TACOMA POWER
TACOMA PUBLIC UTILITIES

Customer Requirements
Customer-owned Transformer Vault Room

C-SV-3000

Application

Requirements for customer-owned and constructed vault rooms containing equipment that are owned, operated and maintained by Tacoma Power.

It does ***not*** address transformer vault rooms that are part of the downtown network system or spot networks.

In This Standard

General Requirements

Vault Room Location

Ground floor rooms adjacent to an exterior wall usually provide the best location for vault rooms in terms of access and natural ventilation. Interior rooms may be acceptable if clear access to install and replace the transformers, forced air cooling and fire/smoke dampers are all provided. Vault locations must be preapproved by Tacoma Power's design Engineer.

Approval of Vault Plans

Final drawing approval will be in the form a letter from the New Services Engineering Department to the customer.

Code & Municipal Requirements

- National Electrical Code, Article 450, Section 41 through 48 and Article 500.
- Uniform Building Code

Customer and Tacoma Power Requirements

Customer Requirements

If a customer is to obtain permanent power on a firm schedule, the procurement of long lead time transformers and associated equipment must be initiated over ***one year*** in advance.

The customer shall be responsible for providing detailed construction drawings with plan and profile views that incorporate the items listed below. Tacoma Power will use the customer provided AutoCAD drawings to prepare construction drawings combining both the customer and Tacoma Power required items.

The following will be supplied and installed by the customer to Tacoma Power specifications:

- Painted vault
- Doors (a personnel door may be required in addition to equipment door)
- Ventilation louvers/screening and baffles
- Fire and heat detectors and annunciation to the building fire control panel
- Thermostats for forced air
- Forced air fans and controls
- Oil spill sill and seal (size specified by Tacoma Power)
- Secondary cables from service to transformers (when applicable)
- Secondary lugs when sizes other than # 4/0, 250 kcmil or 350 kcmil
- Exterior warning horns/lights and signage
- Sump Pump with oil sensing switch and wiring (when required)
- Vault room grounding plan including cast-in electrical grounds (refer to “Grounding” section, see pages 12 – 13)
- Ceiling inserts and threaded rod studs for conduit hangers
- Vault power circuit, lighting and receptacle wiring (see page 16)
- Primary and secondary ducts to and into the vault
- An acceptable pathway to transport the transformer from the street
- Anchorage for seismic bracing
- Pulling eyes
- Primary and secondary conduit routing, with concrete encasement, when exceeding 15 ft. within the building

Customer and Tacoma Power Requirements *(continued)*

Tacoma Power Requirements

The following equipment will be supplied and installed by Tacoma Power:

- Primary cables
- Secondary cables to customer busway at vault wall
- High voltage switches
- High voltage tap boxes
- Transformers
- Conduit hanger horizontal elements
- Secondary compression lugs (only #4/0, 250 kcmil, 350 kcmil)
- Door lock core
- DANGER signage on access doors

Transformers

Table 1

Physical Character-istics of Vault Style Transformers

MID #	kVA	Voltage	Profile	Oil (gal)	Weight (lbs)	Width (in)	Depth (in)	Height (in)
46669	500	120/208V	Low	300	7000	54	72	72
46700	500	480/277V	Low	273	7000	54	72	72
46668	500	120/208V	High	273	7000	54	72	72
[1]	500	480/277V	High	273	7000	54	72	72
46702	1000	120/208V	Low	434	11000	56	74	84
46703	1000	480/277V	Low	434	10500	56	74	84
40627	1000	120/208V	High	434	12000	56	74	84
35638	1000	480/277V	High	434	11000	56	74	84
46704	1500	480/277V	Low	564	16000	58	76	86
35639	1500	480/277V	High	564	15000	58	76	86
[1]	2500	480/277V	Low	808	16500	60	78	86
35640	2500	480/277V	High	808	16500	60	78	86

Notes: [1] non-stock item

Low profile transformers have end-mounted primary and secondary bushings.

High profile transformers have top-mounted primary and front-mounted secondary bushings.

Dimensions shown are transformer maximums, include cooling fins and all protrusions.

Vault Room Dimensions

Vault Dimensions & Clearances

Typical floor areas are shown in Table 2. Exact dimensions will depend on the transformer sizes, switchgear requirements and vault configuration:

Follow these steps in planning vault room dimensions & clearances:

Step	Action
1	Determine the total load and secondary voltages(s) to be served from this location.
2	Consult Tacoma Power as to the number of transformers required and the need for any special equipment.
3	When planning for the space required for a transformer, refer to the dimensions of the next larger size in order to accommodate a larger transformer. For example, if a 500 kVA is required, plan for a 1,000 kVA replacement due to: • Increase in load • Availability of replacement equipment
4	Clearances and Working Space requirements: <u>Ventilation Space</u>: • ***3 ft.*** on either side of transformer and ***3 ft.*** behind the transformer. • For multiple transformer installations, allow for ***4 ft.*** of ventilation space between units. <u>Switching Space</u>: • ***10 ft.*** from the transformer with end-mounted high voltage bushings. • ***10 ft.*** from the front of any switches. <u>Cabling Space</u>: for transformers that have high voltage and secondary voltage bushings on the top of the unit, a cabling space of ***3 ft.*** above the unit is required.

Table 2

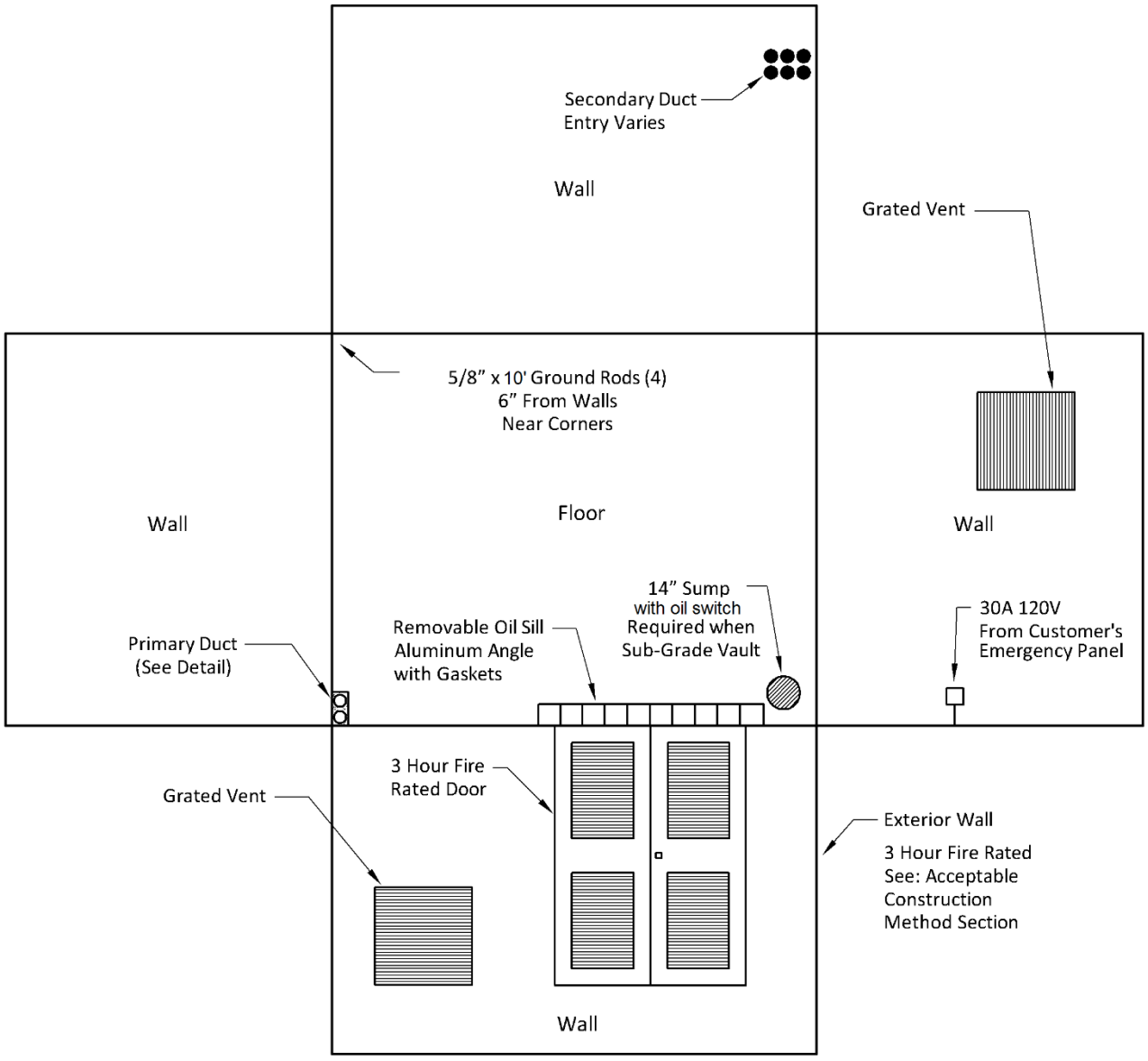
Minimum Vault Room Characteristics

No. of Trans-formers	Trans-former Profile	Clearance Height (ft)	Width (ft)	Length (ft)	Equipment Door (ft)	Personnel Door (in)
One	High	12	15	20	8H x 8W	42 x 84
	Low	9	15	30	8H x 8W	42 x 84
Two*	High	12	20	30	8H x 8W	42 x 84
	Low	9	20	40	8H x 8W	42 x 84

* When load or voltage considerations require a second transformer

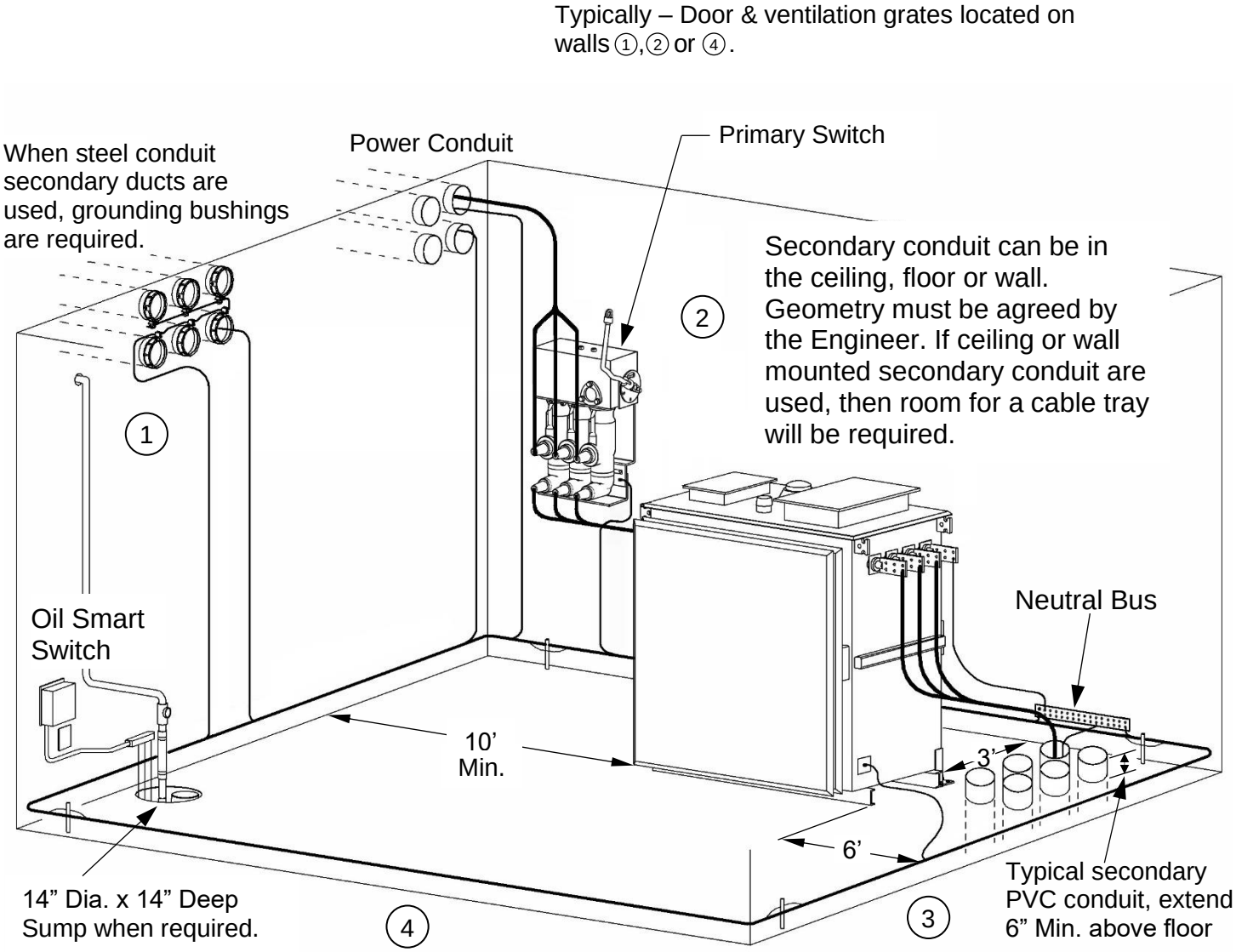
Vault Room Dimensions *(continued)*

Figure 1 Typical Vault Dimensions & Construction Requirements



Vault Room Dimensions *(continued)*

Figure 2 Typical Vault Equipment Layout



Note: ***Tacoma Power crews shall construct*** a 4/0 Cu ground bus around the perimeter of the vault room, except at the access door where it shall turn up, across, and down to wrap the door. The ground bus shall be tapped to each piece of equipment (not daisy-chained), so the ground wire to one piece of equipment can be cut without leaving other pieces of equipment ungrounded. The ground bus shall be located 12 in. above the vault floor.

Walls, Ceiling & Floor

General

- The vault shall be free of all non-utility power equipment, pipes, structural supports, or duct systems.
- Vault room shall have a minimum fire resistance of 3 hours according to ASTM Standard E-119.

Paint

All paint shall be as listed below, or approved equal, and be applied in accordance with manufacturer's recommendations.

All interior surfaces (walls and lid), excluding the floor, shall receive:

- A 14-day minimum concrete curing time.
- One coat of Sherwin-Williams 'Loxon' concrete primer tinted with raw amber at 1/4 oz. per gallon.
- One coat of Sherwin-Williams 100% acrylic Exterior Paint White - Gloss.

Vault Floor

Requirements for the vault room floor include:

- The vault floor shall be at the same finished grade (elevation) as the surface area outside the vault door.
- The vault floor, when in contact with the earth, shall be of reinforced concrete not less than 6 in. thick.
- When vault is constructed with vacant space or other floors below it, the floor shall have adequate structural strength for the installed equipment as well as the dynamic load imposed during construction. Contact Tacoma Power Engineer to determine the amount of equipment to be placed in the vault. Refer to Table 1 for transformer weights.

Vault Ceiling

Requirements for the vault room ceiling include:

- The minimum un-obstructed ceiling height depends on the transformer utilized (see Table 2). The ceiling may require more height to provide adequate ventilation around the equipment, or to provide for cable racking systems.
- Concrete ceilings must have standard SAE 1/2 in. diameter threaded imbeds installed on a 3 ft. grid pattern across the entire ceiling (except for the 2 ft. perimeter). Imbeds shall be rated for 2,000 lbs or as agreed to by Tacoma Power.

Transformer Earthquake Restraints

Provisions for transformer earthquake restraints must be designed into all floors, including post-tension designs.

Walls, Ceiling & Floor *(continued)*

Vault Walls

Typically, doors and ventilation grates are located in the walls and ceiling. Sufficient wall space for racking cables above the equipment and vents shall be reserved. Contact the Engineer for any specific requirements. Walls must be solid reinforced concrete. The use of concrete filled, reinforced CMU block must have Engineer approval. There shall be no building services (plumbing, waste/vent or electrical) within the CIP or CMU walls

Cable Support Grips

For vertical primary and secondary cable runs longer than 20 ft., the customer shall provide support racks or hooks for Tacoma Power cable support grips at intervals specified by Tacoma Power. The grips shall be of non-magnetic material with one grip per each cable.

Conduit Duct Sealing

The customer is responsible for sealing and fire blocking the transformer vault room walls where primary and secondary conduit duct/bus penetrate the transformer vault room.

Pulling Eyes

Tacoma Power will locate the required pulling eyes prior to construction. The size and number will be determined by the vault size and equipment location. Other pulling eye requirements are:

- They shall be constructed with #8 rebar interlaced with the wall rebar and capable of withstanding 12,000 lbs tension minimum.
- Normally installed in the ceiling above the primary conduit or on the wall opposite the primary conduit for pulling primary cables.
- Installed in the walls located 6 in. above the floor, in appropriate locations to aid in the moving of the equipment within the vault.
- Installed directly across from all duct bank entrances into the vault.
- Some pulling eyes may be required outside the vault room along the equipment transport route.

Walls, Ceiling & Floor *(continued)*

Drains, Sumps, & Oil Containment

Vaults with standard vertical door access shall have a sealed but **removable sill** of sufficient height to confine the oil within the vault from the largest transformer. Refer to Table 1 for gallons of oil per transformer. The assumption is only one transformer in a group will leak at a time. For post-tension floors, imbeds are required to bolt the oil seals in place.

It is the customer's responsibility to assure that water does not enter the vault room. Where water intrusion to a transformer vault is possible, then a sump and pump will be required in the design as detailed in this standard.

Where water intrusion is expected, vaults shall include a 14 in. diameter (or square) by 14 in. deep sump with metal grate cover. The sump shall be accessible and have adequate room around it for maintenance. The maintenance space must take into consideration electrical working clearances from high voltage equipment. The sump must be located along a wall and out of the pathway for replacing the transformer. The sump should be placed near any known water entry points, and the vault floor sloped toward the sump. See Figures 1 and 2.

A 1 in. water discharge pipe shall be installed and extend to the building's or street's storm drain system as approved by Tacoma Power. Provisions must be made for natural drainage to the sump or appropriate drain of the transformer vault floor. The customer will provide the sump pump and an oil smart switch, Pump-Zoeller Pump Model # 53; Oil Smart Switch-See Water Model # OSS20PBPR.

If the room has a floor drain within the containment system, an oil-water separator shall be installed that will block the flow of oil. In these cases, a sump will not be required.

Secondary Bus Requirements

Both wireways and secondary buses are acceptable. The vault secondary bus is to be provided by the customer. Vault entry locations of duct and bus must be approved by a Tacoma Power Engineer.

Walls, Ceiling & Floor *(continued)*

Power Conduit The number of ducts will be determined by the specific design. The following conduit requirements shall be approved by the Tacoma Power Engineer prior to construction:

Type & Size	• Sch. 80 or 40 PVC as required by code and Tacoma Power standard. • Steel EMT with grounding bushings at each end of conduit segment. • 4 in. minimum diameter, or as specified.
Number Bends	• From Tacoma Power's designated source, there shall be no more than 180 degrees of bends in the conduit route. • If additional bends are needed, pulling boxes shall be added to the conduit route as designated by Tacoma Power Engineer.
Entry	• Conduit shall enter the transformer vault floor, ceiling or walls no closer than 6 in. from a corner, wall-ceiling junction, beam, column, door, window, vent etc. • Conduit must penetrate into the transformer vault room by at least 6 in.
Extension thru Building	If the distance the primary conduit travels within the building envelope exceeds 15 ft., the primary conduit must be concrete encased.
Placement Exterior to Building	• In accordance with Tacoma Power Standard C-UG-1100. • If the project is served from an overhead system, the customer is required to install pole riser(s) per Tacoma Power standard C-UG-1200.

Vault Access

General Door Specifications

Vaults shall be continuously accessible to Tacoma Power personnel for inspection and maintenance. The vault door should directly access the outside of the building. It may be required that the customer provide an easement. See Table 2 for personnel and equipment door minimum dimensions.

Locks

All egress doorways will be secured with a mortise-type lock and Best brand lock body by customer. The Best Brand 6 pin core will be provided by Tacoma Power with their exclusive lock. Holders of keys shall be limited to authorized Tacoma Power personnel.

Personnel Access Doors

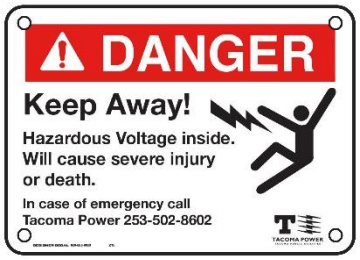
- Personnel doors shall be equipped with a panic exit device and shall swing out from vault room. They shall be a tight-fitting Class A self-closing fire door with a minimum fire rating of 3 hrs.
- Personnel doors may be accessed from within buildings if 24 hr. access is available.

Equipment Door

- Vaults require a permanent equipment door for transformers. Passageway to vault door(s) shall have adequate clearance for transportation and handling equipment outside the vault room along the equipment transport route.
- A lift-out ceiling slab/access lid typically consists of one-piece or sectional removable steel reinforced concrete, usually positioned over a vacant space in the vault. The location and size must be approved by Tacoma Power Engineer and no portion shall weigh more than 15K lbs.
- The slab must be structurally rated for the environment it supports (e.g., H20 if located in streets/sidewalks etc).
- 45 ft. vertically clear lifting space must exist above a lift out slab. Any obstacles less than 45 ft., will be removed at the owner's expense. Adequate area and street mechanical structure must be available immediately adjacent to the lift out slab to accommodate a crane with stiff leg extensions. Boom-swing space and temporary lid storage space within boom reach must be available while the equipment access hole is being utilized. The location for the crane must be accessible and allow for 3-dimensional lifting and swinging space of 40 ft. clear.
- If the hatch is required to be waterproof-sealed, the customer is responsible for removal and replacement of these seals.
- Vault ventilation grates and man access hatches can be integrated within the lift out section if strength and drainage considerations are properly addressed.

Vault Access *(continued)*

DANGER Signs



Prior to energization, Tacoma Power will install approved DANGER signs (MID 21430) on the exterior of all access doors to the transformer vault.

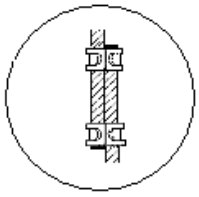
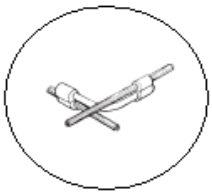
Grounding

All ground wire connections to ground rods shall be with a mechanical compression or exothermic weld (Cadweld ®) or one approved by Tacoma Power Engineer.

Various methods may be used to develop a system to ground the transformer(s) and associated equipment in the vault room.

Grounding for this system may utilize one or more of the following:

Grounding System Elements

 PARALLEL CONNECTION	 CROSS CONNECTION	When connecting ground wires to ground grids or building steel, parallel-connections and cross-connections shall be utilized.

Element I
Ground Rod System

A 5/8” x 10’ copperclad ground rod shall be driven in each corner of the vault into at least 6 ft. of undisturbed or compacted earth (see Figure 1). Additional ground rods along the walls shall be placed on a 12 ft. maximum interval. #4/0 bare Cu wires shall be Cadwelded® to the ground rods, brought through the vault floor slab and located approximately 6 in. from the walls (see Figure 2). A driving head shall be used to prevent damage to the ground rod to accommodate the Cadweld connection. The space between the rods and the floor shall be sealed to prevent water intrusion. Stranded ground wire passing through the slabs or walls shall be solder blocked when water intrusion is anticipated.

Grounding *(continued)*

Element II
Ground Grid in Earth Contact Floor Slab

Vault room grounding will utilize the reinforcement rebar mesh pattern in the floor, or a 2 ft. x 2 ft. ground grid mesh of #2 Cu in the vault floor slab. A #2 Cu grounding tail shall be bonded to the rebar mesh steel or the grid mesh, along the vault walls and brought up 18 in. above the floor slab. Additional tails to be repeated on a maximum of 8 ft. intervals for Tacoma Power to tie into the vault room ground ring.

Element III
Column Steel System

The vault grounding grid shall be tied to the building's grounding electrode system and building structure to create an equal potential zone in the vault room. #4/0 Cu tails will be attached to each column in the room.

Vault Room Location

The location of the vault room will determine which of the grounding system elements will be utilized.

When the vault floor is in contact with earth …….	***If the vault floor is not constructed on soil …….***
Vault room grounding will utilize elements **I & II**.	Vault room grounding will utilize element **III**.

Fire Detection and Suppression Equipment

Tacoma Power does not allow fire suppression systems in transformer vault rooms. The 3 hr. fire containment vault design is to protect the building and public from fire and smoke.

Fire detection equipment (smoke and temperature) shall be located where they can be tested and maintained without climbing over or on top of electrical equipment. Smoke detectors are to be annunciated to the building fire control center. Refer to the following section on "Dampers".

Ventilation

Maximum Vault Temperature

Adequate ventilation shall be provided to limit ambient temperatures in the vault to ***115°F*** (46° C) during continuous operation of the ultimate transformer installation and during maximum temperature conditions of the locality.

Natural Ventilation (Preferred)

Natural ventilation provides the most reliable and maintenance free means of ventilation. The transformer vault shall be located as to be ventilated directly to the outside air without the use of flues or ducts. The net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than ***3.0 square inches per kVA of transformer capacity*** for the ultimate transformer size. Designs should have both an intake grate at a lower elevation and an exhaust grate at an upper elevation.

In case of sidewalk service vaults with grade-level gratings, all ventilation area may be provided in one or more openings in the roof. Vent locations must be located to ***shelter*** electrical equipment from falling or driven water or debris.

The location of vents shall be approved by Tacoma Power Engineer in order to accommodate all planned equipment and drainage considerations.

Forced Air Ventilation or Refrigeration

If natural ventilation to the outside air is not available, forced ventilation or refrigeration will be provided by the building owner. Forced air ventilation or refrigeration solutions must be designed by the building owner's HVAC mechanical engineer and approved by Tacoma Power Engineer. Forced air ventilation shall be a minimum of ***2.1 cubic feet per minute (CFM) per kVA of transformer capacity*** for the ultimate transformer size. All controls and motors shall be located outside of the vault.

Forced air ventilation shall be thermostatically controlled with an adjustable owner-maintained thermostat installed inside the transformer vault to turn the fan on at ***75°F***.

The minimum allowed ventilation ducting size is determined by duct design, fan CFM, total transformer KVA, room size and heat load.

Ventilation *(continued)*

Gratings

Vault ventilation gratings that must be installed within a sidewalk must be non-skid design and have vent gaps of 1/4 in. maximum width. Ventilation gratings are to be avoided within a 5 ft. wide clear foot traffic zone along the direction of the sidewalk. Grating covers must meet H20 loading and have a locking mechanism that is designed to be below the top grade of the grate. Tacoma Power must pre-approve all grate designs for location, ventilation, pedestrian travel when opened, etc.

Alarms

If the fan fails or the room temperature exceeds ***130°F***, a warning light and audible alarm shall sound in the building management system and at the vault just outside the personnel door. If fire detection systems in the vault are activated, then all vault room exhaust fans shall be automatically disabled. Signage at the warning light shall state “If light is on or horn sounds, contact Tacoma Power at (253) 502-8602 and report this address - *list address*.”

Dampers

All ventilation openings to building or garage interiors shall be provided with durable gratings or screens and louvers as well as automatic closing fire/smoke dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 3 hrs. Additional limiting requirements exist for exterior gratings if near or adjacent to occupied space or doors and windows that open or building ingress/egress pathways.

Louvered vents with blocking baffles must be used when located in close proximity to energized parts (required on a case-by-case basis).

Other Equipment

Figure 4

Fault Interrupter

Fault interrupter with wall mounted control box shown with standard side mounted operating handle.

Tacoma Power MID# 47733, 3Ø submersible, vacuum bottle interrupter, 200A loadbreak bushings, mounting bracket for vault applications to include parking stands, and grounding provisions for up to #4/0 Cu wire.

High Voltage Tap Boxes

When high voltage tap boxes are installed in a vault room, the space must be designed to accommodate the following:

- Tap boxes shall be mounted 36 - 40 in. above the floor and have 10 ft. x 10 ft. working space in front of the tap boxes.
- The cables may approach the tap box from above and/or below and shall be secured to racking on the wall, not laid on the floor.
- The portions of cables close to the elbow shall be free to move and not be trapped under other cables with enough slack to easily move the elbows from the tap boxes to the parking stands. Cables shall not come out of the floor directly below a tap box because this does not provide adequate slack.

Lighting & Outlets

Customer requirements to furnish and install lighting and outlets are:

- One 30A, 240/120V, two space minimum, main lug load center in vault room. The 30A feeder will be fed from the building emergency panel and labeled as to its source panel and circuit number.
- One 20A receptacle circuit to serve four GFI protected receptacles and one 20A lighting circuit to serve two LED luminaires (rated for damp locations). Location and conduit routing to be determined by Tacoma Power.
- Provide materials and installation for any additional power needs for Tacoma Power vault installed equipment, specific to the project.