Electric Service Requirements

Customer-Built Vaults

Engineering Specification T001
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1 Purpose

This specification provides the minimum requirements of the Sacramento Municipal Utility District’s (SMUD) design and construction of customer built transformer vault(s), which will be used to house SMUD’s equipment and materials.

This specification is NOT a complete design or construction specification. Compliance with this specification, all SMUD applicable specifications and all local agencies having jurisdiction is a requirement for service.

2 Scope

This Engineering Specification outlines SMUD’s minimum requirements for SMUD customer transformer vaults. The customer shall supply all labor, material(s) and resources necessary to meet or exceed all SMUD’s and applicable local agency requirements for the vault design and construction.

This specification shall apply to all transformer vaults; new construction and renovation.

3 References

The latest revisions of the following references apply to this Engineering Specification.

3.1 National Electric Code (NEC), Article 450, Transformers and Transformer vaults.
3.2 CAL-OSHA General Industry Safety Order #3277 – Fixed Ladders.
3.4 ASTM A153, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
3.5 Metal Framing Standards Publication, No. MFMA – 4.
3.6 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes Type 316 – Round bar (Solid).
3.7 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes Type 316L (If Welding is Required).
3.9 ASTM A240, Standard Specification for Chromium and Chromium – Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications Type 316L (If Welding is required).

3.10 SMUD Engineering Specification, C913 – Structural Concrete.


3.14 NEMA TC9, Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation

3.15 NEMA TCB2, NEMA Guidelines for the Selection and Installation of Underground Nonmetallic Raceways

3.16 NEMA 250 – 3R.

3.17 SMUD Ground Grid UVA1.6, UVA1.7, UVA1.8

3.18 NEMA GR-1 Grounding Rod Electrodes and Grounding Rod Electrode Couplings. See SMUD Specification UVA1.6, UVA1.7 and UVA1.8.


3.20 IEEE 100CD Standards Dictionary: Glossary of Terms and Definitions

3.21 SMUD Commercial & Industrial Electric Service Requirements, T007, latest revision.

3.22 SMUD Fire Sprinkler System Specifications, latest revision.

3.23 ANSI/NEMA C57.12.28, Figure 1.

3.24 California Building Code

3.25 ASHTO - Standard Specifications for Highway Bridges

4 Definitions

Definitions are defined in IEEE 100CD and the references in section 3 of this specification.
5 Customer- Built Transformer Vault, General Requirements

5.1 As-built Documents

5.1.1 The customer shall keep daily as-built records for all work that pertains to SMUD. The customer shall confer with and receive authorization from SMUD’s onsite Inspector to as-built field installations. SMUD’s Inspector will sign and date/time stamp as-built records. The customer shall provide 2-hard copies and 1-CD (Electronic Copy) of all as-built records to SMUD’s Inspector of record, prior to SMUD accepting the vault as complete.

5.2 Bus Duct (Busway)

5.2.1 Busway shall be utilized in any application that is inside the building lines or as determined appropriate by SMUD’s Designer.

5.2.2 When busway is to be utilized, all busway and cable tap box(es) shall meet or exceed NEMA 3R.

5.2.3 A cable tap box shall be provided at each transformer location. Confirm location and orientation with SMUD’s Designer.

5.2.4 Consult SMUD’s Designer for mounting height of cable tap box.

5.2.5 Cable tap boxes shall be enclosed on 5-sides with the bottom to remain open and accessible.

5.2.6 All sides of the cable tap box shall be removable.

5.2.7 Any jagged or sharp edges shall be protected via a shock absorbent bushing that will prevent injury.

5.2.8 Cable tap boxes shall accept a minimum of 10-runs of stranded 500kcmil copper conductor per phase.

5.2.9 Cable tap box(es) shall accept NEMA 2-hole compression type lugs (paddles). Set-screw connections shall not be accepted.

5.2.10 Busway penetrations shall comply with this specification and meet all applicable fire protection requirements.

5.3 Cable Tray

5.3.1 Cable tray shall be CooperB-Line, aluminum, or SMUD approved equal.

5.3.2 Cable tray shall be seismically braced for the Sacramento region. Bracing shall assume that the cable tray is loaded to 110% of capacity or as practical engineering guidelines call for; the most restrictive standard shall apply.
5.3.3 SMUD’s Designer will provide a schematic layout for the cable tray inside the vault. The customer shall supply all parts, resources and engineering involved with designing and installation of the cable tray system.

5.3.4 Cable tray shall be utilized for both the primary and secondary cabled type systems inside the vault.

5.4 Ceiling

5.4.1 The vault depth shall be such that a minimum of 12’ clearance from finished floor (F.F.) grade to the lowest obstruction is achieved. This includes, but is not limited to:

- Lighting
- HVAC
- Plumbing
- Fire Detection
- Span beams or other structural supports
- Bus Duct

The only exception to this requirement will be for cable tray and cable tap boxes. Height of cable tray above finished floor (F.F.) grade will be determined by SMUD’s Designer, but generally will be installed at an elevation of 8’6” above (F.F.) grade. In general a ceiling with a height greater than 15’ above (F.F.) grade shall not be permitted unless explicitly approved in writing by SMUD’s Designer.

5.4.2 The vault ceiling shall be designed to withstand the controlling load combination considering applicable live load, dead load, seismic, all pressures that could be generated by a fire suppression system discharge and AASHTO H-20 full traffic loading plus 30 percent impact.

5.4.3 The vault ceiling shall be painted with not less than two coats of white paint. The paint shall be breathable, specifically designed for concrete, and meet any applicable codes or regulations for fire/fire resistance. All paint shall be applied in accordance with the manufacturer recommendations.

5.5 Conduit System Installation (Ductbank)

5.5.1 All conduits to be conveyed to SMUD shall be installed in accordance with NEMA TCB2 and all applicable SMUD Specifications.
5.5.2 All conduits to be conveyed to SMUD shall be thoroughly cleaned and tested. The test shall consist of drawing an appropriately sized mandrel through each conduit. SMUD’s Inspector will provide the mandrel. Mandrelling of the conduit shall only occur in the presence of SMUD’s Inspector. A complete detailed report shall be generated by the customer detailing the following information:

   a. The start time of each pull
   b. The stop time of each pull
   c. The size of mandrel that was pulled
   d. The length of each pull
   e. The position of each conduit where the test was started
      (i.e. conduit in the 2 x 1 position; identifies the conduit is in the second row, first column).
   f. The position of each conduit where the test finished (i.e. conduit in the 3 x 2 position; identifies the conduit in the third row, second column.
   g. The manhole, pullbox or vault number for the start of each test (SMUD’s Inspector will provide this information).
   h. The manhole, pullbox or vault number for the end of each test (SMUD’s Inspector will provide this information).
   i. The location of each conduit (i.e. west wall).
   j. SMUD’s Inspector will initial and date/time stamp each pull upon successful testing.

5.5.3 A steel brush shall not be used in the conduit.

5.5.4 Conduits which do not pass the mandrel test shall be repaired and retested. Repairs and retesting shall only occur in the presence of SMUD’s Inspector.

5.5.5 All secondary conduits shall be installed and fire sealed pursuant to this specification and all applicable requirements.

5.6 **Conduits (Primary and Secondary)**

5.6.1 The customer shall furnish and install all conduits/ducts that are required pursuant to SMUD’s Commitment package.

5.6.2 All conduits shall comply with SMUD Specification C911.

5.6.3 The minimum number and size of conduits required for SMUD’s primary system and supervisory and control system will be determined by SMUD’s Designer.
5.6.4 If the transformer vault is to be placed outside building lines or subject to flooding, the customer shall utilize stranded 500kcmil copper conductors for their service conductors. The size of conduits and number of runs of conductor shall be pursuant to local agency requirements. The customer shall verify the proposed wire is compatible with SMUD connectors.

5.6.5 The customer shall submit plans detailing the proposed route for secondary conduits to SMUD’s Designer for review. Maximum angle PVC fittings in a single run shall not exceed 270 degrees.

5.6.6 Intermediate pullboxes in the secondary service run shall not be allowed.

5.6.7 Vertical bends shall not be less than a 4’ radius.

5.6.8 Horizontal bends shall not be less than a 12’ radius.

5.6.9 All conduit(s) shall achieve a minimum of 3” of concrete encasement.

5.6.10 The customer shall consult SMUD’s Designer for locations in which the primary and secondary conduits shall penetrate the vault walls.

5.6.11 It shall be the responsibility of the customer to confirm with their civil engineer that the proposed conduit penetrations will not affect structural integrity of the vault. Differential movement shall be taken into account.

5.6.12 All Polyvinyl Chloride (PVC) conduits shall meet or exceed DB 120, gray in accordance with the latest revisions of ASTM F512 and NEMA TC6.

5.6.13 Any manufactured elbow shall meet or exceed Schedule 40, one piece gray in color with an integral bell end.

5.6.14 All conduit fittings shall conform to ASTM F512 and NEMA TC9.

5.6.15 End bells shall be solid, one-piece, PVC and gray in color. End bells shall meet or exceed Schedule 40.

5.6.16 Plugs shall be utilized in every conduit. Conduit plugs shall be tapered and for the appropriate size of conduit.

5.7 Containment

5.7.1 Any vault that utilizes doors for personnel access or equipment access shall have curbing installed to an elevation of 6” above finished floor (F.F.) grade. Note that final curb height shall be dependent upon the size of largest piece of oil filled equipment. Additionally, when required by the Authority Having Jurisdiction, the curb height must accommodate twenty minutes of water from the fire suppression system. For any curbing that exceeds 6”, the curbing shall be removable by use of simple hand tools, by a single person, be water tight and withstand any pressures that could be generated as a result of fire suppression discharge.
5.7.2 Any vaults with equipment or containers storing an aggregate capacity of 1,320 gallons or greater of oil (equipment or containers storing less than 55 gallons of oil are not counted towards this threshold) must have secondary containment installed in accordance with Title 40 Part 112 of the Code of Federal Regulations. Secondary containment systems must be sized to contain the capacity of the largest piece of equipment or container plus precipitation. Should the Authority Having Jurisdiction require water from the fire suppression system to be contained in the secondary containment system, the system must be sized to accommodate the largest piece of equipment plus the anticipated precipitation or 20 minutes of water from the fire suppression system, whichever is greater.

5.7.3 Curb shall be painted red with the vault designation stenciled on the face of the curb. SMUD Inspector will provide the designation. Provide detail or plans for approval.

5.7.4 In general, oil detection/monitoring shall not be required as an integral part of the sump pump/water discharge system and shall not be used.

5.8 Customer Design and Construction of the Vault

5.8.1 The vaults design, including: architectural, engineering and design and design plans shall meet all the requirements of this specification and any other applicable jurisdictional authority. The vault structure and all associated civil/structural items shall be designed by a currently licensed California Civil (or Structural) Engineer. The design loads given in this specification are minimum requirements, the Customer and Engineer of Record shall determine the highest load combination anticipated during the life of the structure.

5.8.2 The customer is required to submit all vault architectural, engineering drawings and calculations, and design plans for review in advance of construction. All drawings and calculations shall be reviewed, stamped and signed by a currently licensed California Civil (or Structural) Engineer. Other documents may be required by SMUD for review.

5.8.3 This specification is not intended to completely satisfy all responsibilities and obligations of the customer.

5.8.4 The vault design shall be in accordance with NEC Article 450.

5.8.5 The customer shall furnish all material, resources and labor as required to engineer, design and construct the vault.

5.8.6 All materials utilized for construction shall be new. Reclaimed, recycled or reconstituted material shall not be accepted under any circumstances.
5.8.7 All concrete used for construction of the vault shall meet or exceed SMUD Specification C913. Concrete of higher strength values shall be used when determined appropriate by the engineer of record having jurisdiction.

5.8.8 All vaults exposed to weather shall be considered subject to flooding/submergence and at a minimum be designed for an at grade water table. The vault design shall include a review of buoyancy to verify that the vault will not become buoyant under an at grade or flood water level condition. All equipment utilized shall be explicitly listed for submergence. The customer shall make provisions to seal conduit/ducts as required to prevent water travel or migration into the building. It is the customer’s sole responsibility to seal conduits/raceways in a manner that shall prevent water migration.

5.8.9 All vaults that utilize a water-type fire suppression system shall be considered subject to flooding/submergence. All equipment utilized shall be explicitly listed for submergence.

5.8.10 Should the customer request use of material/components that are of a non-pre-approved nature, the customer shall submit any and all information as determined necessary by SMUD staff for review. SMUD has the sole discretion to determine the appropriateness of the proposed substitute. The entire burden of proof is upon the customer to demonstrate compliance with the appropriate specifications. The customer shall allow a minimum of 25-business days for SMUD’s review.

5.8.11 It is the customer’s responsibility to ensure material is available for construction. SMUD will not accept inferior material as a result of unavailability of acceptable material.
5.9 Equipment Access

5.9.1 The vault equipment access shall consist of one of the following:

   a) One 6’ x 10’ (ID) grated or solid opening through the roof of the vault adjacent to each transformer position.

   b) One 6’ x 10’ (ID) grated or solid opening through the roof of the vault and directly above a 12’W x 9’H access aisle-way running the length of the vault.

   c) A doorway at curb level opening into a 12’ wide clear access aisle-way running the length of the vault. Equipment access doors shall provide a minimum of 7’W x 8’H (ID) opening. Consult SMUD’s Designer if this option is to be utilized as a larger door could be required if the transformer(s) could exceed 1000kVA. Doors shall comply with all requirements set forth in section 5.11., Fire Protection, and contain auto closers, panic hardware, have a fire rating and smoke rating as specified by the California Electrical Code, the California Building Code, including any local amendments, and open away from the vault. A sign shall be placed on the door with the following: “DANGER, HIGH VOLTAGE, KEEP OUT. KEEP 10’ CLEAR IN FRONT OF DOOR AT ALL TIMES”. The door lockset shall accept a Best Heavy Duty Cylinder Lockset, Cat. # 85K7D4AS3-626.

5.9.2 Equipment access openings located in right-of-way or accessible to vehicular traffic shall be designed for AASHTO H-20 full traffic plus 30 percent impact loading; this requirement includes all sidewalk locations.

5.9.3 Grated openings shall not be located below or adjacent to building fresh air intake, windows that open and are operable, overhangs, canopies, doorways, entrance ways or ingress/egress routes to a building.

5.9.4 Equipment access grates shall not be located in areas exposed to routine traffic (i.e., road surface).

5.9.5 The opening shall be securable with pentahead bolts per ANSI/NEMA C57.12.28, figure 1.

5.9.6 All grates and solid plugs shall include recessed/flush lifting points to facilitate installation and removal of the grate or plug using 5/8” – 13NC eyebolts or lifting hardware.

5.9.7 All grating or plugs shall be A.D.A. compliant and heel safe with clear grate spacing not to exceed 5/16”. All surfaces shall be non-slip coated with SlipNOT® or a SMUD approved equal.
5.9.8 All grates, hatches, solid plugs and lift-outs shall be designed and engineered by a currently licensed California Civil (or Structural) Engineer. All drawings and calculations shall be submitted for SMUD review in accordance with Section 5.8 of this Specification.

5.9.9 All grates shall be lift-out, banded, welded, hot dipped galvanized steel or type-316 stainless steel.

5.10 Failure to Submit Required Information

5.10.1 Should the customer fail to submit the required information, or execute work in advance of review by SMUD’s Designer or other SMUD Department having jurisdictional approval, the customer, at their expense shall rectify any and all deficiencies as a result of performing this work at their expense.

5.11 Fire Protection

5.11.1 The customer shall consult the local agency having jurisdiction for the requirement of, or type of fire detection/suppression that shall be utilized:

- City of Sacramento, Fire Marshal’s Office
- County of Sacramento, Fire Marshal’s Office

Once the system type has been identified by the local agency having authority, the customer shall consult SMUD’s Sr. Fire Protection Specialist for current requirements.

The customer shall direct all correspondence for Fire Protection requirements to:

SMUD
Attention: Sr. Fire Protection & Loss Control Specialist
P.O. Box 15830
Sacramento, CA 95852

5.11.2 The City/County/State building regulatory agency, and/or fire agencies having jurisdiction at the location of the vault may require fire protection and detection to be installed. SMUD assumes no responsibility for the permitting, operation or maintenance of the system. When the agency having jurisdiction has determined that a detection/suppression system is required, the customer shall consult SMUD’s Loss Control & Fire Protection Specialist for requirements.
5.12 Fire Ratings

5.12.1 All wall(s), floor(s), ceiling(s) and any other structural component within the limits of the vault are to have a fire rating as specified in the California Electrical Code and California Building Code including any amendments by the local authority.

5.12.2 All doors, vents, louvers and related hardware shall have a fire rating and a smoke rating as specified in the California Electrical Code, California Building Code, NFPA Standards, and local amendments.

5.12.3 All penetrations into/out of the vault shall be sealed pursuant to the California Building Code & NFPA standards. Sealing designs shall consider pressures that could be generated by a fire suppression system discharge.

5.12.4 All fire stopping used inside the vault shall be UL listed and/or FM approved and shall meet the minimum fire rating as specified in the California Building Code. All fire stopping materials and methods are subject to SMUD review and shall be submitted to SMUD’s Fire Protection & Loss Control Specialist for approval prior to construction.

5.13 Floor

5.13.1 The floor shall be constructed with a smooth fine-broom finish. Final finish shall provide a frictional coefficient that allows for foot traction, but not prevent the movement of equipment or create a trip hazard.

5.13.2 Slope of the floor shall not exceed 1% and shall allow flow to the drainage sumps.

5.14 Floor Drains

5.14.1 Floor drains of any type are specifically prohibited running in, through or traversing the vault.

5.15 Foreign Objects

5.15.1 Any object/facility not explicitly required by SMUD (i.e., piping, conduits, raceways, buss, vents, etc.) shall not be permitted to access, cross or traverse any portion of the vault under any circumstances.
5.16 Identification

5.16.1 The customer shall permanently install a stainless steel, engraved placard adjacent a personnel access, on an interior wall with the following information:

- General Contractor of Record
- Sub-Contractor of Record for Construction of the Vault
- Electrical Contractor of Record
- Building Engineer Contact Information
- Year of Construction
- Vault Number (To be supplied by SMUD’s Inspector)

5.16.2 The lettering shall be engraved and a minimum of 3” high.

5.17 Inspection(s)

5.17.1 SMUD’s Inspector will be the line of communication between the customer and SMUD.

5.17.2 Inspections shall be performed between 7:30AM and 3:00PM, Monday through Friday only. All work requiring inspection shall be scheduled during these hours.

5.17.3 It shall be the customer’s responsibility to coordinate all inspection activities with SMUD’s Inspector of record to ensure all required inspections are performed. SMUD’s Designer will provide the name and phone number of the inspector of record once SMUD’s Designer has reviewed and accepted the vault construction plans.

5.17.4 The customer shall note all requests for inspection(s) in the daily log/as-built records for the vault. Performance of inspection will be noted and initialed by SMUD’s Inspector of record upon successful completion. Unsuccessful performance of an inspection shall be noted in the daily log/as-built records for the vault.

5.17.5 All material and work shall be subject to inspection, examination and testing by SMUD.

5.17.6 Any materials to be fabricated are also subject to inspection, examination and testing by SMUD.

5.17.7 The customer shall provide safe ingress, egress and a safe working environment for all SMUD personnel.

5.17.8 The customer shall provide a minimum 48-hour notice to SMUD’s Inspector in advance of inspection, or as agreed to between the customer and inspector.
5.17.9 At all times SMUD reserves the right to reject defective materials and or workmanship that in its sole opinion does not comply with the reviewed plans. Further, SMUD reserves the right to reject any material or workmanship that it determines to be insufficient or deficient for any reason.

5.17.10 Failure by the customer to contact SMUD’s Inspector shall result in; at the customer’s expense, removal, reworking of, or redoing any work SMUD’s Inspector determines as deficient.

5.17.11 Rejected work shall result in delaying electric service until the inadequacies are corrected. The costs of rectifying rejected work are solely born by the customer.

5.17.12 The customer shall submit to SMUD’s Inspector, documentation from all agencies having jurisdiction detailing their inspection of the vault and stating their acceptance and/or approval. SMUD will not accept the vault as complete until these items in additional to all other applicable items have been addressed to SMUD’s satisfaction.

5.18 **Interior Vault Dimensions**

5.18.1 The minimum interior vault dimensions shall be determined by SMUD’s Designer. See Drawings UVA1.1A – UVA1.1F for general illustrations and general minimum requirements. Final dimensions shall be determined by SMUD’s Designer.

5.18.2 The 15’ dimension assumes a maximum interior height dimension. This dimension may vary with SMUD approval only.

5.19 **Ladders**

5.19.1 The customer shall supply, provide and install all required ladders.

5.19.2 The ladders shall meet CAL-OSHA General Industry Safety Order #3277.

5.19.3 The ladders shall be bolted rigidly in place and be removable.

5.19.4 The ladders shall be manufactured and installed in accordance with SMUD’s drawing UVA1.5.
5.20 Lighting

5.20.1 The customer shall install and maintain lighting facilities within the vault. Lights will generally be placed 8’ on center (O.C.) and be wall mounted at 10’ above finished floor grade. Acceptable wall-mounted type units are Lithonia Lighting, Model (120V System) DMW-2-32W-120-GEB10IS or Model (277V System) DMW-2-32W-277-GEB10IS. Additional lighting may be required. It shall be the responsibility of the customer to provide a lighting diagram (Coefficient of utilization or Isofootcandle plot) that demonstrates lighting to all areas of the vault. Shadows in any portion of the vault are strictly prohibited. The lighting diagram shall account for all obstructions that will be in the vault (i.e., cable tray, HVAC, etc.).

5.20.2 If access doors are to be used, lighting shall be provided at each point of entry on the exterior of the vault.

5.21 Limits of SMUD Review

5.21.1 SMUD’s review is normally limited to the area that is/or will be occupied by SMUD’s equipment and materials. However; when necessary to investigate compliance with SMUD’s requirements, SMUD reserves the privilege to review any and all information necessary to ensure the safety of its staff. SMUD assumes no liability or responsibility with regards to local agency or higher jurisdictional compliance. The customer is responsible for reviewing all items with all applicable jurisdictions.

5.22 Location of Vault

5.22.1 Transformer vaults shall be built on private property at grade (Street Level).

5.22.2 When a transformer vault at grade is not feasible, a transformer vault on the customer’s property one-level below grade (sub-grade) shall be considered.

5.22.3 Should construction of a transformer vault on customer’s property be determined by SMUD’s Designer as unfeasible, a vault in the right – of – way shall be considered.

5.23 Material Furnished and installed by SMUD

5.23.1 All material in accordance with Rule and Regulation 16.

5.23.2 Ground grid conductors (excluding ufers) as part of the ground grid.

5.23.3 Secondary jumpers to cable tap boxes.

5.23.4 NEMA 2-Hole connectors, for terminating source side of conductor only.

5.23.5 Padlock(s) and doorway cylinder.
5.24 Permits, Licenses and Bonds

5.24.1 The customer, at their expense shall obtain, secure and execute all permits, licenses and bonds necessary for the execution of all work related to acquiring service from SMUD.

5.24.2 The customer, at their expense shall obtain, secure and execute all necessary permits/licenses to design and engineer all required portions of the transformer vault. All work shall be signed and stamped by a currently licensed engineer within the State of California within the appropriate discipline. All stamped and signed drawings and calculations shall be submitted to SMUD for review.

5.25 Personnel Access

5.25.1 The vault shall have a minimum of two personnel accesses, located at either extreme end of the vault. Ingress/egress for personnel shall meet the following requirements:

a) A 3'-0" x 6'-8" door at vault curb level through the vault wall. Panic hardware shall be installed on the interior side of the door with the door only being accessible via door knob with a fixed key entry. The door shall contain auto closers, panic hardware, achieve a fire rating as specified in the California Electrical Code and California Building Code including any amendments by the local authority and open away from the vault. A sign shall be placed on the outside of the door with the following: “DANGER, HIGH VOLTAGE, KEEP OUT. KEEP 10’ CLEAR IN FRONT OF DOOR AT ALL TIMES”. The door lockset shall accept a Best Heavy Duty Cylinder Lockset, Cat. #85K7D4AS3-626. SMUD’s field inspector will coordinate keying of the locks.

b) A 3'-6" x 4'-0" opening through the roof of the vault via ladder access. Should this option be utilized, Personnel access shall be designed for AASHTO H-20 full traffic plus 30 percent impact loading; this requirement includes all sidewalk locations, shall be hinged and torsion assisted with a maximum of 35lbs lifting force. The opening shall be securable with pentahead bolts per ANSI/NEMA C57.12.28, Figure 1, and lockable with a recessed covered SMUD padlock. All surfaces shall be non-slip coated with SlipNOT® or a SMUD approved equal. All personnel accesses shall contain a positive latch or restraining device that shall prevent the hatch from falling closed. All steel shall be hot dipped galvanized or type-316 stainless steel, minimum. All grating or hatches shall be A.D.A. compliant and heel safe with clear grate spacing not to exceed 5/16”.

c) All grates shall include recessed/flush lifting points to facilitate installation and removal of the grate using 5/8” – 13NC eyebolts or lifting hardware.
5.25.2 All personnel access points shall be accessible 24-hours a day, seven days a week by SMUD personnel. Ingress/egress, access to and from the vault shall not be blocked or impeded at any time.

5.25.3 Vehicle parking, refuse storage or any other potential obstruction shall be managed with signage and building engineer policies that shall prevent any blockage issues.

5.25.4 Exterior lighting shall be provided at each personnel access point.

5.25.5 All grates and solid plugs shall include recessed/flush lifting points to facilitate installation and removal of the grate or plug using 5/8” – 13NC eyebolts or lifting hardware.

5.25.6 All grates and hatches shall be designed by a currently licensed California Civil (or Structural) Engineer. All drawings and calculations, with signature, shall be submitted to SMUD’s Designer for review in advance of fabrication.

5.26 Pull Tape (Pull Rope)

5.26.1 Inspection of Pull Tape (Pull Rope) is required prior to installing.

5.26.2 A flat pull rope shall be provided and installed by the customer in each conduit. The tape shall exceed the length of each conduit a minimum of 25’ at each end and be a single, continuous run.

5.26.3 Knots in the pull rope are not acceptable.

5.26.4 The pull rope shall be tied to the end of the tapered conduit plug.

5.26.5 The pull rope shall be made of polyester, be lubricated and printed with footage markings or Kevlar and printed with footage markings.

5.26.6 The pull rope shall achieve a minimum tensile strength of 2500lbs.

5.26.7 Reclaimed rope shall not be accepted.

5.27 Pulling Irons

5.27.1 Inspection of Pulling Irons is required prior to forming and placing concrete.

5.27.2 Pulling irons shall be type-316 stainless steel or better and embedded in concrete.
5.27.3 Each pulling iron shall have a minimum safe working load (SWL) rating of 11,000 lbs. applied in any direction. Each pulling iron shall have a minimum safety factor of not less than 3.0. Both the concrete area surrounding the pulling iron and the overall vault structure shall develop the minimum SWL of the pulling iron with a minimum safety factor of 3.0. All pulling irons shall be designed and engineered by a currently licensed California Civil (or Structural) Engineer. All drawings and calculations, with signature, shall be submitted to SMUD for review in accordance with Section 5.8 of this Specification.

5.27.4 The pulling iron shall have a minimum inside clearance of 3”, when installed and blockout shall be designed to accommodate a 7/8” x 4 ½” shackles.

5.27.5 The customer shall reference drawing UVA1.4 for pulling iron locations. At a minimum, nine pulling irons shall be required and placed such that each iron is 18” on center above finished floor grade, 18” on center from the adjacent wall and 18” on center from the ceiling. The ninth pulling iron shall be located on the wall opposite the primary ductbank entrance and in line with centerline of the ductbank.

5.27.6 The vendor shall include stainless steel material test reports in the submittal. The material test reports shall include the actual yield and tensile of the stainless steel for all material used.

5.28 Receptacles

5.28.1 A minimum of two receptacles shall be provided (in addition to dedicated outlets for sump pump requirements). More may be required dependent upon the size of the vault. SMUD’s Designer will confirm minimum number of outlets. Each outlet shall provide 120V single-phase domestic power.

If the customer will have back-up/emergency generation, the customer shall provide one outlet in the vault from the back-up generation that shall be labeled “Back-Up Vault Power” via engraved tag permanently affixed adjacent the outlet.

5.28.2 Outlets shall be GFCI protected, dedicated exclusively to vault power and clearly identified in the customer’s panel as follows: “SMUD Vault Power”.

5.28.3 A shunt-trip shall be supplied at all personnel access points. Each shunt trip shall immediately disable all domestic vault power supplied from the customer’s electrical service. Shunt trips shall be installed 6’ above finished floor grade and identified as “Emergency Vault Power Shut-Off” via an engraved tag adjacent the apparatus.
5.28.4 All conduits, condulets, outlets, piping, wiring, apparatus and associated hardware shall be rated and UL Listed for use in a “Wet” environment.

5.29 Resubmittal of Information

5.29.1 Resubmittal shall include the following:
   a) Three – Copies minimum, of each item being submitted for review.
   b) Transmittal letter.
   c) Original of preceding submittal (Previous plans with back-check comments).
   d) Date of submittal, also include date of original submittal on transmittal sheet.
   e) Date that completed review is being requested. Allow for a minimum of 15-business days for review of each item submitted.

5.30 Scheduling

5.30.1 The customer shall provide a construction schedule to SMUD’s Scheduling Department. The schedule shall provide adequate time for SMUD’s Engineering and Design review of the proposed transformer vault. A minimum of five weeks is typically required for a complete review.

5.30.2 The schedule shall include the following:
   a) Date the vault construction is to begin.
   b) The date construction of the vault will be complete. The customer shall allow time in the construction schedule for field inspections as required by SMUD’s Inspector, local agency inspector, special inspector or any inspector/inspecting authority have jurisdiction. Note that SMUD does not consider the transformer vault construction complete until SMUD controls exclusive access to the vault. SMUD will not begin construction until all criteria of this specification have been satisfied.
   c) The date that permanent service is requested.
   d) The customer shall submit to SMUD’s Scheduling staff, any changes impacting the construction schedule.

5.31 Service Conductors

5.31.1 Conductor shall only be used when a vault is to be built outside the building lines, or in a location that could be subject to flooding. For all other applications, bus duct (busway) shall be utilized (See Section 5.2).

5.31.2 Service conductor size shall be stranded 500kcmil copper conductor. The number of runs and size of conduit(s) shall be pursuant to local agency requirements.
5.31.3 SMUD’s Designer will review the number of runs of conductor to be connected in the transformer vault.

5.31.4 Coordinate the excess length of conductor required inside the vault with SMUD’s Inspector.

5.31.5 The service conductors shall be as close as practicable in length.

5.31.6 SMUD will provide the terminations inside the vault. Wire shall be “landed” via NEMA 2-Hole, long barrel type compression lugs (paddles).

5.32 Sound Insulation

5.32.1 Thermal or acoustical insulation of any type shall not be allowed in the vault.

5.33 Standards and Codes

5.33.1 This specification does not relieve nor indemnify the customer from complying with all applicable codes, ordinances, or other industry standards or practices.

5.33.2 Where there is conflict between this specification and codes, ordinances, industry standard practices, local agency requirements, etc., the customer shall notify SMUD in writing for resolution. In most cases, the most restrictive standard shall apply.

5.33.3 Any issues that arise as a result of conflict with this specification and any applicable codes shall be resolved in advance of constructing the transformer vault.

5.33.4 Any engineering, design or construction that will deviate from SMUD’s Engineering Specification T001 or the plans explicitly reviewed by SMUD’s staff shall be validated in writing by SMUD’s Designer or Inspector. Should the developer fail to receive written authorization from SMUD and the performed work is determined to be deficient, the customer, at their expense shall correct the deficiencies.

5.34 Structural Framing Channel (Unistrut)

5.34.1 All structural framing channel shall be type-316 stainless steel, or better.

5.34.2 All structural framing channel shall conform to Metal Framing Manufacturers Association Standard No. MFMA – 4, or better.

5.34.3 Concrete embedded channel (Unistrut) is the preferred construction method and shall be 1-3/8” x 1-5/8” 12 gauge, CooperBline “B32” type-316 stainless steel or better, or a SMUD approved equal. All channel shall be installed so that the lip of the channel is flush with the wall surface.
5.34.4 Surface mounted channel (Unistrut) shall be considered only if SMUD’s Designer agrees that it is unfeasible to install embedded channel. Surface mounted channel shall be 1-3/8” x 1-5/8” 12 gauge, CooperBline “B32” type-316 stainless steel or better, or a SMUD approved equal.

5.34.5 Channel (Unistrut) on the ceiling will generally run perpendicular to the length of the vault. The first row at either end shall be placed 3’ on center from the face of the interior vault wall and every 2’ on center, thereafter. Channel shall be as evenly spaced as practicable to meet this requirement.

5.34.6 Wall mounted channel shall start at 4’ above finished floor grade and be placed every 3’ on center thereafter to the ceiling.

5.34.7 In general, all channel shall terminate 18” clear of any obstruction or wall.

5.34.8 All channel (embedded or surface mounted) shall be capable of supporting a minimum of 1000lbs/linear foot (1kp/lf.). Holding strength that only meets 1000lbs in a single location on the channel shall be considered a deficient design and shall not be accepted.

5.35 Submittals to SMUD’s Designer/Engineer

5.35.1 The customer shall submit plans, drawings, calculations, material data sheets and other supporting documentation verifying compliance with SMUD’s Engineering Specification T001 and all other applicable SMUD ESR’s for review by SMUD’s Design/Engineering staff in advance of submitting to the local agency of jurisdiction.

All submittals shall include the following:

a) Three – Copies minimum of each item being submitted for review.

b) Transmittal letter.

c) Date of submittal (Or original date of submittal with date of resubmittal).

d) Date that completed review is being requested. Allow for a minimum of 15-business days for review of each item(s) submitted.

All correspondence shall be directed to:

SMUD
Attention: Engineering Designer IV
New Business – Downtown/Network System
4401 Bradshaw Blvd. Sacramento, CA 95827
5.35.2 SMUD’s Designer will provide a checklist of all items required to be submitted for review. The list will be modified to be project specific as required.

5.35.3 Additional information may be required by SMUD’s Designer to determine compliance with this specification. In the case of engineering and design work, the plans shall be stamped in accordance with this specification.

5.35.4 All plans shall be signed and stamped by the engineer of record prior to submission to SMUD’s Designer for review.

5.36 **Sump Pits**

5.36.1 The vault shall contain a minimum of two-sump pits. Sumps shall be placed in locations adjacent to personnel access approximately 6” clear from any walls. The sump pits shall not be situated in any normal travel path.

5.36.2 The sump pits shall be 12”w x 24”l x 12”d. Each sump pit shall be covered with two – 12” removable grates. The grates can be either stainless steel or galvanized and shall be set flush with finished floor grade. Grates shall withstand 500lbs. point load with a minimum 3.0 safety factor.

5.36.3 The two sump pits shall be connected together with 1½” schedule 40, PVC water pipe. Gray PVC shall not be used.

5.36.4 A single 1½” schedule 40 PVC water pipe shall be utilized as a discharge line. The pipe shall start 3” above the sumps bottom.

5.36.5 The discharge line shall typically be routed to face of curb (F.O.C.).

   a) Discharge lines shall not be routed through, across or traverse any building footprint.

5.36.6 A check valve shall be installed approximately 4’ above finished floor grade and shall be capable of preventing any potential back-flow. All mounting hardware for the discharge line shall be type-316 stainless steel or better.

5.36.7 A switched and GFCI protected outlet shall be provided at a minimum of 6’ above finished floor grade and located adjacent each personnel access and sump pit.

5.36.8 The customer shall supply all sump pumps. The customer shall utilize Little Giant Pump, Model 6E-CIA-SFS, Catalog Number: 506700 or a SMUD approved equal.

5.36.9 In general, a drain vent will not be required.
5.37 Transformer Vault Accessibility

5.37.1 SMUD requires immediate and unimpeded personnel and equipment access, 24-hours a day.

5.37.2 The customer shall maintain and facilitate a clear, unimpeded access for delivery, installation, replacement or maintenance of SMUD's equipment and materials.

5.37.3 Once SMUD has accepted the vault, sole access to the vault shall be controlled exclusively by SMUD.

5.37.4 A sign shall be posted in front of all doors into/out of the transformer vault with the following: “DANGER, HIGH VOLTAGE, KEEP OUT. KEEP 10’ CLEAR IN FRONT OF DOOR AT ALL TIMES.” Letter shall be raised tag and a minimum of 3”.

5.37.5 Should the customer require access to the vault once it has been accepted by SMUD, the customer shall coordinate with SMUD for access and only be allowed to enter the vault when escorted by a trained and qualified SMUD electrical worker.

The customer or their designee shall have at a minimum, sturdy shoes, hard hat, safety glasses and any other personal protective equipment deemed necessary by the SMUD qualified electrical worker or code having jurisdiction.

5.37.6 A minimum of two personnel accesses shall be provided, one each at the extreme end of the vault. A third access point could be required, consult SMUD’s Designer for requirements. Refer to section 5.25.

If the transformer vault is located inside the building, the personnel and equipment access routes shall enter directly from the exterior of the building and be a dedicated access to the vault. Refer to section 5.9.

5.38 Vault Ground Grid

5.38.1 Refer to supplemental grounding information: UVA1.6, UVA1.7 and UVA 1.8.

5.38.2 All conductors utilized for the ground grid shall be 500kcmil copper conductor, unless otherwise noted on SMUD’s Commitment.

5.38.3 The customer shall utilize extreme care and caution when building the ground grid. Any damaged or bent conductor throughout the vault construction process shall be determined as useless and shall be replaced.
5.38.4 The customer shall arrange for a ground impedance test with SMUD’s Inspector. Testing shall be done within 5-days of installing the ufers and again when the vault has been completed. Ground resistance shall not exceed 5-ohms upon the ufers being connected to the grid.

5.38.5 Should ground resistance of 5-ohms be exceeded, the customer shall consult SMUD’s Designer for resolution.

5.38.6 For vaults that are not built on native soil, contact SMUD’s Designer for grounding requirements.

5.39 Ventilation

5.39.1 Ventilation shall meet building code requirements for occupied spaces and be sufficient for transformer cooling. The ventilation design shall be reviewed by SMUD’s Designer.

5.39.2 Mechanical Ventilation

a) Ventilation shall run directly to the outside of the building.

b) Ventilation openings shall be covered with durable gratings and screens to prevent bird or rodent intrusion.

c) All ventilation openings in the vault shall have fire/smoke dampers that meet the minimum fire rating specified in the California Electrical Code and the California Building Code, including any local amendments and shall be motor operated. Only motor operators of a maintenance free type shall be accepted.

d) Any filters, screens, operators or other facilities that require maintenance shall be installed on the exterior of the vault and shall be serviced from the exterior of the vault.

e) A mechanical ventilation system shall be designed to maintain a maximum vault air temperature not to exceed 122° F (50° C) with an assumed outside ambient air temperature of 104° F (40° C). The following contributed heat load for the transformers shall be utilized:

<table>
<thead>
<tr>
<th>Transformer Size (KVA)</th>
<th>Heat Load Per Transformer (In kW)</th>
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</thead>
<tbody>
<tr>
<td>&lt;= 1500</td>
<td>14.4</td>
</tr>
<tr>
<td>&gt;1500</td>
<td>18.4</td>
</tr>
</tbody>
</table>
5.39.3 The mechanical design shall take into account all other forms of heat load within the vault.
   a) Mechanical ventilation systems for transformer vaults shall be completely dedicated and shall not share any supply (source or exhaust) with building H.V.A.C.
   b) Maximum air velocity shall not exceed 900 CFM.
   c) The fans shall be controlled via thermostat inside the transformer vault. The ventilation system shall operate at 90° F (18° C) and shut-off at 70° F (~6.9° C).
   d) A means of manually controlling the fans shall be provided inside the vault.
   e) The ventilation system balance diagram showing designed inlet capacity, maximum inlet temperatures and duct sizes shall be submitted to SMUD’s Designer for review.

5.39.4 Natural Ventilation
   a) The net area of ventilation opening, after reduction of the area occupied by screens, grates or louvers, shall not be less than three-square inches per transformer kVA.
   b) Natural ventilation shall only be acceptable in an application that the required net opening area is above the transformer(s).

5.39.5 Ventilation grates shall be designed for AASHTO H-20 full traffic plus 30 percent impact loading; this requirement includes all sidewalk locations, be A.D.A. compliant and heel safe with clear grate spacing not to exceed 5/16”. All surfaces shall be non-slip coated with SlipNOT® or a SMUD approved equal. All steel shall be hot dipped galvanized or type-316 stainless steel, minimum.

5.39.6 Grated openings shall not be located below or adjacent to building fresh air intake, windows that are open and operable, overhangs, awnings, canopies, doorways, entrance ways or ingress/egress routes to a building. The opening shall be securable with pentahead bolts per ANSI/NEMA C57.12.28, figure 1.
5.39.7 All grates and hatches shall be designed, engineered, stamped and signed by a currently licensed California Civil (or Structural) Engineer. All drawings and calculations, with signature, shall be submitted for SMUD review in advance of fabrication.

5.39.8 All grates shall be lift-out, banded, welded, hot dipped galvanized steel or type-316 stainless steel.

5.40 Walls

5.40.1 The walls of the vault shall be painted with not less than two coats of white paint. The paint shall be breathable, specifically designed for concrete, and meet any applicable codes or regulations for fire/fire resistance. All paint shall be applied in accordance with the manufacturer recommendations.

5.40.2 The vault walls shall be designed to withstand all pressures that could be generated by a fire suppression system discharge.

5.40.3 The vault walls shall be designed to withstand the controlling load combination considering applicable live load, dead load, seismic, all pressures that could be generated by a fire suppression discharge, all pressures that could be generated as a result of full internal (vault full of water) or external hydrostatic pressure, and AASHTO H-20 full traffic loading plus 30 percent impact.

5.41 Water Proofing

5.41.1 The vault shall be designed to prevent any intrusion or migration of liquid through all walls, floors, ceiling(s) and joints. Furthermore, the vault shall be designed to contain any liquid for an indefinite amount of time. (Use XYPEX or SMUD approved equivalent to waterproof the exterior face and provide 2 strips of RAM-NECK Joint Sealant or SMUD approved equivalent at all joints)

5.41.2 Provide water proofing submittal or methodology to SMUD Designer for approval.
Appendix A: List of Material Suppliers

The table below lists material suppliers with whom SMUD is familiar. It is not intended to be an exhaustive list of all possible suppliers in the area. There may be additional vendors that can provide the material required by this specification.

**Anti-Slip**
SlipNOT Metal Safety Flooring
800-SlipNOT (800-754-7668) or 313-923-0400
[www.slipnot.com](http://www.slipnot.com)

**Cable Tray**
Cooper B-Line
800-851-7415
[www.cooperbline.com](http://www.cooperbline.com)
Series 2, 3 & 4 Aluminum Cable Tray, 12” Rung spacing.
*Consult SMUD Designer for width requirements.*

**Channel**
Cooper B-Line
800-851-7415
Cooper B-line “B32” type-304 12-gauge stainless steel
[www.cooperbline.com](http://www.cooperbline.com)

**Equipment Hatch**
Madrugua Iron Works, Inc. 209-832-7003
[www.madrugaironworks.com](http://www.madrugaironworks.com)
6’-0” x 10”-0” 3-Piece, Drag-Off Grates, Frame and Cover
Minimum live load design requirement: AASHTO full traffic plus 30% impact applied at any location on the surface.
Equipment/Personnel Hatch
Madruga Iron Works, Inc.
209-832-7003
www.madrugaironworks.com
http://www.madrugaironworks.com/SMUD%206X12%20G&C.pdf
6’-0” x 10’-0” 2-Piece, D/O Grates and Hinged Alum Cover, Frm & Cvr –
Minimum live load design requirement: AASHTO full traffic plus 30% impact applied at any location on the surface.

Ground-Grid components
FCI
800-346-4172
www.fciconnect.com
Burndy Type YGF Ground Plate, size for 500kcmil CU wire
Burndy Type YGHC-C rebar connector, sized for 500kcmil CU wire
Burndy Type YGL-C cross connector, sized for 500kcmil CU wire

Lights
Lithonia Lighting
770-922-9000
www.lithonia.com
Model (277V System) DMW-2-32W-277-GEB10IS
Model (120V System) DMW-2-32W-120-GEB10IS
Pull Rope
Arnco. No. DLWP 25S-3000
Neptco No. WP 2500P
Pacific Strapping NO FMT-P2500
Fibertek NO WP2500
Advance Fiber Tech (AFT) WPP2500PL
Wellington Slicktape N303M10-9083
Redback PW2500
Milliken MT2500-3000

Safety Post
Bilco Specialty Access Products
203-934-6363
www.bilco.com
http://www.bilco.com/foundations/store/shopdetail.asp?product=1LU%2D1
Model LU-2, Galvanized Steel
Required for each ladder.

Sump Pump
Little Giant Pump Company
888-956-0000
www.littlegiant.com or www.lgpc.com
http://www.lgpc.com/QuickSearch.aspx?SearchString=6E-CIA-SFS&TypeID=0
Model: 6E-CIA-SFS
Catalog Number: 506700
Appendix B: Design and Construction Drawings

The customer and/or their representatives or contractors shall adhere to the design and construction drawings listed in the table below, unless otherwise specified in writing by a SMUD inspector or designer. The Customer shall review all drawings. Any questions or comments shall be brought to Sacramento Municipal Utility District’s (SMUD) attention for clarification or resolution.

### Design and Construction Drawings

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<th>Drawing Identification Code</th>
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<td>MINIMUM SPACE REQUIREMENTS FOR 51’ TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER</td>
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<tr>
<td>MINIMUM SPACE REQUIREMENTS FOR 51’ TRANSFORMER VAULT WITH ACCESS ISLE WAY</td>
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<td>MINIMUM SPACE REQUIREMENTS FOR 73’ TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER</td>
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<td>Drawing Title</td>
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<td>BELOW GRADE GROUNDING ELECTRODE CONFIGURATIONS</td>
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<td>STANDARD 39” STEEL MANHOLE FRAME</td>
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<tr>
<td>DETAIL TYPICAL CONDUIT TERMINATION</td>
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MINIMUM SPACE REQUIREMENTS FOR 40' TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER
MINIMUM SPACE REQUIREMENTS FOR 40' TRANSFORMER VAULT WITH ACCESS ISLE WAY

ASSUMED TRANSFORMER POSITION = 6' X 10'
MINIMUM SPACE REQUIREMENTS FOR 51' TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER
MINIMUM SPACE REQUIREMENTS FOR 51' TRANSFORMER VAULT WITH ACCESS ISLE WAY

ASSUMED TRANSFORMER POSITION = 6' X 10'

51'

6'

5'

6'

12'

5'

6'

28'

6'
MINIMUM SPACE REQUIREMENTS FOR 62' TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER

ASSUMED TRANSFORMER POSITION = 6' X 10'

EQMT/MAN ACCESS

6' X 10'

6'

10'

6'

10'

6'

10'

6'
MINIMUM SPACE REQUIREMENTS FOR
62' TRANSFORMER VAULT WITH
ACCESS ISLE WAY

ASSUMED
TRANSFORMER
POSITION = 6' X 10'

6'
10'
6'
5'
12'
6'
5'
6'
5'
6'
6'
28'
62'
62'
MINIMUM SPACE REQUIREMENTS FOR 73' TRANSFORMER VAULT WITH ACCESS OPENING FOR EACH TRANSFORMER

ASSUMED TRANSFORMER POSITION = 6' X 10'
MINIMUM SPACE REQUIREMENTS FOR 73' TRANSFORMER VAULT WITH ACCESS ISLE FOR EACH TRANSFORMER

ASSUMED TRANSFORMER POSITION = 6' X 10'

3' WIDE X 6'8" HIGH DOOR FOR PERSONNEL ACCESS ONLY REQUIRED IN SPECIFIC DESIGNS. SEE SECTION 5.37.6

8' WIDE X 8' HIGH DOOR FOR EQUIPMENT AND PERSONNEL ACCESS
CABLE TRAY IS REQUIRED ON ALL VAULTS

CABLE TRAY AT 8'6" FROM FINISHED FLOOR GRADE ALWAYS USED FOR SMUD PRIMARY. USE ON SECONDARY SIDE FOR SERVICE WIRE ONLY

SECTION A-A

PRIMARY CONDUITS (COORDINATE LOCATION WITH SMUD DESIGNER AND FIELD INSPECTOR)

SERVICE CONDUITS (COORDINATE LOCATION WITH SMUD DESIGNER AND FIELD INSPECTOR)
CABLE TRAY IS REQUIRED ON ALL VAULTS

LOCATION OF BUS DUCT SHOWN FOR ILLUSTRATION ONLY

PRIMARY CONDUITS (COORDINATE LOCATION WITH SMUD DESIGNER AND FIELD INSPECTOR)

SERVICE HEAD/CABLE TAP CAN

SECTION A-A

T001

GENERIC CABLE TRAY LAYOUT VAULT WITH 15' CEILINGS SECONDARY TO CUSTOMER SERVICE CANS
MINIMUM SPACE REQUIREMENTS FOR A TRANSFORMER VAULT WITH ACCESS OPENINGS THROUGH THE WALL

Acceptable wall locations for equipment and personnel access.

Installation direction of embedded ceiling channel:

Every 2'-0"

Typical secondary cable conduit entrance

Primary conduit must be a minimum of 7' from finished floor

Primary conduit:

6' minimum

10' maximum

Secondary conduit:

6' minimum

3' minimum

7' minimum

12'-0" minimum

15'-0" maximum

Transformer:

Primary

Secondary

Primary cable conduit entrance

Desired primary cable conduit entrance

Primary transformer

Secondary transformer

Access aisle

Profile
1. An additional pulling iron shall be in line with and level with the conduit entrance, but not closer than 18" to the ceiling.
THE PERPENDICULAR DISTANCE FROM THE CENTER LINE OF THE RUNGS TO THE NEAREST PERMANENT OBJECT ON THE CLIMBING SIDE SHALL BE NOT LESS THAN 30" FOR LADDERS WITH A PITCH OF 90 DEGREES AND 36" FOR LADDERS WITH A PITCH OF 76 DEGREES.

NOTES:
1. LADDER DESIGN AND FABRICATION SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF ANSI A14.3.
2. FABRICATOR SHALL PROVIDE STAMPED AND SIGNED CALCULATIONS BY A CALIFORNIA LICENSED PROFESSIONAL CIVIL OR STRUCTURAL ENGINEER FOR THE LADDER DESIGN AND THE LADDER ANCHORAGE DESIGN.
3. LADDER DESIGN AND ANCHORAGE SHALL BE DESIGNED FOR THE WORST CASE LOADING CONDITION, INCLUDING THE CONDITION OF LOADING APPLIED TO THE EXTENDED LADDER-UP SAFETY POST.
5. RUNGS SHALL BE 3/4" DIAMETER MINIMUM WITH AN ANTI SLIP SURFACE OF SLIP NOT GRADE 2 MEDIUM OR SMUD APPROVED EQUIVALENT.
6. RAILS SHALL BE 3/4" X 3" MINIMUM.
7. LADDERS SHALL BE ATTACHED AT TOP AND BOTTOM TO THE VAULT OR MANHOLE AND SHALL BE REMOVABLE.
8. LADDER-UP SAFETY POST SHALL BE BILCO OR SMUD APPROVED EQUIVALENT WITH 42" EXTENSION.
9. THE LADDER BOTTOM RUNG SHALL BE 14" MAXIMUM ABOVE THE VAULT OR MANHOLE FLOOR.

LADDER SPACING
NUMBERED NOTES:

1. INSTALL BURNDY TYPE YGF GROUND PLATES (OR SMUD APPROVED EQUIVALENT) Sized for 500 KCMIL conductor 3" from the wall and spaced as evenly as possible around the perimeter of the vault, not exceeding 10' distances between each ground plate. Ensure a ground plate is installed in each corner of the vault. All ground plates are to be connected to the rebar in the floor. Refer to UVA1.7 for in concrete installation and connection details, including rebar connection requirements.

2. In addition to the requirements listed in Note 1 above, four ground plates are also to be individually connected to separate ground electrode conductors in addition to the rebar connections required of all ground plates. Refer to UVA1.7 for detailed rebar connection requirements and reference UVA1.8 for possible grounding electrode configurations.

3. Install standard hex cap screws and washers (silicon bronze) on the four terminals of the ground plates, applying Burndy's PENTETROX E (or SMUD approved equivalent) on all contact surfaces on both the cap screws/washers and threaded holes of the ground plate prior to inserting the bolts.

GENERAL REQUIREMENTS:

A1.1: All connections must be available for visual inspection (by a SMUD inspector) prior to pouring the concrete floor.

A1.2: All compression connections must be made with Burndy compression tools (or a SMUD approved equivalent) and done in accordance to the manufacturer's instruction. The proper die and pressure must be used for each connector. All compression connections shall be inspected for the appropriate embossment (after installation and by a SMUD inspector), to ensure that the proper die was used.

A1.3: All connectors must be direct buried rated and of copper or tinned copper construction.

A1.4 All conductor ends shall have a minimum of 2" beyond the connector.
FIGURE A1: GROUND PLATE PLACEMENT AND SPACING DETAILS (TYPICAL)

- GROUND PLATE CONNECTED TO REBAR
- GROUND PLATE CONNECTED TO REBAR AND THE GROUNDING ELECTRODE (SEE REFERENCE UVA1.8 PAGES B-17B THROUGH B-17E FOR ALTERNATIVE GROUND PLATE TO GROUNDING ELECTRODE CONFIGURATIONS)

ALL CORNER GROUND PLATES ARE TO BE CONNECTED TO THE GROUNDING ELECTRODES (IN ADDITION TO THE REBAR CONNECTION) UNLESS THE ELECTRODES ARE CONFIGURED IN AN ALTERNATING MANNER (SEE REFERENCE UVA1.8 PAGES B-17B THROUGH B-17E FOR DETAILS) (SEE DETAILS 2 & 2A ON PAGE B-15C OF UVA1.6 AND UVA1.7 FOR INSTALLATION AND CONNECTION DETAILS)

PLAN VIEW
(NOT TO SCALE)
**FIGURE A2: GROUND PLATE PLACEMENT DETAILS (CLOSE-UP - TYPICAL)**

- Ground plate placement details (see details 2 & 2A).
- Ground plate (corner location) connected to grounding electrode (see details 2, 2A below and UVA1.7 for installation and connection details).
- Vault wall (not to scale).

**GROUND PLATE (SEE DETAILS 2 & 2A)**

- Ground plate (corner location) connected to grounding electrode.

**GROUND PLATE (CORNER LOCATION)**

- Connected to grounding electrode (see details 2, 2A below and UVA1.7 for installation and connection details).

**VAULT WALL**

- Vault wall (not to scale).

**PLAN VIEW**

- (Not to scale).

**DETAIL 2**

- Ground plate (not to scale).
- See detail 2.
- Thread protectors.
- Set plate 1/8" above top of concrete.
- 3/8" UNC double nut & washer, ASTM B98 silicon bronze.
- Positioning and anchoring rod 3/8" UNC X 5" min. ASTM B98 silicon bronze.

**DETAIL 2A**

- Ground plate (not to scale).
- UVA1.6 Approved equivalent sized for 500 kcmil.
- Burndy Type YGF or SMUD approved equivalent sized for 500 kcmil.
NUMBERED NOTES:

1. THE GROUNDING ELECTRODE(S) AND BONDING CONDUCTOR(S) SHALL BE 500 KCMI BARE CU CONDUCTOR (37 STRAND, SOFT DRAWN - ASTM B3, B6) UNLESS OTHERWISE SPECIFIED.

2. AT LEAST 20' OF THE GROUNDING ELECTRODE IS TO BE PLACED IN A COUNTERPOISED/HORIZONTAL MANNER AT LEAST 36" BELOW THE FLOOR (OR GRADE) AND AS FAR APART AS PERMISSIBLE FROM OTHER GROUNDING ELECTRODES. REFER TO REFERENCE UVA1.8 PAGES 2 THROUGH 5 FOR GROUNDING ELECTRODE LAYOUT CONFIGURATIONS. THE ENTIRE GROUNDING ELECTRODE BELOW THE FLOOR (BOTH THE HORIZONTAL AND VERTICAL PORTION) IS TO BE CONCRETE ENCASED IN AT LEAST 3" OF FULL COVER. NO INSULATING BARRIER BETWEEN THE CONCRETE AND NATIVE SOIL IS ALLOWED. SEE DETAIL 1 ON THIS REFERENCE FOR CONCRETE ENCASEMENT REQUIREMENTS. THE CONCRETE COVER CAN EXTEND TO THE FLOOR OF THE VAULT IF NECESSARY AS SHOWN IN FIGURE A3.

3. A JOINT COMPOUND WILL BE USED ON ALL CONNECTION POINTS (BURNDY'S PENETROX E OR SMUD APPROVED EQUIVALENT) THAT IS SUITABLE FOR COPPER TO COPPER OR COPPER TO STEEL CONNECTIONS. ENSURE ALL CONNECTION SURFACES ARE SMOOTH, CLEAN AND FREE OF RUST, PAINT, OR ANY OTHER NON-CONDUCTIVE MATERIAL AT THE CONNECTION POINT PRIOR TO THE APPLICATION OF THE JOINT COMPOUND. LIBERALLY APPLY THE COMPOUND ON ALL SURFACES TO BE CONNECTED.

4. COMPLETELY COAT ALL REBAR TO COPPER CONNECTORS (DETAIL 3) WITH A SMUD APPROVED, DIRECT BURIED CAPABLE SEALANT AFTER THE CONNECTION HAS BEEN MADE AND PRIOR TO POURING THE CONCRETE FLOOR. APPLY THIS SEALANT ACCORDING TO MANUFACTURER'S INSTRUCTIONS, IN ACCORDANCE TO THEIR CORROSION PROTECTION PROCEDURES.

GENERAL REQUIREMENTS:

A2.1: ALL CONNECTIONS MUST BE MADE AVAILABLE FOR VISUAL INSPECTION (BY A SMUD INSPECTOR) PRIOR TO POURING THE CONCRETE FLOOR.

A2.2: ALL EQUIPMENT OR TOOLS NOT EXPLICITLY OUTLINED IN THIS REFERENCE MUST BE APPROVED BY SMUD PRIOR TO INSTALLATION OR USE.

A2.3: ALL COMPRESSION CONNECTIONS MUST BE MADE WITH BURNDY COMPRESSION TOOLS (OR A SMUD APPROVED EQUIVALENT) AND DONE IN ACCORDANCE TO THE MANUFACTURER'S INSTRUCTION. THE PROPER DIE MUST BE USED FOR EACH CONNECTOR.

A2.4: ALL COMPRESSION CONNECTIONS SHALL BE INSPECTED FOR THE APPROPRIATE EMBOSSMENT (AFTER INSTALLATION), TO ENSURE THAT THE PROPER DIE WAS USED.

A2.5: ALL CONNECTORS MUST BE DIRECT BURIED RATED AND OF COPPER OR TINNED COPPER CONSTRUCTION.

A2.6: ALL CONDUCTOR ENDS SHALL HAVE A MINIMUM OF 2" BEYOND THE CONNECTOR.

A2.7: FOR ALL COPPER TO COPPER CONNECTIONS, LIBERALLY APPLY BURNDY'S PENETROX E (OR SMUD APPROVED EQUIVALENT) OVER THE CONNECTOR. AFTER THE CONNECTION HAS BEEN MADE, COMPLETELY ENVELOPING THE CONNECTION POINT.

A2.8: INSTALL STANDARD HEX CAP SCREWS AND WASHERS (SILICON BRONZE) ON THE FOUR TERMINALS OF THE GROUND PLATES. APPLY BURNDY'S PENETROX E (OR SMUD APPROVED EQUIVALENT) ON BOTH THE CAP SCREWS/WASHERS AND THREADED HOLES OF THE GROUND PLATE PRIOR TO INSERTING THE BOLTS.
FIGURE A3: REBAR CONNECTIONS (TYPICAL)

SEE FIGURE A4
(SEE UVA1.6 FOR SPACING DETAILS)

SEE FIGURE A5
(SEE UVA1.6 FOR SPACING DETAILS)

VAULT FLOOR (STEEL REINFORCED CONCRETE)

REINFORCING BAR
(TYPICAL)

WATER SEAL
(TYPICAL)

CONCRETE ENCASEMENT
(CAN BE POURED TO FLOOR)

MAX AVAILABLE 8' MIN

PROFILE VIEW
(NOT TO SCALE)
DETAIL 1
(CONCRETE ENCASED ELECTRODE)
(4 MINIMUM)

GROUNDING ELECTRODE:
500 KCMIL BARE CU

3" MIN.

DETAIL 2
(GROUND PLATE)
BURNDY TYPE YGF OR SMUD
APPROVED EQUIVALENT
SIZED FOR 500 KCMIL

DETAIL 2A
(GROUND PLATE)
POSITIONING DETAILS

DETAIL 3
(REBAR CONNECTION) BURNDY
TYPE YGHC-C
OR SMUD APPROVED EQUIVALENT
SIZED FOR 500 KCMIL

DETAIL 4
(CROSS CONNECTOR) BURNDY
TYPE YGL-C OR SMUD
APPROVED EQUIVALENT SIZED
FOR 500 KCMIL
FIGURE A4: REBAR CONNECTION DETAILS (TYPICAL)

GROUND PLATE (CORNER LOCATION)
(SEE DETAILS 2 & 2A)
PROFILE VIEW
(NOT TO SCALE)
CONCRETE FLOOR

BONDING CONDUCTOR

REBAR CONNECTION
(SEE DETAIL 3)

REINFORCING BAR

CROSS CONNECTOR
(SEE DETAIL 4)

POSITIONING AND
ANCHORING ROD

CONCRETE ENCASED
GROUNDING ELECTRODE

WATER SEAL
(TYPICAL)

FIGURE A5: REBAR CONNECTION DETAILS (TYPICAL)

GROUND PLATE
(SEE DETAILS 2 & 2A)
PROFILE VIEW
(NOT TO SCALE)
CONCRETE FLOOR

REINFORCING BAR

REINFORCING BAR

POSITIONING AND
ANCHORING ROD

WATER SEAL
(TYPICAL)
GENERAL REQUIREMENTS:

1. Refer to UVA1.6 for installation and connection details for these ground plates.

2. In addition to the requirements listed in Note 1 above, these four ground plates are also to be individually connected to separate concrete encased ground electrode conductors in addition to the rebar connections required of all ground plates. Refer to UVA1.7 for detailed rebar connection requirements.

LAYOUT DESCRIPTIONS:

A3.1: The looped configuration consists of the four grounding electrodes laid out front to back around the perimeter of the floor plan of the vault, with each grounding electrode connected to separate corner ground plates. Sufficient space is required to ensure at least 1' of space exists between each grounding electrode (Figure A6 and A9).

A3.2: The alternating configuration consists of four parallel grounding electrodes, equally spaced from each other, with the ground plate connections done in an alternating manner. At least two of the four corner ground plates are to be connected to the grounding electrodes and must be located in opposite corners. The remaining two grounding electrode to ground plate connection points are to be located along the interior walls as depicted in Figure A7.

A3.3: The parallel configuration consists of four grounding electrodes connected to separate corner ground plates and configured parallel to the longer wall of the vault. This configuration only works in large vaults as at least 6' of spacing is required between the ends of the two in-line electrodes (Figure A8).

GENERAL REQUIREMENTS:

- Ground plate connected to rebar as indicated in UVA1.7
- Ground plate connected to rebar and the grounding electrode as indicated in UVA1.7
- Concrete encased grounding electrode placed at least 3' below grade as indicated in UVA1.7
COUNTERPOISED/HORIZONTAL CONCRETE ENCASED ELECTRODES BURIED AT LEAST 36 INCHES BELOW GRADE.

26' TO 28' (TYPICAL)

MAX PERMISSIBLE (1" MINIMUM)

PLAN VIEW
(NOT TO SCALE)
DISTANCES BETWEEN ELECTRODES ARE TO BE AS EVENLY SPACED AS POSSIBLE
X1 = X2 = X3 (9' MINIMUM)

FIGURE A7: ALTERNATING CONFIGURATION (SEE NOTE A3.2)

TRANSFORMER

TRANSFORMER

TRANSFORMER

X1

X2

X3

20'

PLAN VIEW

(NOT TO SCALE)
FIGURE A8: PARALLEL CONFIGURATION (LARGE VAULT) (SEE NOTE A3.3)
FIGURE A9: LOOPED CONFIGURATION (LARGE VAULT) (SEE NOTE A3.1)

PLAN VIEW
(NOT TO SCALE)
MATERIAL: GRAY CAST IRON
(ASTM A-48 LATEST REVISION)
WEIGHT: APPROXIMATELY 350 LBS.
CASTING TO MEET H-20
BRIDGE LOADING

HOLE 1" DIA.
(6 LOCATIONS)

CAST LETTERS AS
DIMENSIONED AND IN
3/4" BASE-RELIEF,
FLUSH WITH SURFACE.

CAST MONTH AND YEAR
OF MANUFACTURE IN THIS
SPACE THUS: 10-79 WITH 1"
FIGURES IN 3/4" BASE-RELIEF,
FLUSH WITH SURFACE.

BOTTOM VIEW

SAP 10000344
REDRAWN FROM
ORIGINAL C-1019 REV3

STANDARD 39" DIA
STEEL MANHOLE FRAME

ENGR.
SPEC:
T001

CONSTRUCTION STANDARDS

DATE: AUG 2014

DRAWING REFERENCE# UVC1.8.1

PAGE# B-18A
6 ribs
see detail X

2 ribs with
3/4" holes
see detail Y

CAST MONTH AND YEAR OF
MANUFACTURE IN THIS SPACE
WITH 1" FIGURES
IN 3/8" BASE-RELIEF,
FLUSH WITH SURFACE.

TOP VIEW

SECTION B-B

3'-73/8"DIA.
3'-5"±1/16"
3'-4.2"±1/16"
3'-3.8"±1/16"
3'-5/8"DIA.
3'-9"DIA.
3'-10"DIA.
4'-23/8"DIA.

DETAIL X

MACHINED
SURFACE

DETAIL Y

MACHINED
SURFACE

SAP 10020405
MATERIAL: GRAY CAST IRON
(ASM A-48 LATEST REVISION)
WEIGHT: APPROXIMATELY 365 LBS.
CASTING TO MEET H-20 BRIDGE LOADING

REDRAWN FROM ORIGINAL C-1019 REV3
PLUG (REMOVABLE PLUGS DO NOT GLUE)

END BELL

FLAT TAPE PULL ROPE (2,500 LB TEST)

CONDUIT PVC SCHEDULE 40