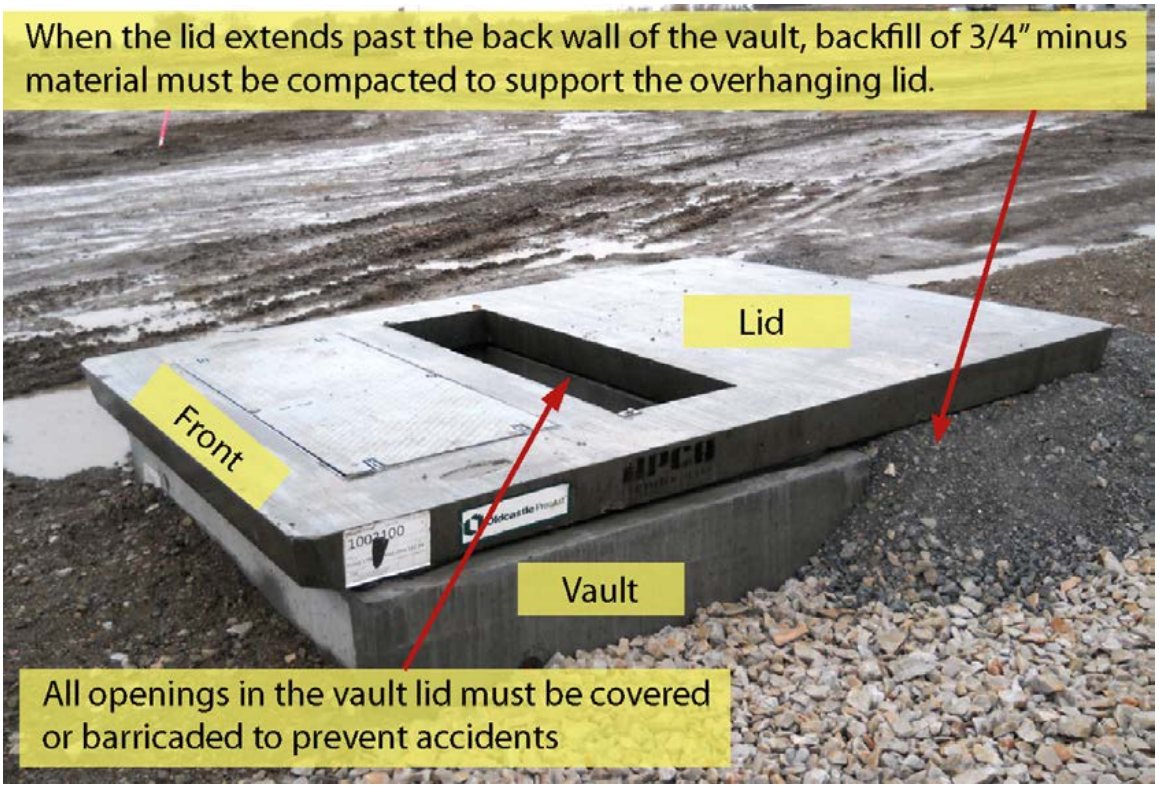


Figure 47—Correctly Installed Padvault in Non-Pedestrian Area

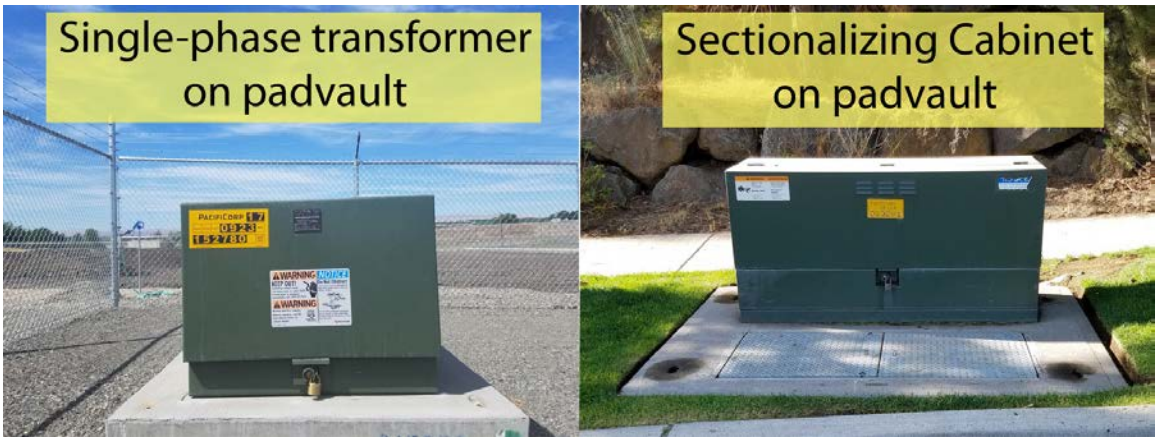


Figure 48—Examples of Transformer and Sectionalizing Cabinet on Padvaults

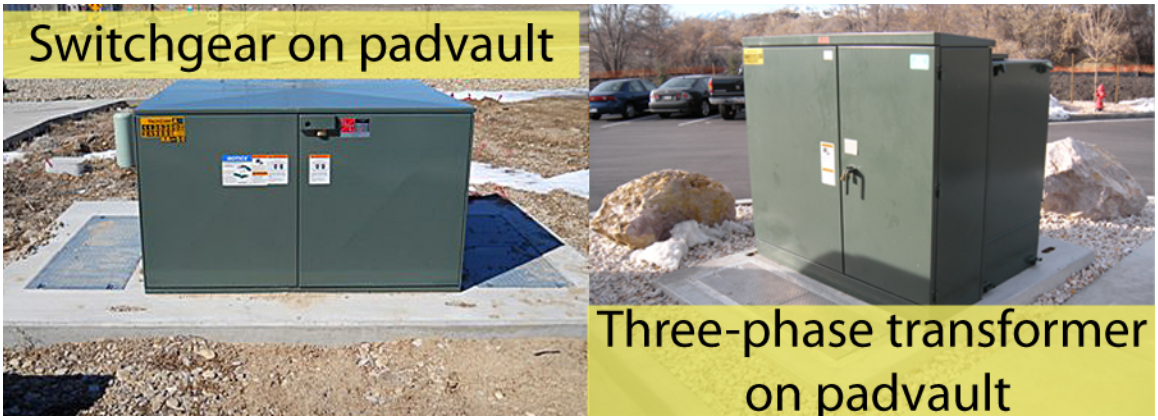


Figure 49—Switchgear and Three-Phase Transformer on a Padvault

7. Types of Padvaults

The Power Company requires the use of padvaults as bases for pad-mounted equipment such as transformers, switchgear, fuse cabinets, etc. All vaults must be supplied by a previously approved manufacturer. Padvaults must have term-a-ducts and their arrangement must comply with the Power Company's requirement. Any deviation from term-a-ducts will require written approval from the Power Company. The following pictures provide a visual aid for these structures.

7.1. Vault for Single-Phase Transformer

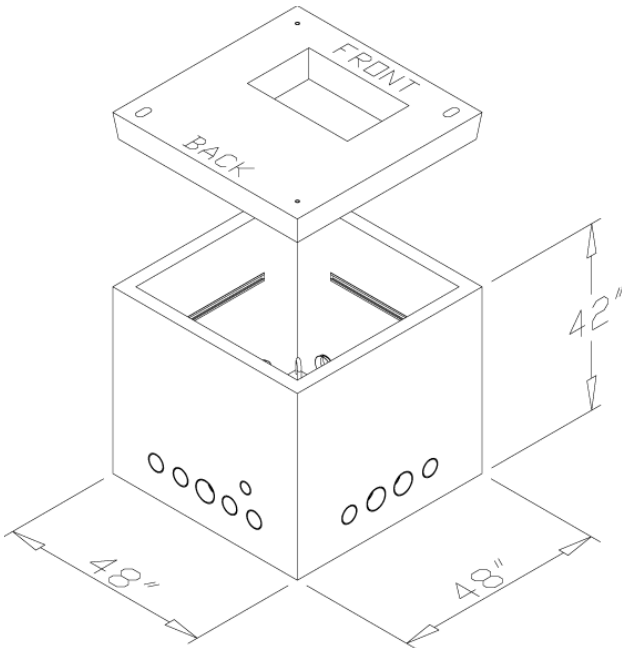


Figure 50—A Typical Vault for a Single-Phase Pad-Mounted Transformer (SI# 7999607)

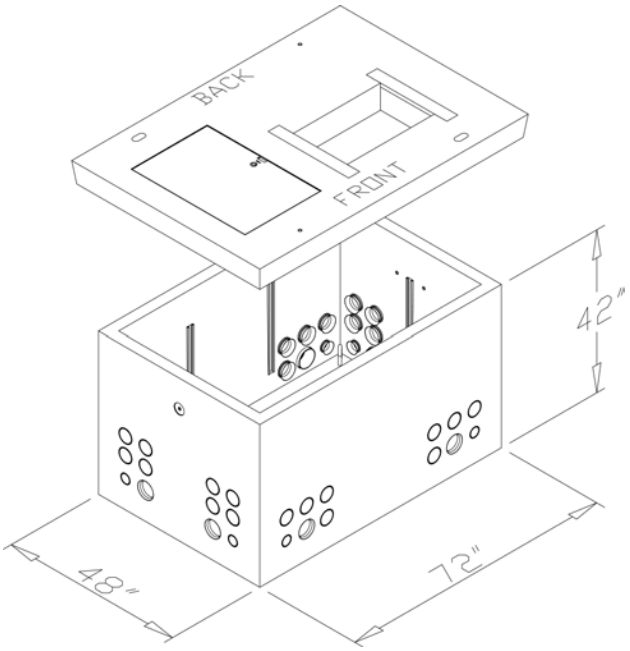


Figure 51—A Typical Vault for a Single-Phase, Pad-Mounted Transformer with Opening (SI# 7992977)

7.2. Vault for Three-Phase Transformer

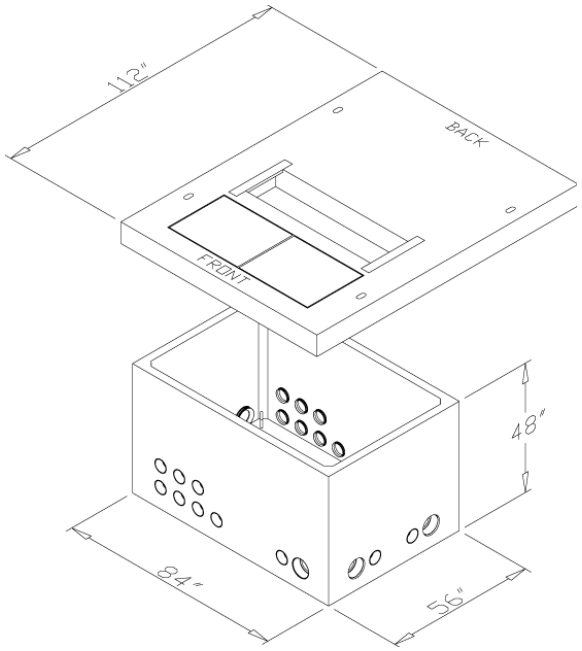


Figure 52—A Typical Vault for a 75-750 kVA Three-Phase Pad-Mounted Transformer (SI# 7992600)

Note: The Power Company will provide information on other vault sizes for bigger transformers.

7.3. Vaults for Single-Phase and Three-Phase Sectionalizers

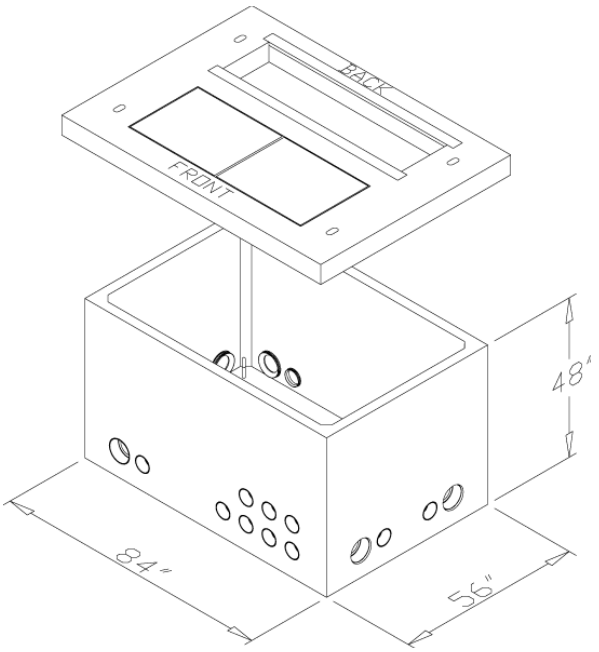


Figure 53—A Typical Vault for a 15 kV Three-Phase Sectionalizing Cabinet (SI# 7992605)

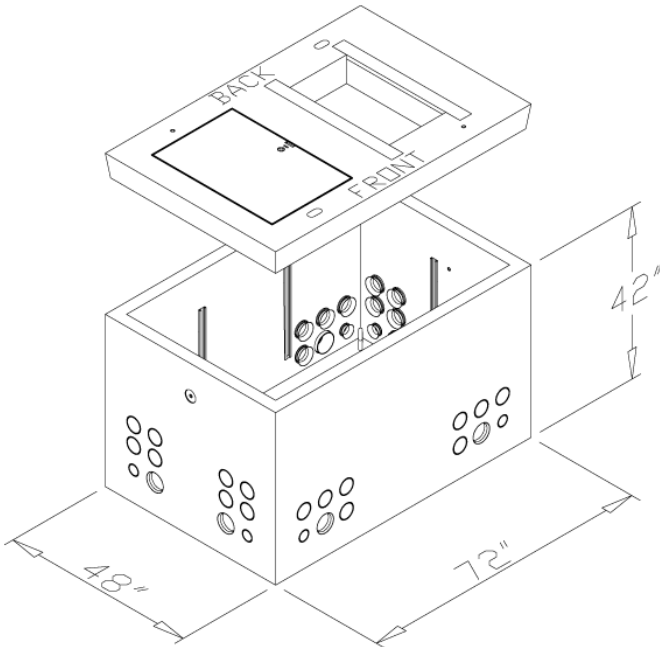


Figure 54—A Typical Vault for a Single-Phase Sectionalizing Cabinet (SI# 7992975)

7.4. Vaults for Three-Phase Switchgear

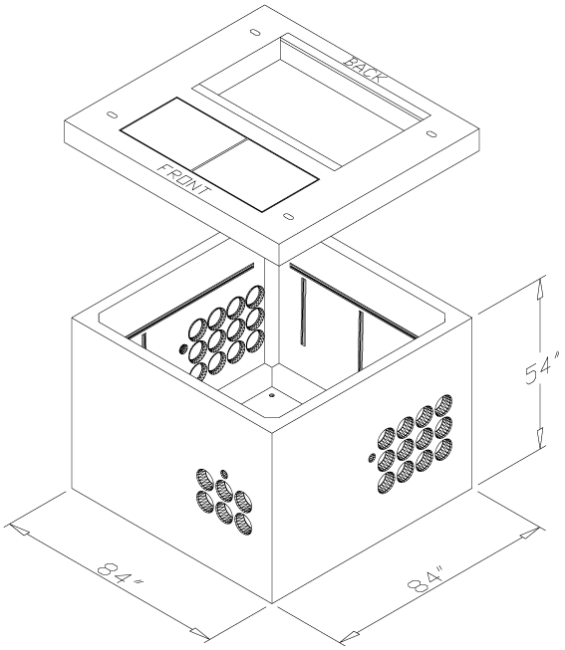


Figure 55—A Typical Vault for a Type 3 Switchgear (SI# 7992787)

Note: The Power Company will provide information regarding any installation using six-inch (6″) conduit.

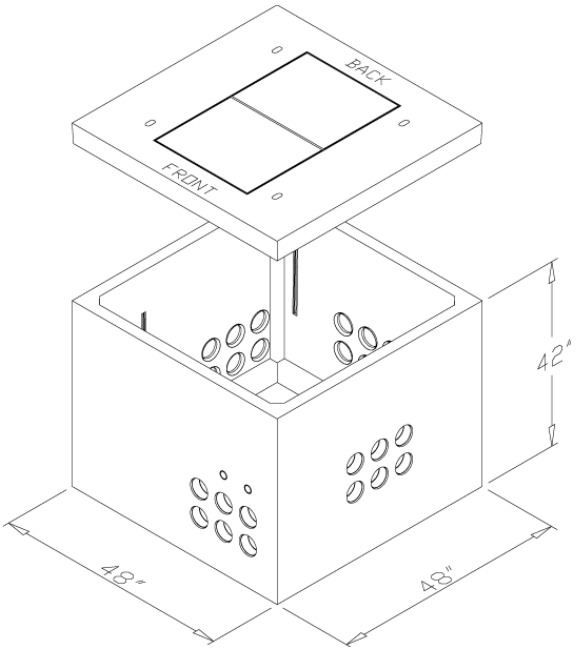


Figure 56—4′×4′ Pull Vault

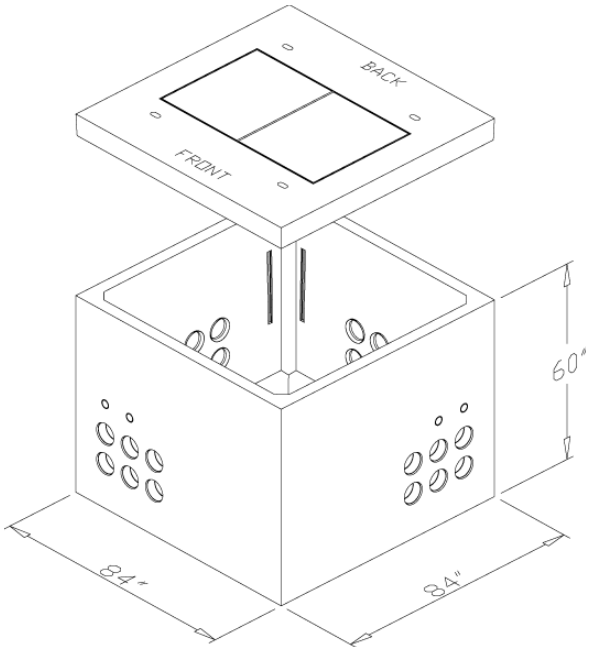


Figure 57—7′×7′ Pull Vault

8. Secondary Boxes

Secondary boxes are comprised of a base and a lid, as shown below, and are used to provide service to multiple customers (typically homes). Secondary boxes should be installed on compacted soil, and the base should be three to six inches (3″-6″) above final grade.

Figure 58—Above Grade Pedestal and Flat Lid Installed on Secondary Boxes

Figure 59—Fiberglass Secondary Box Base Dimensions and Pedestal

Figure 60—Fibercrete Secondary Box Base Dimensions and Flat Lid

Figure 61—Installed Fibercrete Secondary Box Base and Flat Lid

8.1. Conduit Placement Inside Secondary Boxes

The conduit is installed in pedestal applications as shown in "Figure 62" below. Note that the number of conduits may vary depending on the infrastructure design. Conduits entering a secondary box to be covered with a flat lid shall be off-center to allow for proper workspace as shown in "Figure 63" below.

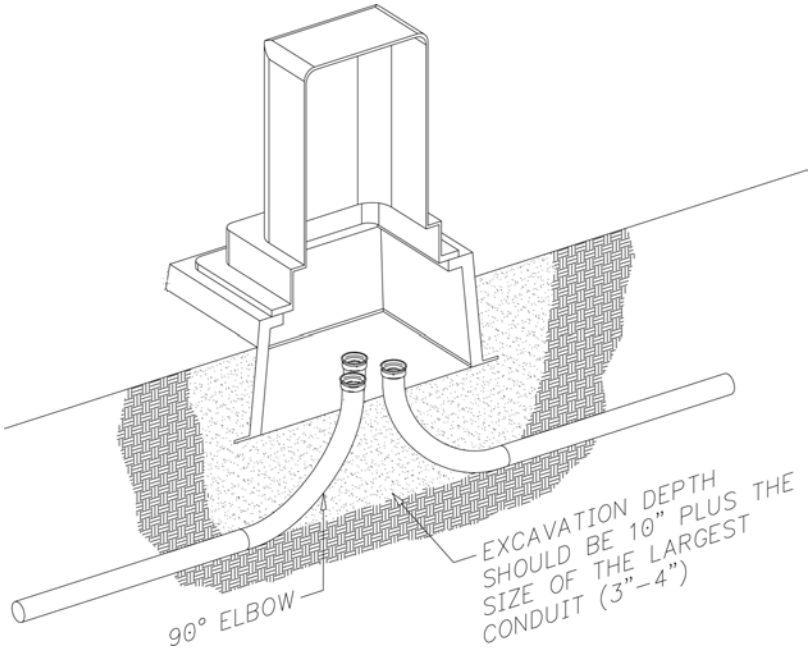


Figure 62—Isometric View of Secondary Box with Pedestal

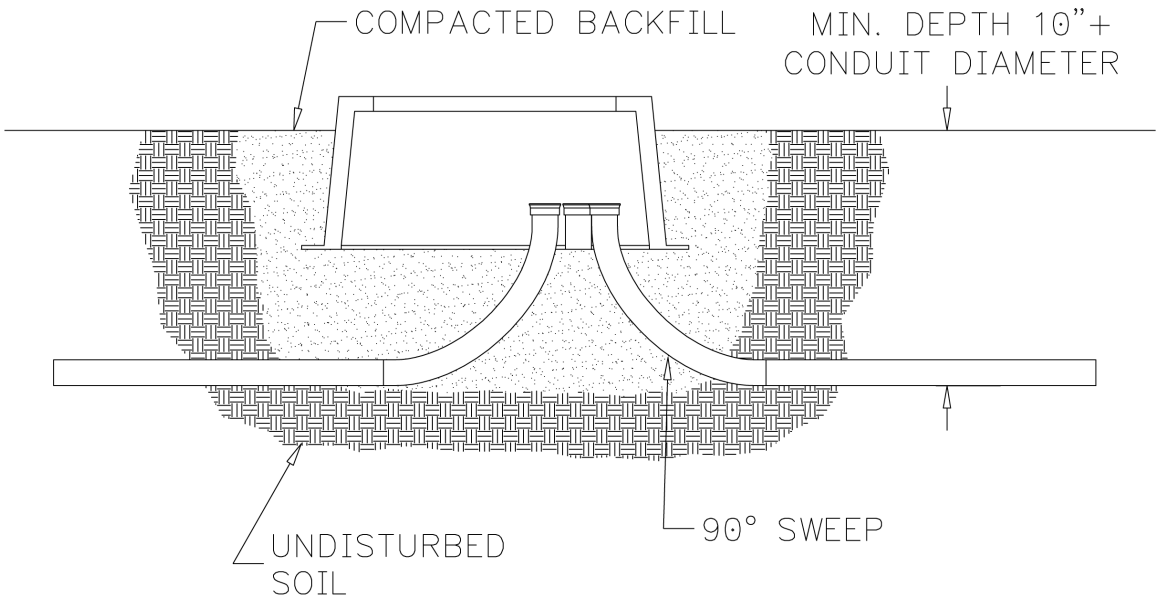


Figure 63—Side View of Secondary Box with Flat Lid

Figure 64—Example of Proper Conduit Installation for Pedestal Top

Figure 65—Example of Proper Conduit Installation for Flat Lid Top

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Pacific Power
UG CONDUIT SYSTEMS
September 2021 (Rev. 2)

Standards Engineering and T&D Operations Policy No. 343

This policy and related documents are posted on the web at:
http://www.pacificpower.net/con/ucsi.html

PACIFIC POWER

POWERING YOUR GREATNESS