

Supplement to

Specifications for Electrical Installations

June 2021

(Supersedes all previous versions of ESB 754/759)

Covering National Grid's Service Areas
in Massachusetts (MA), New York (NY)
and Rhode Island (RI)

**Requirements for National Grid Equipment
in Customer Owned Vaults**

Electric Service Bulletin 754



June 2021

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1.0 INTRODUCTION

1.1 PURPOSE

This Supplement to Electric System Bulletin (ESB) 750 provides guidance for the installation of Company-owned equipment within a Customer-owned vault.

1.2 SCOPE

This supplement applies to urban areas supplied by legacy underground electric systems and where there is not exterior, at grade space to install the required Company-owned pad-mounted equipment. This supplement does not apply to services supplied by network sources or to URD / UCD developments where Company-owned equipment is installed in open areas. Network supplied services shall reference ESB 757 and URD / UCD developments shall reference ESB 759 A & B.

Required Company-owned equipment on Customer-owned or controlled property may include but is not limited to transformers and primary switches.

Not all service sizes or equipment arrangements outlined in this document can be accommodated in all locations.

Customers shall consult the Company in the early stages of a project with load information, service requirements, and applicable site plans.

1.3 LOCATIONS

This document is applicable to the urban centers where customers may be served from one of the Company's legacy underground systems.

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2.0 SERVICES FROM COMPANY EQUIPMENT ON CUSTOMER PREMISES

2.1 GENERAL

The complexity associated with the design and installation of services from Company equipment on Customer Premises necessitates consultation with the Company in the early stages of the project.

2.1.1 Project Details to be Furnished by the Customer to the Company

Project details shall include but not be limited to:

Estimated electric loading:

- Initial and projected kilowatts demand
- Kilowatts connected
- Estimated power factor

Motor information:

- Large motor or groups of motors anticipated to be started simultaneously
- Motor type and use
- Motor horsepower
- Motor currents (full load and locked rotor)

Detailed electric one-line diagram with service equipment ratings, including requested service voltage (208Y/120 or 480Y/277 volt three phase, four wire)

Site plans. The details of site plans shall include:

- The proposed location of Customer service entry equipment
- Available areas and locations of Customer-owned infrastructure that will house Company equipment

2.1.2 Project Details to be Furnished by the Company to the Customer

Project details shall include:

- Service capability
- Transformation to be installed
- Required Company equipment such as switches, metering enclosures, and reclosers
- Maximum service size in amperes at requested voltage
- Short Circuit Duty: calculated maximum symmetrical short-circuit current available at the Customer's point of attachment to Company equipment
- Customer Construction: details of facilities to be installed and maintained by the Customer for use by the Company
- Estimate of Charges: The Customer will be provided an estimate for labor and materials that are reimbursable to the Company by the Customer. This estimate will be provided after the Customer has submitted their final project design thereby allowing the Company to finalize the required labor and materials. Note: Changes to the Customer's final design may require revisions to the estimate of charges and may cause delays to the project.

2.2 LOCATION AND ARRANGEMENT OF SERVICE FACILITIES

Installations referenced in this document consist of submersible equipment. Pad-mounted equipment installations shall refer to ESB 759B and associated addendums. The determining factors for pad-mounted versus submersible equipment include but are not limited to:

- The proposed location of Company equipment plus the associated access.

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- The equipment required, which is determined by the service characteristics being requested and the existing utility electric distribution facilities at the location.
- The required rigging to install equipment.
- The electric distribution system serving the area.

2.2.1 All Vaults

Vault installations require vault style equipment and cannot be accommodated in all locations. Vault style equipment does not typically utilize its own enclosure to secure and house cables plus associated connections. Vault installations are considered in locations where the Company's preexisting infrastructure and operations platform can accommodate the required vault equipment. The Company reserves the right to determine if a vault installation will be accepted in a particular area. In areas where a vault installation cannot be accommodated, the Customer shall make provisions for the installation of Company pad-mounted equipment.

2.2.1.1 Building Vaults and Free-Standing At-Grade Vaults

Building vaults and free-standing at-grade vaults are Customer constructed, owned, and maintained structures within the interior space of the building or a separate fully-enclosed structure with the floor at grade and a roof. The interior ceiling height of a building vault or free-standing at-grade vault shall not be less than 11'-0".

2.2.1.2 Below-Grade Vaults Located Outdoors

Below-grade vaults are Customer constructed, owned, and maintained subterranean structures with the roof at grade for the installation of Company equipment. Company equipment installations and future replacements shall be performed from above the structure via removable roof panels or an entry area with doors wide and high enough for equipment access. Regardless of access for equipment installations, personnel access shall be through doors that accommodate walk-in entry and exit.

2.2.2 Location of Service

The Company reserves the right to designate the location from the public right-of-way where the Company's service enters the Customer's property. This will be determined by the location and suitability of the Company's existing facilities, as well as suitability of the location for equipment and personnel access.

2.2.3 Location of Company Equipment

The Company reserves the right to designate the location of Company Equipment.

The location of Company Equipment and the Customer's service equipment shall be as close as practical to minimize the length of secondary voltage conductors.

2.3 REQUIREMENTS, APPROVALS, AND INSPECTIONS

2.3.1 Requirements

This information is in addition to requirements of the National Electrical Safety Code, and supplements the articles concerning "Oil-Insulated Transformers" and "Transformer Vaults" in The National Electrical Code, any local requirements that may apply, and all applicable municipal and construction codes. It describes the minimum structural, electrical, and mechanical requirements for the installation of Customer-owned facilities to accommodate Company equipment. It is not intended to be a comprehensive document, and should be used only as a guide.

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2.3.2 Codes, Standards and Wiring Adequacy

The Customer's electric service equipment and its installation shall conform to the requirements of the latest edition of the National Electrical Code, all applicable local ordinances and building codes, in addition to the Company requirements and specifications stated herein. It is the Customer's responsibility to ensure that installed equipment meets all applicable ratings and the installation is certified by a design professional.

2.3.3 National Grid Review

The Customer shall submit complete final project plans to the Company for review prior to ordering equipment or beginning construction. This review is to ensure that the proposed installation conforms to Company requirements.

2.3.4 Local Authority Approval

To protect the Customer's interests as well as its own, the Company will require the Customer to furnish satisfactory evidence of meeting applicable code requirements of the vault installation prior to the Company energizing the service. This shall be in the form of approval by the Local Authority having Jurisdiction.

2.4 EASEMENT AGREEMENTS

Execution of easement(s) drafted by the Company will be required prior to the installation of any Company equipment on private property, and prior to the service being energized.

2.5 DIVISION OF RESPONSIBILITIES

The Customer is responsible for providing, installing, owning, and maintaining the following:

- Vault(s) complete with ventilation, lighting, and other accessories as required and detailed in this document
- Ducts, manholes, and conduit between the Company's facilities and the Customer's vault(s)
- Openings through building foundation or walls for conduit
- Means of equipment access
- Fire suppression system (where required by local and state building codes and fire protection code)
- Conductors between Customer service equipment and Company equipment

The Company will provide, install, own, and maintain the following:

- Transformers, primary switches, and accessory equipment
- Primary cables

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2.6 SERVICE CAPABILITY

Maximum service capability varies depending on the actual proposed service location. For each 480Y/277 volt and 208Y/120 volt service, the main switch capacity shall be limited to 3000 amperes. A 480Y/277 volt service request shall require a minimum main switch capacity of 600 amperes. The maximum number of main disconnecting devices shall be in accordance with National Grid Electric System Bulletin No 750 "Specifications for Electrical Installations".

2.7 VAULT DESIGN, LOCATION, AND ACCESS

2.7.1 All Installations

The vault shall be under the sole control of the Company. Access shall be limited to authorized Company personnel only, or other personnel with the Company's agreement and representative in attendance.

The following information provides minimum requirements for all installations and is subject to change depending on location, means of equipment access, and means of personnel access.

The vault location and means of access must be acceptable to the Company. The Customer shall provide a vault design with detailed construction plans for the Company's review. The design must be agreed upon by the Company prior to the start of vault construction.

The Customer must provide the Company a reasonable means of 24 hour-a-day, 7 days a week access to the vault. If access to the vault requires Company personnel to enter the building, the Customer must also provide the Company a reasonable means of 24 hour-a-day, 7 days a week access to the building.

The location of Company equipment on the Customer's site shall always remain accessible to Company vehicles for the installation, removal, and continued operation plus maintenance. Pavement or concrete access ways are required and shall be designed for AASHTO-H20-44 direct wheel loading.

It is the purpose of the transformer vault to isolate the transformers and other apparatus and to confine any fire that might be caused by the failure of any of the apparatus.¹ The Customer's design, construction, and maintenance of the vault structure and its appurtenances must reflect this concern of containment. Location of the vault access openings should be selected so as to minimize the possibility of injury in the event of a fire.

The vault shall be located so that it will be permanently free from moisture and other contaminants. If the vault location is subject to water accumulation or possible flooding, the Customer, at the Customer's expense, will be required to make provisions to insure that the vault floor will be free of water at all times. A sump hole in the vault is permitted and in some cases required. A sump pump permanently installed inside the vault is permitted, provided it meets Company requirements for automatic disabling in the presence of insulating fluid. If the floor is pitched towards a sump hole, pitch shall not exceed 1" in 15'.

2.7.2 Building Vaults and Free-Standing Above-Grade Vaults

Vehicular overhead clearance to the vault location of at least 14'-0" must be provided for Company service vehicles at all times. Additional overhead clearance will be required in the area around and above the vaults depending on means of equipment installation. Minimum width for vehicle access shall be at least 12'-0".

The vault shall be located at grade at an outside wall to facilitate ventilation and access. Access openings shall be located to allow truck approach for initial delivery or replacement of transformers and

¹ McPartland, F.F., et al., National Electrical Code Handbook, 18th edition, McGraw-Hill, New York, 1984.

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associated equipment. In some cases, a crane or boom truck may be required for the installation and replacement of equipment. A location at a parking or loading area is preferred. The Customer shall be responsible for installation and removal of all doors, hardware, and other obstructions as required for installation and removal of any Company equipment, both at the time of initial installation and at any time in the future as required by the Company. A clear passageway must be provided in advance of the Company scheduling equipment installation.

Refer to Vault Standard Arrangements in the Appendix for minimum access requirements for transformers and other associated heavy equipment.

Access for personnel, which may be via another route, shall be at least 3'-0" wide x 7'-0" high.

A route through the building for heavy equipment access is not recommended. Should the Customer select a route through the building for heavy equipment access, rigging costs and labor expenses incurred by the Company will be billable to the Customer.

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Refer to Table 1 and the applicable figures in the Appendix for standard vault arrangements and dimensions.

Maximum Disconnect Capacity	Maximum Transformer kVA	Maximum Primary Voltage	Service Voltage	Applicable Figures
3000 A	1000	15 kV	208Y/120V	7, 8
1200 A	1000	15 kV	480Y/277V	9, 10
1800 A	1500	15 kV	480Y/277V	11, 12
2400 A	2000	15 kV	480Y/277V	13, 14
3000 A	2500	15 kV	480Y/277V	15, 16
3000 A	1000	23 kV	208Y/120V	17, 18
1200 A	1000	23 kV	480Y/277V	19, 20
1800 A	1500	23 kV	480Y/277V	21, 22
2400 A	2000	23 kV	480Y/277V	23, 24
3000 A	2500	23 kV	480Y/277V	25, 26
2 – 3000 A	2 – 1000	15 kV	208Y/120V	27, 28
2 – 3000 A	2 – 2500	15 kV	480Y/277V	29, 30
2 – 3000 A	2 – 1000	23 kV	208Y/120V	31, 32
2 – 3000 A	2 – 2500	23 kV	480Y/277V	33, 34

Table 1 – Standard Arrangements – Transformer and Primary Switch Vaults

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2.7.3 Below-Grade Vaults

Vehicular overhead clearance to the vault location of at least 14'-0" must be provided for Company service vehicles at all times. Additional overhead clearance will be required in the area around and above the vaults depending on means of equipment access. Vaults shall be located away from building entrances where possible. Minimum width for vehicle access shall be at least 12'-0".

The vault shall have access openings located to allow truck approach with boom or crane installation for initial delivery and replacement of transformers, primary switches, and associated equipment. The area above and around all equipment access openings shall be designed for unobstructed equipment access. The Customer shall be responsible for installation and removal of all obstructions as required for installation and removal of any Company equipment, both at the time of initial installation and at any time in the future as required by the Company. A clear passageway must be provided in advance of the Company scheduling equipment installation. Hinged openings for equipment access shall adhere to National Grid standards and specifications. A list of approved vendors can be provided upon request.

Access for personnel into a Below-Grade Vault shall be through doors and stairways. Hinged openings and ladders for personnel entry are not acceptable due to switching safety requirements for the type of equipment in the vault. Doors for personnel entry shall be at least 3'-0" wide x 7'-0" high. A minimum of two (2) means of personnel entry is required.

Below-grade vaults require equipment arrangements and dimensions as shown in Section 2.7.2, Table 1 (Standard Arrangements - Building Vaults and Free-Standing Above-Grade Vaults). Refer to Table 2 for minimum access requirements for transformers, primary switches, and associated equipment. The dimensions in Table 2 are applicable for removable sections in the roof of the vault. The removable roof sections shall be accessible with a boom or crane from above. Lifting provisions shall be provided by the Customer and reviewed by the Company in advance of fabrication.

Transformer Unit Maximum kVA	Maximum Primary Voltage	Service Voltage	Minimum Clear Opening for Equipment Access (width x length)
1000	15 kV	208Y/120V	6'-0" W x 9'-4" L
1500	15 kV	480Y/277V	6'-2" W x 10'-0" L
2000	15 kV	480Y/277V	6'-10" W x 10'-9" L
2500	15 kV	480Y/277V	7'-4" W x 12'-0" L
1000	25 kV	208Y/120V	6'-1" W x 10'-1" L
1500	25 kV	480Y/277V	6'-8" W x 10'-5" L
2000	25 kV	480Y/277V	7'-4" W x 11'-7" L
2500	25 kV	480Y/277V	7'-11" W x 12'-9" L
1000	35 kV	208Y/120V	6'-4" W x 10'-9" L
1500	35 kV	480Y/277V	6'-11" W x 11'-1" L
2000	35 kV	480Y/277V	7'-11" W x 12'-0" L
2500	35 kV	480Y/277V	8'-6" W x 12'-11" L

Table 2 – Minimum Equipment Access Requirements for Below-Grade Vaults with Removable Roof Sections

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Below-Grade Vaults without removable roof sections require a “landing area” in front of equipment access doors. This landing area shall be accessible with a boom or crane from above. Required equipment landing area dimensions are specified in Table 3.

Transformer Unit Maximum kVA	Maximum Primary Voltage	Service Voltage	Landing Area for Equipment Access (width x length)
1000	15 kV	208Y/120V	10'-6" W x 13'-4" L
1500	15 kV	480Y/277V	10'-8" W x 14'-0" L
2000	15 kV	480Y/277V	11'-4" W x 14'-9" L
2500	15 kV	480Y/277V	11'-10" W x 16'-0" L
1000	25 kV	208Y/120V	10'-7" W x 14'-1" L
1500	25 kV	480Y/277V	11'-2" W x 14'-5" L
2000	25 kV	480Y/277V	11'-10" W x 15'-7" L
2500	25 kV	480Y/277V	12'-5" W x 16'-9" L
1000	35 kV	208Y/120V	10'-10" W x 14'-9" L
1500	35 kV	480Y/277V	11'-5" W x 15'-1" L
2000	35 kV	480Y/277V	12'-5" W x 16'-0" L
2500	35 kV	480Y/277V	13'-0" W x 16'-11" L

Table 3 – Equipment Landing Area Requirements for Below-Grade Vaults without Removable Roof Sections

2.8 CONSTRUCTION

2.8.1 Company Requirements, Specifications, and Inspection

The Customer shall refer to the Company's "Specifications for Electrical Installations Underground Commercial Distribution (UCD) Installation and Responsibility Guide" (Electric System Bulletin No. 759B) for requirements and standards for the following:

- Concrete Specifications
- Conduit Construction
- Approved Material - conduit and accessories, manhole frames and covers

All phases of construction must be inspected by the Company and must meet Company requirements prior to the installation of any Company equipment. See also "Construction Inspection" section in this document for further details.

2.8.2 Foreign Structures

Pipes, duct systems, or other items foreign to the vault electrical installation shall not enter or pass through the vault. Systems enclosed in concrete, masonry, etc., to the applicable thickness specified in "Walls, Roof, and Floor" section of this document are not considered to be in the vault provided there is no interference in operation, maintenance, or construction of the vault. All such cases must be submitted to the Company for review.

2.8.3 Code Requirements

It is the Customer's responsibility to determine that the fire rating of the vault will meet all applicable codes and regulations for Less-Flammable Liquid-Insulated equipment in a building.

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Although the following structural requirements are believed to be conservative, it is the customer's responsibility to determine that the vault will meet all national and local structural codes with the consultation of a licensed design professional.

2.8.4 Walls, Roof, and Floor

2.8.4.1 Building Vaults and Free-Standing Above-Grade Vaults

The quality of materials used in vault construction shall be of approved grade, as determined by the applicable codes and Company requirements. Building walls and floors (new or existing) meeting the following requirements may serve as part of the vault.

The vault in its entirety shall have a fire rating of three hours, minimum.

Walls shall be solid masonry or concrete construction and free of holes, deep scars, cracks, or other breaks. All concrete work shall conform to ACI 318-11; all masonry work shall conform to ACI 530-11.

All walls shall be structurally connected to the floor and ceiling.

Walls up to a maximum of 16' in height shall be constructed to the following minimum standards.

- 4500 psi Concrete – 6" thick reinforced with #5 bars @ 10" grid (Figure 35 in the Appendix)
- 4500 psi Concrete – 8" thick reinforced with #4 bars @ 10" grid (Figure 36 in the Appendix)
- CMU – 12" thick, fully grouted, reinforced with 2 - #4 bars @ 8" OC (Figures 37 & 38 in the Appendix)

Walls greater than 16' in height will require a design specific to the installation by a design professional.

The floor of a building vault or free-standing above grade vault located with supporting soil directly below it shall be constructed to the following minimum construction standards:

- 4500 psi Concrete – 6" thick reinforced with #4 bars @ 12" grid (Figure 39 in the Appendix)

If a vault does not have supporting soil below the floor, in the case of a building vault located directly above the basement level, a structural design professional shall be consulted to design new or verify the adequacy of the existing floor for the proposed vault location and company equipment.

Any portion of a vault roof located at grade and outside shall meet the requirements of section 2.8.4.2. The roof of building vaults located indoors shall meet applicable local codes and a 3-hour fire rating. Gypsum board shall not be used to achieve the 3-hour fire rating.

The roof of free standing above-grade vaults shall meet a 3-hour fire rating, minimum. A licensed design professional shall be consulted for the structural design of the roof specific for the environmental loading conditions in accordance with ASCE-7-10 "Minimum Design Loads for Buildings and Other Structures" and applicable local building codes.

Floor criteria listed above will not exempt free standing above-grade vaults from meeting foundation depth and frost-protection requirements in accordance with national and local building codes.

2.8.4.2 Below Grade Vaults Located Outdoors

Below-grade vaults located outdoors shall be constructed with reinforced concrete with a minimum thickness of 12". When applicable, location of removable access panels for equipment installations shall be specified by the Company's Engineer. Partition walls built to create a below-grade sidewalk vault from former basement space shall conform to the requirements of building vaults.

All covers, grating, and removable panels located at grade shall be designed to meet H-20 tractor-trailer loading requirements as outlined in Figure 40 in the Appendix.

All steel grating and field covers shall have anti-slip surface treatment in compliance with coatings such as "Safety Sure Grip" / GALVAGRIT™ Specification on in the Appendix.

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2.8.5 Pulling Eyes

The customer shall equip the vault with pulling-eyes in locations specified by the Company. All materials shall be in accordance with the Company's Construction Standards and Material Standards.

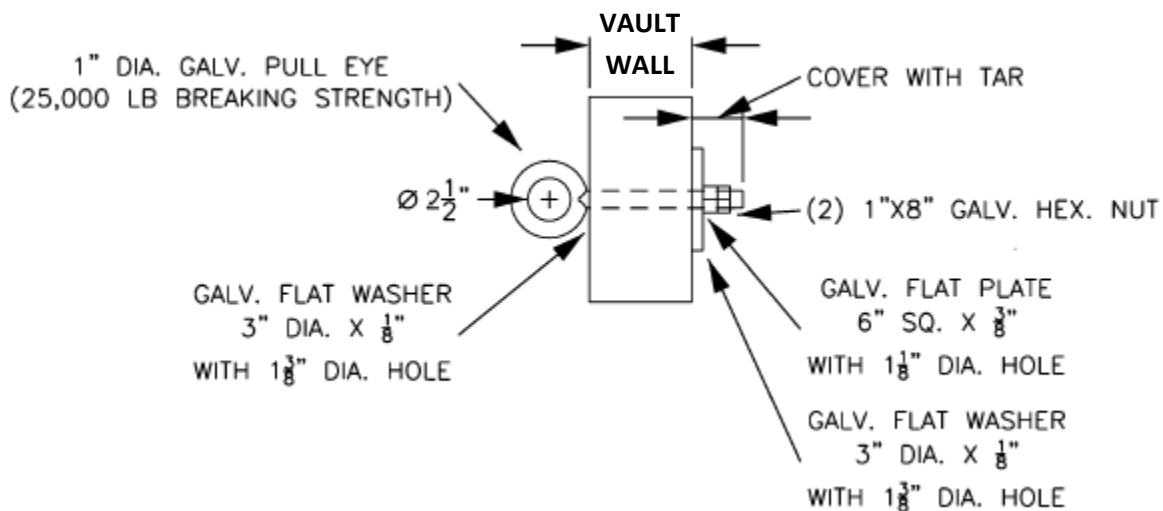


Figure 1 – Typical Pulling Eye Detail

2.8.6 Floor, Ceiling, and Wall Loading (Weights)

The weight of the Company's equipment must be supported in the final locations and in all other locations that might arise during initial installation and future maintenance. Provisions shall be made to support the maximum transformer that would be installed in the vault, even though the initial transformer installation may be less than maximum. Weights of standard units are provided in Table 4. In addition to consideration of transformer weights, planning for primary switches weighing 1500 pounds is required.

The Customer may be required to provide wall, ceiling, and floor penetrations to accommodate miscellaneous Company equipment or supports. The Customer may also be required to provide and install anchors, rods, and channel strut to support Company cables and other miscellaneous equipment. Locations and maximum weights to be supported will be specified by the Company.

Service Voltage	Primary Voltage	Transformer kVA	Maximum Weight per Unit
208Y/120V	Up to 23 kV	Up to 1000	16,000 lb
480Y/277V	Up to 23 kV	Up to 1000	16,000 lb
480Y/277V	Up to 23 kV	1500	18,000 lb
480Y/277V	Up to 23 kV	2000 & 2500	28,000 lb

Table 4 – Transformer Weights

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2.8.7 Doors (All Vaults Building Vaults and Free-Standing Above-Grade Vaults)

Type of doors must be as approved for Class A situations in accordance with National Fire Protection Association for protection of openings in walls and partitions against fire. Doors shall be set in a metal frame, with the metal rabbeted all around and held tight in rabbet by a fire-rated latch and strike.

Additional door hardware required is as follows: (a) butt hinges with non-removable pins, (b) automatic door closer, (c) panic bars on vault side of doorways to allow quick egress, and (d) lock sets to accept the Company's standard cylinder, which will be furnished by the Company.

1. Double door arrangements can either have panic hardware installed on one door with an inactive / fixed second door if egress requirements allow, or both doors can be equipped with panic hardware if equipped with a removal post / stanchion.
2. Depending on service area and application, the Company's standard cylinder will be either a Wilson Bohannon (WB) cylinder or a Best®, figure eight, seven pin cylinder.
3. The number, location, and clear opening of doors required will be specified by the Company. Refer to Figures 7 through 34. Additional doors for personnel access may be required and shall be a minimum of 3'-0" wide x 7'-0" high.

Doors shall be hung on 3 hinges per door (minimum), or 3 hinges per leaf (minimum) if a double door, and shall open out from the vault. Doors shall fit closely in the door frame and be secure and immovable when closed. Door sills shall be located 6" above the vault floor.

Identifying signs will be furnished and installed by the Company on the outside of all vault doors and adjacent walls.

The Customer shall be responsible for internally lit exit signs as required by local applicable codes.

The doors shall have the same UL approved fire rating as the wall in which the door is installed.

2.8.8 Stairways (Below-Grade Vaults)

Personnel access to-Below-Grade Vaults requires stairways and shall comply with OSHA 1910.25 for "Stairways" and OSHA 3124 for "Stairways and Ladders". Areas outside the vault for equipment access can also be used for personnel access if appropriate stairways and door entries are provided.

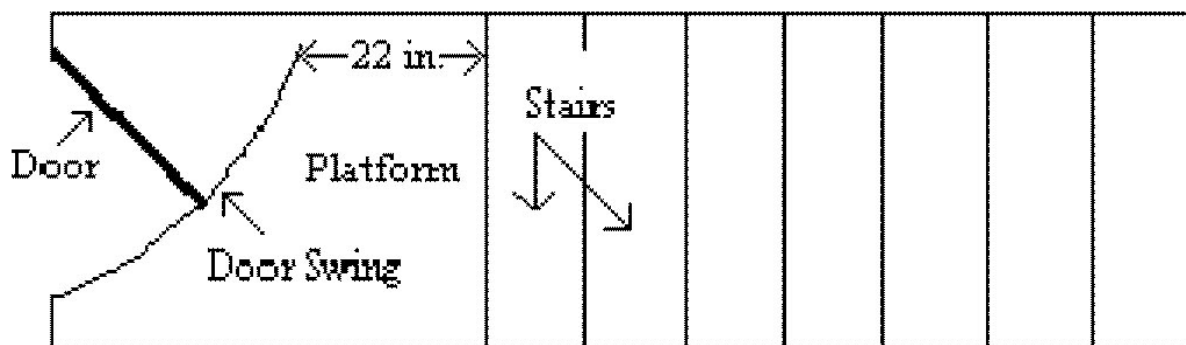


Figure 2 – OSHA Figure D-7 (1910.25) – Door or Gate Opening on Stairway

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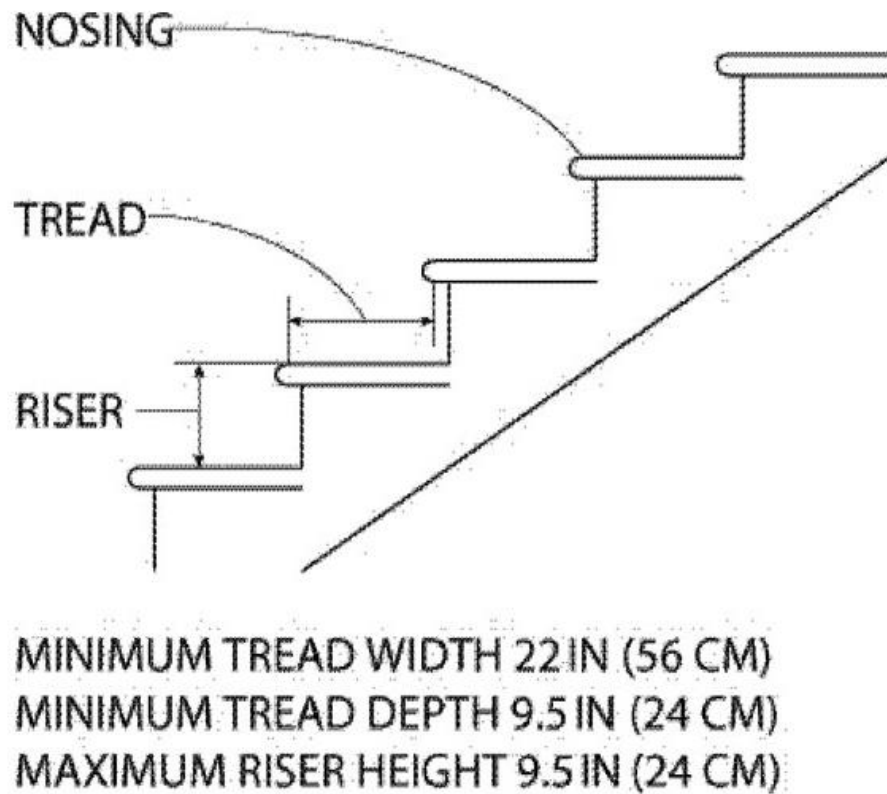


Figure 3 – OSHA Figure D-8 (1910.25) – Dimensions of Standard Stairs

2.8.9 Lighting and Convenience Outlets

The Customer shall install, maintain, and provide energy for a lighting system and 120 volt duplex convenience outlets in the vault. The lighting system and outlets shall be supplied from dedicated branch circuits (30 amperes minimum) which shall be clearly labeled as “Utility Vault” at the Customer’s distribution panel. Locations of lamps and convenience outlets shall be shown on the Customer’s vault design and shall be reviewed by the Company. A switch shall be mounted on the inside wall at every access point so that the lights may be turned on or off at any point of entry. A red pilot lamp connected so as to light when vault lighting is on shall be located outside the vault and shall be visible at all entrance doors. All electrical wiring shall be housed in rigid electrical conduit or electrical metal tubing. Covers of conduit fittings shall be gasketed.

Lighting and power systems installed in below-grade vaults located outdoors shall use materials suitable for the environment.

Wall-mounted fixtures are required for below-grade vaults, and are preferred for all other locations. Fixtures shall be equipped with a globe, guard, and a standard-base 120 volt lamp. Ceiling-mounted fixtures with a standard-base lamp are an alternative for areas remote from live parts if fixture height is not more than 11’-0” and there is no interference with Company equipment or access hatchways. Fixture heights in excess of 11’-0” may be allowed for certain applications, but require advance review by the Company’s engineer.

In the event the Customer’s fixtures are not standard base and do not accommodate the Company’s standard bulbs, the Customer will be required to provide all replacement bulbs, including a supply of spare bulbs at the time of initial installation.

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Lighting shall be designed for a minimum of 10 foot-candle illumination. Light fixtures shall be placed and have provisions to reduce glare for company personnel. Lighting diffusers may be required depending on type of lighting selected and placement.

2.8.10 Ventilation

2.8.10.1 Natural Ventilation

Natural ventilation shall be used only when a vault roof can be utilized to exhaust heat. Vent openings in the roof of a below-grade structure can also serve as equipment access hatchways. In this case, the openings shall be in accordance with the Company's Construction Standards and Material Standards for precast vaults (provided upon request). Openings shall have net free air space as follows:

Maximum Disconnect Capacity	Maximum Transformer kVA	Service Voltage	Minimum Ventilation Net Free Air Space (in ²)
3000 A	1000	208Y/120V	3240
2 – 3000 A	2 – 1000	208Y/120V	6480
1200 A	1000	480Y/277V	3000
1800 A	1500	480Y/277V	4500
2400 A	2000	480Y/277V	6000
3000 A	2500	480Y/277V	7500
2 – 3000 A	2 – 2500	480Y/277V	15000

Table 5 – Required Natural Ventilation

The Customer is responsible for insuring the design meets all applicable local and state building code and fire protection codes. The ventilation design shall be submitted to the Company for review, and the Customer shall submit ventilation calculations for the Company's records.

2.8.10.2 Air Conditioning

Air conditioning of transformer vaults is permitted. A vault air conditioning system shall be separate from the building system and shall be in accordance with state and local codes.

2.8.10.3 Forced Ventilation

The Customer will, at the Customer's expense, install, maintain, and provide energy for a forced air, thermostatically-controlled ventilation system designed to move outside air through the vault.

Extreme caution must be exercised in the design, routing, and installation of forced ventilating systems. Exhaust openings to outside walls should not be located adjacent to other openings that serve or could serve as air intakes. Exhaust openings should be located as far as possible from doors, windows, fire escapes, and combustible material, and at an adequate elevation above grade.

Duct facilities should not be routed through areas where system leaks (possibly initiated by explosion) could result in the escape of potentially toxic gases or residue to occupied areas. Vaults located below grade must have forced intake and natural exhaust.

Intake and exhaust openings shall be equipped with rustproof metal louvers and 1/2" mesh rustproof screens where they meet the outside air. The exhaust ducts shall be located high in the vault and the intake ducts low; both suitably spaced to provide air circulation around all transformers. Fire dampers,

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when required by local and state building code and fire protection code, shall be a minimum of #10 gauge galvanized steel constructed in accordance with ANSI/UL 555 "Standard for Fire Dampers." Fire damper fuse links shall allow dampers to fall or rotate closed in the event of fire, and not as a result of excessive transformer temperature. In addition, the dampers shall be arranged so that operation of the blower does not hold them open.

Ventilation capacity is to be furnished for the maximum capacity of the vault, even though the initial transformer installation may be less than maximum capacity.

Ventilation design shall be based on the following.

- Heat dissipation rates shall be as listed in Table 6
- Maximum ambient temperature of the vault shall not exceed 104°F near the transformers, and average ambient temperature for any 24-hour period shall not exceed 86°F;
- An adjustable thermostatic control shall be provided for automatic operation, with a manual on/off switch. The thermostat shall be set to start the fan at 86°F and stop at 80°F, but the maximum temperature limits shall not be exceeded;
- Power supply to the blower shall be connected from the load side of the Customer's meter. Thermostatic controls and the manual on/off switch shall be located inside the vault near the door. Controls for vault ventilation shall be separate from other building controls and only controlled from within the vault. A safety switch shall also be located inside the vault if allowed by local code. All other ventilation equipment shall be located externally.
- An audible alarm shall be installed at a location normally attended by Customer Building Maintenance Personnel such that if the system fails to operate as designed, the alarm shall be actuated. The Customer shall promptly make repairs to prevent damage to the Company's equipment.
- All Below-grade vaults (building and exterior) shall have forced intake and natural exhaust, to provide positive pressure.

The ventilation design shall be submitted to the Company for review, and the Customer shall submit ventilation calculations for the Company's records.

Service Voltage	Single Service Size	Heat Dissipation Rate (BTU/min)
208Y/120V	≤ 3000 A	1200
480Y/277V	≤ 2000 A	1200
480Y/277V	2001 A - 3000 A	1350

Table 6 – Required Vault Heat Dissipation for Forced Ventilation

2.8.10.4 Vaults without Transformers

Vaults without transformers shall have a minimum ventilation rate of 0.40 CFM per ft² of vault floor area.

2.8.11 Conduit and Equipment Foundations

The Customer will, at the Customer's expense, install a conduit system from two feet inside the property line to the vault. Penetration of any building walls or footings is the responsibility of the Customer. The Company will specify locations and sizes of conduits for incoming cables. All conduit and foundations for the ultimate vault arrangement must be installed at the time of initial vault construction. Conduit shall be rigid galvanized steel where it penetrates building walls or footings, and in other locations shall be rigid galvanized steel or concrete-encased PVC. Conduit shall be installed

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with vertical bends having a radius of not less than 36". The Customer's design shall be submitted to the Company for review.

Refer to the Company's ESB 759B for additional conduit construction requirements.

2.8.12 Construction Inspection

Inspection by the Company is required for construction of the vault and all work pertaining to the vault. All ground grids, foundations, and related conduit must be inspected by a representative of the Company before concrete is poured. The Customer is to contact a representative of the Company at least two working days prior to the start of construction to arrange for a preconstruction meeting.

Refer to the Company's ESB 759B for additional construction inspection requirements.

2.8.13 Fluid Volume and Liquid Curb (Building Vaults and Free-Standing Above-Grade Vaults)

An effective liquid curb at least 6" high will be installed as part of the vault design; all conduits and floor and wall penetrations will terminate above that level. Door sills are acceptable as part of the liquid curb.

Volumes of fluid for the largest transformers that could be installed in the vault are provided in Table 7.

Service Voltage	Primary Voltage	Transformer kVA	Fluid Volume per Transformer. (gal)
208Y/120V	Up to 15 kV	Up to 1000	400
208Y/120V	23 kV	Up to 1000	500
480Y/277V	Up to 15 kV	Up to 1500	500
480Y/277V	Up to 15 kV	2000 & 2500	650
480Y/277V	23 kV	Up to 2500	650

Table 7 - Fluid Volume

2.8.14 Audible Sound Levels

Should the Customer be concerned about any possible undesirable sound or vibration transmission to other portions of the building, any soundproofing is the Customer's responsibility. Should the Customer desire to support the transformers on soundproofing devices, any device should be fabricated so as not to exceed 2" thickness and so that it will hold its dimensions over time given the weights involved and variation in vault temperature.

Transformers are designed so that the average sound level does not exceed values specified in the current issue of IEEE/ANSI C57.12.24 for submersible three-phase transformers.

2.8.15 Sealing of Customer Conduits

The Customer shall seal conduits containing Customer owned conductors and empty / spare conduits with a fire stop sealant consistent with the vault three hour fire rating and applicable codes.

2.9 FIRE SUPPRESSION SYSTEMS

Where required by the local and state building code and fire protection code, the Company will permit a water fire suppression system to be installed in the vault provided the Customer is responsible for and insures the following conditions are met.

2.9.1 Design and Installation

The system must take into consideration the locations of Company equipment. The system shall be designed and installed so that there is no interference in the construction, operation, or maintenance of

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the vault or equipment therein. Location of all pipes, detectors, sprinkler heads, and nozzles must not interfere with any of the Company's electrical equipment or access thereof. The system must be designed so that it can be maintained without removal, relocation, or de-energizing of any Company equipment.

The Customer's proposed design for any fire protection system must be submitted to the Company for review. The design must be reviewed and agreed upon by the Company prior to the start of vault construction. Information must be site specific and plans must be provided showing location of detectors and sprinkler heads or nozzles. All plans must be drawn to scale and fully dimensioned, and the Company's equipment must be accurately located on the plans. Information must include type of system and a complete step-by-step description of the system's sequence of operation, including means of fire detection and number of devices required to be in alarm before the system actuates.

The suppression system shall be a supervised double-interlock cross-zoned pre-action system. A pre-discharge alarm shall be provided inside the vault to indicate that water has entered the system.

The system shall be dedicated for protection in the vault area only and pipes shall not fill for an event in areas other than the vault.

2.9.2 Construction

All construction must conform to the design drawings reviewed and agreed to by the Company, and must be inspected by a representative of the Company as it pertains to the Company's vault equipment before the system is placed in service. The Company's engineer must review and agree to any proposed deviation from plans already reviewed and agreed to by the Company.

2.9.3 Variances

Should a Code variance be required for any reason, it is the Customer's responsibility to obtain such variances from appropriate authority having jurisdiction and provide written notice to the Company.

2.9.4 Easement Language

Language concerning any fire suppression system will be included in the Company's standard vault easement agreement (see "Vault Easement Agreement" section in this document) and will include, but may not necessarily be limited to, the following.

- The Customer assumes sole responsibility for proper operation of the fire suppression system.
- The Company assumes no liability for any result or consequences of a fire suppression system that has the potential to apply water on an insulating fluid fire.

The Customer shall indemnify and hold the Company harmless for any damages resulting from operation, misoperation, or inadvertent system discharge of a fire suppression system. Should the system misoperate or discharge unnecessarily, the Customer will be responsible for damage to the Company's equipment and any cost for vault cleanup, as well as Company representative in attendance required while the Customer is working in the vault.

2.10 ELECTRICAL

2.10.1 Grounding

The following grounding criteria are for the sole purpose of grounding Company-owned equipment in the vault. In all instances vault grounding shall be tied to the same ground system as customer's main. Connection from that building ground system point of origin to the vault ground system shall consist of two (2) 500 kcmil copper 600 volt insulated conductors. The 500 kcmil conductors shall be installed in galvanized steel conduit provided by the customer. The 500 kcmil shall be terminated to a ground bus

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installed in the transformer vault as shown in Figure 4. The vault ground bus shall also be connected to the vault ground loop shown in Figure 4.

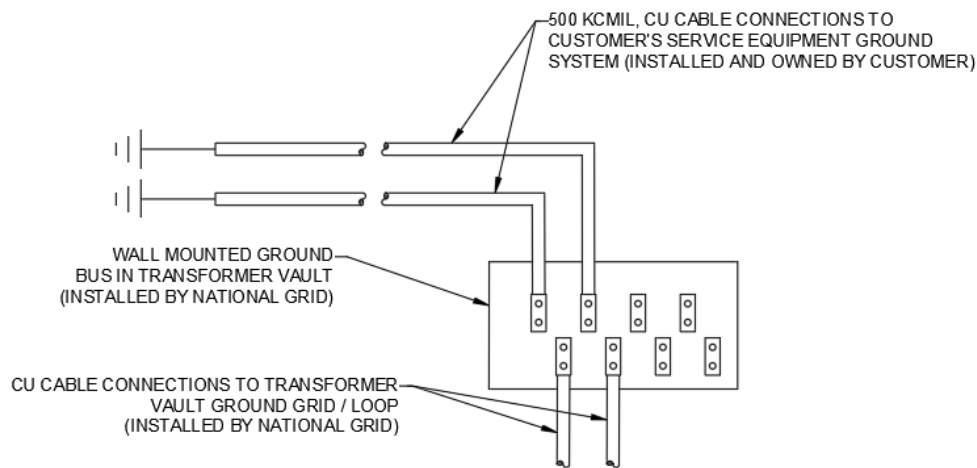
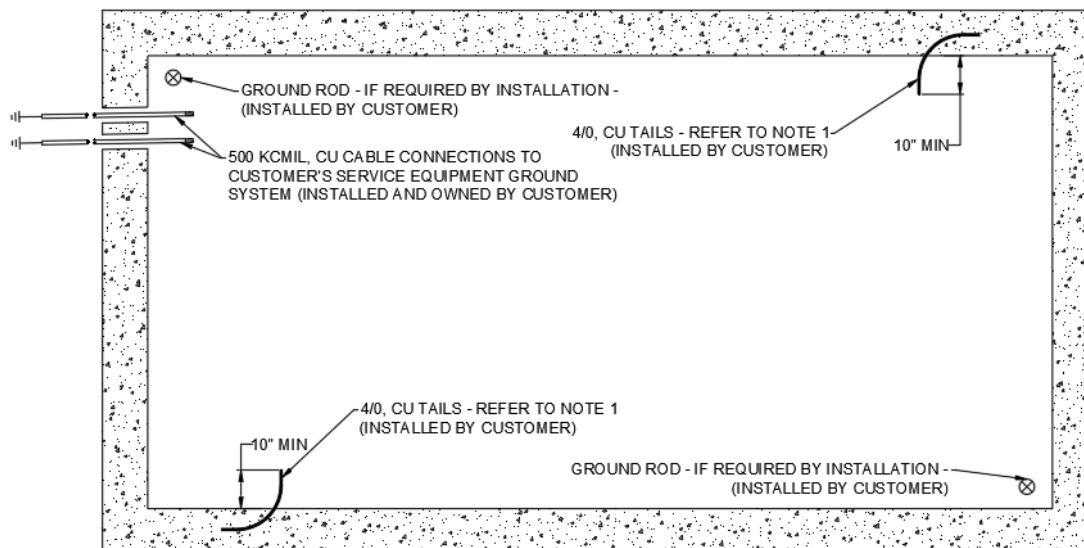


Figure 4 – Vault Ground Bus

Additionally pigtails shall be taken from the structure's reinforcing steel or building steel as shown in Figure 5.



Note 1 – Minimally two 4/0 tails bonded to the building steel or vault rebar are required. Additional 4/0 tails may be required for vaults that are cast with separate floor sections. Ground bonding shall connect floor and all wall sections. Epoxy coated rebar is not allowed.

Figure 5 – Vault Grounding Loop Plan View

The Customer shall suitably ground incoming conduits and ventilating and convenience outlet systems as required by applicable codes.

The customer shall bond all customer owned and installed equipment in the vault.

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2.10.2 Interrupting

The calculated maximum symmetrical three phase short-circuit current available at the Customer's point of attachment to the Company's equipment in the proposed vault for a zero impedance fault for service voltage and service capability is shown in Table 8.

Service Voltage	Maximum Service Capability	Maximum Available Short Circuit Current (calculated symmetrical amperes)*
208Y/120V	≤ 3000 A	55,000
480Y/277V	≤ 1200 A	25,000
480Y/277V	1800 A	34,000
480Y/277V	2400 A	46,000
480Y/277V	3000 A	57,000
*Calculated at the customer connection with Company owned equipment (Refer to Division of Responsibilities section)		

Table 8 – Available Short Circuit Current

2.10.3 Secondary Conductors and Construction

The Customer is responsible for installing secondary service conductor and conduit into the vault, and for providing a method of attachment to the Company's equipment in the vault. Review by the Company will be required in advance. Point of connection will be at the Company's equipment. Attachment and final torqueing of secondary lugs will be by Company personnel.

The Customer shall provide the required connectors. Terminal lugs shall be compression-type, long barrel, with a two-hole pad having standard NEMA drillings (two holes sized for 1/2" bolts, spaced 1-3/4" on center). Maximum lug width shall be 2". Connectors, bolts, nuts, flat washers and lock washers will be supplied by the Customer. Point of connection will be at the Company's equipment.

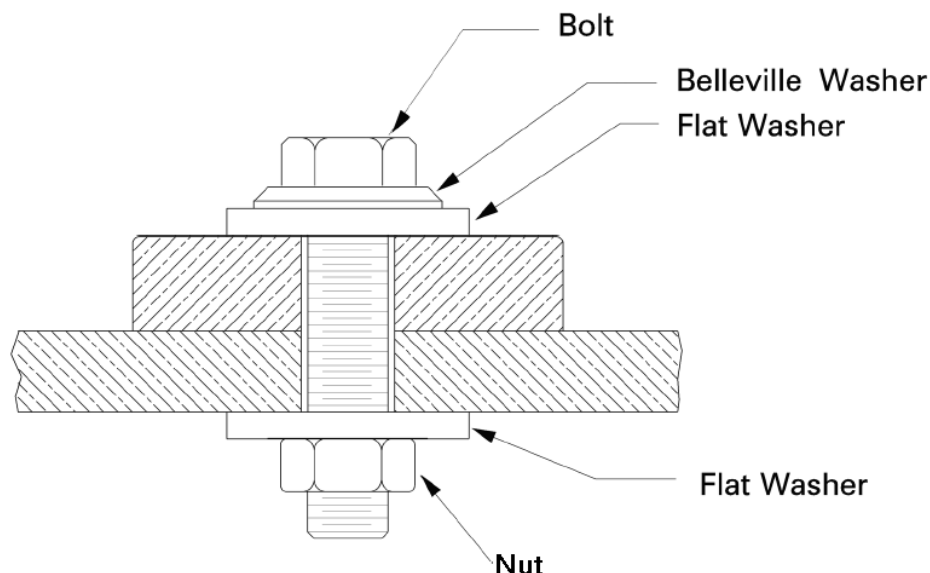


Figure 6 – Secondary Connections

The proposed location of the Customer's secondary conduits must be reviewed by the Company in advance of construction. Conduits must be located such that adequate vertical and horizontal clearance to the Company's equipment is maintained, conduits will not present an obstruction to movement in the vault, and adequate working space is maintained.

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The maximum number of secondary cable sets that can be accommodated for connection to National Grid's 500 kVA to 2500 kVA three phase transformers is limited to 10 sets of 600 kcmil or 8 sets of 750 kcmil. Spade terminals for connection of secondary cables are mounted on the top of the transformer unit. For installations where transformer capacity is less than 500 kVA, the customer shall consult with the Company for the maximum number of secondary cables that can be accommodated.

For all installations the customer shall provide cable supports with cable support insulators for their cables such that transformer terminals are not loaded by the weight of hanging cable.

2.11 METERING

Refer to ESB 750 for all installations.

2.12 VAULT MAINTENANCE

Should the vault or any Customer-owned systems associated with the vault require maintenance or repair, it will be brought to the attention of the Customer who shall promptly make repairs with a Company representative in attendance.

2.12.1 Qualified Personnel

Should repairs to or inspection of Customer-owned equipment require the Customer's representative to enter the vault, it is the Customer's responsibility to provide personnel qualified to perform the required maintenance, and qualified and properly equipped to enter the vault space in accordance with applicable regulations, including OSHA regulations for enclosed space entry.

2.12.2 Customer Access to Company-Controlled Spaces within Customer-Owned Facilities

The Company's control of electric spaces in Customer-owned electric facilities is for the sole purpose of protecting the integrity of the Company's energy supply and security of the utility metering equipment. Any billable Company costs to facilitate Customer access to the vault shall be determined by the Company's filed tariff. In these requirements, "Customer" refers to the Customer or their agent. Under this and all other policies, it is expected and it is the Customer's responsibility to provide a qualified person as defined in the National Electrical Code and any other applicable codes.

1. The Company can provide isolation and tagging (and grounding upon customer request), if requested, at the Company's primary isolation point on the supply line ahead of the Customer's service equipment. However, the Customer is solely responsible for the protection of personnel who work on Customer equipment.
2. When the Customer does not require isolation and tagging on the supply line and needs access to Company-controlled electrical spaces for their maintenance purposes, the Company in its sole judgment may determine the ability to grant access to the Customer for the duration established by the Company. When granted, the Company will witness the Customer's placement of their lock immediately after the removal of the Company's lock. Upon notification by the Customer that their work is complete, the Customer shall relinquish access back to the Company and the Company's lock shall be placed immediately upon the removal of the Customer's lock. In each case the transfer shall occur in the presence of both parties. The Company will check its electrical equipment for any signs of tampering.

In the event that the required access is of short duration and the Company's representative remains on site to avoid a second trip to the site, it is understood they are doing so without any supervisory or oversight capacity relative to the Customer.

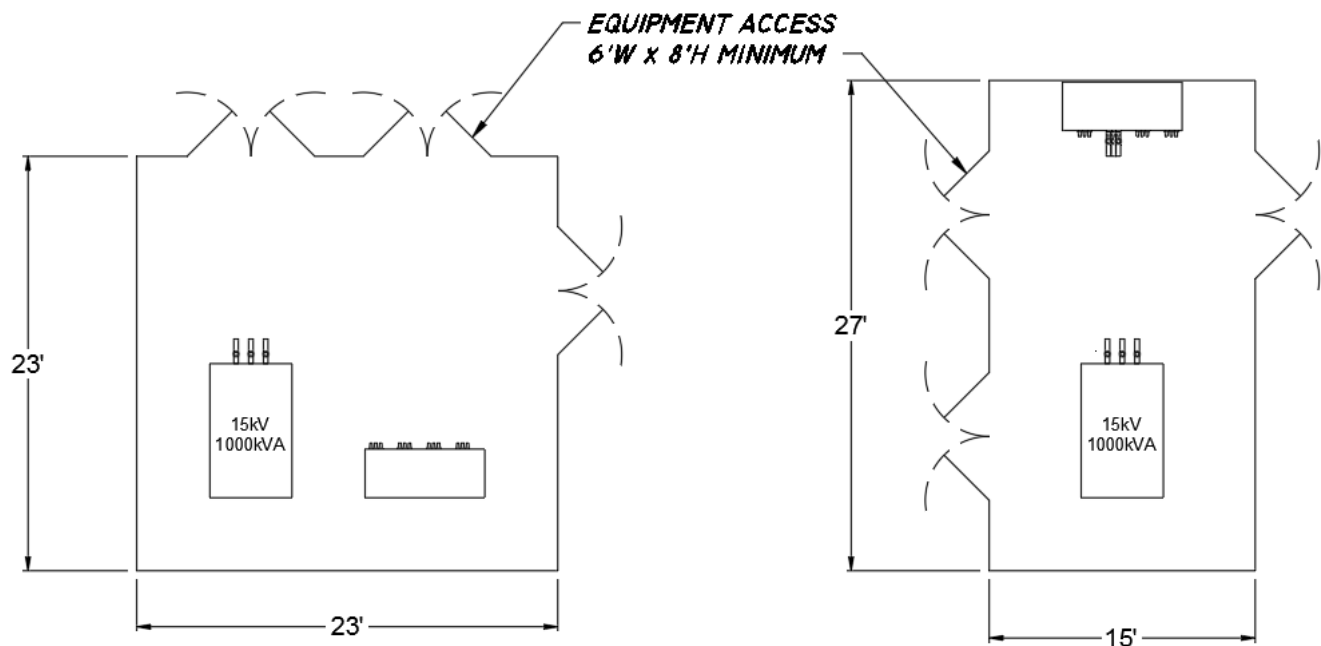
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3.0 Appendices

3.1 VAULT STANDARD ARRANGEMENTS

STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT

1-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 208Y/120V, UP TO 3000 A, 15 KV PRIMARY



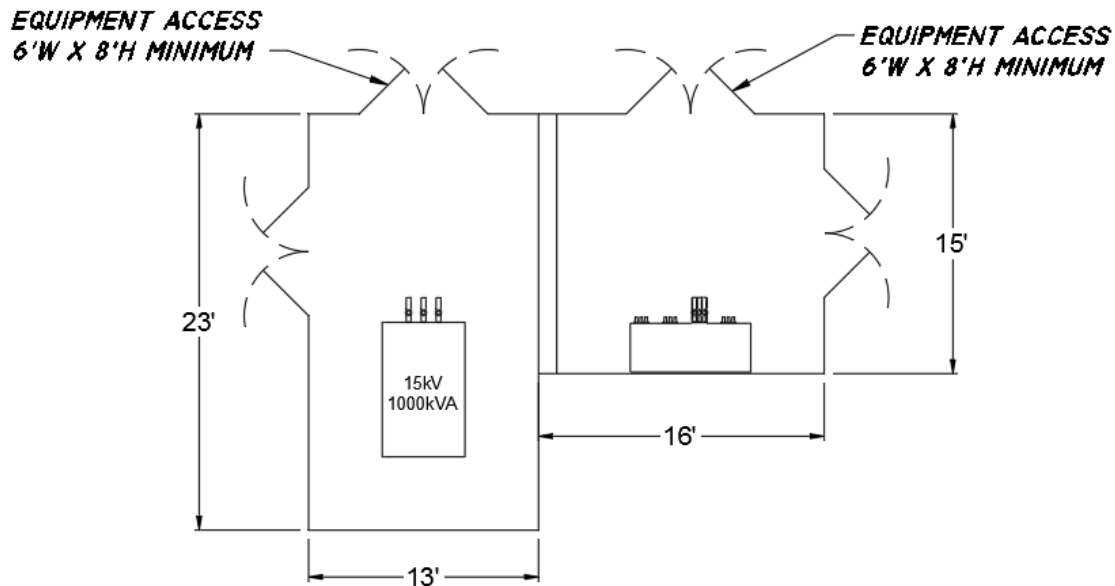
NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 7 – Vault Standard Arrangement, 208Y/120V Service, up to 3000 A, 15 kV, Transformer and Primary Switch

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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
208Y/120V, UP TO 3000 A, 15 KV PRIMARY

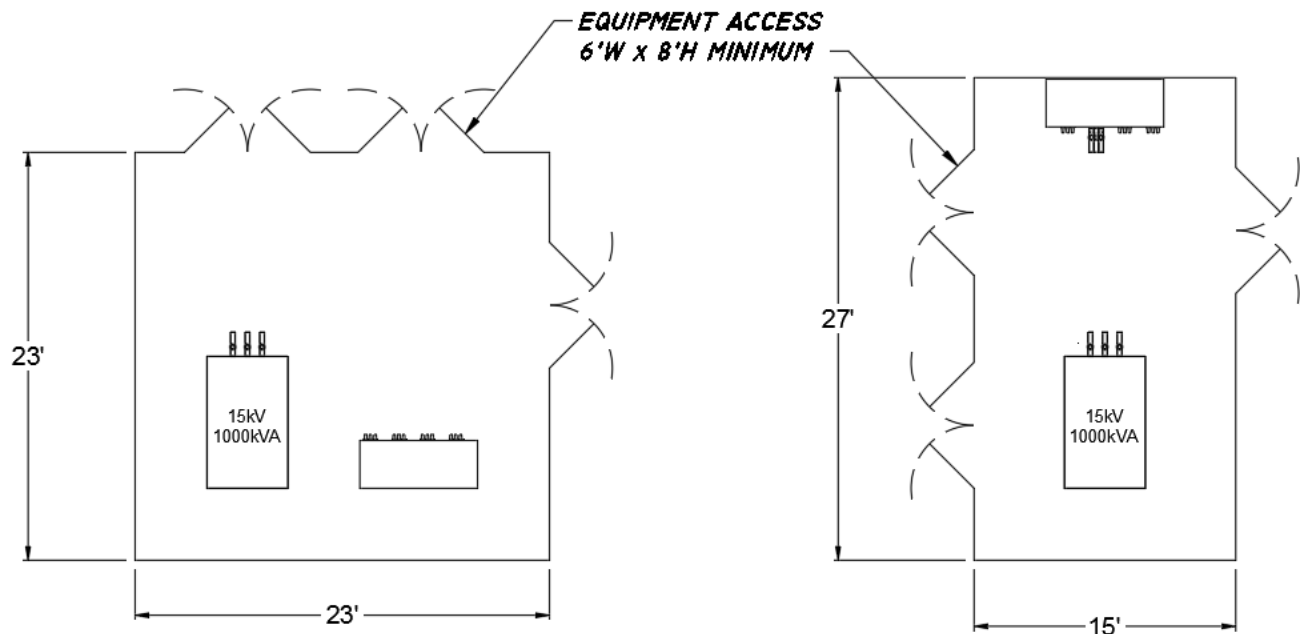


NOTES:

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Figure 8 – Vault Standard Arrangement, 208Y/120V Service, up to 3000 A, 15 kV, Transformer and Primary Switch in Separate Vaults

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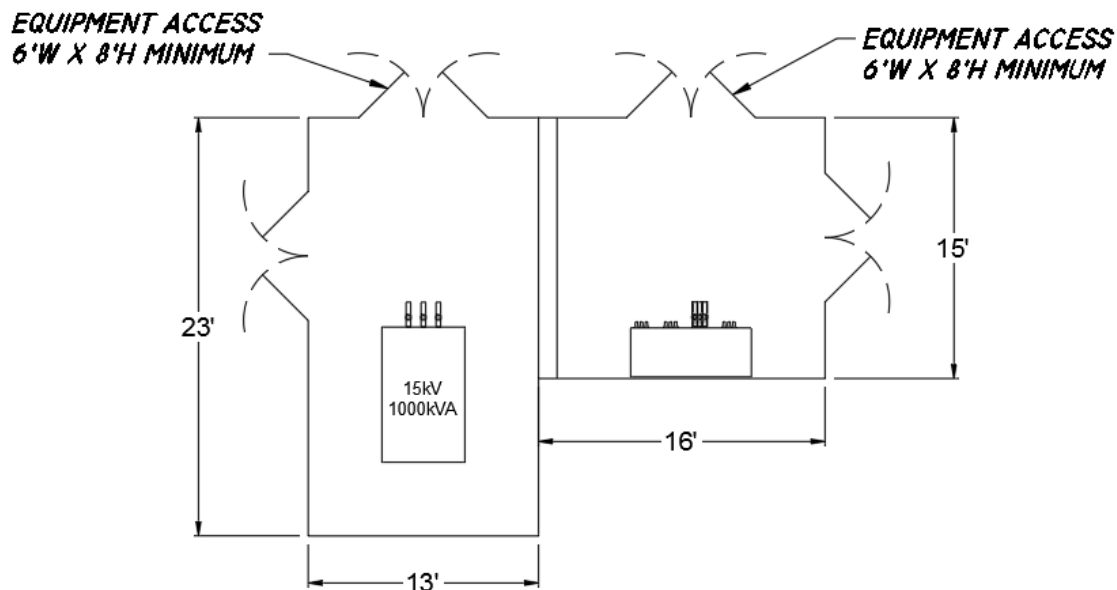
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 1200 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 9 – Vault Standard Arrangement, 480Y/277V, up to 1200 A Service, 15 kV, Transformer and Primary Switch

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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 1200 A, 15 KV PRIMARY

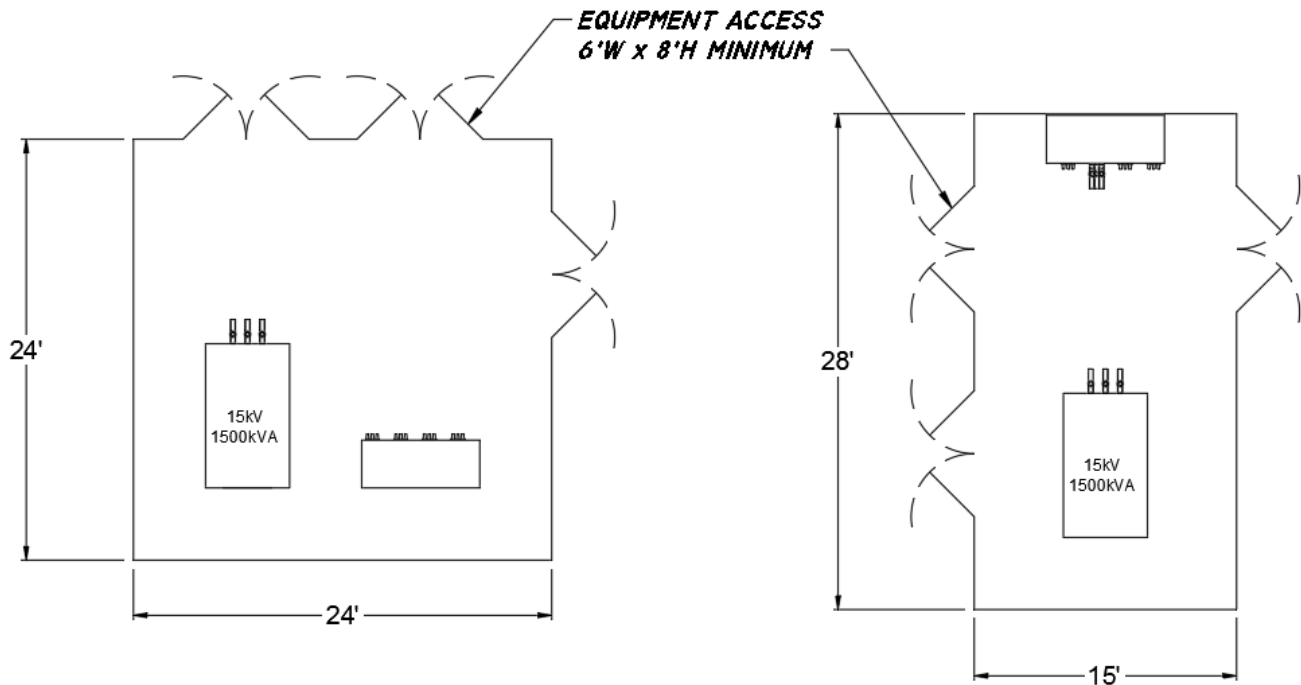


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 10 – Vault Standard Arrangement, 480Y/277V, up to 1200 A Service, 15 kV, Transformer and Primary Switch in Separate Vaults

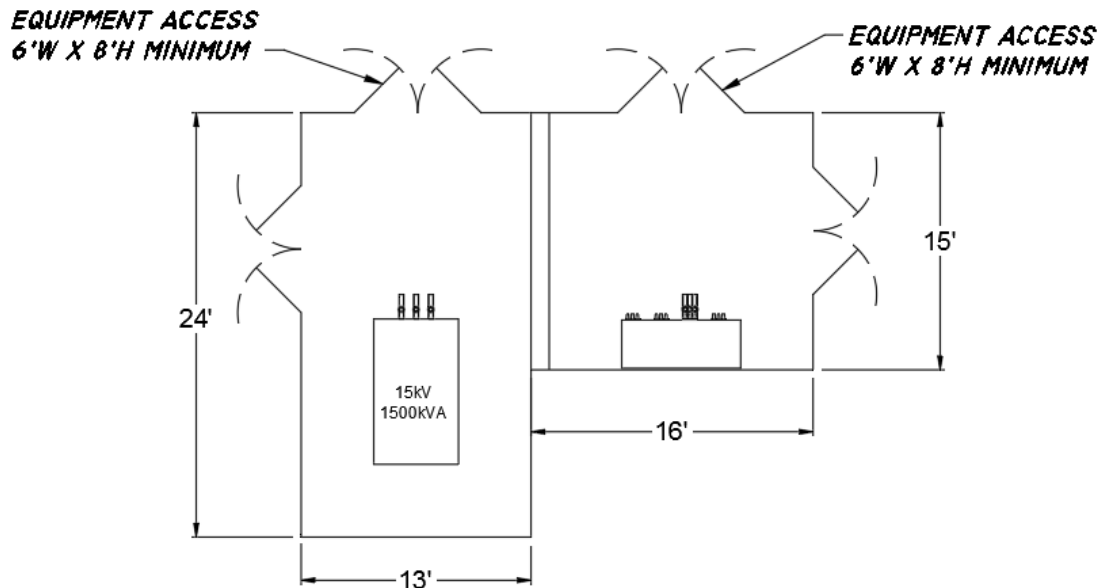
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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 1800 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 11 – Vault Standard Arrangement, 480Y/277V, up to 1800 A Service, 15 kV, Transformer and Primary Switch

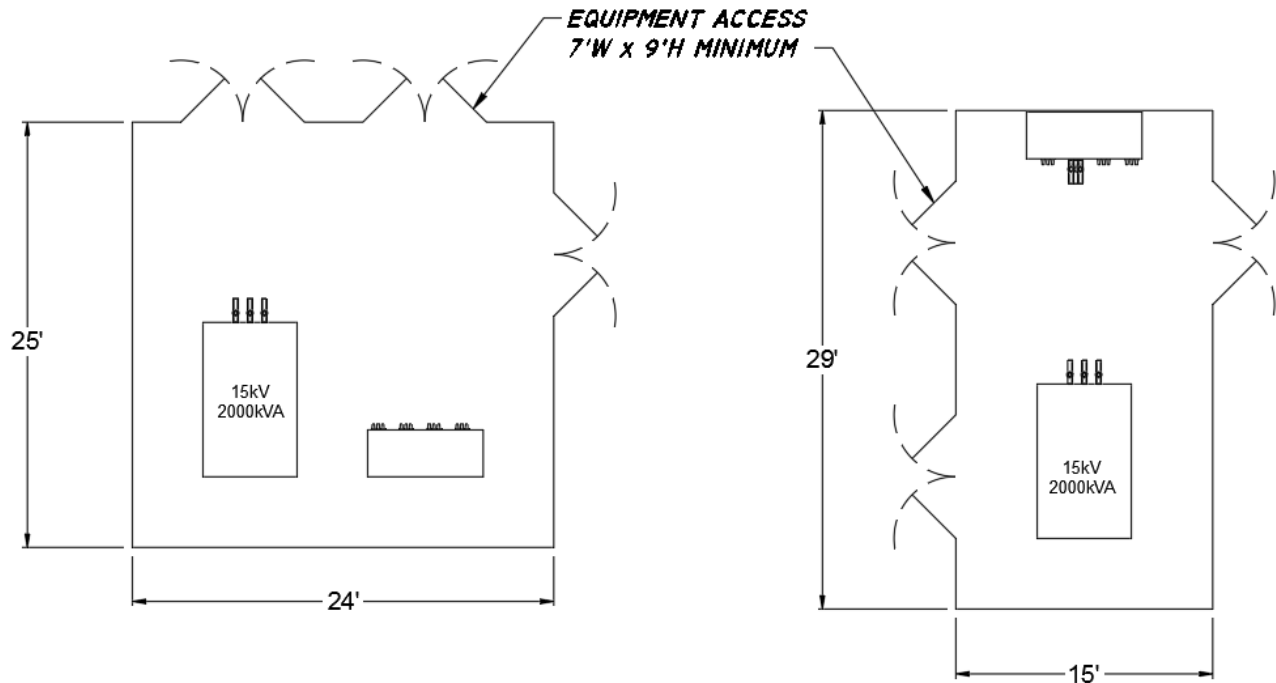
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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT****480Y/277V, UP TO 1800 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 12 – Vault Standard Arrangement, 480Y/277V, up to 1800 A Service, 15 kV, Transformer and Primary Switch in Separate Vaults

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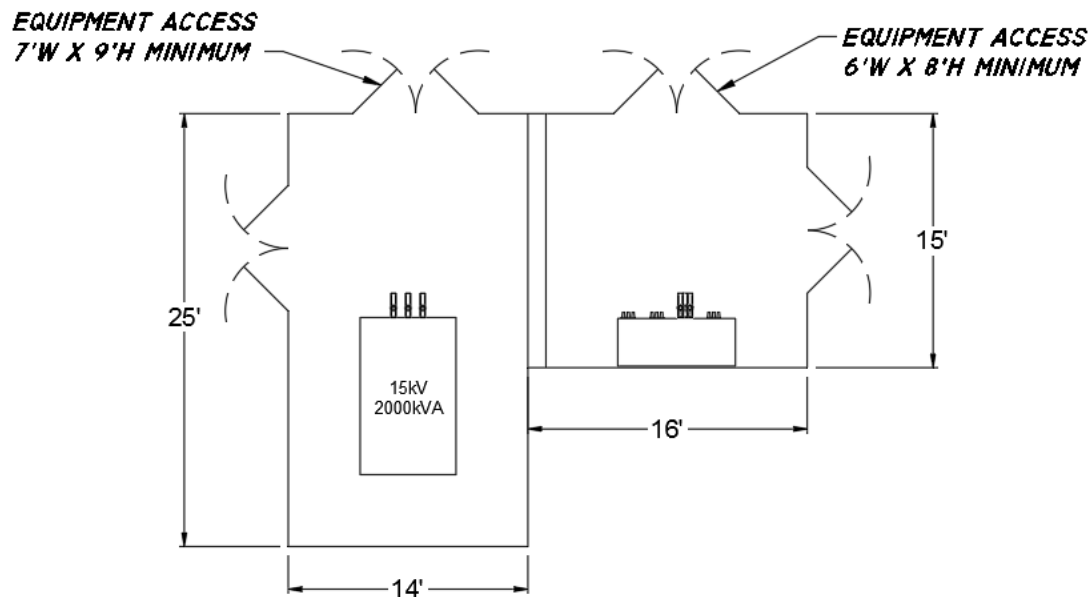
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 2400 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 13 – Vault Standard Arrangement, 480Y/277V, up to 2400 A Service, 15 kV, Transformer and Primary Switch

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 2400 A, 15 KV PRIMARY**

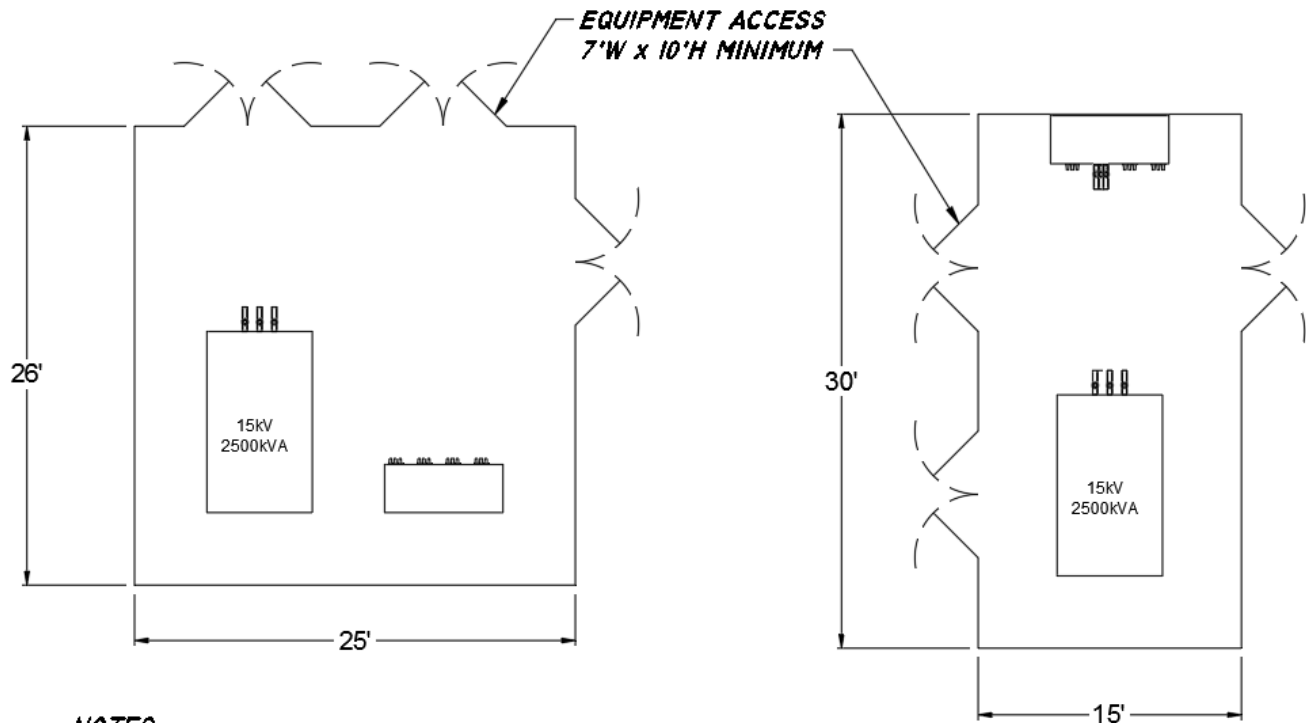


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1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 14 – Vault Standard Arrangement, 480Y/277V, up to 2400 A Service, 15 kV, Transformer and Primary Switch in Separate Vaults

June 2021

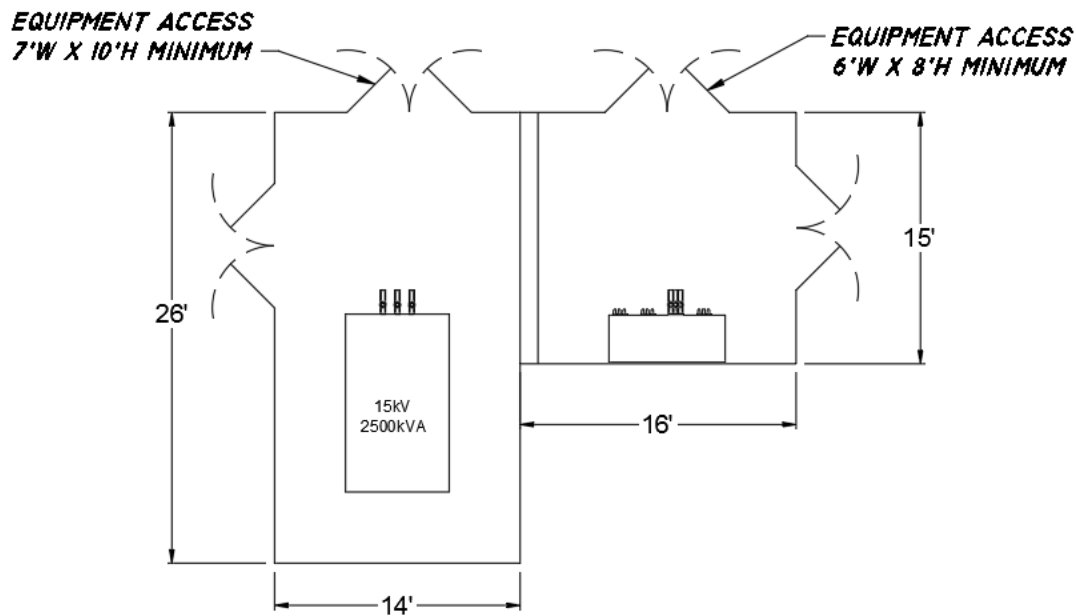
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 3000 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 15 – Vault Standard Arrangement, 480Y/277V up to 3000 A Service, 15 kV, Transformer and Primary Switch

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 3000 A, 15 KV PRIMARY**

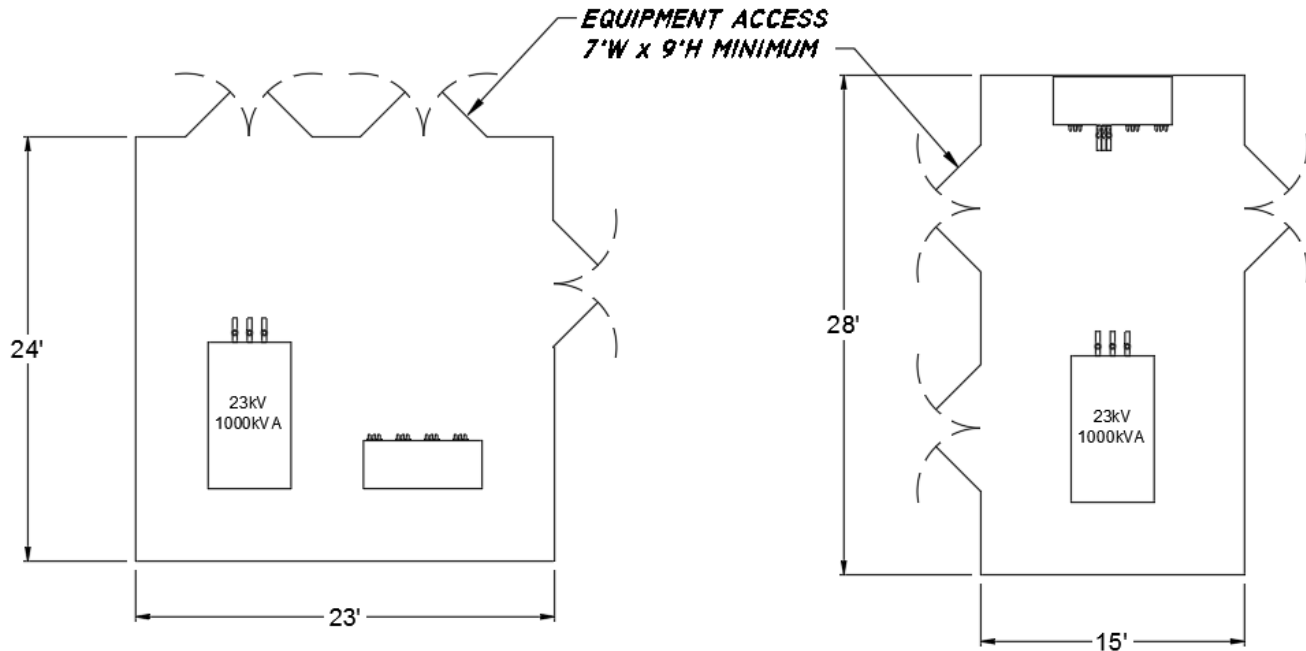


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 16 – Vault Standard Arrangement, 480Y/277V up to 3000 A Service, 15 kV, Transformer and Primary Switch in Separate Vaults

June 2021

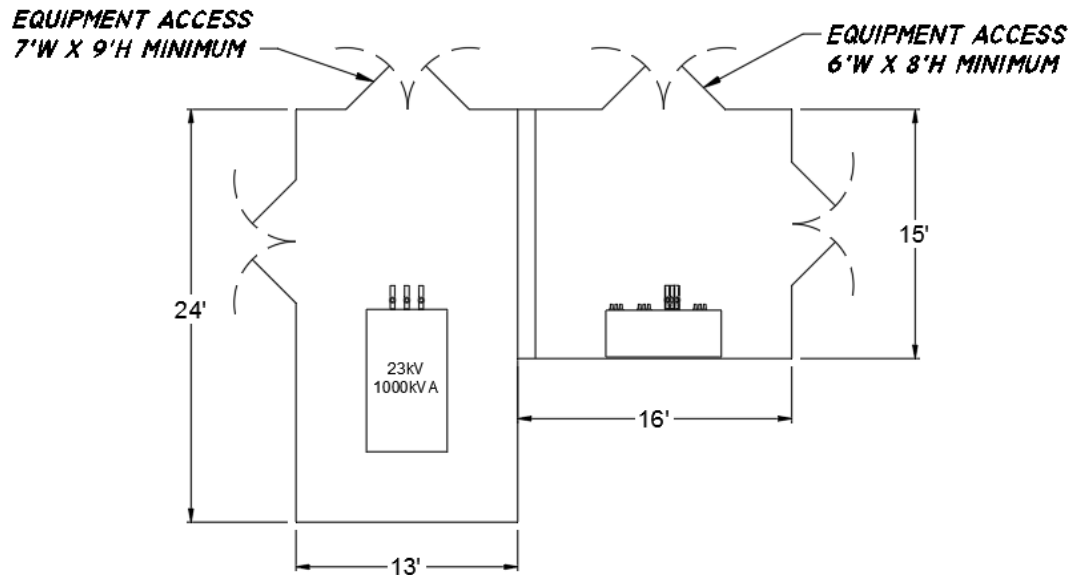
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 208Y/120V, UP TO 3000 A, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 17 – Vault Standard Arrangement, 208Y/120V Service, up to 3000 A, 23 kV, Transformer and Primary Switch

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
120/208Y V, UP TO 3000 AMP, 23 KV PRIMARY**

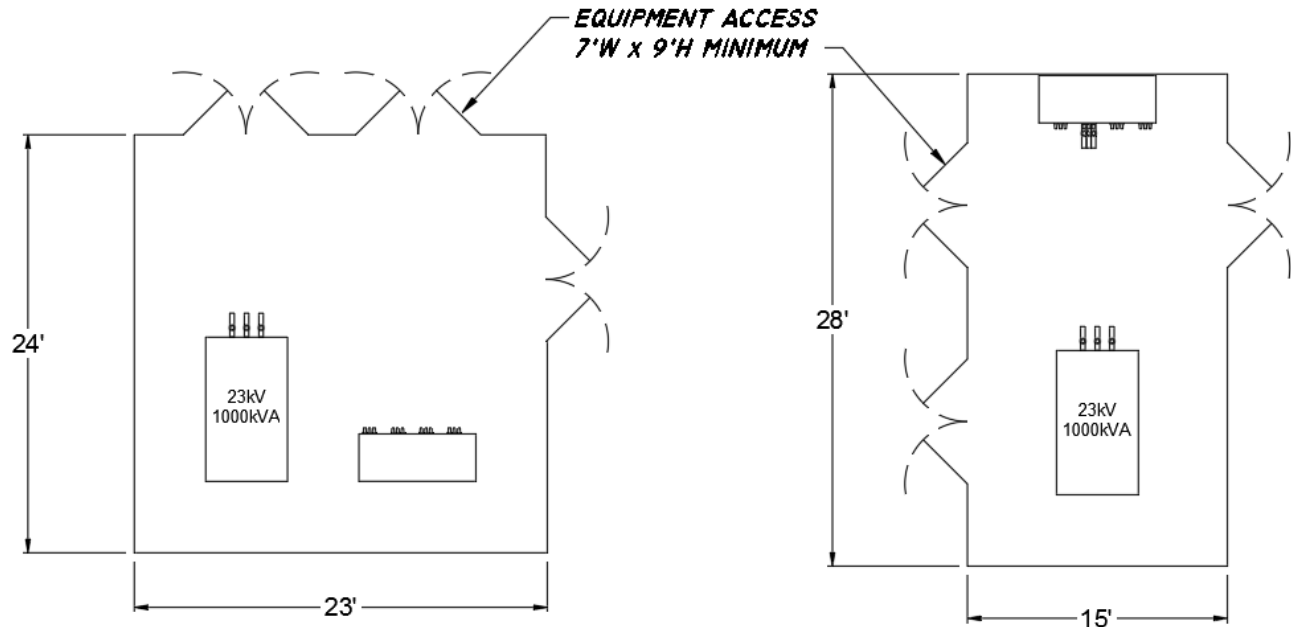


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 18 – Vault Standard Arrangement, 208Y/120V up to 3000 A Service, 23 kV, Transformer and Primary Switch in Separate Vaults

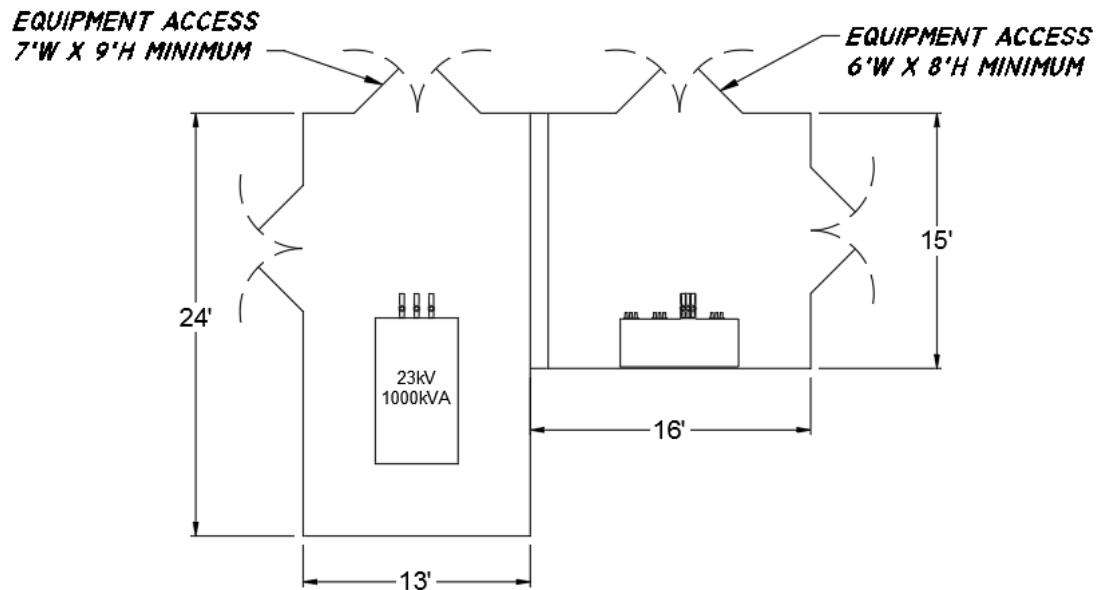
June 2021

STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 1200 A, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 19 – Vault Standard Arrangement, 480Y/277V Service, up to 1200 A, 23 kV, Transformer and Primary Switch

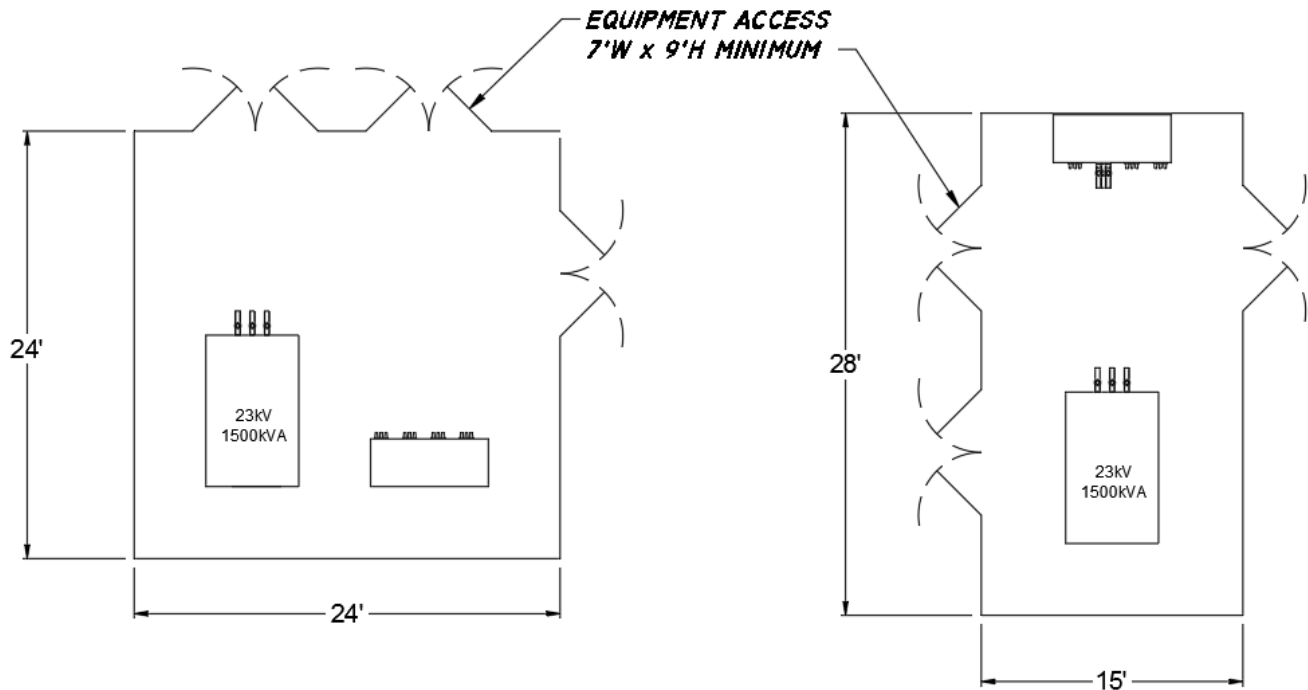
June 2021

STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 1200 A, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 20 – Vault Standard Arrangement, 480Y/277V up to 1200 A Service, 23 kV, Transformer and Primary Switch in Separate Vaults

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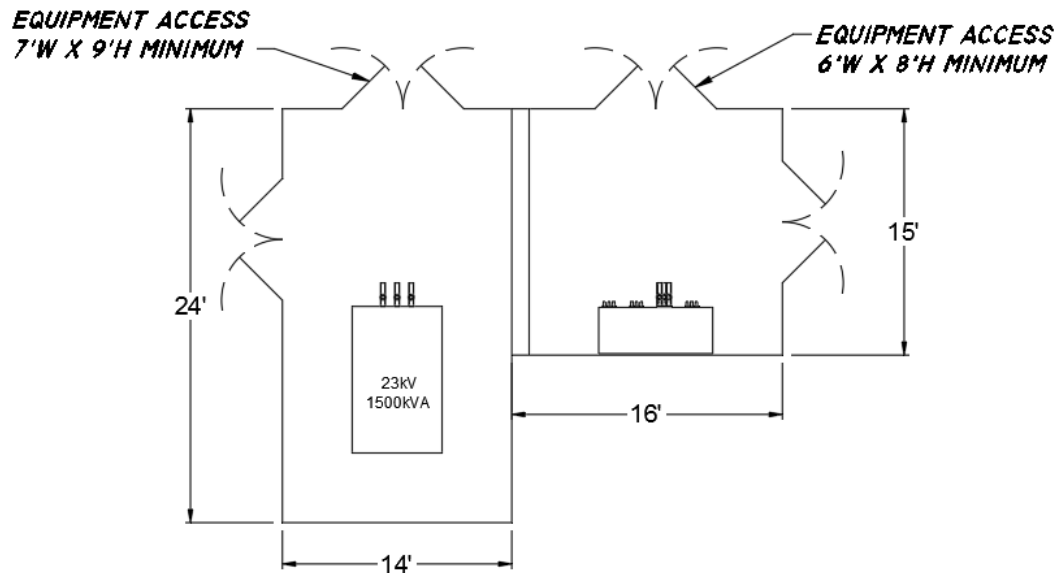
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 1800 A, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 21 – Vault Standard Arrangement, 480Y/277V Service, up to 1800 A, 23 kV, Transformer and Primary Switch

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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
277/480Y V, UP TO 1800 A, 23 KV PRIMARY

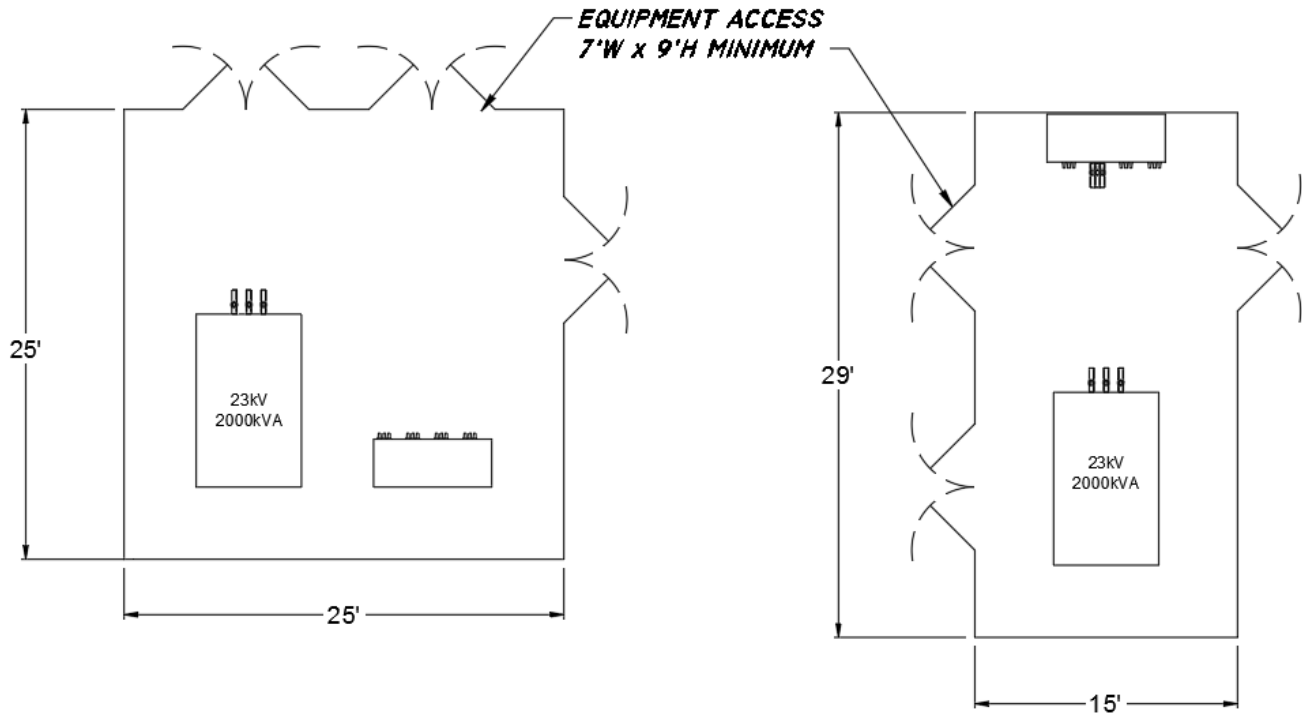


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 22 – Vault Standard Arrangement, 480Y/277V up to 1800 A Service, 23 kV, Transformer and Primary Switch in Separate Vaults

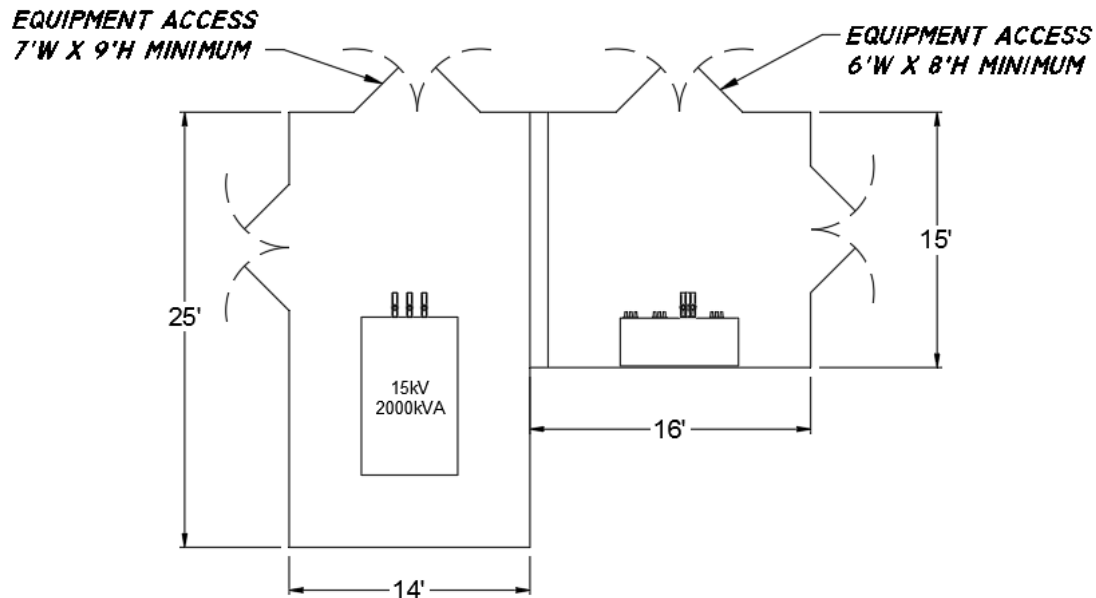
June 2021

STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 2400 A, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 23 – Vault Standard Arrangement, 480Y/277V Service, up to 2400 A, 23 kV, Transformer and Primary Switch

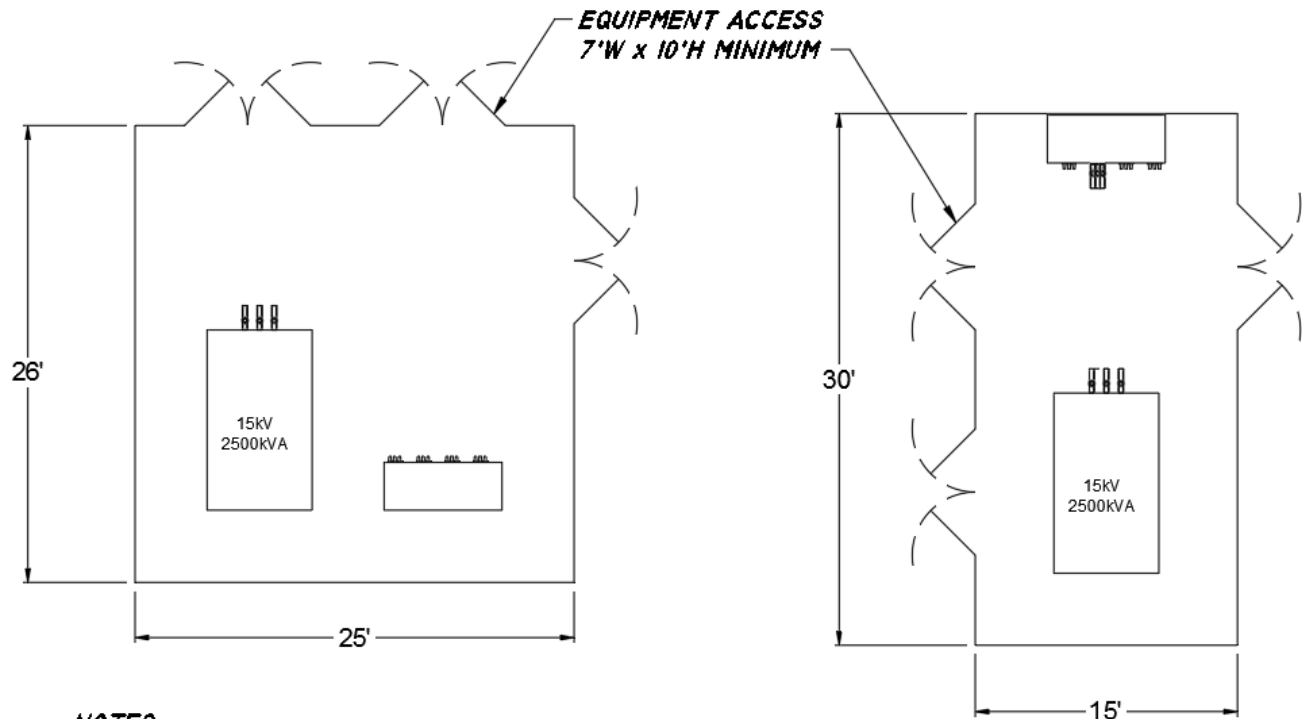
June 2021

STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 2400 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 24 – Vault Standard Arrangement, 480Y/277V up to 2400 A Service, 23 kV, Transformer and Primary Switch in Separate Vaults

June 2021

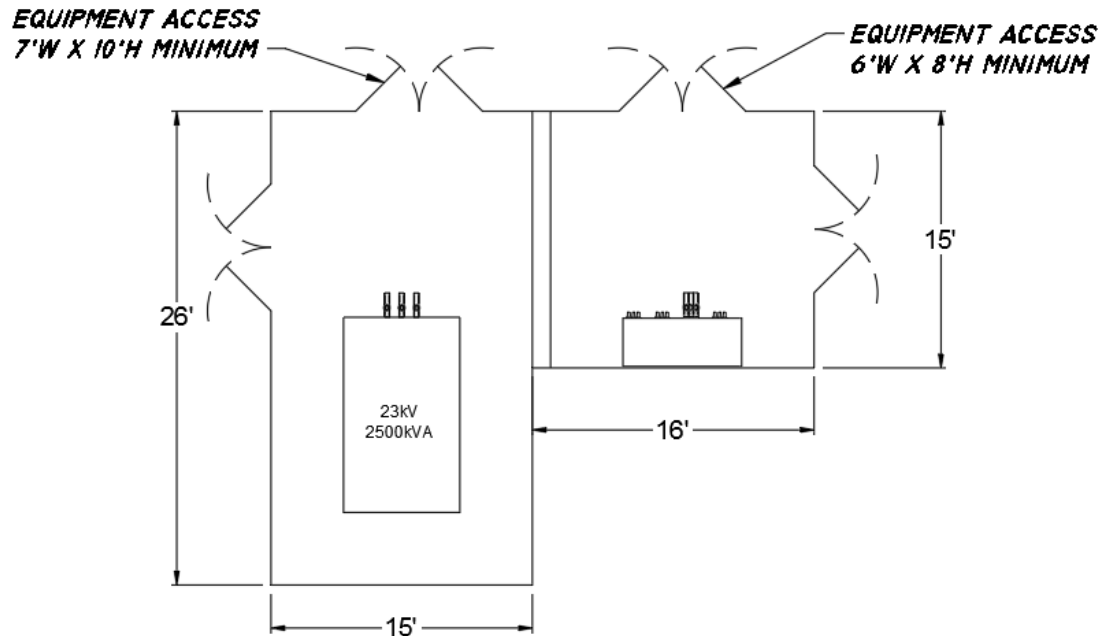
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**I-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V, UP TO 3000 A, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 25 – Vault Standard Arrangement, 480Y/277V Service, up to 3000 A, 23 kV, Transformer and Primary Switch

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
I-TRANSFORMER BUILDING / WALK-IN VAULT & I-SWITCH BUILDING / WALK-IN VAULT
480Y/277V, UP TO 3000 A, 23 KV PRIMARY**



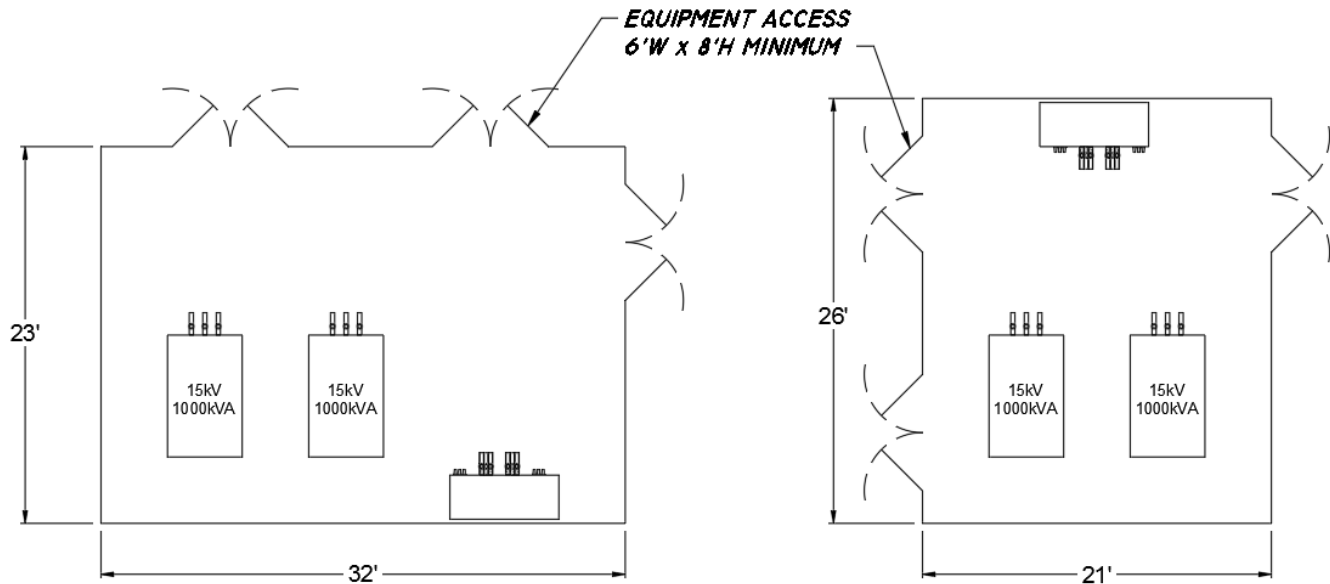
NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 26 – Vault Standard Arrangement, 480Y/277V up to 3000 A Service, 23 kV, Transformer and Primary Switch in Separate Vaults

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
2-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 208Y/120V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 15 KV PRIMARY**



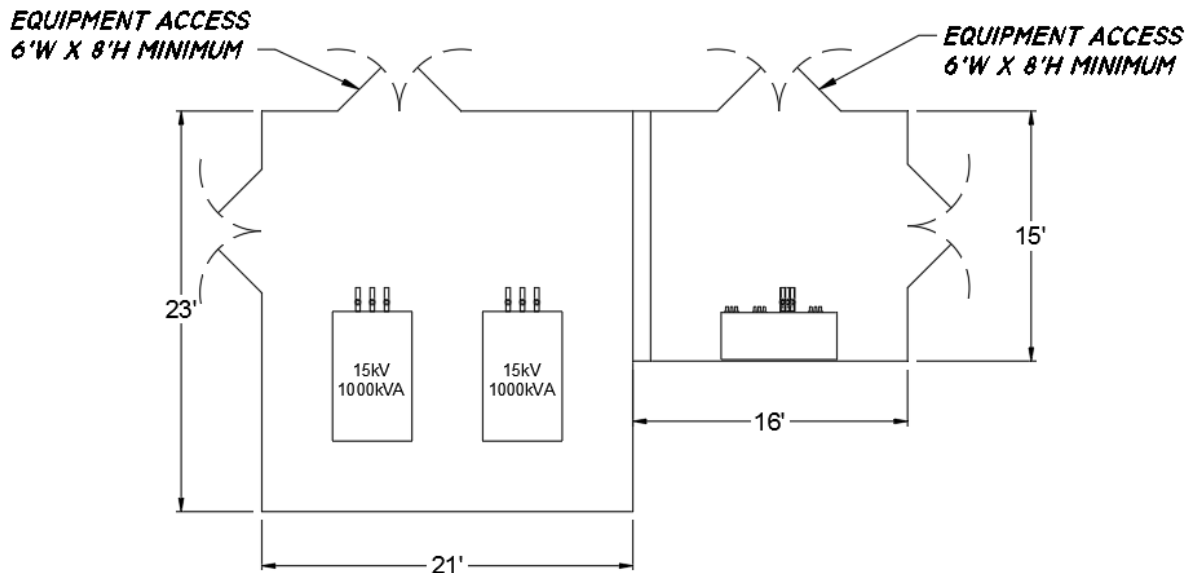
NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 27 – Vault Standard Arrangement, 208Y/120V up to 2 – 3000 A Main-Disconnects, 15 kV, 2 – Transformers and Primary Switch (Arrangement Not Available in All Locations)

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
2-TRANSFORMER SWITCH BUILDING / WALK-IN & PRIMARY SWITCH BUILDING / WALK-IN VAULT
208Y/120V, UP TO 2 - 3000 A MAIN-DISCONNECTS, 15 KV PRIMARY**



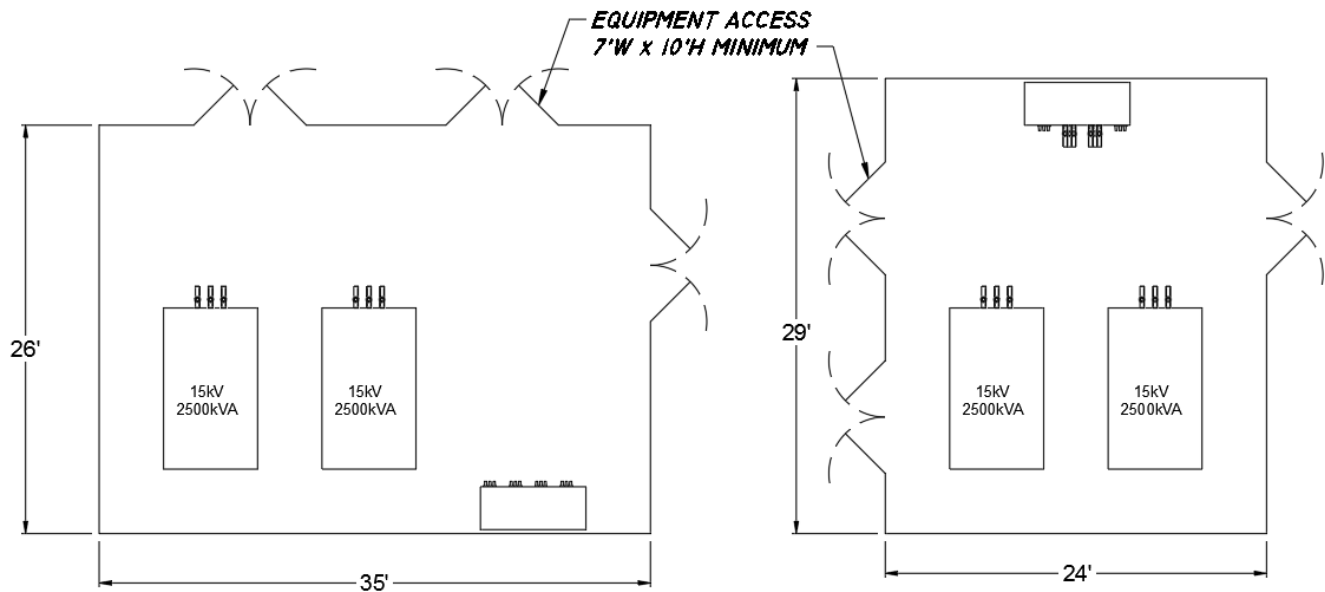
NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 28 – Vault Standard Arrangement, 208Y/120V up to 2 – 3000 A Main-Disconnects, 15 kV, 2 – Transformers and Primary Switch in Separate Vaults (Arrangement Not Available in All Locations)

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
2-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 15 KV PRIMARY**

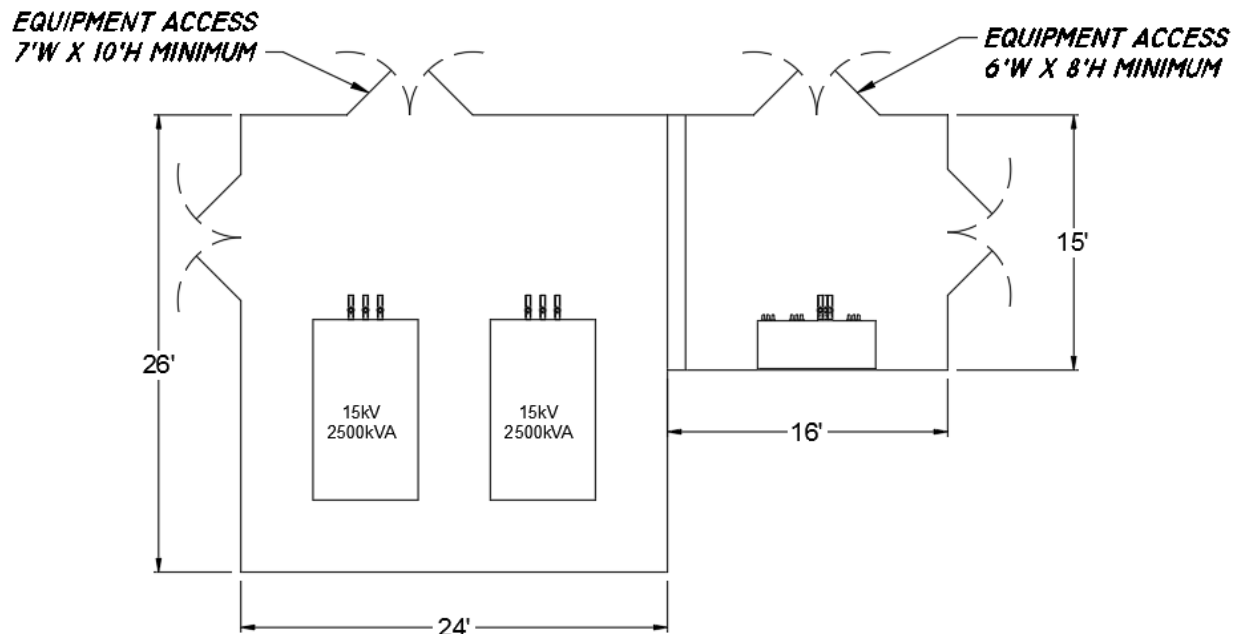


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 29 – Vault Standard Arrangement, 480Y/277V up to 2 – 3000 A Main-Disconnects, 15 kV, 2 – Transformers and Primary Switch (Arrangement Not Available in All Locations)

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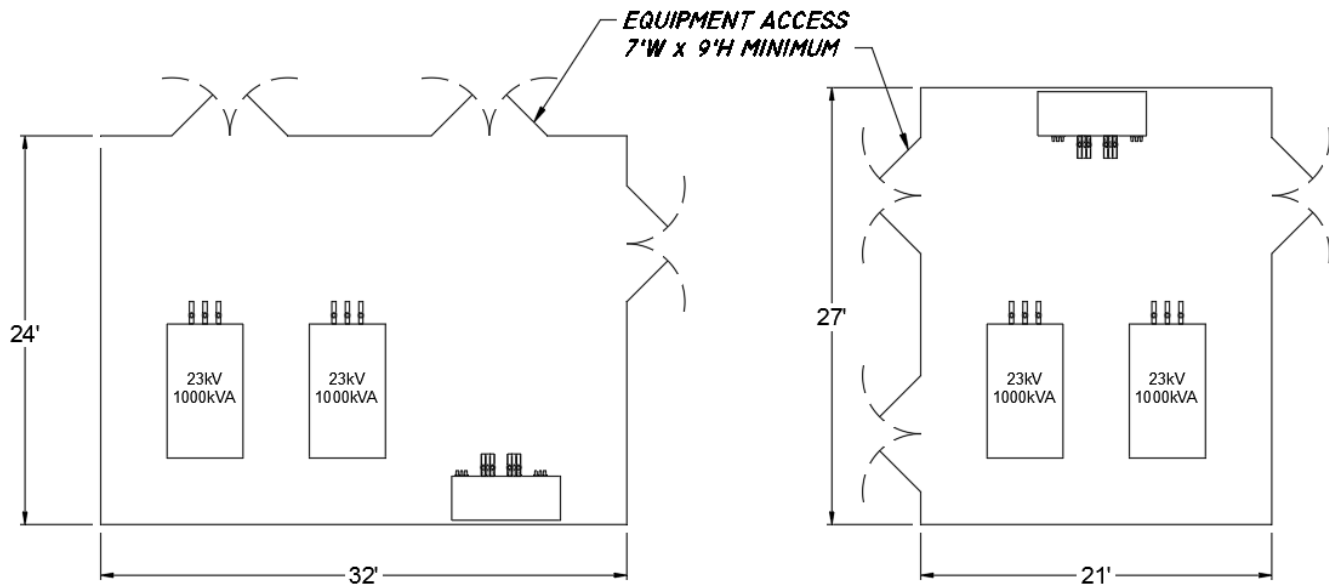
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**2-TRANSFORMER SWITCH BUILDING / WALK-IN & PRIMARY SWITCH BUILDING / WALK-IN VAULT****480Y/277V, UP TO 2 - 3000 A MAIN-DISCONNECTS, 15 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 30 – Vault Standard Arrangement, 480Y/277V up to 2 – 3000 A Main-Disconnects, 15 kV, 2 – Transformers and Primary Switch in Separate Vaults (Arrangement Not Available in All Locations)

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
2-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 208Y/120V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 23 KV PRIMARY**

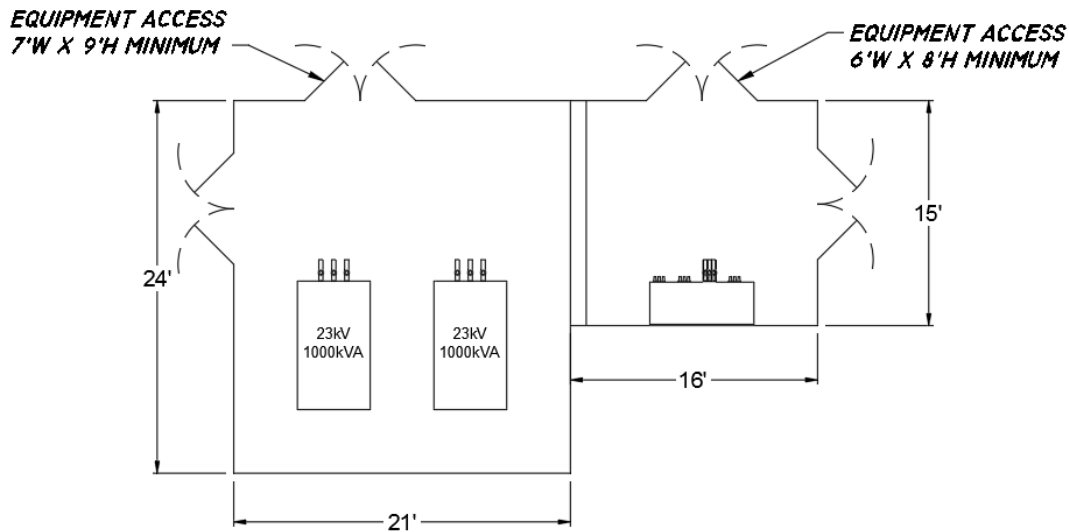


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 31 – Vault Standard Arrangement, 208Y/120V up to 2 – 3000 A Main-Disconnects, 23 kV, 2 – Transformers and Primary Switch (Arrangement Not Available in All Locations)

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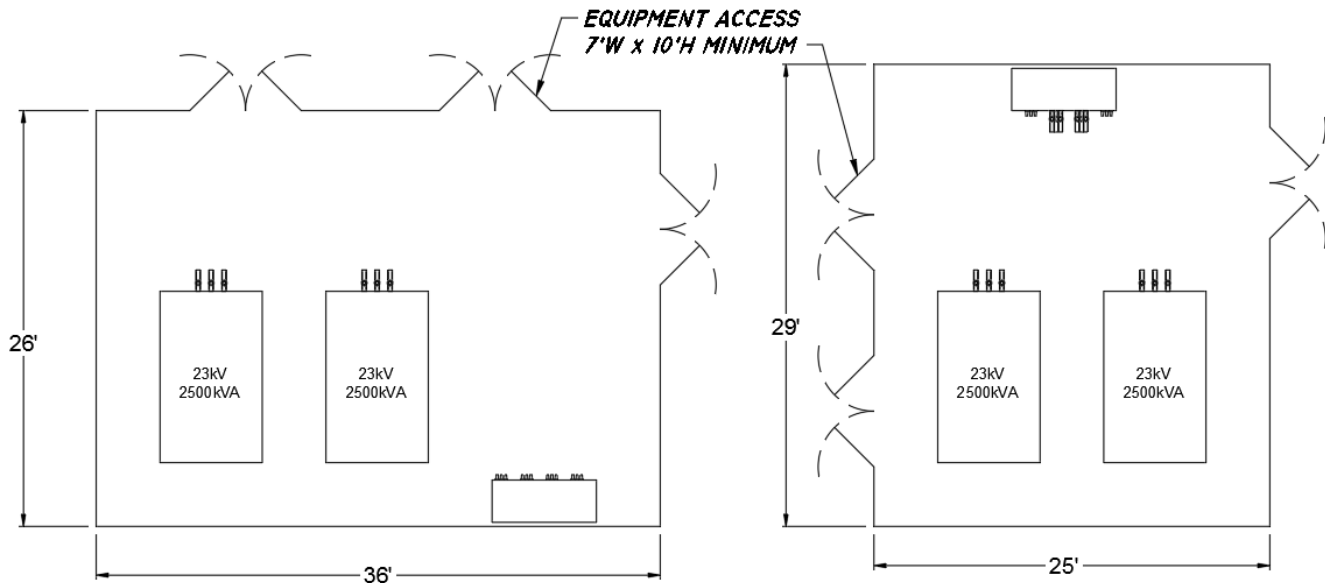
STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**2-TRANSFORMER SWITCH BUILDING / WALK-IN & PRIMARY SWITCH BUILDING / WALK-IN VAULT 208Y/120V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 32 – Vault Standard Arrangement, 208Y/120V up to 2 – 3000 A Main-Disconnects, 23 kV, 2 – Transformers and Primary Switch in Separate Vaults (Arrangement Not Available in All Locations)

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**STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT
2-TRANSFORMER & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 23 KV PRIMARY**

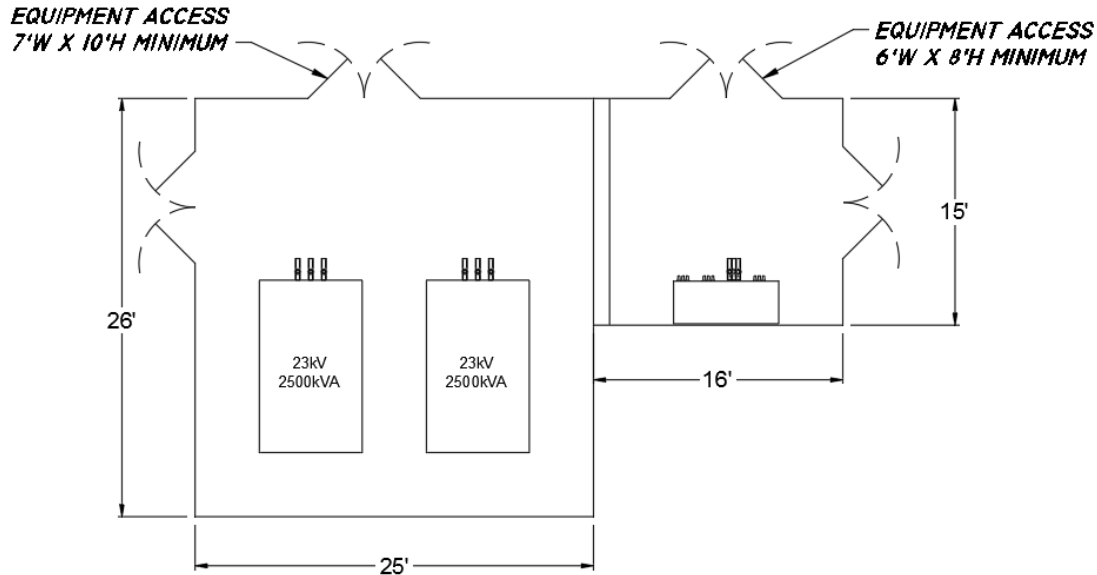


NOTES:

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 33 – Vault Standard Arrangement, 480Y/277V up to 2 – 3000 A Main-Disconnects, 23 kV, 2 – Transformers and Primary Switch (Arrangement Not Available in All Locations)

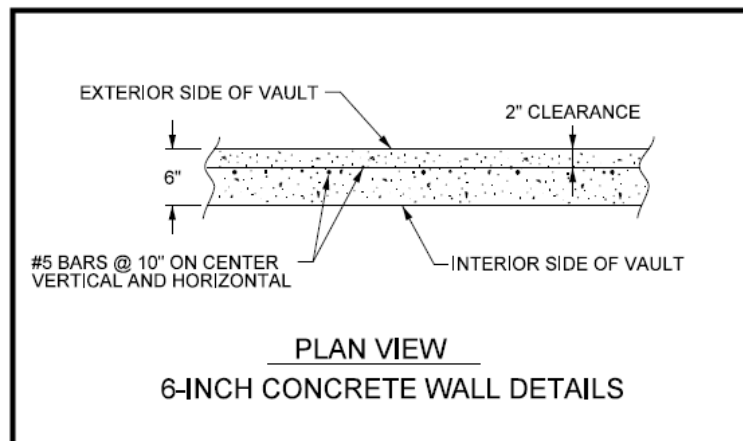
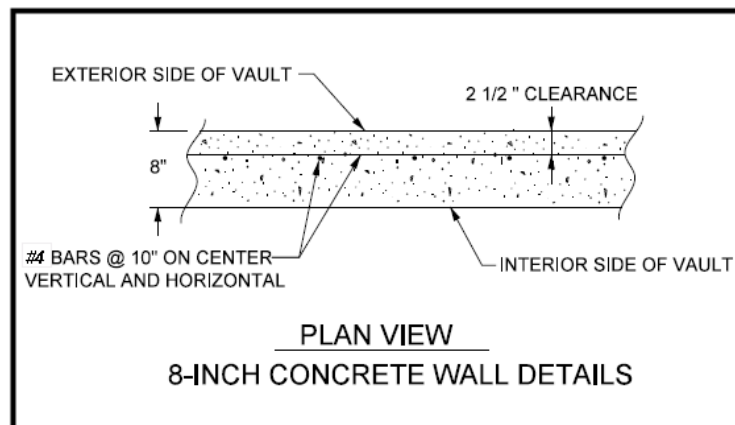
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STANDARD ARRANGEMENTS - RADIAL ELECTRIC VAULT**2-TRANSFORMER SWITCH BUILDING / WALK-IN & PRIMARY SWITCH BUILDING / WALK-IN VAULT 480Y/277V,
UP TO 2 - 3000 A MAIN-DISCONNECTS, 23 KV PRIMARY****NOTES:**

1. VAULT HEIGHT 11' MINIMUM FOR ALL ARRANGEMENTS.
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, LOCATION OF PRIMARY CABLE ENTRY, AND LOCATION OF SECONDARY CABLE ENTRY.

Figure 34 – Vault Standard Arrangement, 480Y/277V up to 2 – 3000 A Main-Disconnects, 23 kV, 2 – Transformers and Primary Switch in Separate Vaults (Arrangement Not Available in All Locations)

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3.2 WALL, FLOOR, AND ROOF REINFORCING DETAILS:**Figure 35 – 6" Concrete Wall Minimum Standards****Figure 36 – 8" Concrete Wall Minimum Standards**

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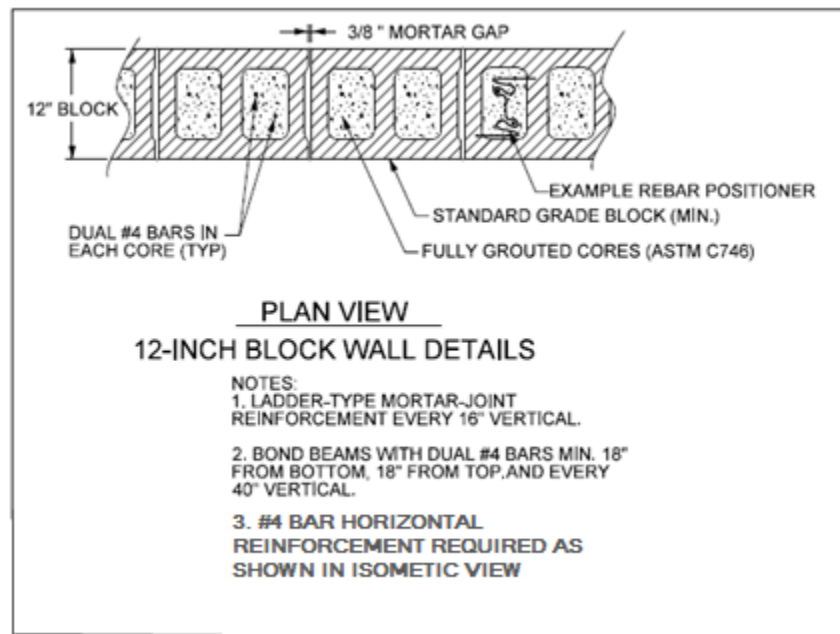


Figure 37 – CMU Wall Minimum Standards Plan View

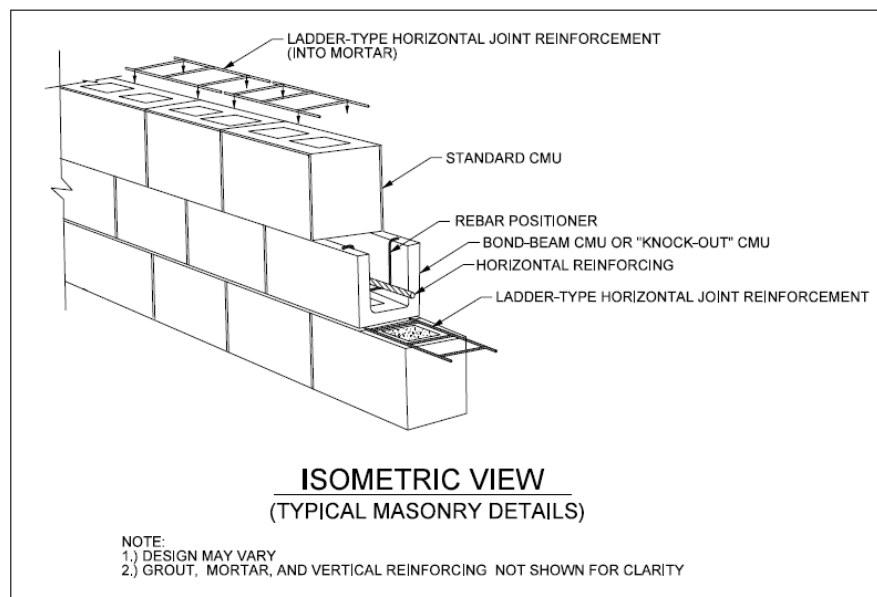
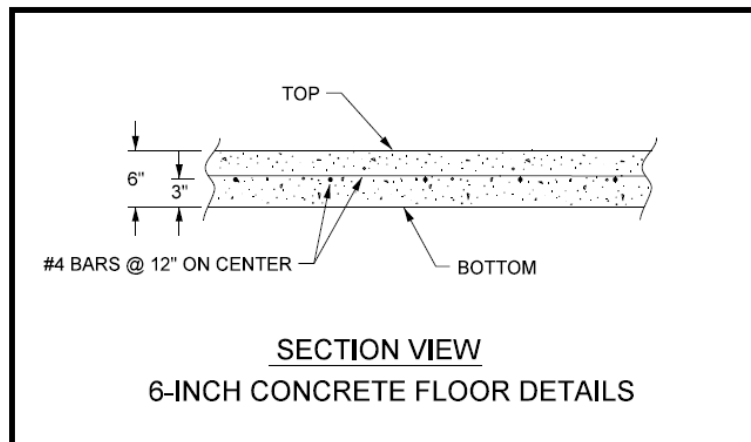


Figure 38 – CMU Wall Minimum Standards Isometric View

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**Figure 39 – Concrete Floor Minimum Standards****3.3 COMPANY AND NESC STRUCTURAL DESIGN REQUIREMENT:**

Vaults shall be designed to sustain all expected loads that may be imposed upon the structure. The horizontal design loads, vertical design loads, or both shall consist of dead load, live load, equipment load, impact, load due to water table, frost, and any other load expected to be imposed upon the structure, to occur adjacent to the structure, or both. The structure shall sustain the combination of vertical and lateral loading that produces the maximum shear and bending moments in the structure.

For all below grade vaults, the live load shall consist of the weight of a moving tractor-semitrailer truck illustrated in the figure below. In the case of multilane pavements, the structure shall sustain the combination of loadings that results in vertical and lateral structure loadings that produce the maximum shear and bending moments in the structure.

Live loads shall be increased by 30% for impact.

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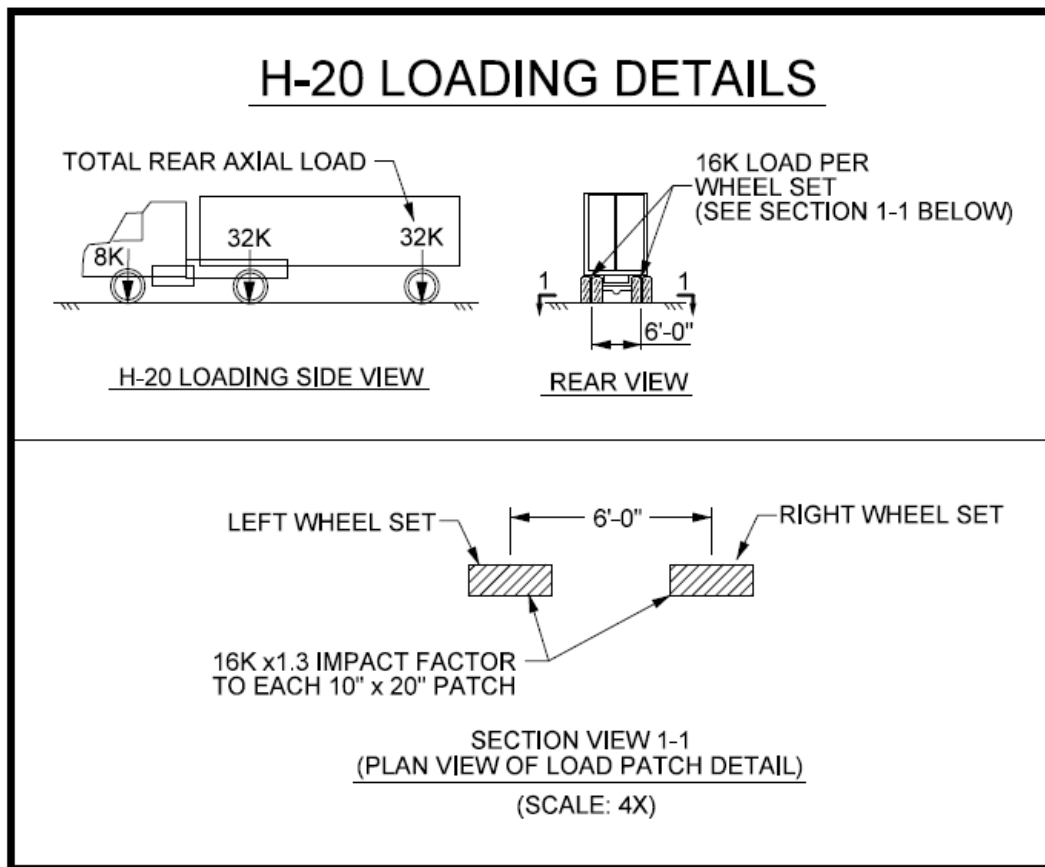


Figure 40 – Below Grade Vault Loading (Detail Common to NESC 2012 and AASHTO 2012)

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3.4 ANTI-SLIP TREATMENT SPECIFICATION:

TITLE: GALVAGRIT™ COATING ON GALVANIZED STEEL SURFACES

SCOPE: This specification covers the performance qualities and application of a slip resistant coating material over steel surfaces and then hot dipped galvanized.

Product Description:

Galvagrit™ is an anti-slip steel surface covering 100% of substrate consisting of a random matrix with a surface hardness of at least 35 on the Rockwell "C" scale and a bond strength to the steel of at least 8,000 psi. and then hot dipped galvanized. The anti-slip surface has a minimum coefficient of friction of 0.6.

Process:

Slip resistant material shall be applied to bare steel shall be a thermal spray coating (metalizing). This is a coating produced by a process in which molten or semi-molten particles are applied by impact onto a steel substrate. This results in a lenticular or lamellar grain structure resulting from the rapid solidification of small globules, flattened from striking a cold surface at high velocities. The product is then galvanized, fusing the friction resistant coating.

Materials:

Slip Resistant Material:

Materials shall be Iron Base Hardfacing Alloys of Iron and Aluminum. The aluminum content shall be 5.5%, 2.0% Carbon, 0.8% Manganese with the remainder being iron by weight. The alloy shall have a Rockwell Hardness Scale of HRC 35. The wire used shall have a diameter of 1/16 in. (1.6 mm).

Galvanizing:

All materials to hot dipped galvanized shall be galvanized in accordance with ASTM A 123. Only the dry-kettle (pre-fluxing) process shall be used. An American Galvanizers Association trained Master Galvanizer shall be on the premises during the hot dipped galvanizing process.

Surface Preparation:

The steel surface shall be clean and free of oils and grease before they are metalized. The surface shall be grit blasted to SSPC Surface Preparation Specification 10. The piece shall be metalized within 6 hours of blasting. Oils and grease shall be removed by use of an aqueous alkaline solution and/or hand or power tool cleaning.

Galvagrit™ Coat Application

The metalizing applicator shall be capable of providing 400 amp spray arc and 100 psi compressed air, a deposit rate of 10 lbs/hr/100A and a deposit efficiency of 70%. Typical wire Coverage is 0.6 oz/sq.ft/mil with a typical Hardness of HRC 35 and bond strength of 8000 psi.