



Electric Service Requirements

Customer-Built Vaults Engineering Specification T001

March 2025




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| | | REV. 11 | DATE: 3/25 |
| CATEGORY ELECTRIC SERVICE REQUIREMENT | | | |
| SUBJECT Customer Built Vaults | | | |

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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 California Electrical Code (CEC).
- 3.2 National Electric Code (NEC), Article 450, Transformers and Transformer vaults.
- 3.3 CAL-OSHA General Industry Safety Order #3277 – Fixed Ladders.
- 3.4 ASTM A123, Standard Specification for Zinc (Hot Dipped Galvanized) Coatings on Iron and Steel Products.
- 3.5 ASTM A153, Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
- 3.6 Metal Framing Standards Publication, No. MFMA – 4.
- 3.7 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes Type 316 – Round bar (Solid).
- 3.8 ASTM A276, Standard Specification for Stainless Steel Bars and Shapes Type 316L (If Welding is Required).

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- 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 316 – Plate.
- 3.10 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).
- 3.11 SMUD Engineering Specification, SS4001 – Structural Concrete.
- 3.12 SMUD Engineering Specification, SS0801 – Polyvinyl Chloride Electrical Conduit.
- 3.13 ASTM F512, Standard Specification for Smooth – Wall Polyvinyl Chloride (PVC) Conduit and Fittings for Underground Installation.
- 3.14 NEMA TC 6 & 8 Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
- 3.15 NEMA TC9, Fittings for Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation
- 3.16 NEMA TCB2, NEMA Guidelines for the Selection and Installation of Underground Nonmetallic Raceways
- 3.17 NEMA 250 – 3R.
- 3.18 SMUD Ground Grid UVA1.6, UVA1.7, UVA1.8
- 3.19 NEMA GR-1 Grounding Rod Electrodes and Grounding Rod Electrode Couplings. See SMUD Specification UVA1.6, UVA1.7 and UVA1.8.
- 3.20 California Fire Code and National Fire Protection Association Standards.
- 3.21 IEEE 100CD Standards Dictionary: Glossary of Terms and Definitions.
- 3.22 SMUD Commercial & Industrial Electric Service Requirements, T007, latest revision.
- 3.23 SMUD Fire Sprinkler System Specifications, latest revision.
- 3.24 ANSI/NEMA C57.12.28, Figure 1.
- 3.25 California Building Code.
- 3.26 ASHTO - Standard Specifications for Highway Bridges.

4 Definitions

Definitions are defined in IEEE 100CD and the references in section 3 of this specification.

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5 Vault Location

- 5.1 Transformer vaults shall be built on the customer's property at grade (street level) with at least one wall directly adjacent to the street or alley.
- 5.2 When a transformer vault at grade is not feasible, a transformer vault on the customer's property one-level below grade (sub-grade) can be considered pending SMUD Engineering approval.
- 5.3 If a transformer vault on the customer's property is not feasible, a transformer vault in the right-of-way (sidewalk) can be considered pending SMUD Engineering approval and approval from the appropriate jurisdiction having authority. Right-of-way feasibility is at the sole responsibility of the customer.
- 5.4 Any other location within the building requires SMUD Engineering approval.

6 Minimum Vault Dimensions

- 6.1 Vault dimensions are based on service size, service type (12 kV network or 21 kV) and location.

Table 1: In-Building Vault Location

| TOTAL PANEL SIZE (Amps) ¹ | V | SYSTEM | VAULT LOCATION | MIN. VAULT SIZE (LxWxH) (ft) | SWITCH SPACE (VISTA) (LxWxH) (ft) |
|--------------------------------------|-----|---------|----------------|------------------------------|-----------------------------------|
| 400 to 2,000 | 208 | Network | In-Building | 24 x 24 x 12 | None |
| 2,001 to 4,000 | 208 | Network | In-Building | 34 x 24 x 12 | None |
| 4,001 to 5,000 | 208 | Network | In-Building | 44 x 24 x 12 | None |
| 400 to 1,800 | 480 | Network | In-Building | 24 x 24 x 12 | None |
| 1,801 to 3,500 | 480 | Network | In-Building | 34 x 24 x 12 | None |
| 3,501 to 5,000 | 480 | Network | In-Building | 44 x 24 x 12 | None |
| 5,001 to 6,000 | 480 | Network | In-Building | 54 x 24 x 12 | None |
| 400 to 2,500 | 208 | 21 kV | In-Building | 14 x 24 x 12 | 12 x 15 x 12 |
| 2,501 to 4,000 | 208 | 21 kV | In-Building | 24 x 24 x 12 | 12 x 15 x 12 |
| 400 to 3,000 | 480 | 21 kV | In-Building | 14 x 24 x 12 | 12 x 15 x 12 |
| 3,001 to 5,000 | 480 | 21 kV | In-Building | 24 x 24 x 12 | 12 x 15 x 12 |

¹ Maximum allowable individual metering section is 4,000 Amps.

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Table 2: Below-Grade/Sidewalk Vault Location

| TOTAL PANEL SIZE (Amps) ² | V | SYSTEM | VAULT LOCATION | MIN. VAULT SIZE (LxWxH) (ft) | SWITCH SPACE (LxWxH) (ft) | # OF EQUIP. HATCHES ³ |
|--------------------------------------|-----|---------|----------------|------------------------------|---------------------------|----------------------------------|
| 400 to 2,000 | 208 | Network | Outside | 24 x 18 x 12 | None | 2 |
| 2,001 to 4,000 | 208 | Network | Outside | 34 x 18 x 12 | None | 3 |
| 4,001 to 5,000 | 208 | Network | Outside | 44 x 18 x 12 | None | 4 |
| 400 to 1,800 | 480 | Network | Outside | 24 x 18 x 12 | None | 2 |
| 1,801 to 3,500 | 480 | Network | Outside | 34 x 18 x 12 | None | 3 |
| 3,501 to 5,000 | 480 | Network | Outside | 44 x 18 x 12 | None | 4 |
| 5,001 to 6,000 | 480 | Network | Outside | 54 x 18 x 12 | None | 5 |
| 400 to 2,800 | 208 | 21 kV | Outside | 14 x 18 x 12 | 9 x 15 x 12 | 1 |
| 2,801 to 4,000 | 208 | 21 kV | Outside | 24 x 18 x 12 | 9 x 15 x 12 | 2 |
| 400 to 1,800 | 480 | 21 kV | Outside | 14 x 18 x 12 | 9 x 15 x 12 | 1 |
| 1,801 to 5,000 | 480 | 21 kV | Outside | 24 x 18 x 12 ⁴ | 9 x 15 x 12 | 2 |

- 6.2 If a service has multiple panels, each panel will require the indicated space (21 kV).
- 6.3 Multiple panels on the network can be served from a single vault provided the combined panel total meets the sizing criteria listed above, otherwise multiple vaults will be required.
- 6.4 Maximum allowable individual metering section is 4,000 Amps.
- 6.5 21 kV primary is a service option available upon request. Primary service requires SMUD Engineering approval. Primary service is NOT available on the 12 kV network system.

² Maximum allowable individual metering section is 4,000 Amps.

³ For transformers only. Excludes any personnel or hatches for switches.

⁴ Larger 21kV below-grade/sidewalk vault versus in-building vault footprint required due to natural ventilation requirements

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- 6.6 All 21 kV services may require additional switch space depending on the service size. Each switch will require additional space as noted in Tables 1 and 2 above. Please see SMUD Engineering Specification DS0608 if the switch is to be located outside of the building in a below grade (vault)⁴. Please consult with SMUD Engineering to determine if a switch is necessary.
- 6.7 Please see Drawings UVA1.1A and UVA1.1B for general illustrations and spacing requirements.
- 6.8 ***Indicated space requirements are minimums.*** Variances to any of the dimensions or configurations require SMUD Engineering approval.

7 Vault Design

- 7.1 General Design Requirements
 - 7.1.1 The vault's design 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.
 - 7.1.2 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, not explicitly stated here, may be required by SMUD for review.
 - 7.1.3 This specification is not intended to completely satisfy all responsibilities and obligations of the customer for SMUD electrical service.
 - 7.1.4 The vault design shall be in accordance with CEC and NEC Article 450.
 - 7.1.5 The customer shall furnish all material, resources and labor as required to engineer, design, and construct the vault except as noted in Section 7.29 Materials Furnished and Installed by SMUD.
 - 7.1.6 All materials utilized for construction shall be new. Reclaimed, recycled, or reconstituted material shall not be accepted under any circumstances.


⁴ Requires either an easement if on property or an encroachment permit if in road right-of-way. Any off-property switch will also require SMUD approval.

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- 7.1.7 All concrete used for construction of the vault shall meet or exceed SMUD Specification SS4001 (Structural Concrete). Concrete of higher strength values shall be used when determined appropriate by the engineer of record having jurisdiction.
- 7.1.8 All vaults exposed to weather (e.g., Sidewalk Vaults) 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.
- 7.1.9 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.
- 7.1.10 It is the customer's sole responsibility to ensure that water does not enter the building or service entrance equipment from the vault space.
- 7.1.11 Should the customer request use of material/components that are of a non-pre-approved nature, the customer shall submit 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.
- 7.1.12 All anchors to support mechanical or electrical components shall be stainless steel type 316, or hot dipped galvanized.
- 7.2 Equipment Access
 - 7.2.1 At grade in-building vaults shall have at least one equipment access opening on the outside wall of the vault along the sidewalk or alley in a location that is accessible to SMUD vehicles, equipment, and personnel.
 - 7.2.1.1 All equipment access shall be sized to accommodate the installation, maintenance, and removal of any installed electrical equipment.
 - 7.2.1.2 Equipment access opening shall be at least 7'Wx8'H unless directed otherwise by SMUD Engineering.
 - 7.2.1.3 All equipment access openings shall be clear of any overhead obstructions or obstacles that would prevent the use of a crane for equipment installation.

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- 7.2.1.4 All equipment access opening door(s) shall comply with Sections 7.5 Containment and 7.15 Fire Protection.
- 7.2.1.5 The door(s) shall be auto closing, have a panic bar and shall open outward from the vault.
- 7.2.1.6 The door shall be keyed to a SMUD “HA1” key. SMUD Building Maintenance to supply and install HA1 lock. Customer to coordinate with SMUD Inspector and provide a reasonable amount of notice to allow for material procurement.
- 7.2.1.7 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.”
- 7.2.1.8 All equipment 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.
- 7.2.1.9 This opening shall be at the opposite end of any personnel door (see Section 7.3 Personnel Access) to the vault. Please see UVA1.1A for additional information.
- 7.2.2 Below-grade in-building vaults shall have at least one at grade equipment access opening.
 - 7.2.2.1 Equipment access opening shall be located on the customer’s property.
 - 7.2.2.2 If the equipment access opening cannot be placed on the customer’s property, a location in the sidewalk area of the road right-of-way is acceptable upon SMUD Engineering approval. Right-of-way feasibility and approval is the sole responsibility of the customer.
 - 7.2.2.3 The equipment access opening shall be grated or a removable solid plug opening at least 10'x6' in size unless directed otherwise by SMUD Engineering. Please note that solid openings cannot be considered as part of any ventilation requirements for the vault (see Section 7.14 Ventilation).
 - 7.2.2.4 The equipment access opening location shall not be directly over the transformer area. Please see UVA1.1A for additional information or consult SMUD Engineering for acceptable locations.

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- 7.2.2.5 The equipment access opening shall be designed for AASHTO H-20 full traffic plus 30% impact loading for any location within the road right-of-way or if the hatch location is accessible to any vehicular traffic, this includes all sidewalk locations.
- 7.2.2.6 If the equipment access opening is a grate with personnel access, the grate shall have a built-in personnel entry hatch 3 feet long and the width of the equipment grate (6 feet) with a fixed ladder (see Section 7.4 Ladders and UVA1.5). The opening shall not exceed 37" long when the hatch is locked open to accommodate rescue equipment.
- 7.2.2.6.1 The personnel hatch shall be hinged, and torsion assisted with a maximum 35 lbs. of lifting force and open and lock 100 degrees from horizontal with 180 degree lay back capable. Shock strut hinges should not be used.
- 7.2.2.6.2 The hatch shall be securable with a penta head bolts per ANSI/NEMA C57.12.28, Figure 1 and lockable with a recessed covered SMUD Padlock.
- 7.2.2.6.3 The hatch shall be designed for AASHTO H-20 full traffic plus 30% impact loading for any location within the road right-of-way or if the hatch location is accessible to any vehicular traffic. For sidewalk and landscape locations hatch shall be designed for AASHTO H-20 full traffic without impact.
- 7.2.2.6.4 The hatch shall be non-slip coated with SlipNOT (or SMUD-approved equivalent) and A.D.A. compliant and heel safe with a clear grate spacing not to exceed 5/16".
- 7.2.2.6.5 All steel shall be hot-dipped galvanized or type-316 stainless steel at a minimum.
- 7.2.2.7 If the equipment access opening is a removable solid-plug design, a 39" diameter steel round East Jordan (EJ) cover and frame shall be incorporated into the solid plug for personnel access. Part # 00341643A01 or SMUD approved equivalent. Set frame with 6# x 12" minimum radial rods. Refer to Section 7.2.7 & 7.2.9 for additional requirements.
- 7.2.3 Below-grade outside vaults (e.g., sidewalk) shall have at grade equipment access openings as outlined in the Table found in Section 6.1 (# of Equip. Hatches).

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- 7.2.3.1 The equipment access openings shall be a grated design at least 10'x6' in size unless directed otherwise by SMUD Engineering.
- 7.2.3.2 All equipment access opening locations and configurations must be approved by SMUD Engineering. Please see UVA1.1B for typical equipment access opening locations and configurations.
- 7.2.3.3 The two-end equipment access opening grates shall have a built-in personnel entry hatch at least 3 feet deep and the width of the equipment hatch (6 feet), refer to section 7.2.2.6, with a fixed ladder (see Section 7.4 Ladders and UVA1.5).
- 7.2.3.4 The two-end equipment access openings shall be spaced no more than two (2) feet from the inner vault wall (See UVA1-1B).
- 7.2.3.5 All openings shall be spaced as far apart from each other as permissible.
- 7.2.3.6 All equipment access opening grates shall be designed for AASHTO H-20 full traffic plus 30% impact loading for any location within the road right-of-way or if the location is accessible to any vehicular traffic. For sidewalk and landscape locations hatch and grate shall be designed for AASHTO H-20 full traffic without impact.
- 7.2.4 Grated equipment access openings shall not be located below or adjacent to building air intakes, windows that open and are operable, overhangs, canopies, doorways, entrance ways or ingress/egress routes.
- 7.2.5 Equipment access openings shall not be located in areas exposed to routine traffic (i.e., driveways, parking lot entrances, etc.).
- 7.2.6 All equipment access openings shall be securable with Penta head bolts per ANSI/NEMA C57.12.28, figure 1.
- 7.2.7 All equipment access opening grates shall include recessed/flush lifting points to facilitate installation and removal of the grate or plug using 5/8" – 11 UNC eyebolts or lifting hardware. Equipment access openings with solid plugs shall include 3/4" coil nuts with 3"x3"x1/4" min plate washer at the bottom of the slab and 3/4" schedule 40 pipe to top of surface for lifting. Customer to verify lifting hardware design is adequate for plug design.

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- 7.2.8 All equipment access openings 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 equivalent.
- 7.2.9 All equipment access 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 7.1 of this Specification.
- 7.2.10 All equipment access grates shall be lift-out, banded, welded, hot dipped galvanized steel or type-316 stainless steel.
- 7.3 Personnel Access
 - 7.3.1 The vault shall have a minimum of two personnel access openings, located at the opposite ends of the vault.
 - 7.3.2 At grade or below grade in-building vaults shall have the following requirements:
 - 7.3.2.1 At least two doors are needed at the opposite ends of the vault.
 - 7.3.2.2 Any personnel access door shall be at least 3' W x 6'8" H in size and shall be auto closing, have a panic bar and shall open outward from the vault.
 - 7.3.2.3 An equipment access opening can fulfill part of this requirement provided it is placed at the opposite end of the vault to the personnel access door (see Sections 7.2.1 and 7.2.2 Equipment Access) and can be used as a personnel access point.
 - 7.3.2.4 The door shall be keyed to a SMUD "HA1" key. SMUD Building Maintenance to supply and install HA1 lock. Customer to coordinate with SMUD Inspector and provide a reasonable amount of notice to allow for material procurement.
 - 7.3.2.5 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."
 - 7.3.2.6 All personnel access doors shall comply with Section 7.5 Containment and Section 7.15 Fire Protection.
 - 7.3.3 Please see Section 7.2.3 (Below Grade Sidewalk Vault Equipment Access) for personnel access requirements for below grade sidewalk vaults.

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7.3.4 If a separate/dedicated personnel hatch is needed to fulfill the requirements of 7.3.1, this hatch must meet the following criteria:

7.3.4.1 Any dedicated personnel hatch must be at least 42x48 inches in dimensions, through the roof the vault and located at the opposite end of the vault to the other personnel entry hatch.

7.3.4.2 Meet all requirements listed in 7.2.2.6

7.3.5 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.

7.4 Ladders

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

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

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

7.4.4 The ladders shall be manufactured and installed in accordance with SMUD's drawing UVA1.5.

7.4.6 Ladders shall be designed for the worst-case loading scenario of either a 350lb point load located anywhere along the ladder or the design loading specified in CAL-OSHA General Industry Safety Order #3277.

7.4.7 The ladder shall be designed by a currently licensed California Civil (or Structural) Engineer and calculations for the ladder and ladder anchorage shall be submitted to SMUD.

7.5 Containment

7.5.1 All conduits or other penetrations into the vault (especially for conduit floor penetrations) shall be designed to maintain the oil-containment requirements of the vault space if applicable. Please see 7.21.5 for additional information.

7.5.2 All equipment or personnel access doors shall have fluid-containment curbing installed.

7.5.2.1 The height of the curb shall be dependent on the oil volume requirements of any vault equipment but shall not be less than 6".

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- 7.5.2.2 Additionally, when required by the Authority Having Jurisdiction, the curb height may be required to accommodate up to twenty minutes of water from the fire-suppression system (please contact the pertinent governing authority for additional information and requirements).
- 7.5.2.3 The curbing shall be removable by simple hand tools by a single person and still be watertight and withstand any pressures that could be generated as a result of any fire-suppression discharge.
- 7.5.2.4 All containment curbs shall be painted red.
- 7.5.3 All vaults housing equipment with a total oil volume capacity equal to or greater than 1,320 gallons of oil (equipment or containers storing less than 55 gallons of oil are not counted towards the total) shall have a secondary fluid containment installed in accordance with Title 40 Part 112 of the Code of Federal Regulations.
 - 7.5.3.1 The secondary containment must be able to accommodate the oil capacity of the largest oil-volume piece of equipment in the vault plus the larger of the following Freeboard:
 - 7.5.3.2 When the vault is below grade with grated openings, precipitation from a 25-year, 24-hour storm.
 - 7.5.3.3 Any fire-suppression discharge (if required by the Authority Having Jurisdiction).
 - 7.5.3.4 Refer to Section 7.11.11 for pumps used in vaults where secondary containment is required.
- 7.6 Transformer Vault Accessibility
 - 7.6.1 SMUD requires immediate and unimpeded personnel and equipment access to all vault entrances 24 hours a day without exception.
 - 7.6.2 The customer shall maintain and facilitate a clear, unimpeded access for delivery, installation, replacement or maintenance of SMUD's equipment and materials.
 - 7.6.3 Once SMUD has accepted the vault, sole access to the vault shall be controlled exclusively by SMUD.
 - 7.6.4 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.

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7.7 Walls

- 7.7.1 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.
- 7.7.2 The vault walls shall be designed to withstand all pressures that could be generated by a fire suppression system discharge.
- 7.7.3 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.

7.8 Ceiling

- 7.8.1 The vault depth shall be such that a minimum of 10' 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. The height of cable tray above finished floor (F.F.) grade will be determined by Network Personnel, 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 Engineering.

- 7.8.2 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.

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7.8.3 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's recommendations.

7.9 Floor

7.9.1 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.

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

7.9.3 Design and construct floor to support equipment weight plus an additional 50% to account for replacement equipment weight increases. SMUD to provide transformer equipment specifications, weight and base dimensions, to the customer.

7.10 Floor Drains

7.10.1 Floor drains, external to the vault, of any type are specifically prohibited from running in, through or traversing the vault.

7.11 Sump Pits

7.11.1 Sump pits are only required in below-grade vaults, or as required as part of the fire protection drainage requirements of Sec. 7.15.3.7, or as directed by SMUD Engineering.

7.11.2 A minimum of two sump pits are necessary for vaults required to have sump pits. Each sump pit shall have a pump per Section 7.11.9 or 7.11.11. 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.

7.11.3 The sump pits shall be 12"W x 24"L x 18"D. Customer to verify sump pit size can accommodate sump pump. 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.

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

7.11.5 Each pump shall have a separate discharge line. A single 2" schedule 40 PVC water pipe shall be utilized as a discharge line. The pipe shall start 3" above the sumps bottom.

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- 7.11.6 The discharge line shall typically be routed to face of curb (F.O.C.).
 - 7.11.6.1 Discharge lines shall not be routed through, across or traverse any building footprint.
- 7.11.7 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.
- 7.11.8 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.
- 7.11.9 The customer shall supply all sump pumps. The customer shall utilize the Stancor Pump, Model SS-50A for the non-oil minder type pumps, or a SMUD approved equivalent.
- 7.11.10 In general, a drain vent will not be required.
- 7.11.11 For all vault locations that require secondary fluid containment per section 7.5.3 and that requires a sump pump or as required per Sec. 7.15.3.7, the sump pump shall have oil sensors (oil minders) such as the Stancor II Control System (115V-TSE50/SW1151SMUD) and SS-50 Sump Pump or SMUD approved equivalent.
- 7.12 Vault Ground Grid
 - 7.12.1 Refer to supplemental grounding information: UVA1.6, UVA1.7 and UVA 1.8.
 - 7.12.2 All conductors utilized for the ground grid shall be 500kcmil copper conductors unless approved otherwise by SMUD Engineering.
 - 7.12.3 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. Total ground resistance shall not exceed 5-ohms upon the ufers being connected to the grid.
 - 7.12.4 Should ground resistance of 5-ohms be exceeded, the customer shall consult with SMUD Engineering for resolution.
 - 7.12.5 Please contact SMUD Engineering for any vault that is not built directly on native soil for site-specific grounding requirements.

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7.12.6 Sidewalk vaults can use ground rods in lieu of the grounding requirements outlined in the supplemental section. Ground rods shall be 5/8" diameter x 8 ft in length Copper-clad and shall be placed in the four corners of the vault and every ten feet along the length and width of the vault.

7.12.7 All grounding installations shall be done in the presence of a SMUD inspector.

7.12.8 Any variances to the above-listed grounding requirements requires SMUD Engineering approval.

7.13 Water Proofing

7.13.1 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)


7.13.2 Provide water proofing submittal or methodology to SMUD Designer for approval.

7.14 Ventilation/Cooling System

7.14.1 The ventilation/cooling system shall be provided to dispose of heat from the transformer total losses without creating a room temperature exceeding 85°F or the maximum allowed transformer rating, whichever is less.

7.14.1.1 Submit calculations clearly identifying parameters, assumptions, and methodology for the design of the ventilation/cooling system for SMUD engineering review, confirming the basis of selected airflow, minimum ventilation CFM, and the temperature of the room will not exceed 85°F or the maximum allowed transformer rating, whichever is less.

7.14.2 The customer is responsible for maintaining all aspects of the vault ventilation/cooling system to ensure proper and continued operation. Should, upon SMUD inspection, if a component(s) of the ventilation/cooling system is deemed not operable, the customer shall make repairs as necessary in a timely manner to ensure safe and continued operation. It is at SMUD's discretion to remove any transformer(s) from service should SMUD determine the space is consistently greater than 85°F or the transformer(s) are operating above their temperature rating.

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- 7.14.3 Ventilation/cooling system shall meet all building code requirements for occupied spaces and be sufficient for transformer cooling (CEC 450.9/450.45 etc.). The ventilation/cooling system design shall be reviewed by SMUD Engineering.
- 7.14.4 Road right-of-way/sidewalk vaults have the option of using natural ventilation or mechanical ventilation/cooling system.
- 7.14.5 Any vault that has mechanical ventilation/cooling system shall not have a grated equipment opening.
- 7.14.6 Minimum natural and forced ventilation requirements can be found on drawing B-22 Ventilation Guidelines.
- 7.14.7 Mechanical Ventilation/Cooling System
 - 7.14.7.1 A mechanical ventilation/cooling system shall be designed to maintain a maximum vault air temperature not to exceed 85°F with an assumed outside ambient air temperature of 118°F.
 - 7.14.7.2 The mechanical ventilation/cooling system shall also account for any other forms of heat load within the vault, such as equipment and minimum ventilation.
 - 7.14.7.3 The mechanical ventilation/cooling system can be recirculating and shall provide a minimum of 0.05 CFM/ft² of ventilation air.
 - 7.14.7.4 Any fans for the ventilation/cooling systems shall be direct-drive and Air Movement and Control Association (AMCA) Type A or B spark resistance with an explosion-proof motor. The outside condensing unit does not require an explosion proof motor if there is no air exchange with the vault.
 - 7.14.7.5 The mechanical ventilation/cooling system shall be completely dedicated and shall not share any supply or exhaust from the building space conditioning systems.
 - 7.14.7.6 The mechanical ventilation/cooling system shall be controlled via a thermostat(s) inside the vault located within three (3) feet of a personnel access door, at least five (5) feet above the finished floor
 - 7.14.7.7 The mechanical ventilation/ cooling system, via thermostat(s), shall activate at 85 °F and shutoff at temperatures below 70 °F.
 - 7.14.7.8 A means of manually controlling the ventilation/cooling system shall be provided inside the vault.

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- 7.14.7.9 Intake and return vents for any recirculating cooling system shall be located on the opposite ends of the vault and shall be installed with the supply provided low and return/exhaust provided high, across the transformers. Exceptions to this may be granted pending SMUD approval.
- 7.14.7.10 Any external exhaust outlets shall not be located below or adjacent to building air intakes, windows that open and are operable, overhangs, canopies, doorways, entrance ways or ingress/egress routes. Please consult with the jurisdiction having authority for additional requirements.
- 7.14.7.11 Ventilation openings shall be covered with durable gratings and screens to prevent bird or rodent intrusion.
- 7.14.7.12 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. Pending SMUD approval, only fire dampers are required when the ventilation opening is directly to the exterior of the building.
- 7.14.7.13 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.
- 7.14.7.14 The ventilation system balance diagram showing designed inlet capacity, maximum inlet temperatures, duct sizes, ventilation placement, and CFM shall be submitted to SMUD Engineering for review.
- 7.14.7.15 The ventilation/cooling system shall be connected to the local building management system (BMS) to notify of operational alarms or faults. Submit the control documents and sequence of operations to SMUD Engineering for review.
- 7.14.7.15.1 After installation and operation, any cooling/ventilation system issues are to be addressed immediately and SMUD notified, as needed.
- 7.14.7.16 HVAC Systems that utilize flammable refrigerants:
 - 7.14.7.16.1 Systems shall be placed outside when feasible and designed to minimize the amount of refrigerant required.

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7.14.7.16.2 When systems are used indoors leak detection and sufficient ventilation shall be provided to prevent concentrations of flammable gas from reaching 25% of the LEL.

7.14.7.16.3 If systems go through more than two floors, they must be in fire-rated, ventilated shafts.

7.14.7.16.4 Systems must have labels indicating that they use a flammable refrigerant.

7.14.8 Mechanical Equipment Support Requirements

All materials supporting mechanical equipment, including concrete attachment, shall be compliant with SMUD requirements.

7.14.9 Natural Ventilation

7.14.9.1 Natural ventilation is only acceptable for road right-of-way/sidewalk vault locations with a grated equipment opening, and is approved by SMUD Engineering.

7.14.9.2 Please see drawing B-22 and consult with SMUD Engineering to determine the minimum KVA requirement as it pertains to the ventilation.

7.14.9.3 Please follow all other requirements for grated equipment openings as listed in Section 7.2 (Equipment Access).

7.15 Fire-Protection Requirements

7.15.1 There are two options for fire protection. The customer shall meet all requirements in either option pursuant to the jurisdiction having authority.

7.15.2 Option 1:

7.15.2.1 Meeting Vault requirements as outlined in CEC 450 Part 3.

7.15.2.2 3-hour fire resistance for walls, roofs and floors.

7.15.2.3 Solid doors with 3-hour fire resistance rating.

7.15.2.4 6" minimum removable door sill for fluid containment. See 7.5.4 for additional requirements.

7.15.2.5 Ventilation per CEC 450.9/450.45.

7.15.2.6 No SMUD required clearances to openings around vault door(s).

7.15.2.7 SMUD required clearances for installation, operation, and maintenance of units.

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7.15.3 Option 2:

- 7.15.3.1 Fire-suppression system (see 7.15.4).
- 7.15.3.2 Installation of units with FM rated less-flammable fluids.
- 7.15.3.3 1-hour fire resistance rating for walls, roofs and floors.
- 7.15.3.4 Solid doors with 1-hour fire resistance rating.
- 7.15.3.5 6" minimum removable door sill for fluid containment. See 7.5.4 for additional requirements.
- 7.15.3.6 Ventilation per CEC 450.9/450.45.
- 7.15.3.7 Provide drainage design sized to the anticipated fire suppression flow. The design should incorporate an oil minder pump per Sec. 7.11.11 and discharge to the sewer.
- 7.15.3.8 No SMUD required clearances to openings around vault door(s).
- 7.15.3.9 SMUD required clearances for installation, operation and maintenance of units.

7.15.4 Fire-Suppression System: In accordance with section 10.1.1, SMUD provides in these specifications (specifically section 7.15) its preferred methods for fire suppression. We provide no guidance on complying with applicable OSHA standards, Fire Department, and other local authority specifications. We merely provide what we believe are the safest vault specifications as it relates to fire suppression. If a fire suppression system is installed due to requirements by the local authority having jurisdiction, the desire of the owner, or to meet 7.15.3 (Option 2), SMUD prefers the fire suppression system be a pre-action fire sprinkler designed in accordance with section 7.15.5, or a wet fire sprinkler system in lieu of a pre-action fire sprinkler system only if all criteria of section 7.15.6 are met. While SMUD believes these types of fire suppression are most effective in fighting transformer fires, alternatives as required by the local AHJ or regulations will be considered as an option. The local AHJ and SMUD shall approve the design of any fire-suppression system prior to the delivery of the transformer.

7.15.5 Pre-action fire sprinklers

- 7.15.5.1 Pre-action fire sprinklers shall be double interlock.
- 7.15.5.2 All associated detection shall be heat type detectors.
- 7.15.5.3 The sprinkler heads are to be intermediate temperature rated and standard response.

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7.15.5.4 The sprinkler heads are to have a minimum k-factor of 8.0

7.15.5.5 The design density for the vault is to be a minimum of 0.30 gpm/sf.

7.15.5.6 Sprinkler heads are to be protected with listed guards.

7.15.5.7 Penetrations shall be sealed with an approved fire stopping system.

7.15.6 Wet fire sprinklers

7.15.6.1 Sprinkler piping is not to run directly above the transformer and associated wiring and is to be located as far to the rear or the side of the vault as possible.

7.15.6.2 The sprinkler heads are to be intermediate temperature rated and standard response.

7.15.6.3 The sprinkler heads shall have a minimum k-factor of 8.0

7.15.6.4 The design density for the vault is to be a minimum of 0.30 gpm/sf.

7.15.6.5 Sprinkler heads are to be protected with listed guards.

7.15.6.6 A single control valve that controls the water supply to all sprinkler heads protecting vault shall be provided and located in the vault, to the rear, and easily visible and accessible to personnel without the use of a ladder or other tool.


7.15.6.7 A tamper switch connected to the building's fire alarm or sprinkler monitoring system shall be provided on the control valve.

7.15.6.8 Penetrations shall be sealed with an approved fire stopping system.

7.16 Service Connections

7.16.1 All in-building vaults can use busway or busway cable tap boxes (cable wall flange) to connect the vault to the customer's service entrance equipment. Service cables can be used for in-building vaults with SMUD Engineering approval. Please see drawings UVA1.1C, D, and E for typical examples.

7.16.2 All road right-of-way/sidewalk vaults and/or vaults subject to flooding shall use service cables to connect the vault to the customer's service entrance equipment. Please see drawing UVA1.1E for typical examples.

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- 7.16.3 All busway and busway cable tap box(es) shall meet or exceed NEMA 3R.
- 7.16.4 Orientation of the transformers and secondary connections will be dependent on the vault exit locations. The secondary side will always face or be closer to any vault exit. Any customer service connection will need to take this into consideration for service entrance location.
- 7.16.5 The location, height and disposition of any busway, busway cable tap box(es) or service entrance cables is vault/site specific and shall be designed and located in conjunction with SMUD Engineering and the Downtown Network Group.
- 7.16.6 Busway cable tap boxes shall be enclosed on 5-sides with the bottom to remain open and accessible.
- 7.16.7 All sides of the busway cable tap box shall be removable.
- 7.16.8 Any jagged or sharp edges shall be protected via a shock absorbent bushing that will prevent injury.
- 7.16.9 Cable tap boxes shall accept a minimum of 10-runs of stranded 500kcmil copper conductor per phase and/or be sufficient to accommodate enough cables per the NEC to meet the service panel requirements.
- 7.16.10 Cable tap box(es) shall accept NEMA 2-hole compression type lugs (paddles). Set-screw connections shall not be accepted.
- 7.16.11 Busway penetrations shall comply with this specification and meet all applicable fire protection requirements.
- 7.17 Service Conductors
 - 7.17.1 Service conductors, if used for the service connection, shall be stranded 500kcmil copper conductor.
 - 7.17.2 SMUD's Designer will review the number of runs of conductor to be connected in the transformer vault.
 - 7.17.3 Coordinate the excess length of conductor required inside the vault with SMUD's Inspector.
 - 7.17.4 The service conductors shall be as close as practicable in length.
 - 7.17.5 SMUD will provide the terminations inside the vault. Wire shall be "landed" via NEMA 2-Hole, long barrel type compression lugs (paddles).
 - 7.17.6 Customer service conductors are supplied by the customer.
- 7.18 Cable Tray

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- 7.18.1 Cable tray, if applicable and/or required, shall be Cooper B-Line, aluminum, or SMUD-approved equivalent.
- 7.18.2 Cable tray shall be designed to accommodate and support 125% of specific and size and weight of cable (both customer and SMUD cable). Cable will be specified by SMUD during the design stage. This quantity of cable shall be based on the vault's full build-out potential. Cable tray design shall be per the NEC.
- 7.18.3 Cable tray shall be seismically braced for the Sacramento region. Bracing shall assume design loading of the cable tray or as practical engineering guidelines call for; the most restrictive standard shall apply.
- 7.18.4 The customer shall supply all parts, resources and engineering involved with designing and installation of the cable tray system and provide structural calculations to SMUD for the cable tray trapeze design and anchorage and provide cable tray layout drawings and elevations.
- 7.18.5 Cable tray height is typically 8.5 ft from the F.F grade. However, the specific heights to be determined on a case-by-case basis and dictated by the overall vault design.
- 7.18.6 The cable tray shall be bonded and grounded to the vault ground ring. Cable tray bond/ground points shall be attached every five (5) feet along the cable tray.
- 7.18.7 All cables trays not mechanically and electrically continuous shall be bonded together per the NEC 250.
- 7.19 Structural Framing Channel (Unistrut)
 - 7.19.1 All structural framing channel shall be type-316 stainless steel, or better.
 - 7.19.2 All structural framing channel shall conform to Metal Framing Manufacturers Association Standard No. MFMA – 4, or better.
 - 7.19.3 Concrete embedded channel (Unistrut) is the preferred construction method and shall be 1-3/8" x 1-5/8" 12 gauge, Unistrut P3200 Concrete Inserts type-316 stainless steel or better, or a SMUD approved equivalent. All channel shall be installed so that the lip of the channel is flush with the wall surface.
 - 7.19.4 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 1-5/8" x 1-5/8" 12 gauge, Unistrut P1000 Channel type-316 stainless steel or better, or a SMUD approved equivalent.

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- 7.19.5 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. Channels on the ceiling are intended for the attachment of cable tray supports and braces. Refer to UVA1.3 for structural channel locations.
- 7.19.6 Wall mounted channel shall start at 4' above finished floor grade and be placed every 3' on center thereafter to the ceiling.
- 7.19.7 In general, all channel shall terminate 18" clear of any obstruction or wall.
- 7.19.8 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.
- 7.20 Pulling Irons
- 7.20.1 Pulling irons shall be type-316 stainless steel or better and embedded in concrete.
- 7.20.2 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 8 of this Specification.
- 7.20.3 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 1/2" shackle.
- 7.20.4 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. Additional pulling iron(s) shall be located on the wall(s) opposite all ductbank entrance(s) and in line with centerline of the ductbank.

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- 7.20.5 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.
- 7.20.6 Inspection of Pulling Irons is required prior to forming and placing concrete.
- 7.20.7 No customer infrastructure or equipment shall block use of the installed pulling iron.
- 7.21 Conduits (Primary and Secondary)
 - 7.21.1 The customer shall furnish and install all conduits/ducts that are required pursuant to SMUD's Commitment package.
 - 7.21.2 All conduits shall comply with SMUD Specification SS0801.
 - 7.21.3 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.
 - 7.21.4 For all sidewalk vaults or vaults subject to flooding, the customer shall utilize stranded 500kcmil copper conductors for their service conductors and service connections. The size and number of conduits shall be pursuant to local agency requirements for this type of service conductor. The customer shall verify the proposed wire is compatible with SMUD connectors.
 - 7.21.5 All conduits or other penetrations into the vault (especially for conduit floor penetrations) shall be designed to maintain the oil-containment requirements of the vault space and to prevent water intrusion into the vault from the connected subsurface manhole. The minimum height above finished floor grade shall be at least one (1) foot, encased in at least three (3) inches of concrete. Actual height will be dictated by oil containment and/or water intrusion prevention, whichever is higher or as required by SMUD Engineering.
 - 7.21.6 All secondary conduits for service connections (if applicable) shall be sealed by the customer, after the conduits have been inspected and cable installed. Sealing shall be for the purposes of stopping water, smoke, and fire.
 - 7.21.7 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.
 - 7.21.8 Intermediate pullboxes in the secondary service run shall not be allowed.
 - 7.21.9 All conduit(s) shall achieve a minimum of 3" of concrete encasement.

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- 7.21.10 The customer shall consult with SMUD Engineering and the Downtown Network Group for locations in which the primary and secondary conduits shall penetrate the vault walls.
- 7.21.11 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.
- 7.21.12 All Polyvinyl Chloride (PVC) conduits shall meet or exceed DB 120, gray in accordance with the latest revisions of ASTM F512 and NEMA TC6.
- 7.21.13 Any manufactured elbow shall meet or exceed Schedule 40, one-piece gray in color with an integral bell end.
- 7.21.14 All conduit fittings shall conform to ASTM F512 and NEMA TC9.
- 7.21.15 End bells shall be solid, one-piece, PVC and gray in color. End bells shall meet or exceed Schedule 40.
- 7.21.16 Plugs shall be utilized in every conduit. Conduit plugs shall be tapered and for the appropriate size of conduit.
- 7.22 Conduit System Installation (Ductbank)
 - 7.22.1 All conduits to be conveyed to SMUD shall be installed in accordance with NEMA TCB2 and all applicable SMUD Specifications.
 - 7.22.2 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:
 - 7.22.2.1 The start time of each pull
 - 7.22.2.2 The stop time of each pull
 - 7.22.2.3 The size of mandrel that was pulled
 - 7.22.2.4 The length of each pull
 - 7.22.2.5 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).
 - 7.22.2.6 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).

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- 7.22.2.7 The manhole, pullbox or vault number for the start of each test (SMUD's Inspector will provide this information).
- 7.22.2.8 The manhole, pullbox or vault number for the end of each test (SMUD's Inspector will provide this information).
- 7.22.2.9 The location of each conduit (i.e. west wall).
- 7.22.2.10 SMUD's Inspector will initial and date/time stamp each pull upon successful testing.
- 7.22.3 A steel brush shall not be used in the conduit.
- 7.22.4 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.
- 7.22.5 All secondary conduits shall be installed and fire sealed pursuant to this specification and all applicable requirements.
- 7.23 Pull Tape (Pull Rope)
 - 7.23.1 Inspection of Pull Tape (Pull Rope) is required prior to installing.
 - 7.23.2 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.
 - 7.23.3 Knots in the pull rope are not acceptable.
 - 7.23.4 The pull rope shall be tied to the end of the tapered conduit plug.
 - 7.23.5 The pull rope shall be made of polyester, be lubricated and printed with footage markings or Kevlar and printed with footage markings.
 - 7.23.6 The pull rope shall achieve a minimum tensile strength of 2500lbs.
 - 7.23.7 Reclaimed rope shall not be accepted.
- 7.24 Lighting
 - 7.24.1 For all in-building vaults, 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 Iso-foot-candle plot) that demonstrates lighting to all areas of the vault. Shadows in any portion of the vault are strictly prohibited.

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The lighting diagram shall account for all obstructions that will be in the vault (i.e., cable tray, HVAC, etc.).

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

7.25 Receptacles

7.25.1 A minimum of two receptacles shall be provided (In addition to dedicated outlets for any 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.

7.25.2 Outlets shall be GFCI protected, dedicated exclusively to vault power and clearly identified in the customer's panel as follows: "SMUD Vault Power".

7.25.3 All conduits, outlets, piping, wiring, apparatus, and associated hardware shall be rated and UL Listed for use in a "Wet" environment.

7.26 Sound Insulation

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

7.27 Foreign Objects

7.27.1 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.

7.28 Identification

7.28.1 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
- Design Floor Load

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- Vault Number (To be supplied by SMUD's Inspector)

7.28.2 The lettering shall be engraved and a minimum of .40" high.

7.29 Material Furnished and installed by SMUD

7.29.1 All material in accordance with Rule and Regulation 16.

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

7.29.3 Secondary cable from the transformer to cable tap boxes or cable bus (see 7.16).

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

7.29.5 Padlock(s) and doorway cylinder.

8 Inspection

8.1 SMUD will provide an Inspector who will be the line of communication between the Customer and SMUD during construction.

8.2 The hours of work for the Inspector are from 8:00 A.M. to 3:00 P.M., Monday through Friday. All work requiring the presence of the Inspector shall be scheduled during these hours. Advanced notice of two (2) full working days shall be given to the Inspector for all work to be inspected, or as agreed between the customer and the inspector.

8.3 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 has reviewed and accepted the vault construction plans.

8.4 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.

8.5 All material and work shall be subject to inspection, examination, and testing by SMUD, at any time during manufacture, installation, or construction. The Customer shall provide and maintain proper facilities and safe access for such inspections or testing. The costs of all tests required under this inspection will be paid by the Customer.

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- 8.6 SMUD reserves the right to reject defective materials and or workmanship that in its sole opinion does not comply with the reviewed plans. Furthermore, SMUD reserves the right to reject any material or workmanship that it determines to be insufficient or deficient for any reason.
- 8.7 Failure of the Customer to adhere to the inspection provisions outlined in this document may result in the Customer being required, at his/her expense, to remove, uncover, or otherwise enable inspection of such work by the Inspector.
- 8.8 Rejected work may result in delaying electric service until these inadequacies are corrected. The costs of correcting rejected work shall be paid by the Customer.
- 8.9 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 addition to all other applicable items have been addressed to SMUD's satisfaction.
- 8.10 Limits of SMUD Review
 - 8.10.1 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 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.
- 8.11 As-built Documents
 - 8.11.1 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.

9 Submittals

- 9.1 The Customer shall submit documentation showing compliance with this specification and shall include, but is not limited to:

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- 9.1.1 Detailed vault site plan.
- 9.1.2 Any structural, electrical, mechanical and fire protection details and/or calculations of the vault or of any equipment inside the vault. All structural drawings and calculations must be reviewed, stamped, and signed by a currently licensed Civil or Structural Engineer.
- 9.1.3 Material specifications for all material inside the vault or embedded in the vault concrete.
- 9.1.4 Other documents, not explicitly stated here, may be required by SMUD for review.
- 9.1.5 Transmittal letter.
- 9.1.6 All submittals shall be directed to the SMUD Designer who is handling the job by email or electronic upload. All submittals shall be submitted prior to application for permit with the Authority Having Jurisdiction (AHJ). The purpose of this requirement is to allow the Customer to provide the AHJ with SMUD approved documentation if required.
- 9.1.7 All submittals shall be electronic. Please consult the SMUD Designer if you wish to provide physical “hard copy” submittals.
- 9.1.8 Transmittal letter.
- 9.1.9 Date of submittal (Or original date of submittal with date of resubmittal).
- 9.1.10 Date that completed review is being requested. Allow for a minimum of 15-business days for review of each item(s) submitted.
- 9.1.11 Additional information may be required by SMUD’s Designer or Engineer to determine compliance with this specification. In the case of engineering and design work, the plans shall be stamped in accordance with this specification.
- 9.1.12 All plans shall be signed and stamped by the engineer of record prior to submission to SMUD’s Designer for review.
- 9.1.13 Submittals marked “NOT APPROVED” shall be corrected and resubmitted for review.
- 9.2 Failure to Submit Required Information
 - 9.2.1 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 all deficiencies as a result of performing this work at their expense.

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9.3 Resubmittal of Information

9.3.1 Resubmittal shall include the following:

- 9.3.1.1 Transmittal letter.
- 9.3.1.2 Original of preceding submittal (Previous plans with back-check comments).
- 9.3.1.3 Date of submittal also include date of original submittal on transmittal sheet.
- 9.3.1.4 Date that completed review is being requested. Allow for a minimum of 15-business days for review of each item submitted.

9.4 Scheduling

9.4.1 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.

9.4.2 The schedule shall include the following:

- 9.4.2.1 Date the vault construction is to begin.
- 9.4.2.2 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.
- 9.4.2.3 The date that permanent service is requested.
- 9.4.2.4 The customer shall submit to SMUD's Scheduling staff, any changes impacting the construction schedule.

10 Standards and Codes

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

10.2 Where there is conflict between this specification and codes, ordinances, industry standard practices, local agency requirements, etc., the customer

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shall notify SMUD in writing for resolution. In most cases, the most restrictive standard shall apply.

- 10.3 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.
- 10.4 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.

11 Permits, Licenses and Bonds

- 11.1 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.
- 11.2 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.

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12 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, nor is this considered an endorsement. 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

Cable Tray

Cooper B-Line

800-851-7415

www.cooperblineline.com

Series 2, 3 & 4 Aluminum Cable Tray, 12" Rung spacing.

Consult SMUD Designer for width requirements.

Channel

Atkore Unistrut

Unistrut P3200 Concrete Inserts 12-gauge type-316 stainless steel

[Flex-Strut](#)

[FS-7370 Series Concrete Inserts 12 gauge type 316 stainless steel](#)

[Kumar Industries](#)

[NU-STRUT Concrete Inserts N-3300 Series type 316 stainless steel](#)

Equipment Hatch


Madrug Iron Works, Inc. 209-832-7003

www.madrugaironworks.com

<http://www.madrugaironworks.com/SMUD%206X12%20G&C.pdf>

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.

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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 Iron

Inwesco Incorporated 9-1/4" High x 1-1/4" Diam. X 42" Material Grade 316/316L Stainless Steel

Specifications ASTM A276 Condition A, Min Yield = 25ksi, Min Tensile = 70ksi

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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

Stancor Pumps

860-391-5794

<http://stancorpumps.com/>

Stancor II Control System (115V- TSE50/SW1151SMUD), and SS-50 (with oil minder) Sump Pump (or SMUD approved equivalent)

| | | | |
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13 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

| Drawing Title | Drawing Identification Code | Page Number |
|----------------------------------------------------------------------------------------|-----------------------------|-------------|
| MINIMUM SPACE REQUIREMENTS FOR AN IN-BUILDING VAULT | UVA1.1A | B-1 |
| MINIMUM SPACE REQUIREMENTS FOR A SIDEWALK VAULT | UVA1.1B | B-2 |
| SERVICE CONNECTION: CUSTOMER BUS (TYPICAL) (AT-GRADE, IN-BUILDING VAULT) | UVA1.1C | B-3 |
| SERVICE CONNECTION: BUS CABLE TAP BOX (TYPICAL) (AT-GRADE, IN-BUILDING VAULT) | UVA1.1D | B-4 |
| SERVICE CONNECTION: CUSTOMER WIRE/ RICHARDS IBB (TYPICAL) (BELOW-GRADE SIDEWALK VAULT) | UVA1.1E | B-5 |
| STRUCTURAL CHANNEL LOCATIONS IN TRANSFORMER VAULT & TRANSFORMER VAULT CONDUIT ENTRANCE | UVA1.3 | B-6 |
| PULLING IRON LOCATIONS FOR TRANSFORMER VAULT | UVA1.4 | B-7 |
| REQUIREMENTS FOR FIXED LADDERS IN VAULTS AND MANHOLES | UVA1.5 | B-8 |
| GROUND PLATE PLACEMENT AND SPACING DETAILS | UVA1.6 | B-9 to 11 |
| REBAR CONNECTION DETAILS | UVA1.7 | B-12 to 15 |

| | | | |
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| Drawing Title | Drawing Identification Code | Page Number |
|------------------------------------------------|-----------------------------|-------------|
| BELOW GRADE GROUNDING ELECTRODE CONFIGURATIONS | UVA1.8 | B-16 to 20 |
| DETAIL TYPICAL CONDUIT TERMINATION | U12P3X2 | B-21 |
| VENTILATION GUIDELINES | | B-22 |

| 21KV (IN BUILDING VAULT) | | | |
|--------------------------|---------|-------------------------|------------------------------------------|
| PANEL SIZE | VOLTAGE | MIN. VAULT SIZE (LxWxH) | SWITCH SPACE (IF NECESSARY) ^D |
| 400 TO 2,500 AMPS | 208 | 14' x 24' x 12' | 12' x 15' x 12' |
| 2,501 TO 4,000 AMPS | 208 | 24' x 24' x 12' | 12' x 15' x 12' |
| 400 TO 3,000 AMPS | 480 | 14' x 24' x 12' | 12' x 15' x 12' |
| 3,001 TO 5,000 AMPS | 480 | 24' x 24' x 12' | 12' x 15' x 12' |

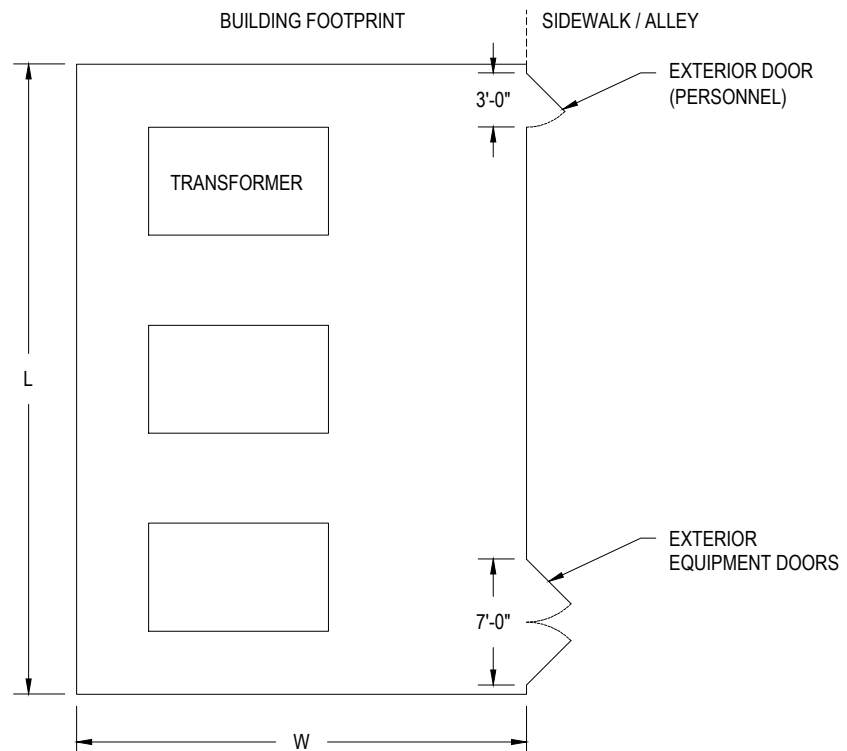
| NETWORK (IN BUILDING VAULT) | | |
|-----------------------------|---------|-------------------------|
| PANEL SIZE | VOLTAGE | MIN. VAULT SIZE (LxWxH) |
| 400 TO 2,000 AMPS | 208 | 24' x 24' x 12' |
| 2,001 TO 4,000 AMPS | 208 | 34' x 24' x 12' |
| 4,001 TO 5,000 AMPS | 208 | 44' x 24' x 12' |
| 400 TO 1,800 AMPS | 480 | 24' x 24' x 12' |
| 1,801 TO 3,500 AMPS | 480 | 34' x 24' x 12' |
| 3,501 TO 5,000 AMPS | 480 | 44' x 24' x 12' |
| 5,001 TO 6,000 AMPS | 480 | 54' x 24' x 12' |

^APLEASE SEE NOTE D FOR ADDITIONAL SWITCH SPACE REQUIREMENTS.

NOTES:

- SHOWN CONFIGURATIONS ARE TYPICAL. ACTUAL CONFIGURATIONS CAN VARY. PLEASE CONSULT WITH SMUD ENGINEERING FOR VAULT LAYOUT & BUILDING LOCATION APPROVAL.
- AT LEAST TWO DOORS/ENTRANCES NEEDED ON OPPOSITE ENDS OF THE VAULT. AN EQUIPMENT ACCESS CAN BE CONSIDERED AS PART OF THIS REQUIREMENT IF IT CAN BE USED AS A PERSONNEL ENTRY.
- IT IS THE CUSTOMER'S SOLE RESPONSIBILITY TO ENSURE THAT WATER DOES NOT ENTER THE BUILDING OR SERVICE ENTRANCE EQUIPMENT FROM THE VAULT SPACE.
- (D)** ALL 21 KV SERVICES MAY REQUIRE ADDITIONAL SWITCH SPACE DEPENDING ON THE SERVICE SIZE. EACH SWITCH REQUIRES A SEPARATE 12'x15' DEDICATED VAULT SPACE (SEE SMUD ENGINEERING SPECIFICATION DS0608).
- ALL IN-BUILDING VAULTS SHALL BE FULLY ACCESSIBLE BY SMUD AT ALL TIMES (SEE 7.3).
- ALL EQUIPMENT ACCESS OPENINGS SHALL BE CLEAR OF ANY OVERHEAD OBSTRUCTIONS OR OBSTACLES THAT WOULD PREVENT THE USE OF A CRANE FOR INSTALLATION (SEE 7.2).

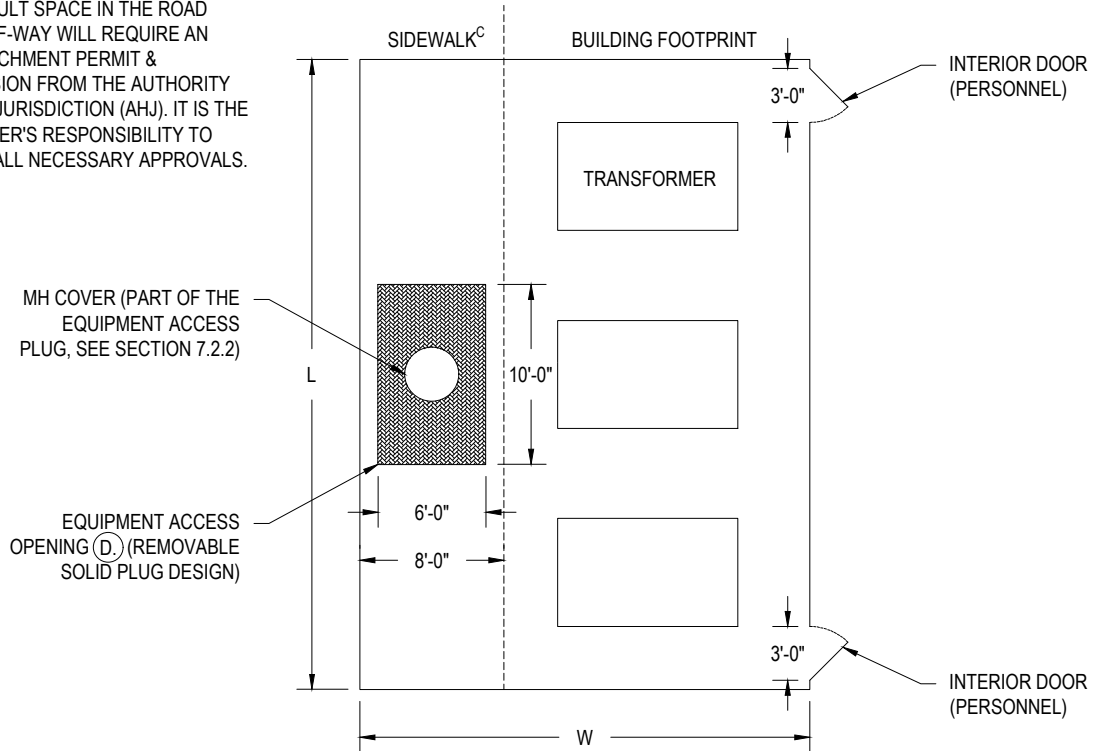
**IN-BUILDING VAULT (1ST FLOOR)
PLAN VIEW, TYP^B**



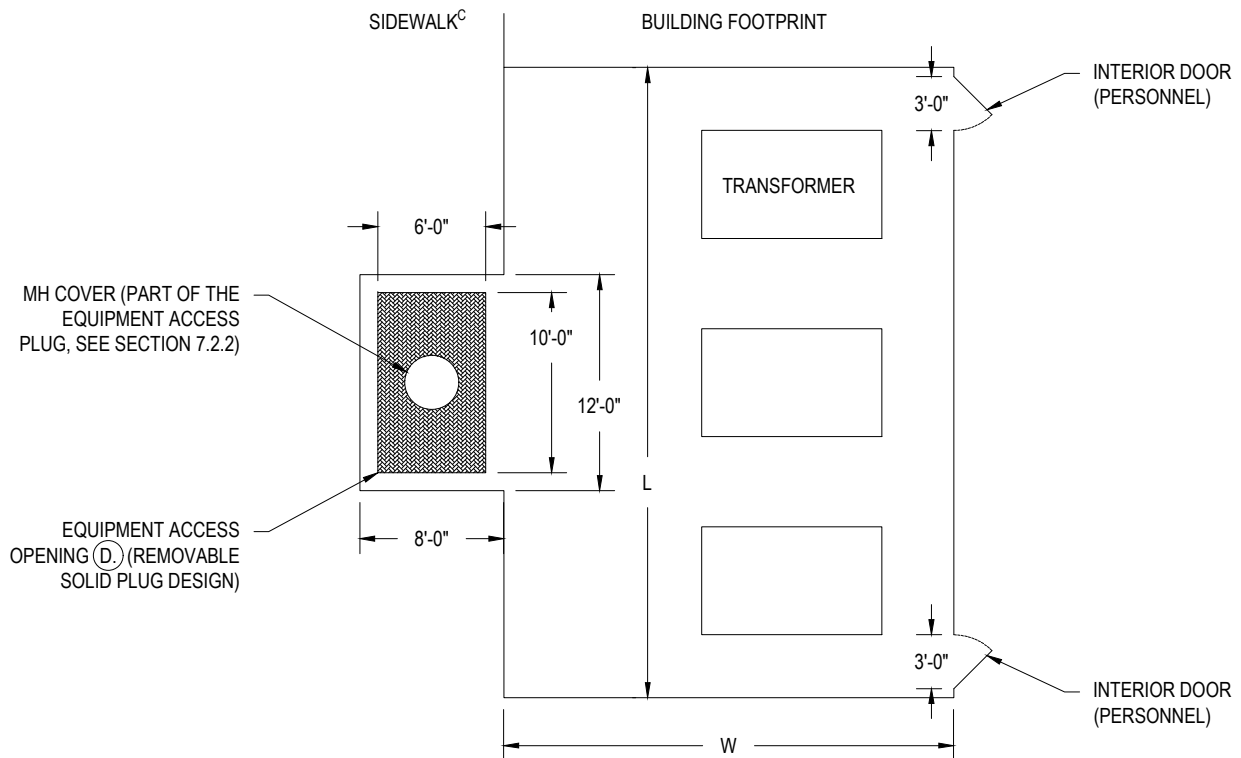
^BPLEASE SEE SMUD T013 FOR ALTERNATIVE ENCLOSURE/ALCOVE SPACE REQUIREMENTS FOR 21KV GROUND-FLOOR IN-BUILDING TRANSFORMER SPACE. ANY BELOW-GRADE 21KV SERVICES WILL REQUIRE VAULTED SERVICES & FALL UNDER T001.

**PARTIAL IN-BUILDING VAULT (BASEMENT)
PLAN VIEW, TYP**

ANY VAULT SPACE IN THE ROAD RIGHT-OF-WAY WILL REQUIRE AN ENCROACHMENT PERMIT & PERMISSION FROM THE AUTHORITY HAVING JURISDICTION (AHJ). IT IS THE CUSTOMER'S RESPONSIBILITY TO OBTAIN ALL NECESSARY APPROVALS.



**IN-BUILDING VAULT (BASEMENT)
PLAN VIEW, TYP**



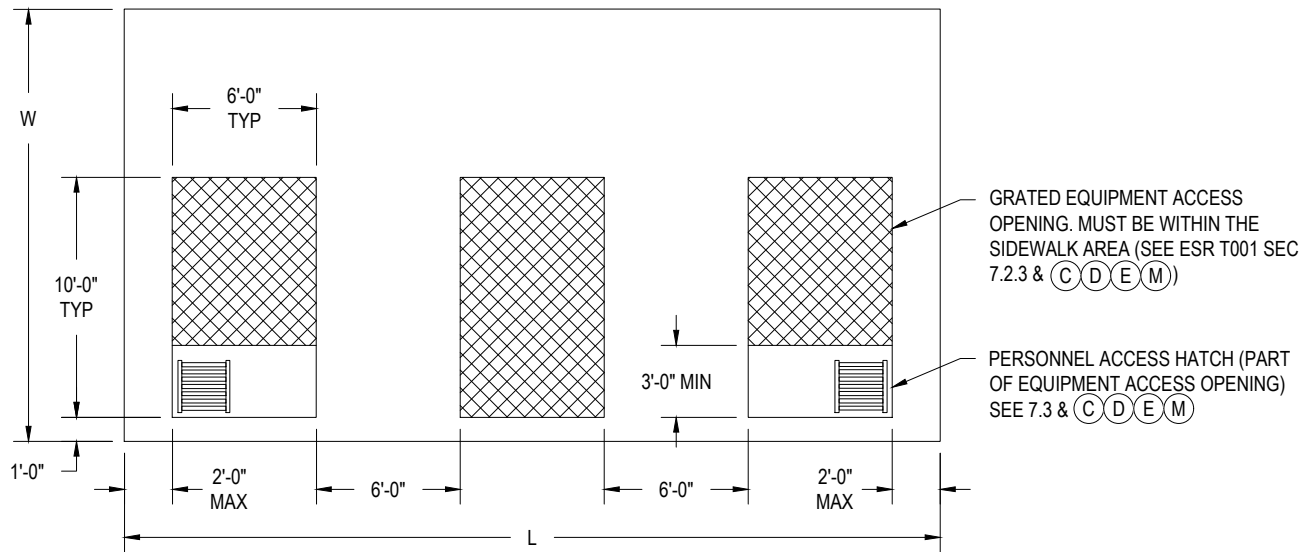
| 21KV (SIDEWALK VAULT) | | | | |
|-----------------------|---------|----------------------------|------------------------------------|---------------------------|
| PANEL SIZE | VOLTAGE | MIN. VAULT SIZE (LxWxH) | SWITCH SPACE (IF NECESSARY) (J) | # OF EQUIPMENT HATCHES |
| 400 TO 2,800 AMPS | 208 | 14' x 18' x 12' | 9' x 15' x 12' | 1 |
| 2,801 TO 4,000 AMPS | 208 | 24' x 18' x 12' | 9' x 15' x 12' | 2 |
| 400 TO 1,800 AMPS | 480 | 14' x 18' x 12' | 9' x 15' x 12' | 1 |
| 1,801 TO 5,000 AMPS | 480 | 24' x 18' x 12' | 9' x 15' x 12' | 2 |

| NETWORK (SIDEWALK VAULT) | | | |
|--------------------------|---------|----------------------------|---------------------------|
| PANEL SIZE | VOLTAGE | MIN. VAULT SIZE (LxWxH) | # OF EQUIPMENT HATCHES |
| 400 TO 2,000 AMPS | 208 | 24' x 18' x 12' | 2 |
| 2,001 TO 4,000 AMPS | 208 | 34' x 18' x 12' | 3 |
| 4,001 TO 5,000 AMPS | 208 | 44' x 18' x 12' | 4 |
| 400 TO 1,800 AMPS | 480 | 24' x 18' x 12' | 2 |
| 1,801 TO 3,500 AMPS | 480 | 34' x 18' x 12' | 3 |
| 3,501 TO 5,000 AMPS | 480 | 44' x 18' x 12' | 4 |
| 5,001 TO 6,000 AMPS | 480 | 54' x 18' x 12' | 5 |

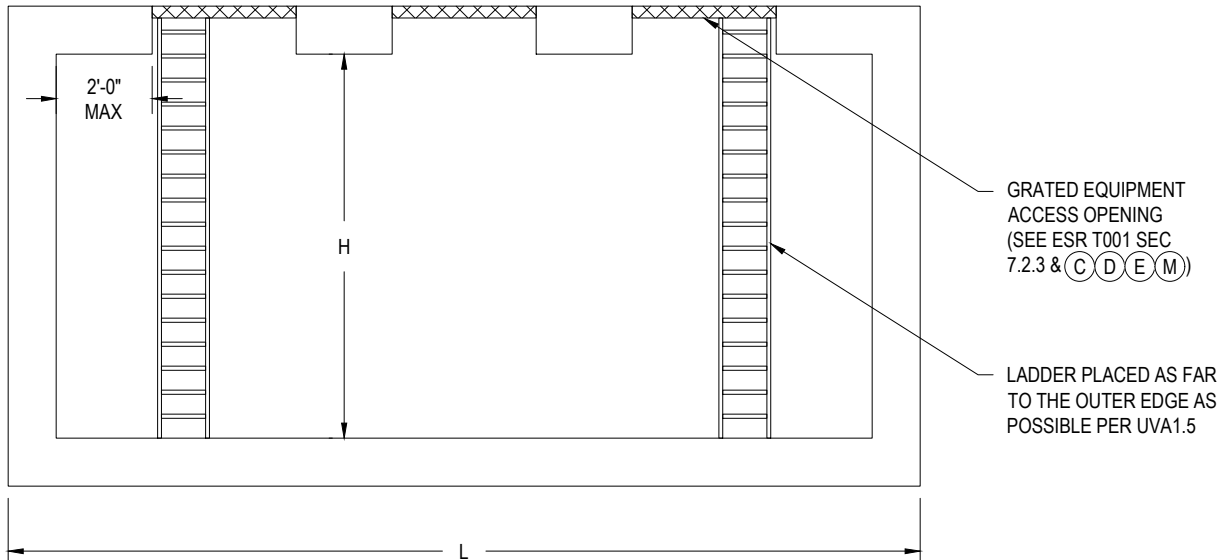
NOTES:

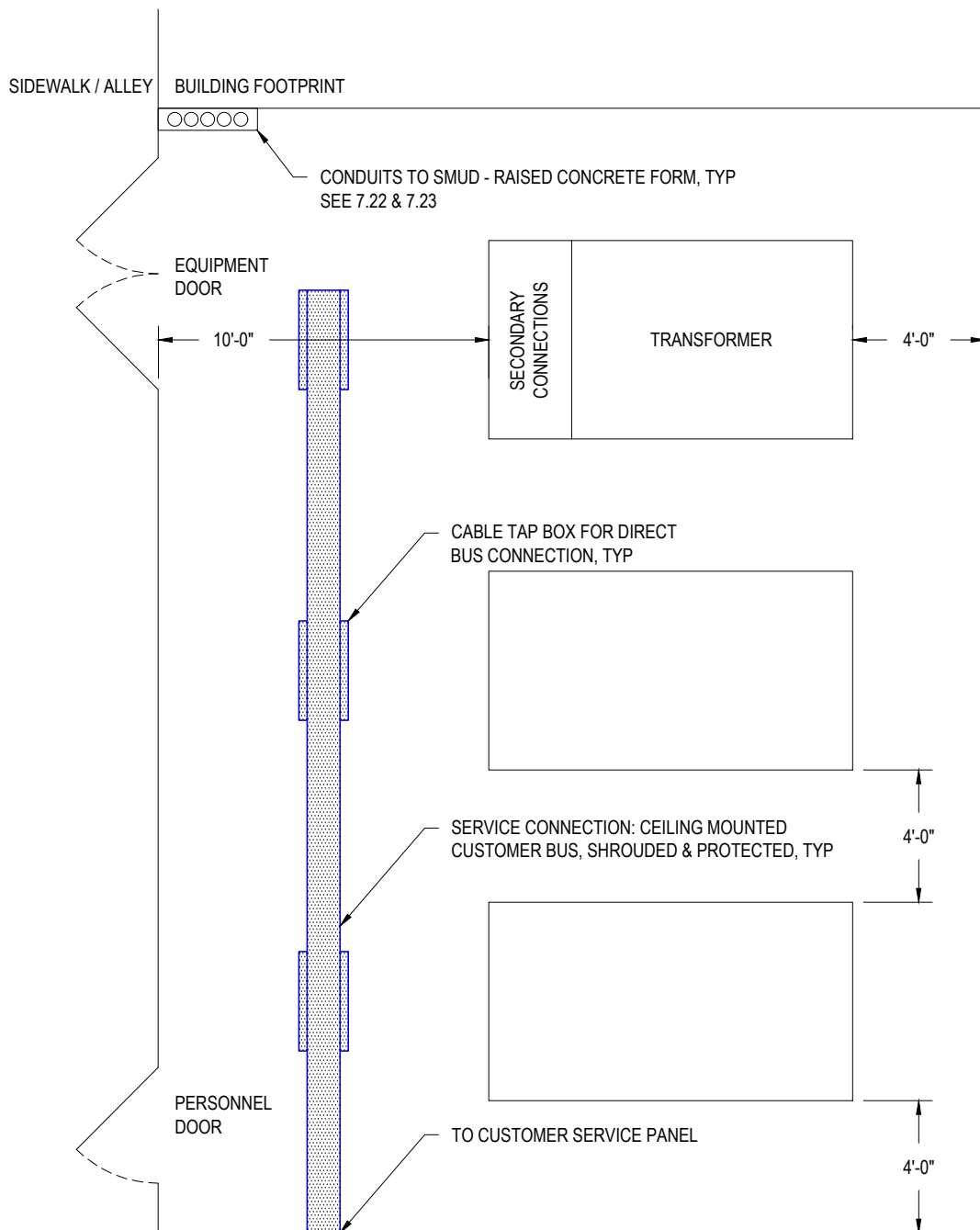
- A. BELOW GRADE OR SIDEWALK VAULT FEASIBILITY IS AT THE SOLE RESPONSIBILITY OF THE CUSTOMER.
- B. ANY SIDEWALK LOCATION MUST BE APPROVED BY SMUD ENGINEERING.
- (C) TWO PERSONNEL ACCESS HATCHES NEEDED ON OPPOSITE ENDS OF THE VAULT & CAN BE INCORPORATED INTO THE OUTER EQUIPMENT HATCHES.
- D. THE OUTER EQUIPMENT/PERSONNEL HATCHES MUST BE SPACED NO MORE THAN 2'-0" FROM THE INNER WALL OF THE VAULT.
- E. ANY PERSONNEL HATCH THAT IS PART OF THE EQUIPMENT HATCH MUST BE AT LEAST 3'-0" DEEP & THE WIDTH OF THE EQUIPMENT HATCH (6'-0").
- (F) HATCHES SHALL BE SPACED AS FAR APART FROM EACH OTHER AS PERMISSIBLE.
- G. ANY ALTERNATE HATCH ORIENTATION REQUIRES SMUD ENGINEERING APPROVAL.
- H. LADDER TO BE PLACED AS FAR TO THE OUTER EDGE AS PERMISSIBLE WITHIN THE LIMITS OF UVA1.5.
- I. IT IS THE CUSTOMER'S RESPONSIBILITY TO ENSURE THAT WATER DOES NOT ENTER THE BUILDING OR SERVICE ENTRANCE EQUIPMENT FROM THE VAULT SPACE.
- (J) ALL 21 KV SERVICES MAY REQUIRE ADDITIONAL SWITCH SPACE DEPENDING ON THE SERVICE SIZE. EACH SWITCH REQUIRES A SEPARATE 9'x15' DEDICATED VAULTED SPACE (SEE SMUD ENGINEERING SPECIFICATION DS0608).
- K. VAULT SHALL BE FULLY ACCESSIBLE BY SMUD AT ALL TIMES (SEE 7.3).
- L. ALL EQUIPMENT ACCESS OPENINGS SHALL BE CLEAR OF ANY OVERHEAD OBSTRUCTIONS OR OBSTACLES THAT WOULD PREVENT THE USE OF A CRANE FOR INSTALLATION (SEE 7.2).
- M. HATCH POSITIONING OVER THE VAULT SPACE WILL DEPEND ON SERVICE LOCATION. PLEASE CONTACT SMUD ENGINEERING.

**BELOW GRADE/SIDEWALK VAULT
PLAN VIEW, TYP**



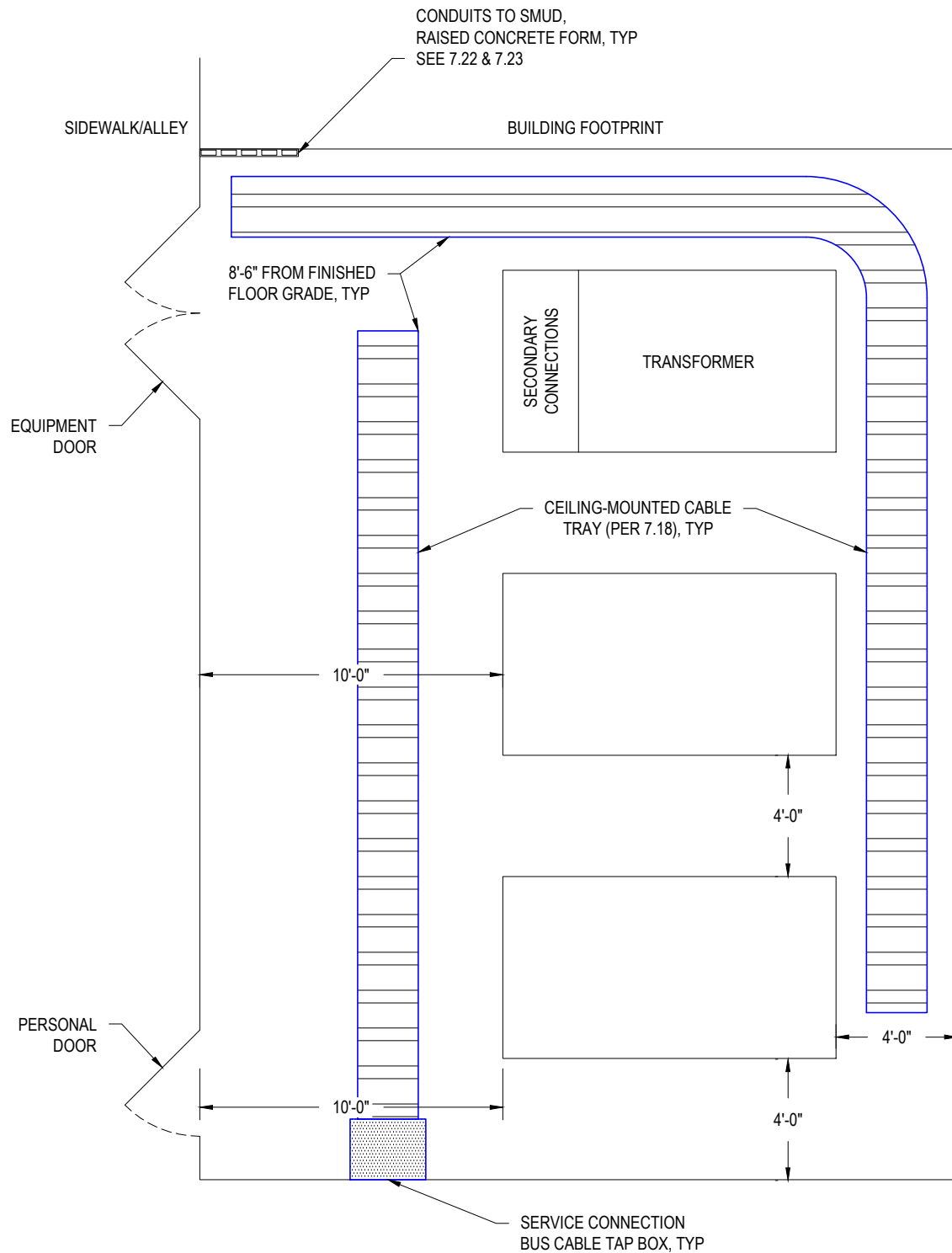
**BELOW GRADE/SIDEWALK VAULT
PROFILE VIEW, TYP**





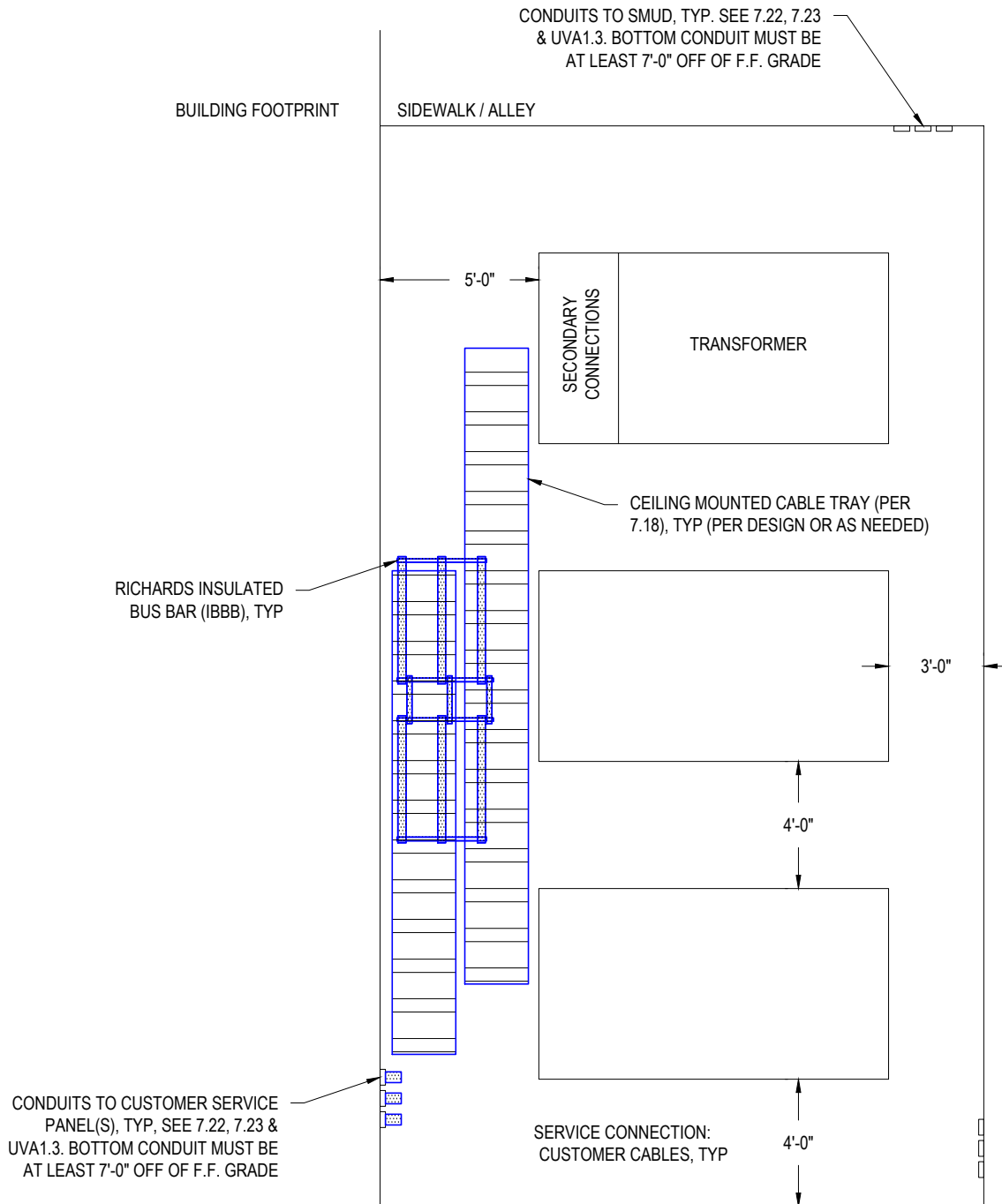
NOTES:

- A. SHOWN CONFIGURATIONS ARE TYPICAL. ACTUAL CONFIGURATIONS CAN VARY.
- B. THIS TYPE OF SECONDARY CONNECTION IS SUITABLE FOR BELOW-GRADE OR GROUND-LEVEL IN-BUILDING TYPE INSTALLATIONS.
- C. THIS TYPE OF SECONDARY CONNECTION IS NOT SUITABLE FOR SUBMERSIBLE / WET ENVIRONMENTS.



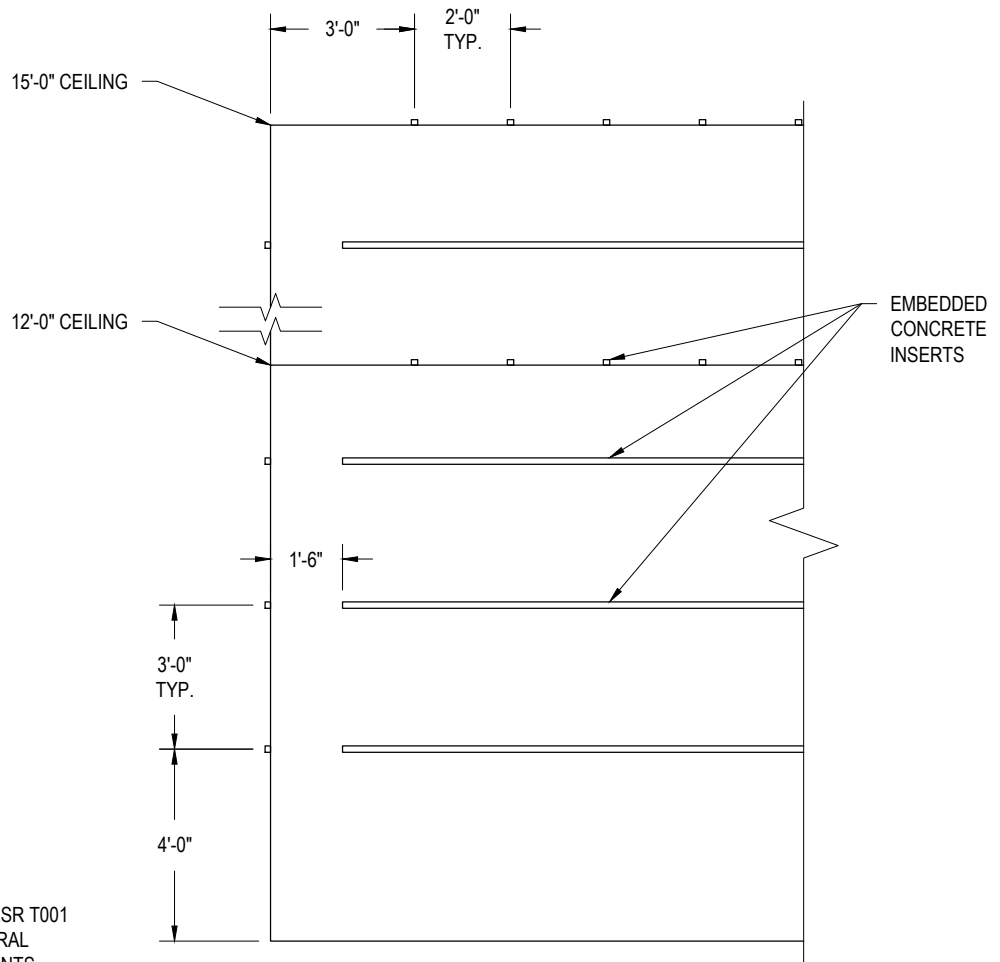
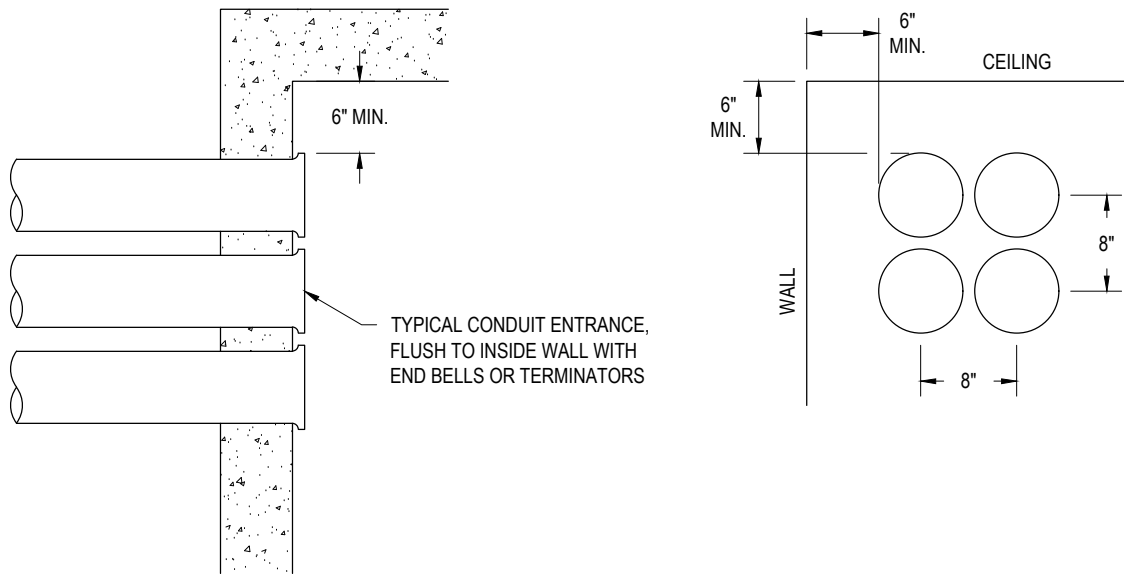
NOTES:

- A. SHOWN CONFIGURATIONS ARE TYPICAL. ACTUAL CONFIGURATIONS MAY VARY.
- B. THIS TYPE OF SECONDARY CONNECTION IS SUITABLE FOR BELOW-GRADE OR GROUND-LEVEL IN-BUILDING TYPE INSTALLATIONS.
- C. THIS TYPE OF SECONDARY CONNECTION IS NOT SUITABLE FOR SUBMERSIBLE / WET ENVIRONMENTS.



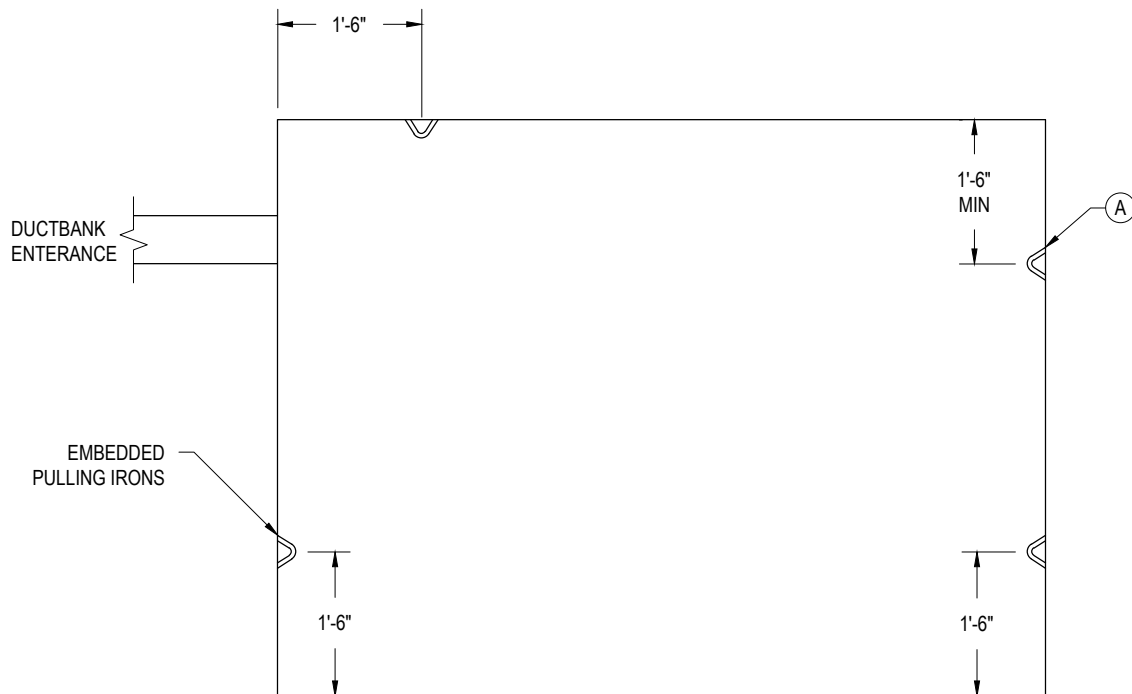
NOTES:

- A. SHOWN CONFIGURATIONS ARE TYPICAL. ACTUAL CONFIGURATIONS MAY VARY.
- B. THIS TYPE OF SECONDARY CONNECTION IS SUITABLE FOR SUBMERSIBLE / WET INSTALLATIONS, SUCH AS BELOW-GRADE SIDEWALK VAULTS.
- C. CUSTOMER CABLE TO THE VAULT IS REQUIRED FOR CONNECTION.

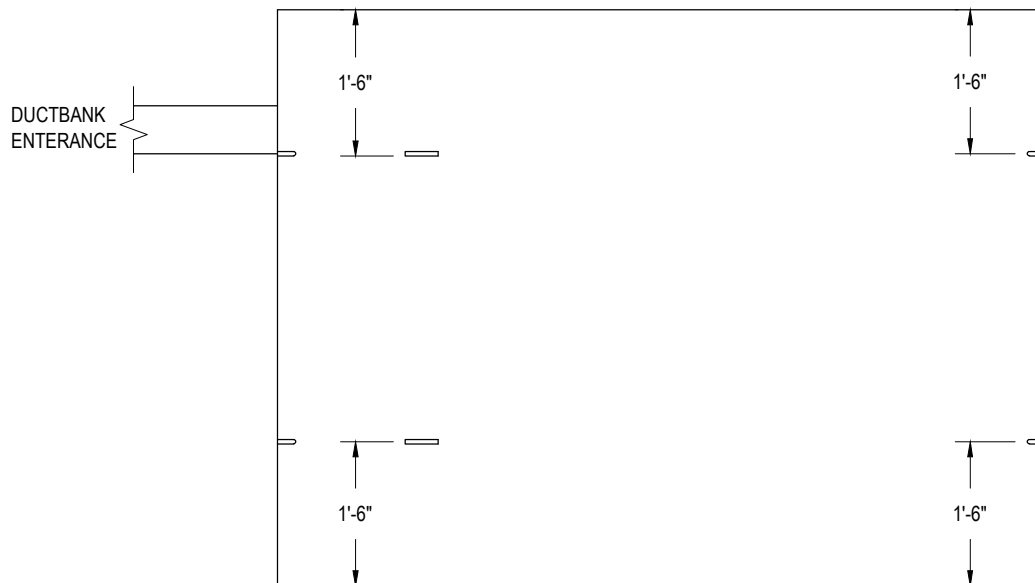


NOTES:

- A. PLEASE REFERENCE SECTION ESR T001 7.19 FOR ADDITIONAL STRUCTURAL FRAMING CHANNEL REQUIREMENTS.



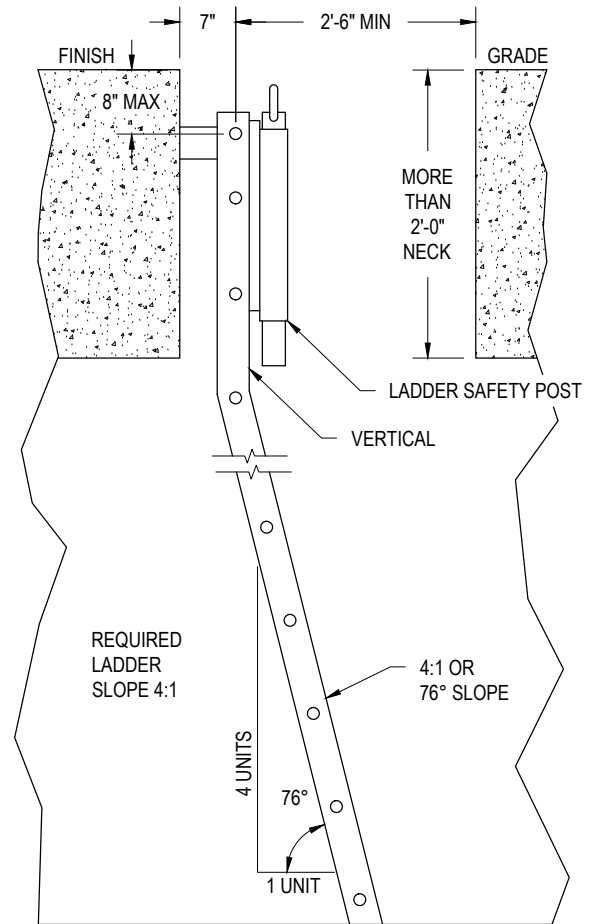
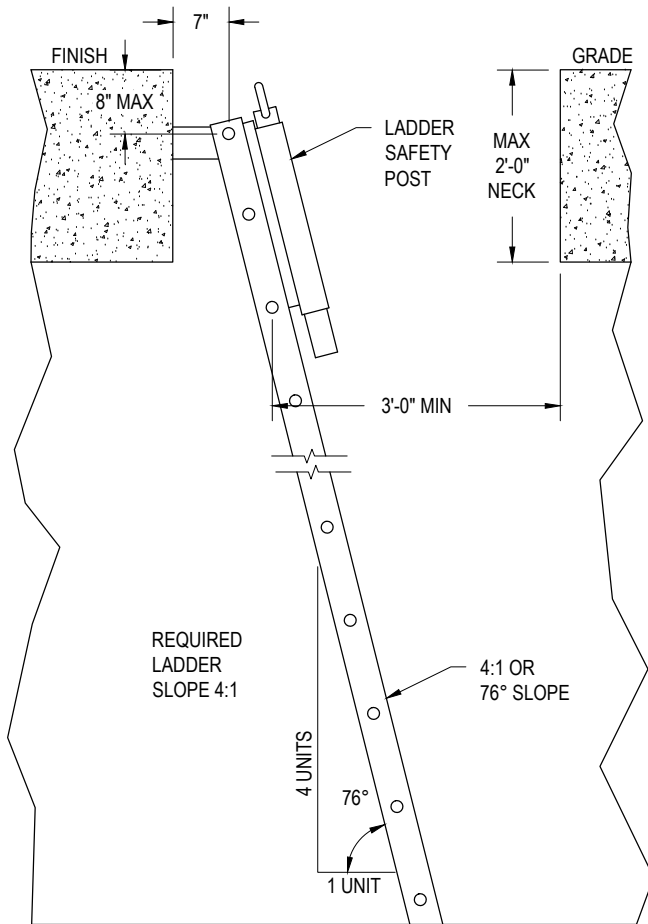
PLAN



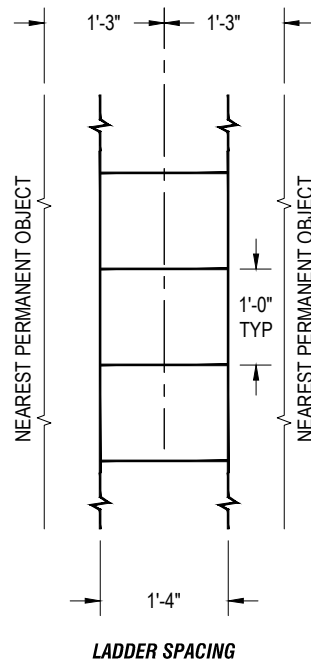
PROFILE

NOTES:

- (A) THIS PULLING IRON SHALL BE IN LINE WITH & LEVEL WITH THE CONDUIT ENTRANCE, BUT NOT CLOSER THAN 1'-6" 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 2'-6" FOR LADDERS WITH A PITCH OF 90° & 3'-0" FOR LADDERS WITH A PITCH OF 76°.



NOTES:

- LADDER DESIGN & FABRICATION SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF ANSI A14.3.
- FABRICATOR SHALL PROVIDE STAMPED & SIGNED CALCULATIONS BY A CALIFORNIA LICENSED PROFESSIONAL CIVIL OR STRUCTURAL ENGINEER FOR THE LADDER DESIGN & THE LADDER ANCHORAGE DESIGN.
- LADDER DESIGN & ANCHORAGE SHALL BE DESIGNED FOR THE WORST CASE LOADING CONDITION, INCLUDING THE CONDITION OF LOADING APPLIED TO THE EXTENDED LADDER UP SAFETY POST.
- LADDER & ALL COMPONENTS SHALL BE ASTM A36 STEEL MINIMUM & SHALL BE HOT DIP GALVANIZED ACCORDING TO ASTM A123 & A153.
- RUNGS SHALL BE $\frac{3}{4}$ " DIAMETER MINIMUM WITH AN ANTI SLIP SURFACE OF SLIP NOT GRADE 2 MEDIUM OR SMUD APPROVED EQUIVALENT.
- RAILS SHALL BE $\frac{3}{8}$ " X 3" MINIMUM.
- LADDERS SHALL BE ATTACHED AT TOP & BOTTOM TO THE VAULT OR MANHOLE & SHALL BE REMOVABLE.
- LADDER UP SAFETY POST SHALL BE BILCO OR SMUD APPROVED EQUIVALENT WITH 3'-6" EXTENSION.
- THE LADDER BOTTOM RUNG SHALL BE 1'-2" MAXIMUM ABOVE THE VAULT OR MANHOLE FLOOR.

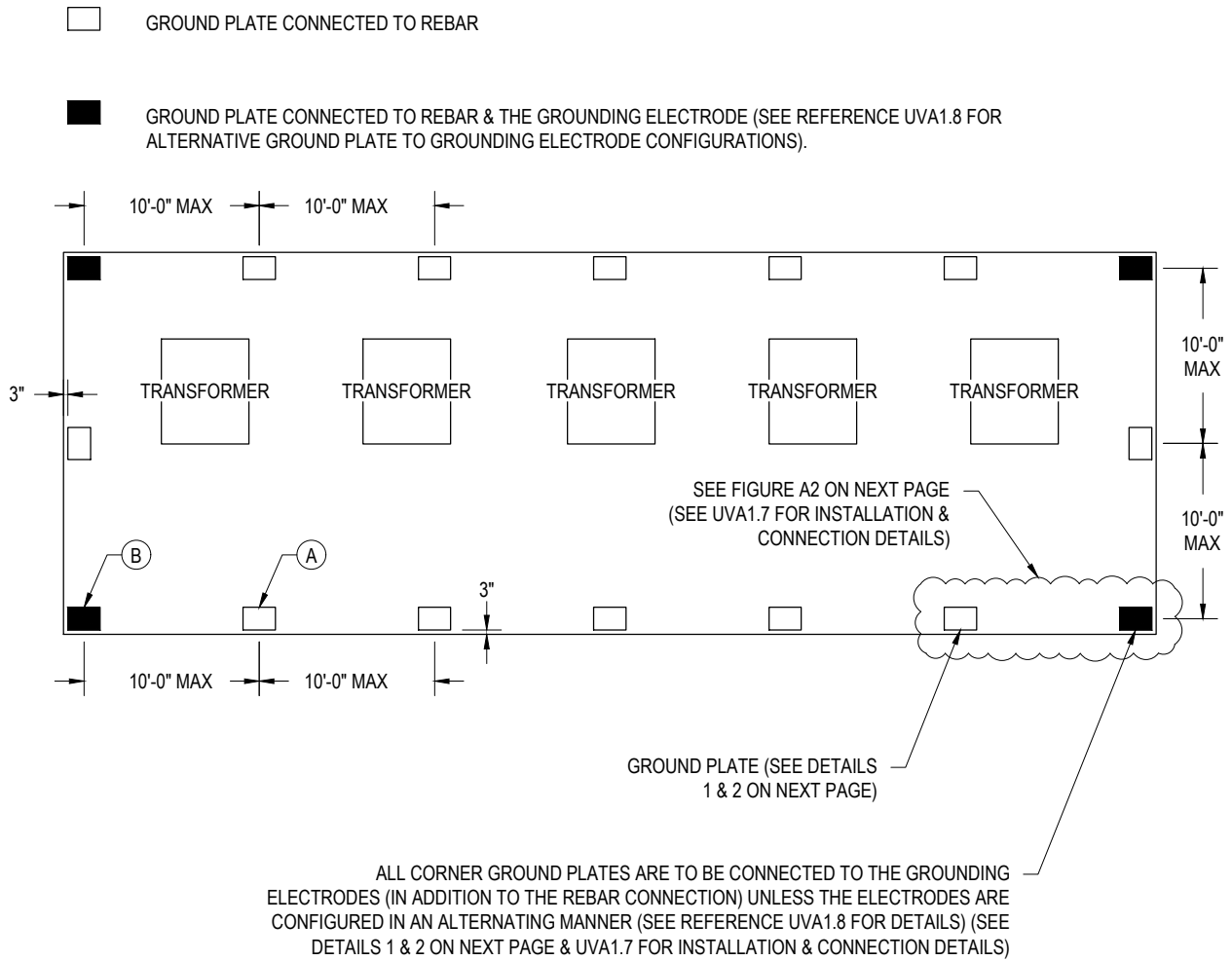
LETTERED NOTES

- (A) INSTALL BURNDY TYPE YGF GROUND PLATES (OR SMUD APPROVED EQUIVALENT) SIZED FOR 500 KCMIL CONDUCTOR 3" FROM THE WALL & SPACED AS EVENLY AS POSSIBLE AROUND THE PERIMETER OF THE VAULT, NOT EXCEEDING 10'-0" 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 & CONNECTION DETAILS, INCLUDING REBAR CONNECTION REQUIREMENTS.
- (B) IN ADDITION TO THE REQUIREMENTS LISTED IN NOTE A 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 & REFERENCE UVA1.8 FOR POSSIBLE GROUNDING ELECTRODE CONFIGURATIONS.
- (C) INSTALL STANDARD HEX CAP SCREWS & 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 & THREADED HOLES OF THE GROUND PLATE PRIOR TO INSERTING THE BOLTS.

GENERAL REQUIREMENTS

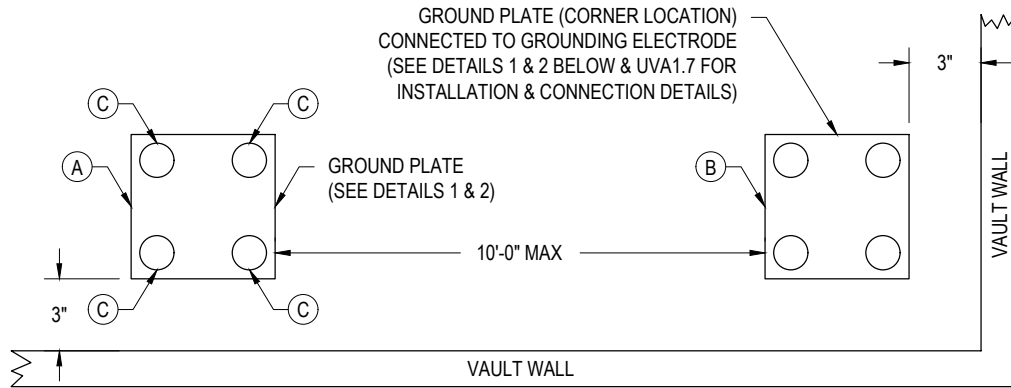
- A1.1
ALL CONNECTIONS MUST BE AVAILABLE FOR VISUAL INSPECTION (BY A SMUD INSPECTOR) PRIOR TO POURING THE CONCRETE FLOOR.
- A1.2
ALL COMPRESSION CONNECTIONS MUST BE MADE WITH BURNDY COMPRESSION TOOLS (OR A SMUD APPROVED EQUIVALENT) & DONE IN ACCORDANCE TO THE MANUFACTURER'S INSTRUCTION. THE PROPER DIE & PRESSURE MUST BE USED FOR EACH CONNECTOR. ALL COMPRESSION CONNECTIONS SHALL BE INSPECTED FOR THE APPROPRIATE EMBOSSEMENT (AFTER INSTALLATION & BY A SMUD INSPECTOR), TO ENSURE THAT THE PROPER DIE WAS USED.
- A1.3
ALL CONNECTORS MUST BE DIRECT BURIED RATED & 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 & SPACING DETAILS (TYPICAL)

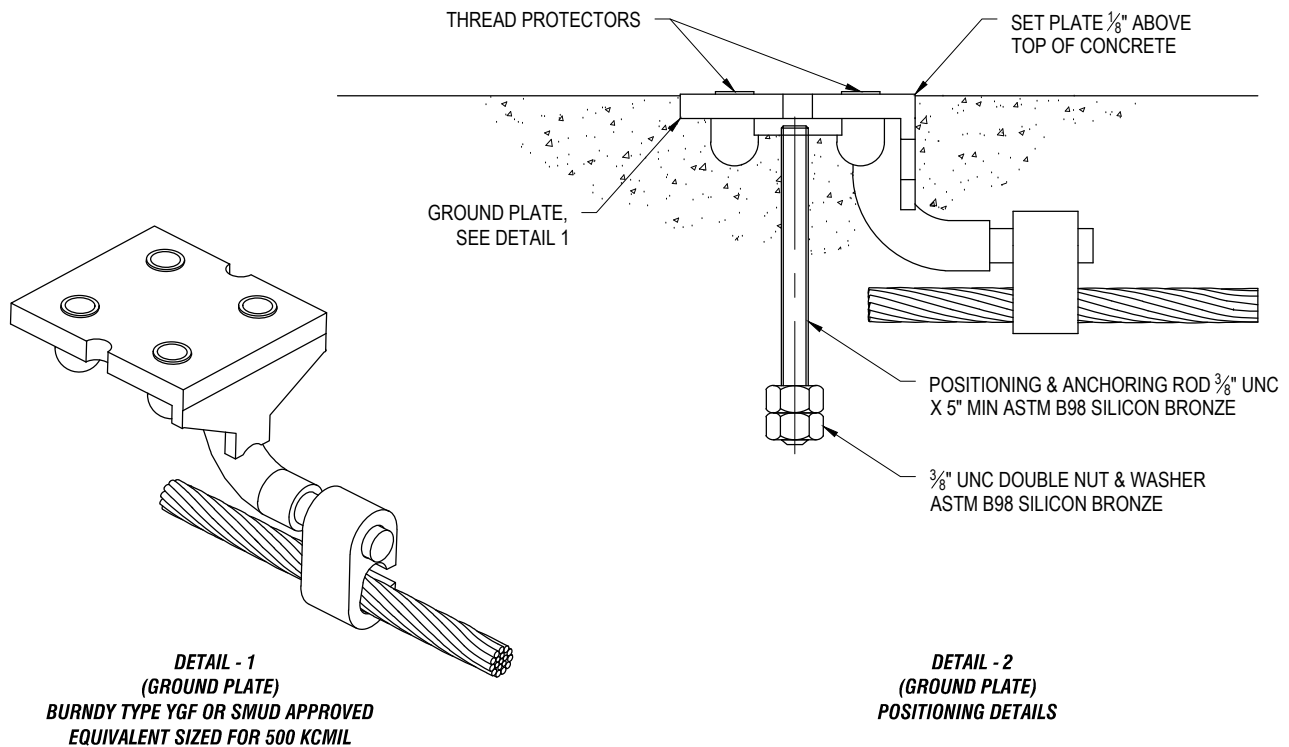


PLAN VIEW
NOT TO SCALE

FIGURE A2
GROUND PLATE PLACEMENT DETAILS (CLOSE UP - TYPICAL)



PLAN VIEW
NOT TO SCALE



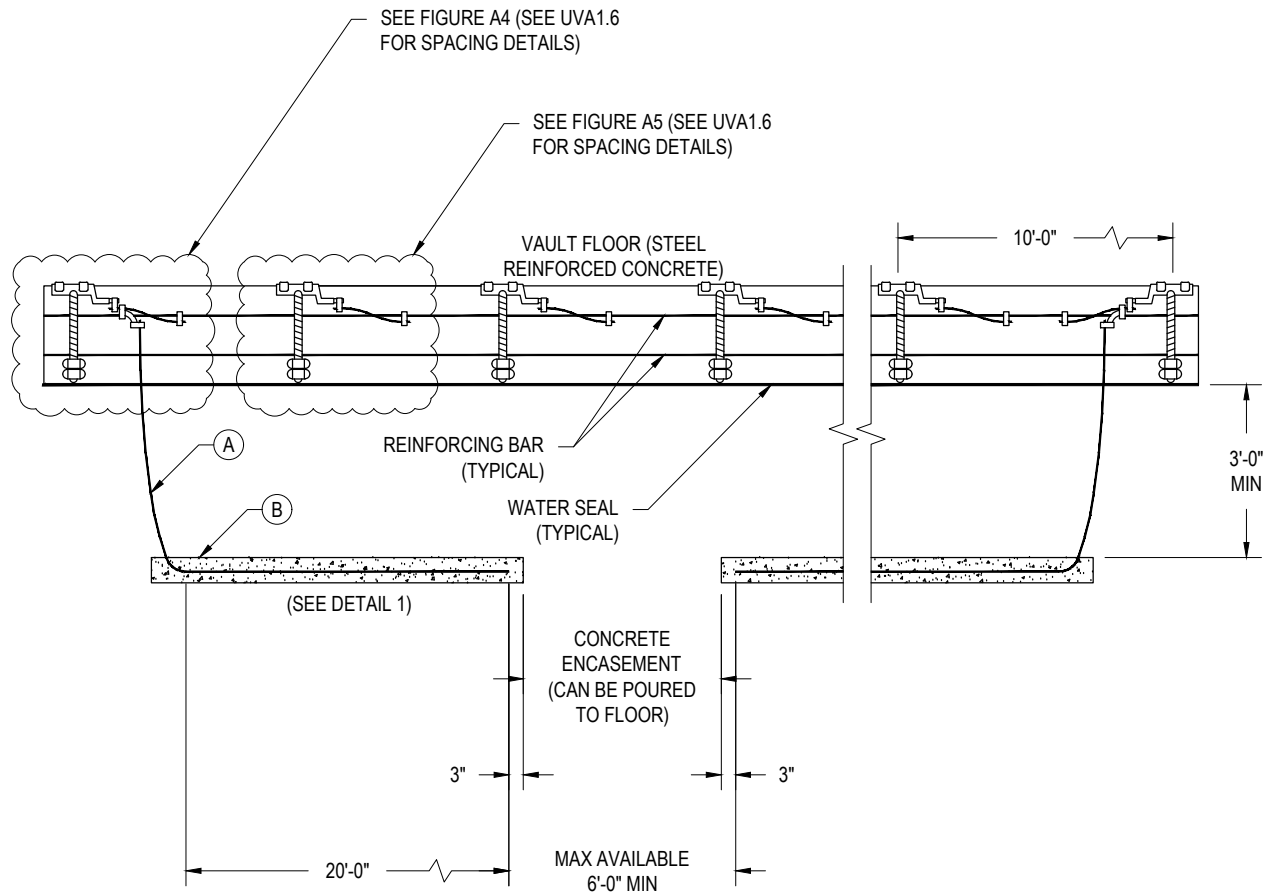
LETTERED NOTES

- (A.) THE GROUNDING ELECTRODE(S) & BONDING CONDUCTOR(S) SHALL BE 500 KCMIL BARE CU CONDUCTOR (37 STRAND, SOFT DRAWN - ASTM B3, B8) UNLESS OTHERWISE SPECIFIED.
- (B.) AT LEAST 20'-0" OF THE GROUNDING ELECTRODE IS TO BE PLACED IN A COUNTERPOISED / HORIZONTAL MANNER AT LEAST 3'-0" BELOW THE FLOOR (OR GRADE) & AS FAR APART AS PERMISSIBLE FROM OTHER GROUNDING ELECTRODES. REFER TO REFERENCE UVA1.8 FOR GROUNDING ELECTRODE LAYOUT CONFIGURATIONS. THE ENTIRE GROUNDING ELECTRODE BELOW THE FLOOR (BOTH THE HORIZONTAL & VERTICAL PORTION) IS TO BE CONCRETE ENCASED IN AT LEAST 3" OF FULL COVER. NO INSULATING BARRIER BETWEEN THE CONCRETE & NATIVE SOIL IS ALLOWED. SEE DETAIL 1 FOR CONCRETE ENCASEMENT REQUIREMENTS. THE CONCRETE COVER CAN EXTEND TO THE FLOOR OF THE VAULT IF NECESSARY AS SHOWN IN FIGURE A3.
- C. 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 & 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.
- D. COMPLETELY COAT ALL REBAR TO COPPER CONNECTORS (DETAIL 3) WITH A SMUD APPROVED, DIRECT BURIED CAPABLE SEALANT AFTER THE CONNECTION HAS BEEN MADE & PRIOR TO POURING THE CONCRETE FLOOR. APPLY THIS SEALANT ACCORDING TO MANUFACTURER'S INSTRUCTIONS, IN ACCORDANCE TO THEIR CORROSION PROTECTION PROCEDURES.

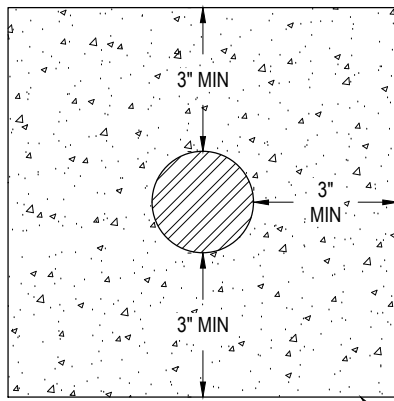
GENERAL REQUIREMENTS

- 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) & 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 & 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 & 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 & THREADED HOLES OF THE GROUND PLATE PRIOR TO INSERTING THE BOLTS.

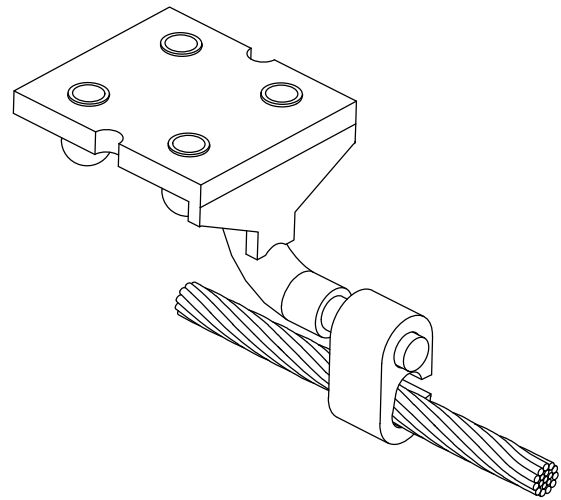
FIGURE A3
REBAR CONNECTIONS (TYPICAL)



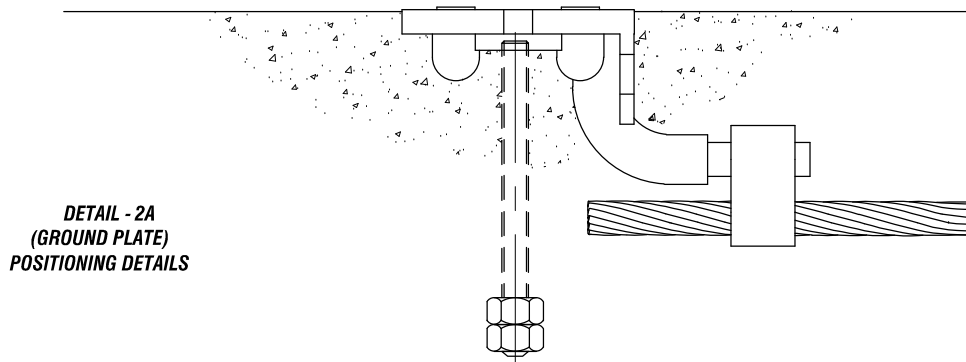
PROFILE VIEW
NOT TO SCALE



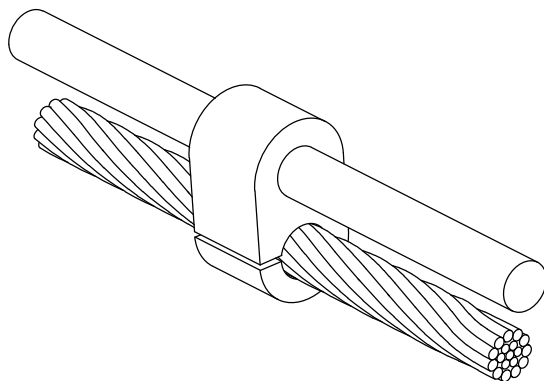
DETAIL - 1
(CONCRETE ENCASED ELECTRODE)
(4 MINIMUM)



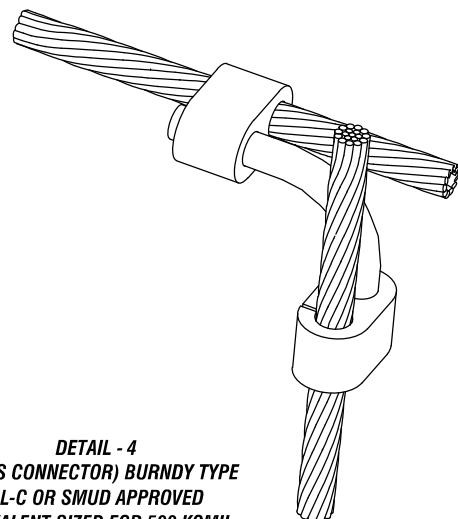
DETAIL - 2
(GROUND PLATE)
BURNDY TYPE YGF OR SMUD APPROVED
EQUIVALENT SIZED FOR 500 KCMIL



DETAIL - 2A
(GROUND PLATE)
POSITIONING DETAILS

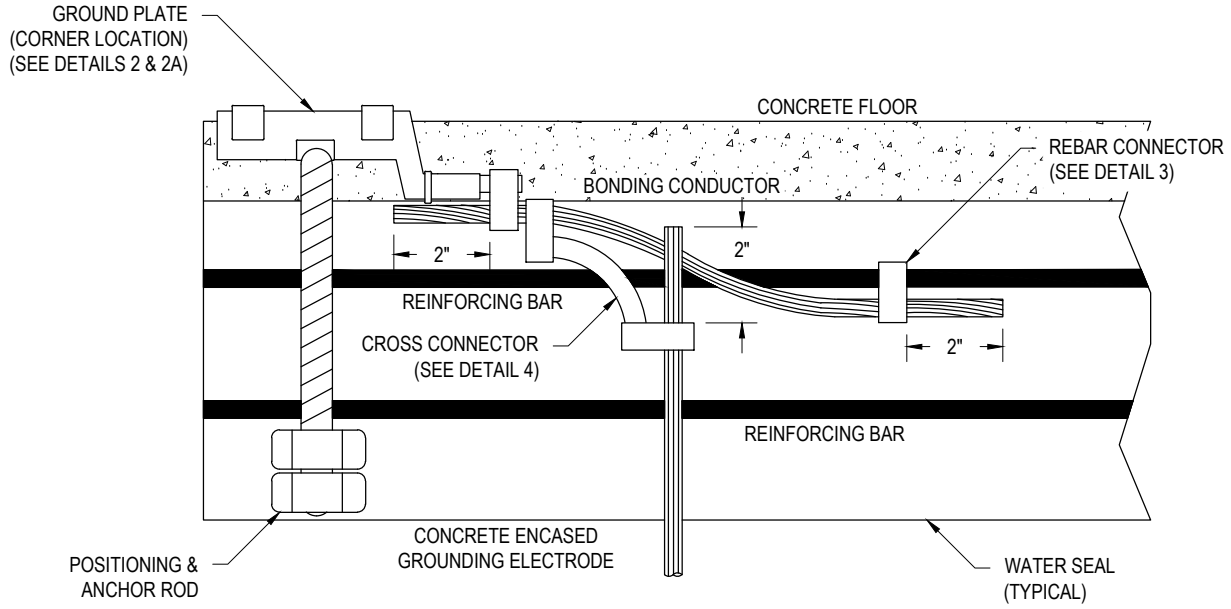


DETAIL - 3
(REBAR CONNECTION) BURNDY TYPE
YGHC-C OR SMUD APPROVED
EQUIVALENT SIZED FOR 500 KCMIL



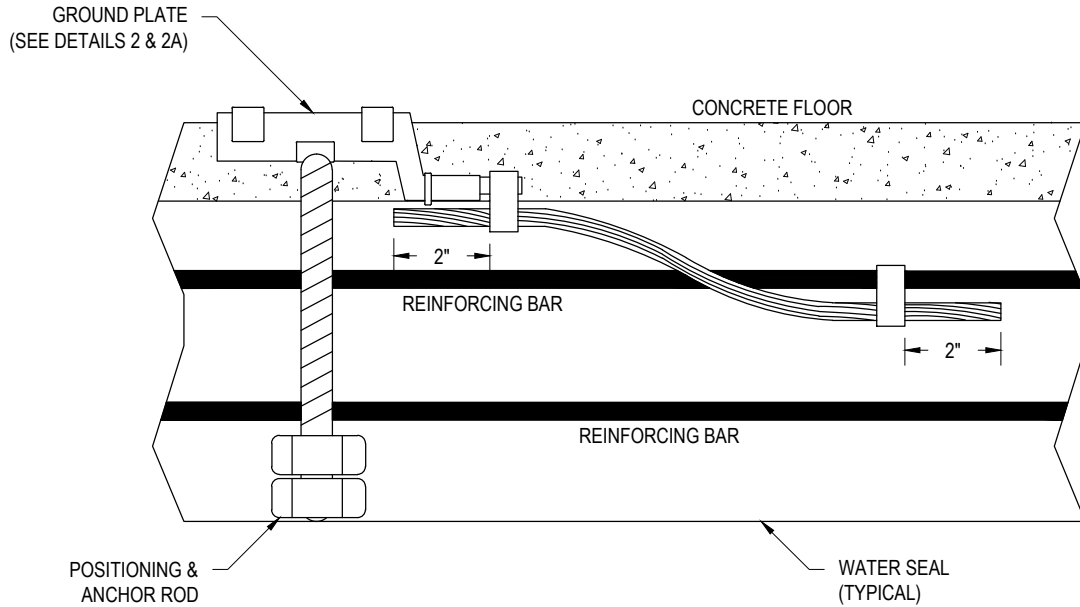
DETAIL - 4
(CROSS CONNECTOR) BURNDY TYPE
YGL-C OR SMUD APPROVED
EQUIVALENT SIZED FOR 500 KCMIL

FIGURE A4
REBAR CONNECTION DETAILS (TYPICAL)



PROFILE VIEW
NOT TO SCALE

FIGURE A5
REBAR CONNECTION DETAILS (TYPICAL)



PROFILE VIEW
NOT TO SCALE

LETTERED NOTES

- (A.) REFER TO UVA1.6 FOR INSTALLATION & CONNECTION DETAILS FOR THESE GROUND PLATES.
- (B.) IN ADDITION TO THE REQUIREMENTS LISTED IN NOTE A 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'-0" OF SPACE EXISTS BETWEEN EACH GROUNDING ELECTRODE (FIGURE A6 & 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 & 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 & CONFIGURED PARALLEL TO THE LONGER WALL OF THE VAULT. THIS CONFIGURATION ONLY WORKS IN LARGE VAULTS AS AT LEAST 6'-0" OF SPACING IS REQUIRED BETWEEN THE ENDS OF THE TWO IN-LINE ELECTRODES (FIGURE A8).

GENERAL REQUIREMENTS




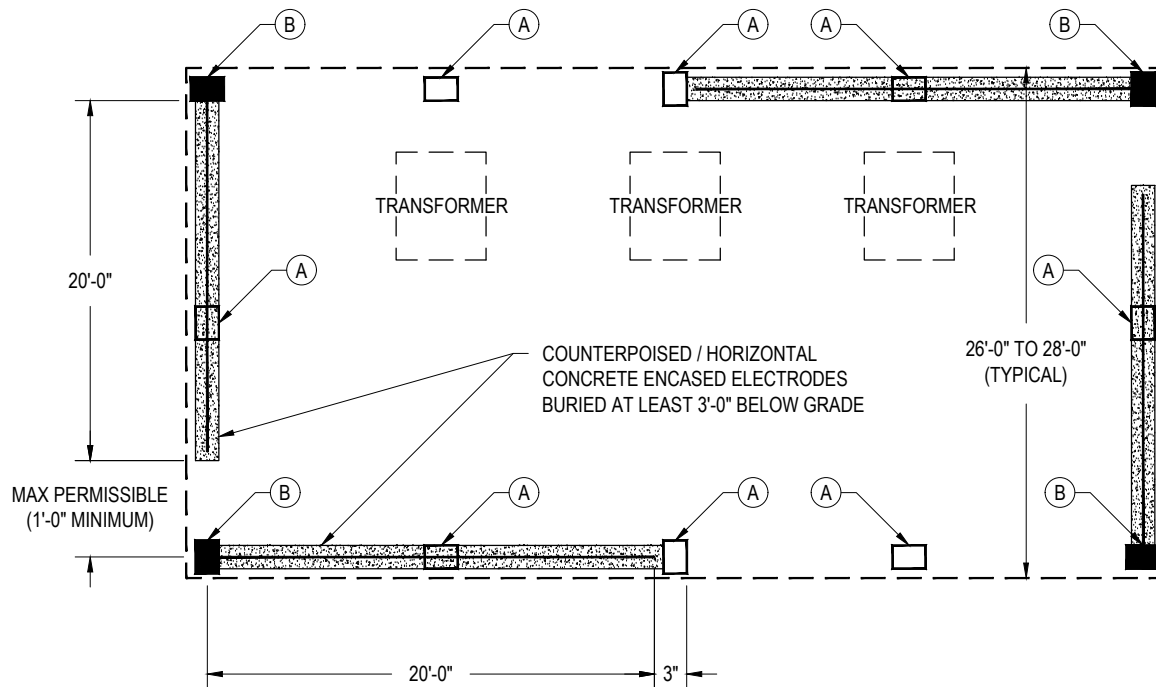
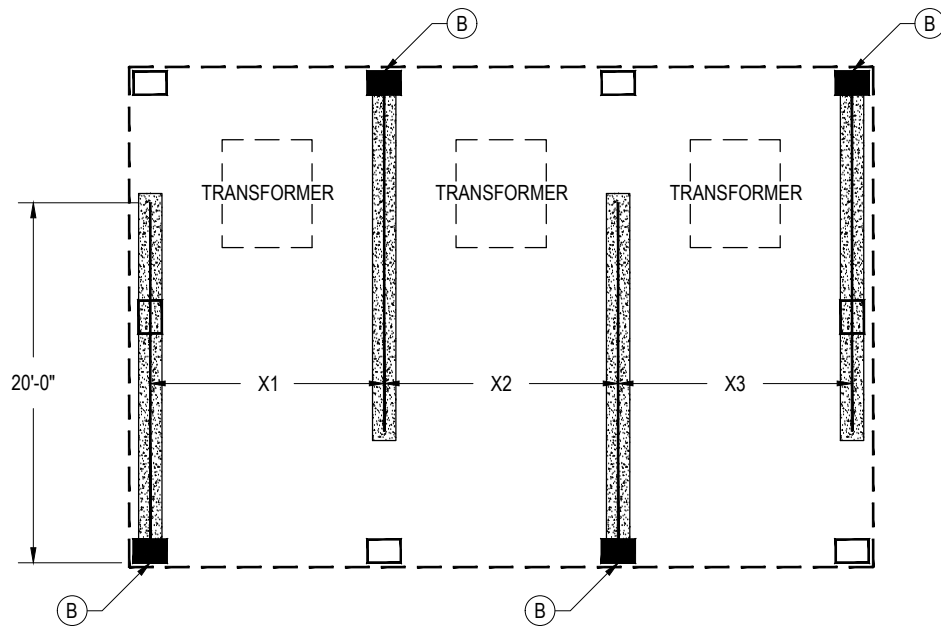
-  GROUND PLATE CONNECTED TO REBAR AS INDICATED IN UVA1.7
-  GROUND PLATE CONNECTED TO REBAR & THE GROUNDING ELECTRODE AS INDICATED IN UVA1.7
-  CONCRETE ENCASED GROUNDING ELECTRODE PLACED AT LEAST 3'-0" BELOW GRADE AS INDICATED IN UVA1.7

FIGURE A6
LOOPED CONFIGURATION (SEE NOTE A3.1)



PLAN VIEW
NOT TO SCALE

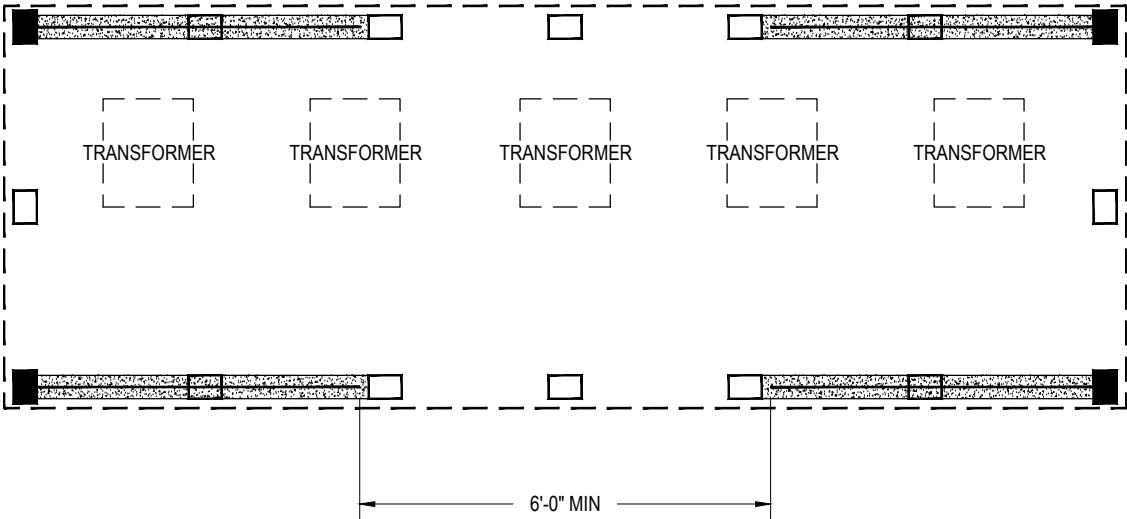
FIGURE A7
ALTERNATING CONFIGURATION (SEE NOTE A3.2)



DISTANCES BETWEEN
 ELECTRODES ARE TO BE AS
 EVENLY SPACED AS POSSIBLE
 $X1 = X2 = X3$ (9'-0" MINIMUM)

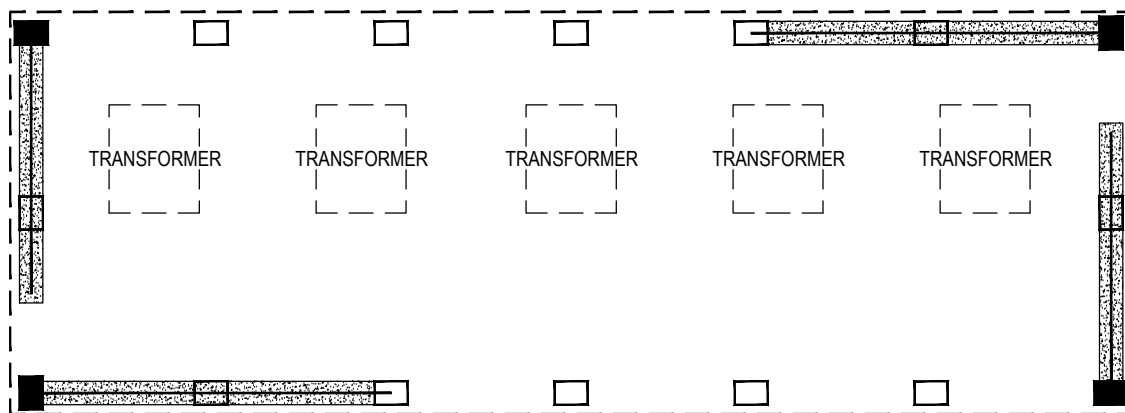
PLAN VIEW
NOT TO SCALE

FIGURE A8
PARALLEL CONFIGURATION (LARGE VAULT) (SEE NOTE A3.3)

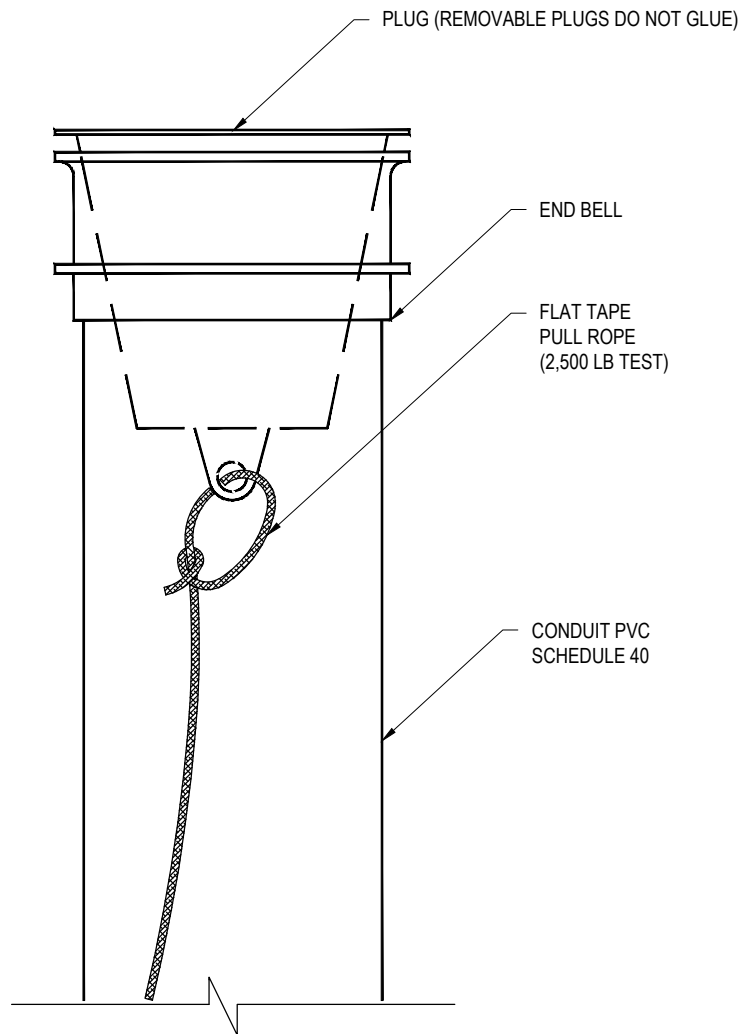


PLAN VIEW
NOT TO SCALE

FIGURE A9
LOOPED CONFIGURATION (LARGE VAULT) (SEE NOTE A3.1)



PLAN VIEW
NOT TO SCALE



| <u>kVA</u> | <u>Min. Required Natural Ventilation (Vents x Size)</u> |
|------------|-------------------------------------------------------------|
| 45 | 2 x 1ft. ² |
| 75 | 2 x 1ft. ² |
| 150 | 2 x 2ft. ² |
| 300 | 2 x 3.5ft. ² |
| 500 | 2 x 5.5ft. ² |
| 750 | 2 x 8ft. ² |
| 1000 | 2 x 11ft. ² |
| 1500 | 2 x 16ft. ² |
| 2000 | 2 x 21ft. ² |
| 2500 | 2 x 26.5ft. ² |
| 3325 | 2 x 35ft. ² |

| <u>kVA</u> | <u>LOSSES (kW)</u> |
|------------|--------------------|
| <75 | 1 |
| 150 | 2 |
| 300 | 3 |
| 300 | 4 |
| 500 | 5 |
| 750 | 6 |
| 750 | 7 |
| 1000 | 8 |
| 1000 | 9 |
| | 10 |
| 1500 | 11 |
| 1500 | 12 |
| | 13 |
| | 14 |
| 2000 | 15 |
| | 16 |
| | 17 |
| 2500 | 18 |
| | 19 |
| | 20 |
| | 21 |
| | 22 |
| | 23 |
| | 24 |
| | 25 |
| 3325 | 26 |

NOTE 1:
VENTILATION AREA DOES NOT ACCOUNT FOR ANY SPACE
OCCUPIED BY SCREENS, GRATES OR LOUVERS, WHICH
NEED TO BE DEDUCTED FROM THE TOTAL AREA.

NOTE 2:
THE MINIMUM REQUIRED VENTILATION AND MINIMUM CFM
REQUIREMENTS ARE BASED ON THE MAXIMUM INSTALLED
INFRASTRUCTURE CAPABILITY OF THE ENCLOSURE.