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Supplement to

Specifications for Electrical Installations

Requirements for Services Supplied from National Grid's Secondary Networks

Electric System Bulletin No. 757

September 2016
(Supersedes all previous versions of ESB 757)

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1.0 DEFINITIONS

Applicant: Any entity (individual, firm, partnership, corporation, association, municipality, or governmental body) requesting a new service from the Company for their own use and not for resale or delivery to others.
Note: The Company must be consulted for specific Applicant rules as they apply in the Company's applicable tariff.

Authority Having Jurisdiction (AHJ): Governmental bodies or their Agent exercising legal jurisdiction over applicable codes.

Building: A structure which stands alone or which is cut off from adjoining structures by approved fire walls with all openings therein protected by approved fire doors.

Cable Limiter[1]**:** An enclosed fuse for disconnecting a faulted cable from a low-voltage network distribution system and for protecting the unfaulted portion of that cable against serious thermal damage. Note: A cable limiter is also referred to as a network limiter or a limiter.

Clearance: Required separation mandated by codes or the Company.

Cold Sequence metering: Metering equipment located on the Customer's side of the service equipment. Refer to Figure 1.

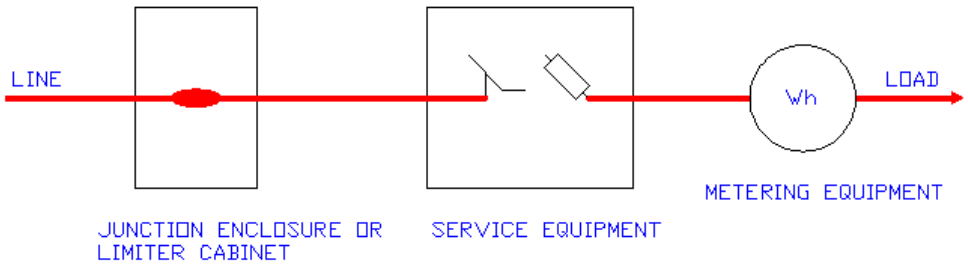


Figure 1 – Cold Sequence Metering

Company: The electric utility companies doing business as National Grid to which these requirements apply are:

Massachusetts Electric Company
The Narragansett Electric Company
Niagara Mohawk Power Corporation

Company Approval: Acceptance for the minimum requirements of National Grid exclusive of the Customer's obligation of complying with all applicable codes, statutes, rules or regulations.

Conduit: A cylindrical wire-way for the purpose of carrying and protecting electric cables.

Customer: An existing user of recurring electric service. A contractor or developer performing work on behalf of a Customer is considered an agent of the Customer.

[1] IEEE Std C57.12.44-2005, pages 2-3

Design Professional: A Professional Engineer (PE) licensed to practice in the state where service is being installed and who is directly retained by the Customer for that purpose. If the state licensed PE is representing a multi-member design firm, the firm shall have state certification to practice professional engineering and a copy of such license must be provided to the Company upon request. Any Company requested design professional certification proof must be submitted to the Company in writing upon initial design submission.

Distribution Line: A distribution line is an electric line, either overhead or underground, including the necessary and ancillary accessories to distribute electric energy, which may provide service to more than one customer. A distribution line may be located (1) in a street, highway, alley, or (2) on private right-of-way when used or useful to supply two or more customers at separate premises.

Electric Service: Maintenance by the Company of the appropriate voltage and frequency at the point of delivery shall constitute the delivery of electric service to the Customer.

Electrical Inspector: Inspectors external to the Company who are approved by the municipality in which they are working and recognized by the Company. Electrical Inspectors are responsible for ensuring that the installation complies with all applicable codes and Company requirements, service equipment, material, installations, and/or procedures.

Emergency: An unplanned natural or accidental event that affects existing electric service.

Emergency Power System: A system legally required and classed as emergency by codes or any governmental agency having jurisdiction that automatically provides an independent reserve source of electricity, upon failure or outage of the normal power source, to elements of a power system essential to the safety of human life.

Exclusive Control: Generally covers installation, ownership, restricted access, operation, and maintenance by qualified and authorized persons.

Fire Wall: A wall separating buildings or subdividing a building to prevent the spread of fire and having a fire resistance rating and structural stability as determined and approved in writing by the AHJ.

General Network[2]**:** A secondary network system with geographically separated network units and the network-side terminals of the network protectors interconnected by low-voltage cables that span the distance between sites. The low-voltage cable circuits of the general networks are typically highly meshed and supplied by numerous network units. Note: A general network is also referred to as a street network, or an area network.

Multiple Residential Occupancy Building: A structure, including row houses, enclosed within exterior walls or fire walls, which is built, erected and framed of component structural parts and is designed to contain four or more individual dwelling units for permanent residential occupancy.

Non-Residential Service: All service types other than residential.

Primary: The Company's distribution systems typically operating over 600 volts.

[2] National Renewable Energy Laboratory Technical Report NREL/TP-560-38079, July 2005, pages 5-6

Residential Service: Service to one or more dwelling unit(s) providing complete and independent living facilities for one or more persons and which include permanent provisions for sleeping, cooking, and sanitation.

Secondary: The Company's distribution systems typically operating at 600 volts or below.

Service: The conductors and equipment for delivering energy from the Company's distribution line to the wiring system of the Customer served.

Secondary Collector Bus: Conductors utilized to parallel transformers or network units, also known as Transformer Paralleling Bus.

Service entrance: That part of the Customer's wiring from the point of attachment or termination of the service lateral or service line to and including the service equipment.

Service equipment: The Customer's necessary disconnecting and protective equipment intended to constitute the main control and cutoff of the supply from the service point. This consists of a circuit breaker(s) or switch(es) and fuse(s) and their accessories connected to the load end of service conductors. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto.

Spot Network[3]**:** A small network, usually at one location, consisting of two or more primary feeders, with network units and one or more load service connections.

[3] IEEE Std C57.12.44-2005, pages 2-3

2.0 SERVICES SUPPLIED FROM THE GENERAL NETWORK

2.1 LOCATIONS

In the urban centers of the following Municipalities, customers may be served from one of the Company's Low Voltage Alternating Current (LVAC) Network systems.

New York:	**Massachusetts:**	**Rhode Island:**
Albany	Brockton	Pawtucket
Buffalo	Lynn	Providence
Cortland	Worcester	
Glens Falls		
Niagara Falls		
Schenectady		
Syracuse		
Troy		
Utica		
Watertown		

2.2 GENERAL NETWORK SERVICES

Service voltages of 208Y/120 volts can be served from the general network subject to capacity limitations that are dictated by each particular LVAC system and geographic locations. Company owned conductors are connected from the 208Y/120 volt source in the public right-of-way and terminated to customer owned conductors within a customer owned enclosure (Refer to Figure 2). Service sizes larger than area system limitations or voltages of 480Y/277 volts will require supply from transformers in customer owned vaults.

Not all service sizes can be supplied from network facilities in all areas.

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

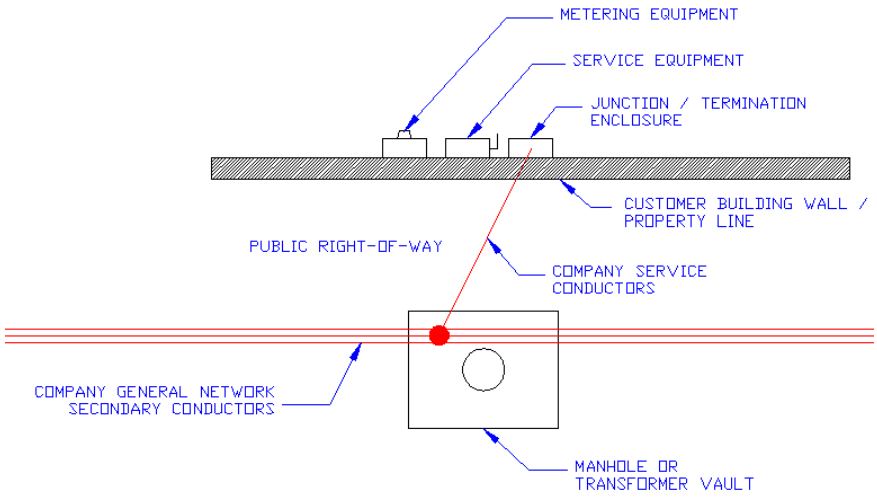


Figure 2 – Typical General Network Service Layout

GENERAL NETWORK SERVICE SIZES

The following diagrams are intended as an illustrative reference for service requirements. Actual equipment layouts may differ.

2.3 SINGLE PHASE, TWO WIRE OR THREE WIRE

Massachusetts & Rhode Island, 100 amperes maximum

New York, 200 amperes maximum

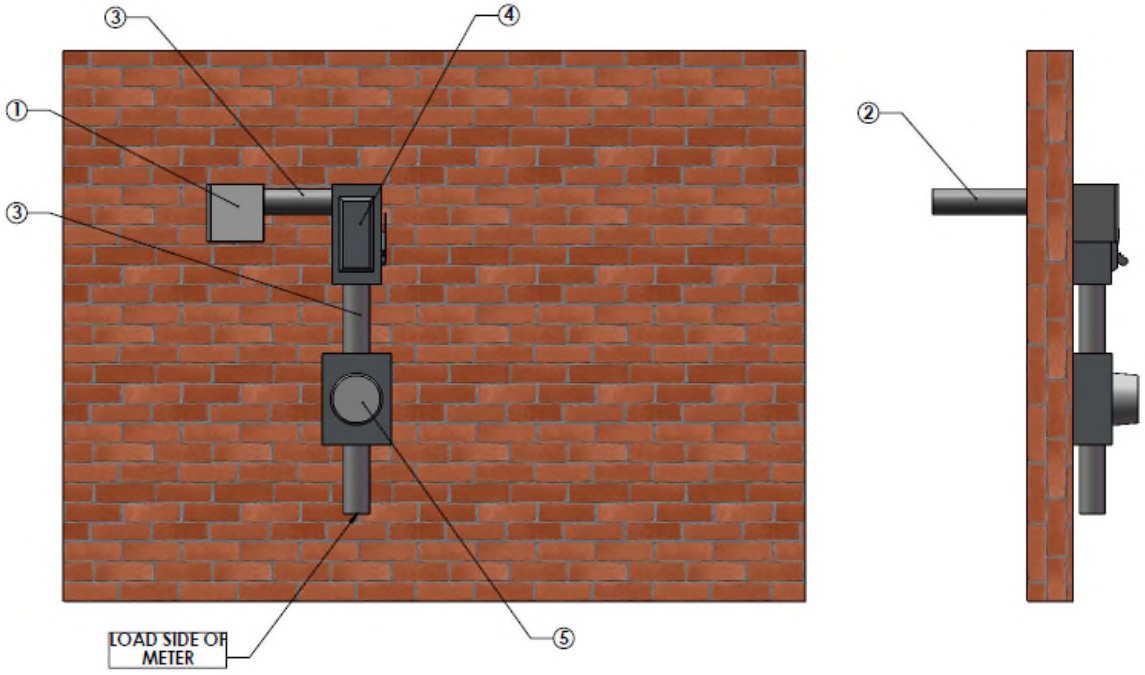


Figure 3 – 100 to 200 amperes Single Phase Equipment Example Layout

1. Junction / Termination Enclosure and Conductors:

a. Customer installed and owned in a location mutually agreed upon by the Company and customer

b. Minimum dimensions: 10 in (252 mm) x 10 in (252 mm) x 8 in (203 mm)

c. Shall be located at the closest possible point to conduit entrance into the building and be accessible by company personal for cable pulling and splicing

d. The floor area in front of the junction box shall provide minimally 8 ft of working clearance and be suitable for the installation of anchor inserts.

e. Shall have provisions for locking and sealing with the Company's standard padlock

f. Junction boxes installed outdoors shall be listed as weatherproof

g. Shall meet applicable NEC requirements and listings

h. Company conductors shall be spliced to customer owned conductors within this enclosure. Company conductor size shall be XHHW type, #2 soft drawn copper (100 ampere) or 4/0 soft drawn copper (200 ampere).

i. The Customer shall install the junction box oriented, and with conduits entering the box, such that parallel connections may be made between Company and customer cables. Orientation of the junction box and conduits can be adjusted as needed to accommodate actual installation; however the relative locations of the conduits that house the Company and customer cables shall be as shown in Figure 4.

j. Customer owned conductors shall be XHHW type, soft drawn copper.

k. Connectors will be provided by the Company, and connections in the junction box will be made by the Company.

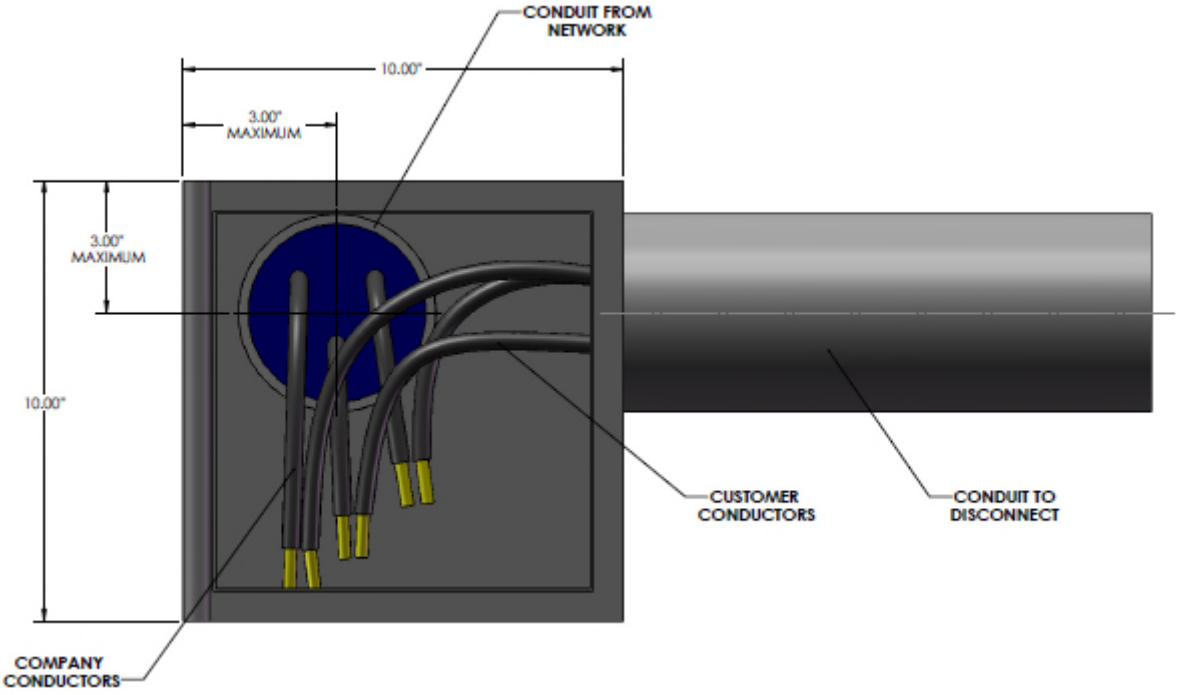


Figure 4 – Single Phase Junction Enclosure Example Layout with conductors

2. Service Conduits:

a. The junction between customer owned and installed conduits and Company owned and installed conduits shall be at a mutually agreed upon location

b. Shall be minimally 4 inch nominal

c. Number of service conduits and spare conduits shall be determined by the Company

d. Customer shall be responsible for all building foundation penetrations

e. All conduits containing company owned conductors that penetrate the building foundation shall be rigid galvanized steel

f. All conduits containing company owned conductors installed outside of the building foundation shall be rigid galvanized steel or concrete-encased PVC

g. All exposed conduits containing company owned conductors and/or conduits before (up-stream of) metering equipment shall be rigid galvanized steel

h. Conduit sweep radii shall be minimally 36 inches

3. Conductor wire-ways / troughs before metering:

a. Customer installed and owned

b. Shall not contain metered or load side conductors

c. Shall be Rigid Galvanized steel, Lockable wire-way / troughs, or incorporated into a securable enclosure

d. Shall be sized in accordance with NEC requirements

4. Service Equipment / Main Disconnect:

a. Customer installed and owned

b. Shall contain only a Single Disconnecting Device before Metering Equipment

c. Shall have a minimum short circuit withstand rating of 100,000 amperes RMS symmetrical

d. Main Over-current Protection shall meet required withstand rating and applicable NEC requirements and listings

5. Metering Equipment:

a. Shall be Cold Sequenced

b. Shall be located as close as possible to the Service Equipment / Main Disconnect in one central location

c. No unmetered conductors shall be installed beyond the central metering location

d. Refer to ESB 750 for appropriate specifications

2.4 200 AMPERES, THREE PHASE, FOUR WIRE

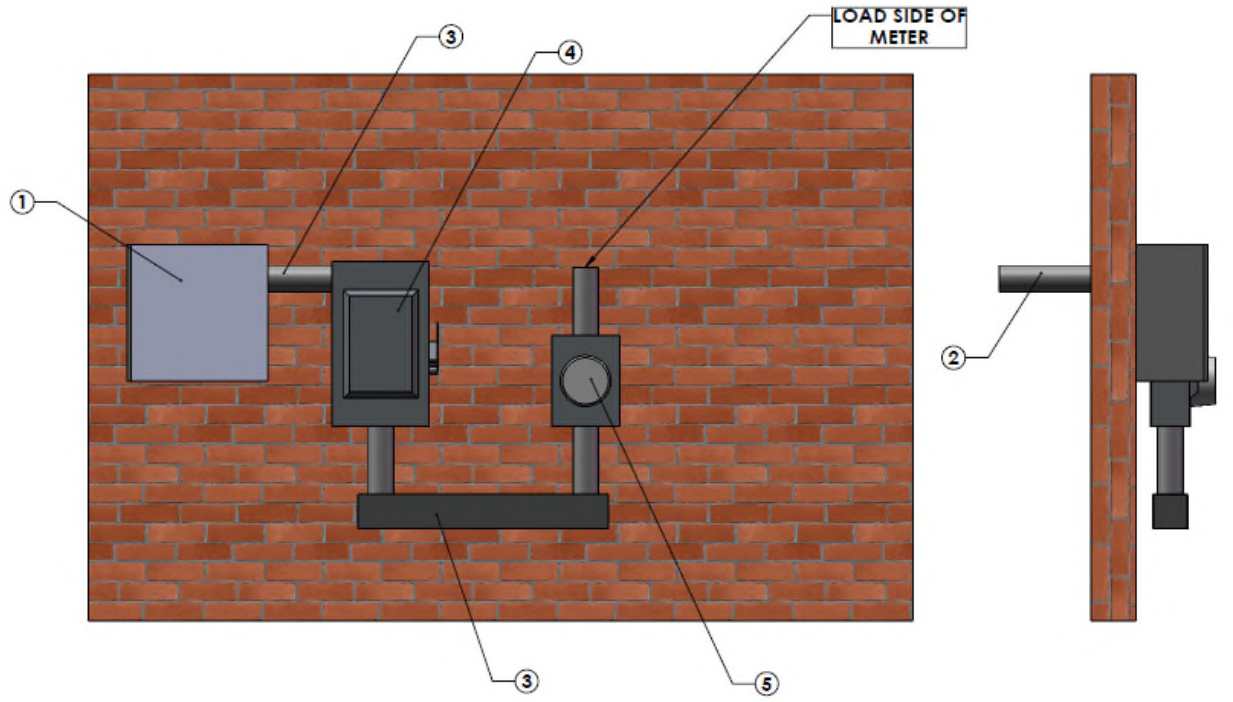


Figure 5 – 200 amperes Three Phase Equipment Example Layout

1. Junction / Termination Enclosure and Conductors:

a. Customer installed and owned in a location mutually agreed upon by the Company and customer

b. Minimum dimensions: 24 in (610 mm) x 24 in (610 mm) x 12 in (305 mm)

c. Shall be located at the closest possible point to conduit entrance into the building and be accessible by company personal for cable pulling and splicing

d. The floor area in front of the junction box shall provide minimally 8 ft of working clearance and be suitable for the installation of anchor inserts.

e. Shall have provisions for locking and sealing with the Company's standard padlock

f. Junction boxes installed outdoors shall be listed as weatherproof

g. Shall meet applicable NEC requirements and listings

h. Company conductors shall be spliced to customer owned conductors within this enclosure. Company conductor size shall be XHHW type, 4/0 soft drawn copper.

i. The Customer shall install the junction box oriented, and with conduits entering the box, such that parallel connections may be made between Company and customer cables. Orientation of the junction box and conduits can be adjusted as needed to accommodate actual installation; however the relative locations of the conduits that house the Company and customer cables shall be as shown in Figure 6.

j. Customer owned conductors shall be XHHW type, soft drawn copper.

k. Connectors will be provided by the Company, and connections in the junction box will be made by the Company.

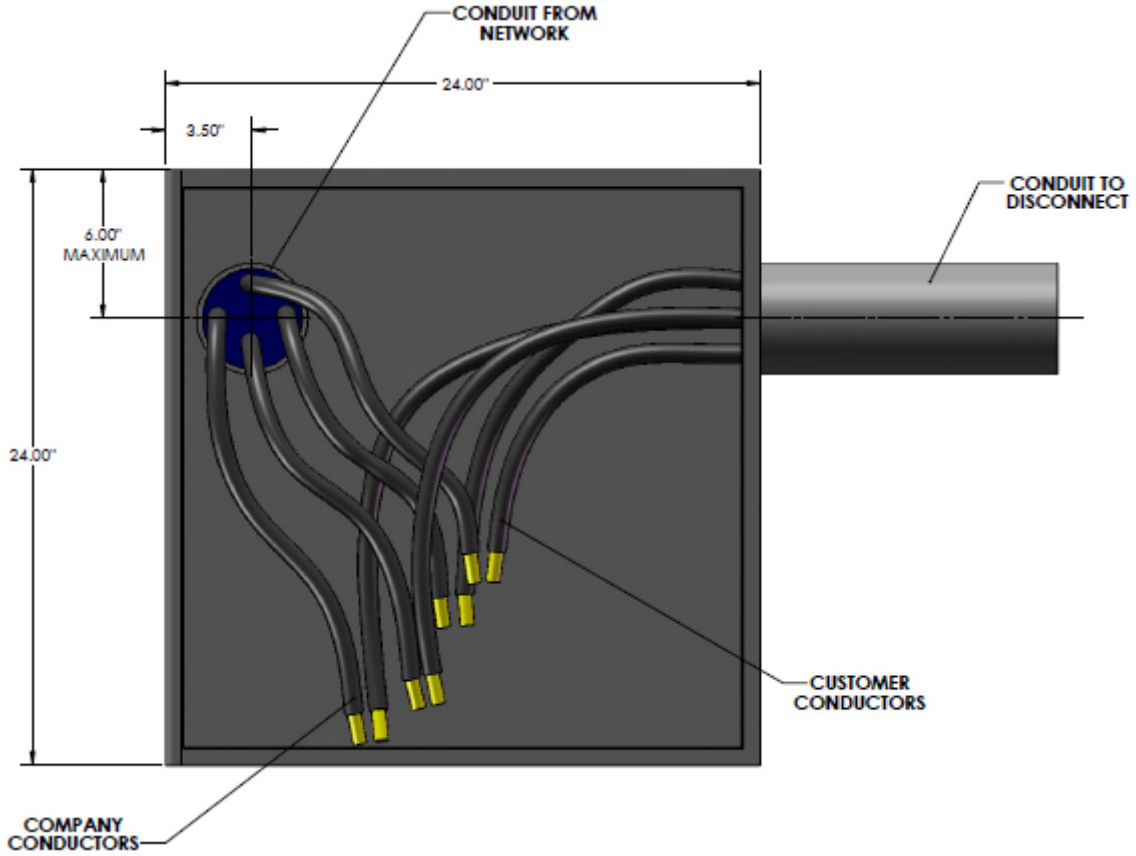


Figure 6 – 200 amperes Three Phase Junction Enclosure Example Layout with conductors

2. Service Conduits:

a. The junction between customer owned and installed conduits and Company owned and installed conduits shall be at a mutually agreed upon location

b. Shall be minimally 4 inch nominal

c. Number of service conduits and spare conduits shall be determined by the Company

d. Customer shall be responsible for all building foundation penetrations

e. All conduits containing company owned conductors that penetrate the building foundation shall be Rigid Galvanized steel

f. All exposed conduits containing company owned conductors and/or conduits before (up-stream of) metering equipment shall be Rigid Galvanized steel

g. Conduit sweep radii shall be minimally 36 inches

3. Conductor wire-ways / troughs before metering:

a. Customer installed and owned

b. Shall not contain metered or load side conductors

c. Shall be Rigid Galvanized steel, Lockable wire-way / troughs, or incorporated into a securable enclosure

d. Shall be sized in accordance with NEC requirements

4. Service Equipment / Main Disconnect:

a. Customer installed and owned

b. Shall contain only a Single Disconnecting Device before Metering Equipment

c. Shall have a minimum short circuit withstand rating of 100,000 amperes RMS symmetrical

d. Main Over-current Protection shall meet required withstand rating and applicable NEC requirements and listings

5. Metering Equipment:

a. Shall be Cold Sequenced

b. Shall be located as close as possible to the Service Equipment / Main Disconnect in one central location

c. No unmetered conductors shall be installed beyond the central metering location

d. Refer to ESB 750 for appropriate specifications

2.5 400 AMPERES, THREE PHASE, FOUR WIRE

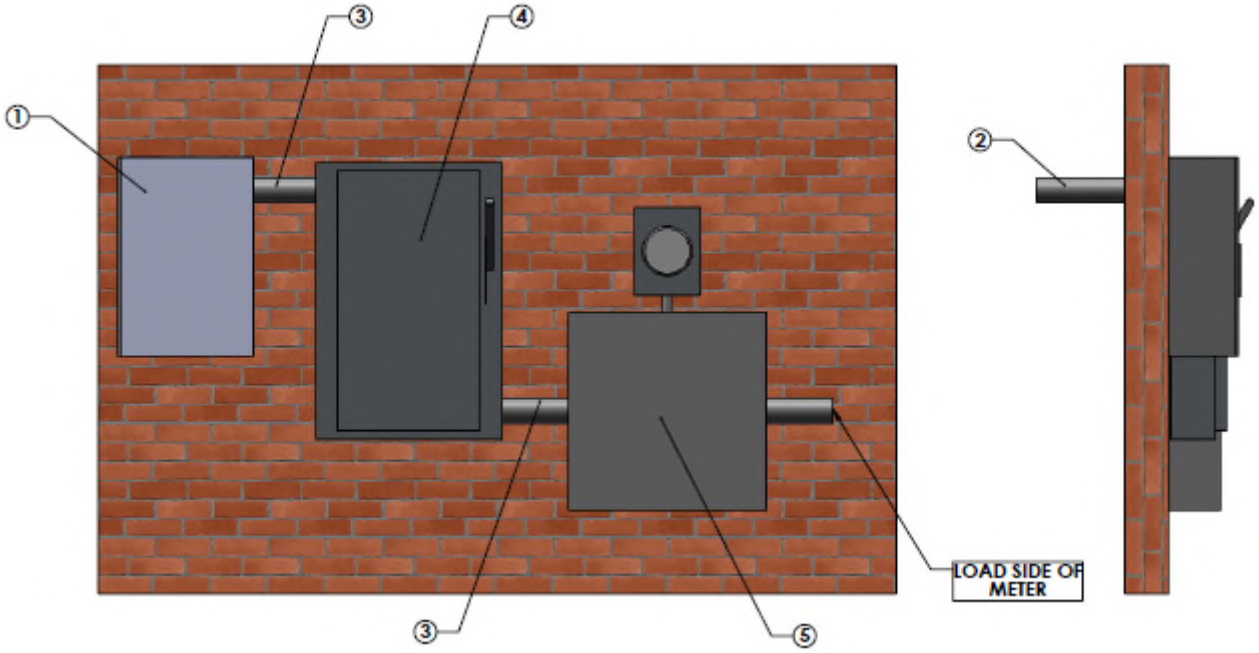


Figure 7 – 400 amperes Three Phase Equipment Example Layout

1. Junction / Termination Enclosure and Conductors:

a. Customer installed and owned in a location mutually agreed upon by the Company and customer

b. Minimum dimensions: 36 in (915 mm) height x 24 in (610 mm) width x 12 in (305 mm) deep

c. Shall be located at the closest possible point to conduit entrance into the building and be accessible by company personal for cable pulling and splicing

d. The floor area in front of the junction box shall provide minimally 8 ft of working clearance and be suitable for the installation of anchor inserts.

e. Shall have provisions for locking and sealing with the Company's standard padlock

f. Junction boxes installed outdoors shall be listed as weatherproof

g. Shall meet applicable NEC requirements and listings

h. Company conductors shall be spliced to customer owned conductors within this enclosure. Company conductor size shall be XHHW type, 500 kcmil soft drawn copper.

i. The Customer shall install the junction box oriented, and with conduits entering the box, such that parallel connections may be made between Company and customer cables. Orientation of the junction box and conduits can be adjusted as needed to accommodate actual installation; however the relative locations of the conduits that house the Company and customer cables shall be as shown in Figure 8.

j. Customer owned conductors shall be XHHW type, soft drawn copper.

k. Connectors will be provided by the Company, and connections in the junction box will be made by the Company.

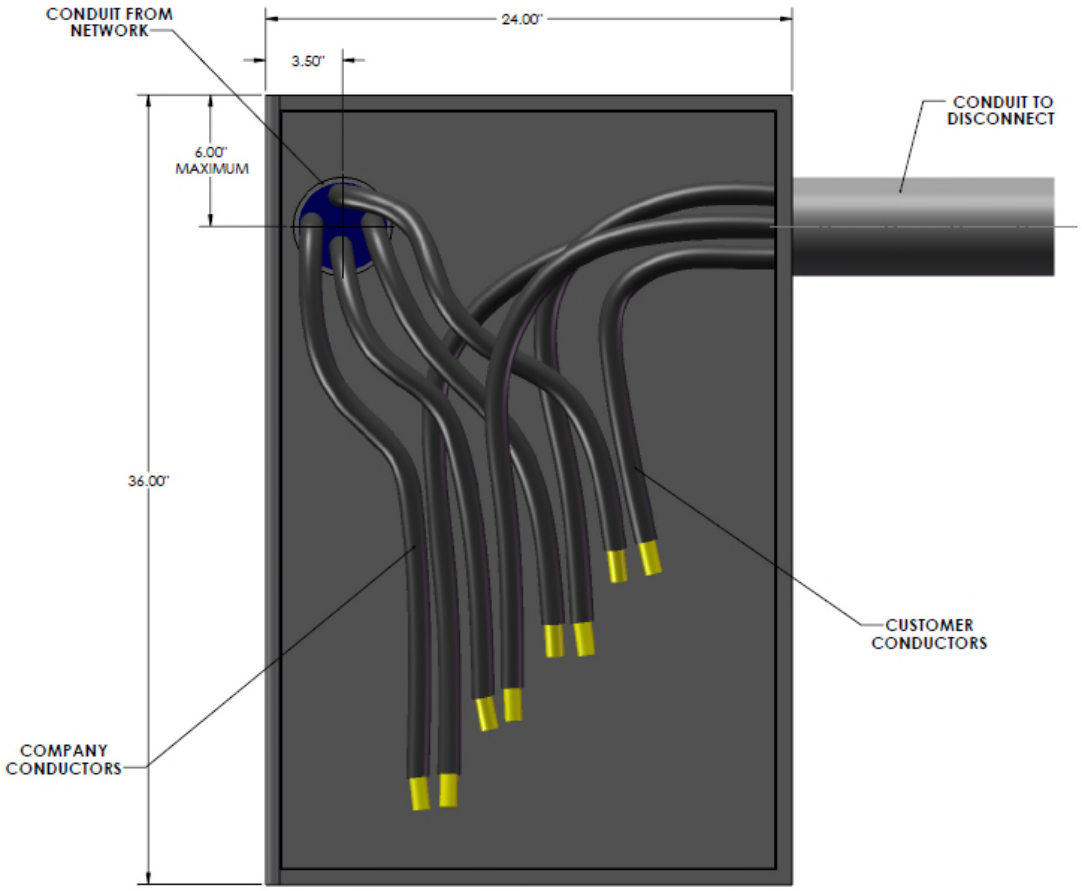


Figure 8 – 400 amperes Three Phase Junction Enclosure Example Layout with conductors

2. Service Conduits:

a. The junction between customer owned and installed conduits and Company owned and installed conduits shall be at a mutually agreed upon location

b. Shall be minimally 4 inch nominal

c. Number of service conduits and spare conduits shall be determined by the Company

d. Customer shall be responsible for all building foundation penetrations

e. All conduits containing company owned conductors that penetrate the building foundation shall be Rigid Galvanized steel

f. All exposed conduits containing company owned conductors and/or conduits before (up-stream of) metering equipment shall be Rigid Galvanized steel

g. Conduit sweep radii shall be minimally 36 inches

3. Conductor wire-ways / troughs before metering:

a. Customer installed and owned

b. Shall not contain metered or load side conductors

c. Shall be Rigid Galvanized steel, Lockable wire-way / troughs, or incorporated into a securable enclosure

d. Shall be sized in accordance with NEC requirements

4. Service Equipment / Main Disconnect:

a. Customer installed and owned

b. Shall contain only a Single Disconnecting Device before Metering Equipment

c. Shall have a minimum short circuit withstand rating of 100,000 amperes RMS symmetrical

d. Main Over-current Protection shall meet required withstand rating and applicable NEC requirements and listings

5. Metering Equipment:

a. Shall be Cold Sequenced

b. Shall be located as close as possible to the Service Equipment / Main Disconnect in one central location

c. No unmetered conductors shall be installed beyond the central metering location

d. Refer to ESB 750 for appropriate specifications

2.6 800 AMPERES, THREE PHASE, FOUR WIRE

Please consult the Company for possible area General Network service size limitations

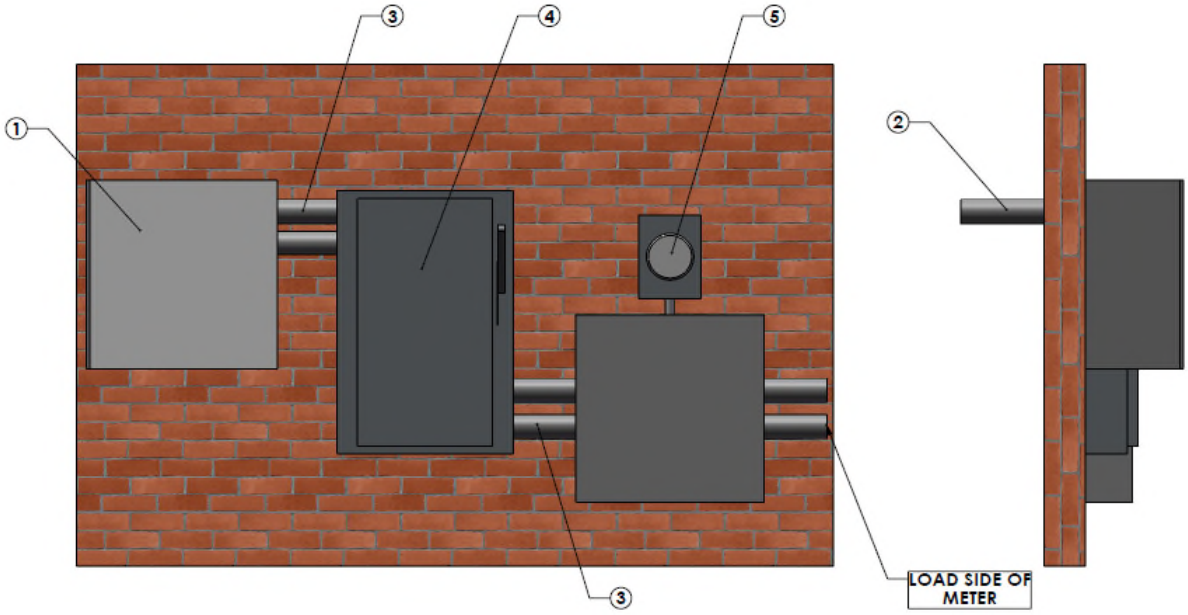


Figure 9 – 800 amperes Three Phase Equipment Example Layout

1. Junction / Termination Enclosure and Conductors:

a. Customer installed and owned in a location mutually agreed upon by the Company and customer

b. Minimum dimensions: 36 in (915 mm) x 36 in (915 mm) x 12 in (305 mm)

c. Shall be located at the closest possible point to conduit entrance into the building and be accessible by company personal for cable pulling and splicing

d. The floor area in front of the junction box shall provide minimally 8 ft of working clearance and be suitable for the installation of anchor inserts.

e. Shall have provisions for locking and sealing with the Company's standard padlock

f. Junction boxes installed outdoors shall be listed as weatherproof

g. Shall meet applicable NEC requirements and listings

h. Company conductors shall be spliced to customer owned conductors within this enclosure. Company conductor size shall be two sets of XHHW type, 500 kcmil soft drawn copper.

i. The Customer shall install the junction box oriented, and with conduits entering the box, such that parallel connections may be made between Company and customer cables. Orientation of the junction box and conduits can be adjusted as needed to accommodate actual installation; however the relative locations of the conduits that house the Company and customer cables shall be as shown in Figure 10.

j. Customer owned conductors shall be XHHW type, soft drawn copper.

k. Connectors will be provided by the Company, and connections in the junction box will be made by the Company.

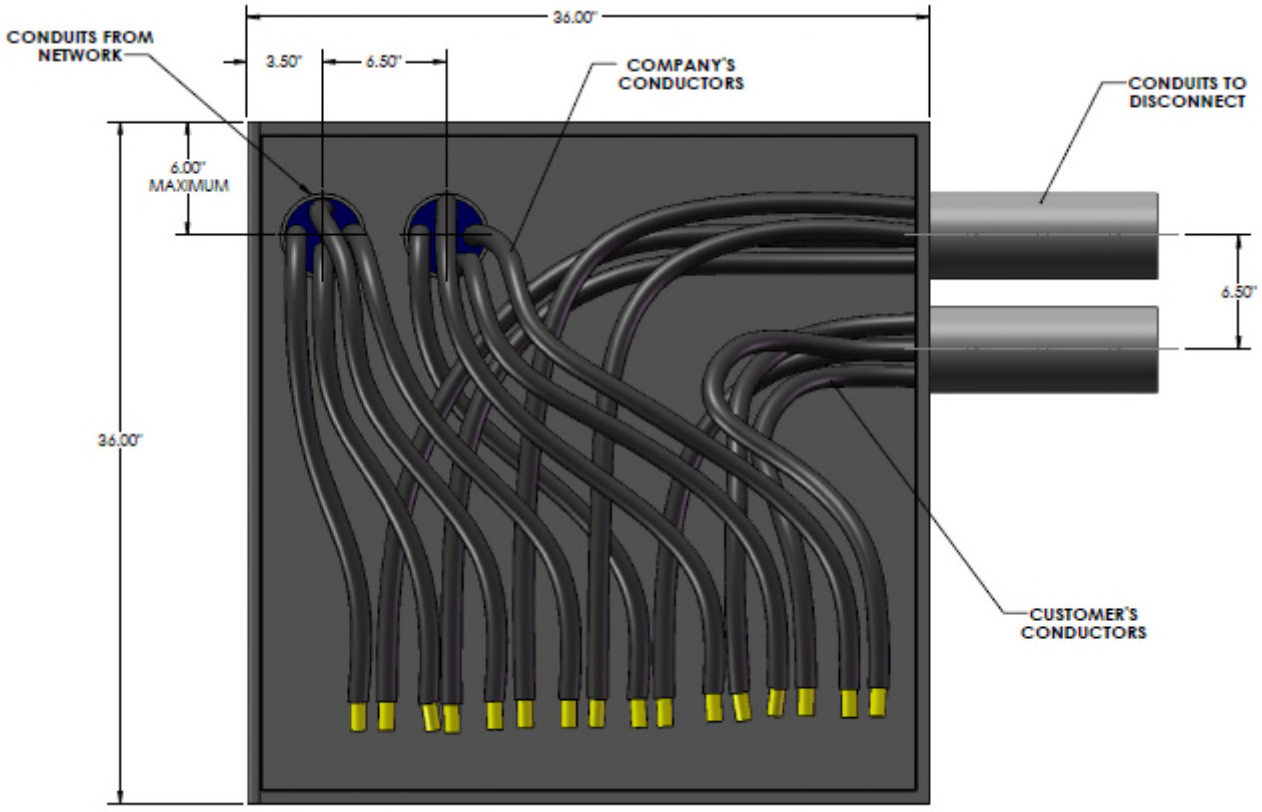


Figure 10 – 800 amperes Three Phase Junction Enclosure Example Layout with conductors

2. Service Conduits:

a. The junction between customer owned and installed conduits and Company owned and installed conduits shall be at a mutually agreed upon location

b. Shall be minimally 4 inch nominal

c. Number of service conduits and spare conduits shall be determined by the Company

d. Customer shall be responsible for all building foundation penetrations

e. All conduits containing company owned conductors that penetrate the building foundation shall be Rigid Galvanized steel

f. All exposed conduits containing company owned conductors and/or conduits before (up-stream of) metering equipment shall be Rigid Galvanized steel

g. Conduit sweep radii shall be minimally 36 inches

3. Conductor wire-ways / troughs before metering:

a. Customer installed and owned

b. Shall not contain metered or load side conductors

c. Shall be Rigid Galvanized steel, Lockable wire-way / troughs, or incorporated into a securable enclosure

d. Shall be sized in accordance with NEC requirements

4. Service Equipment / Main Disconnect:

a. Customer installed and owned

b. Shall contain only a Single Disconnecting Device before Metering Equipment

c. Shall have a minimum short circuit withstand rating of 100,000 amperes RMS symmetrical

d. Main Over-current Protection shall meet required withstand rating and applicable NEC requirements and listings

5. Metering Equipment:

a. Shall be Cold Sequenced

b. Shall be located as close as possible to the Service Equipment / Main Disconnect in one central location

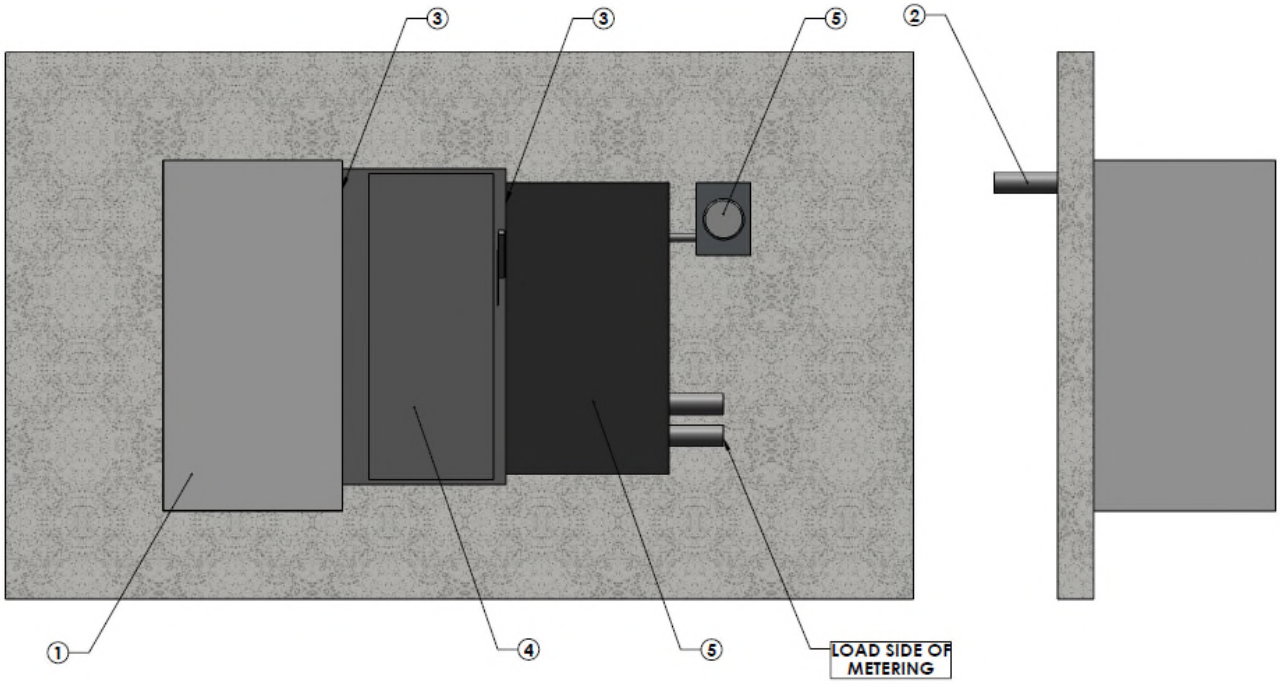
c. No unmetered conductors shall be installed beyond the central metering location

d. Refer to ESB 750 for appropriate specifications

2.7 1000 TO 1600 AMPERES, THREE PHASE, FOUR WIRE

Consult the Company for possible area General Network service size limitations

In many network areas, services of this size cannot be supplied from the General Network, and will require a customer owned transformer vault or vaults. The information that follows in this section does not apply to those locations requiring customer owned vaults. The Company shall be consulted for service requirements specific to the location for which service is requested.



2.7.1 Figure 11 – 1000 to 1600 amperes Three Phase Equipment Example Layout

1. Limiter / Termination Enclosure:

a. Customer installed and owned in a location mutually agreed upon by the Company and customer

b. Approximate minimum dimensions of utility area (depth x width x height): 41 in (1041 mm) in x 44 in (1143 mm) in x 78 in (1981 mm)

c. Shall be located at the closest possible point to conduit entrance into the building and be accessible by company personal for cable pulling and splicing

d. The floor area in front of the Limiter / Termination Enclosure shall provide minimally 8 ft of working clearance and be suitable for the installation of anchor inserts.

e. Company conductors shall be terminated onto the customer owned bus work within this enclosure.

f. Shall have provisions for locking and sealing with the Company's standard padlock

g. Shall meet applicable NEC requirements and listings

h. The bus bars in the Limiter / Termination Enclose shall be arranged such that the neutral bus is closest to the conduit and cable entry as shown in Figures 12 to 14

i. Cable limiters and terminations will be provided by the Company, and connections in the enclosure will be made by the Company.

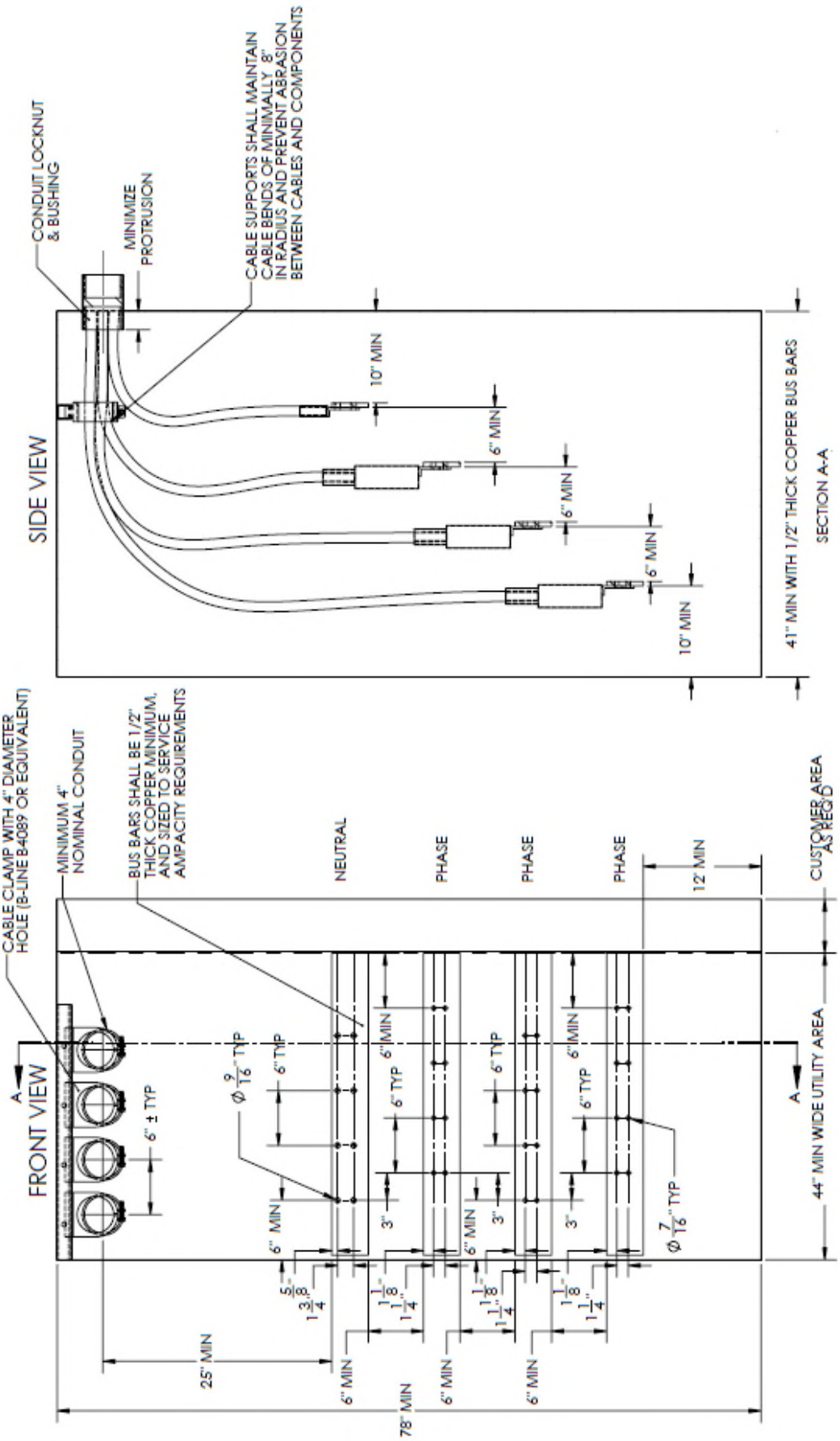


Figure 12 – 1000 to 1600 amperes Limiter Enclosure (Top Entry from Wall)

FOR THE LATEST AUTHORIZED VERSION PLEASE REFER TO THE COMPANY'S WEBSITE AT http://www.nationalgridus.com/electricalspecifications.

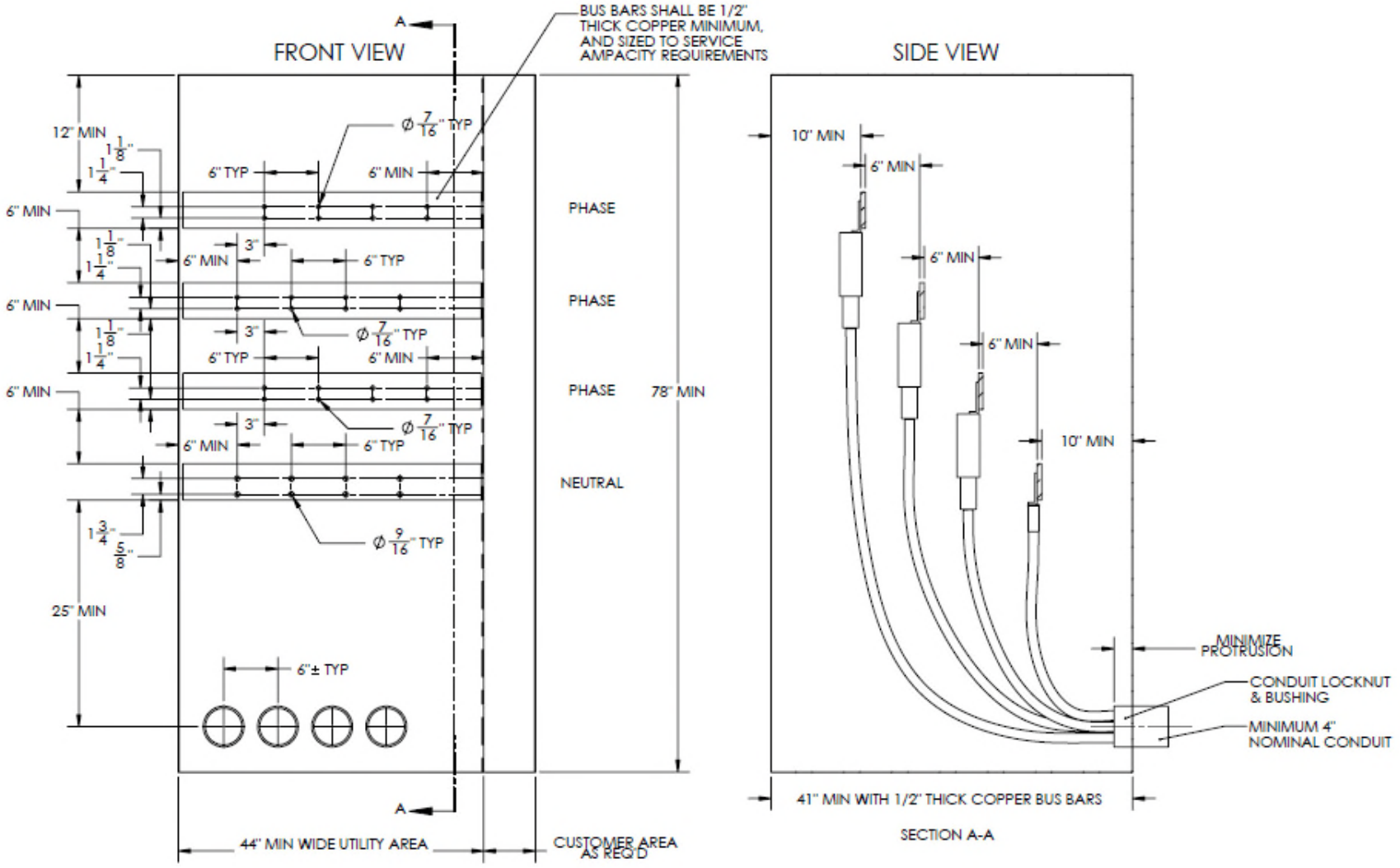


Figure 13 – 1000 to 1600 amperes Limiter Enclosure (Bottom Entry from Wall)

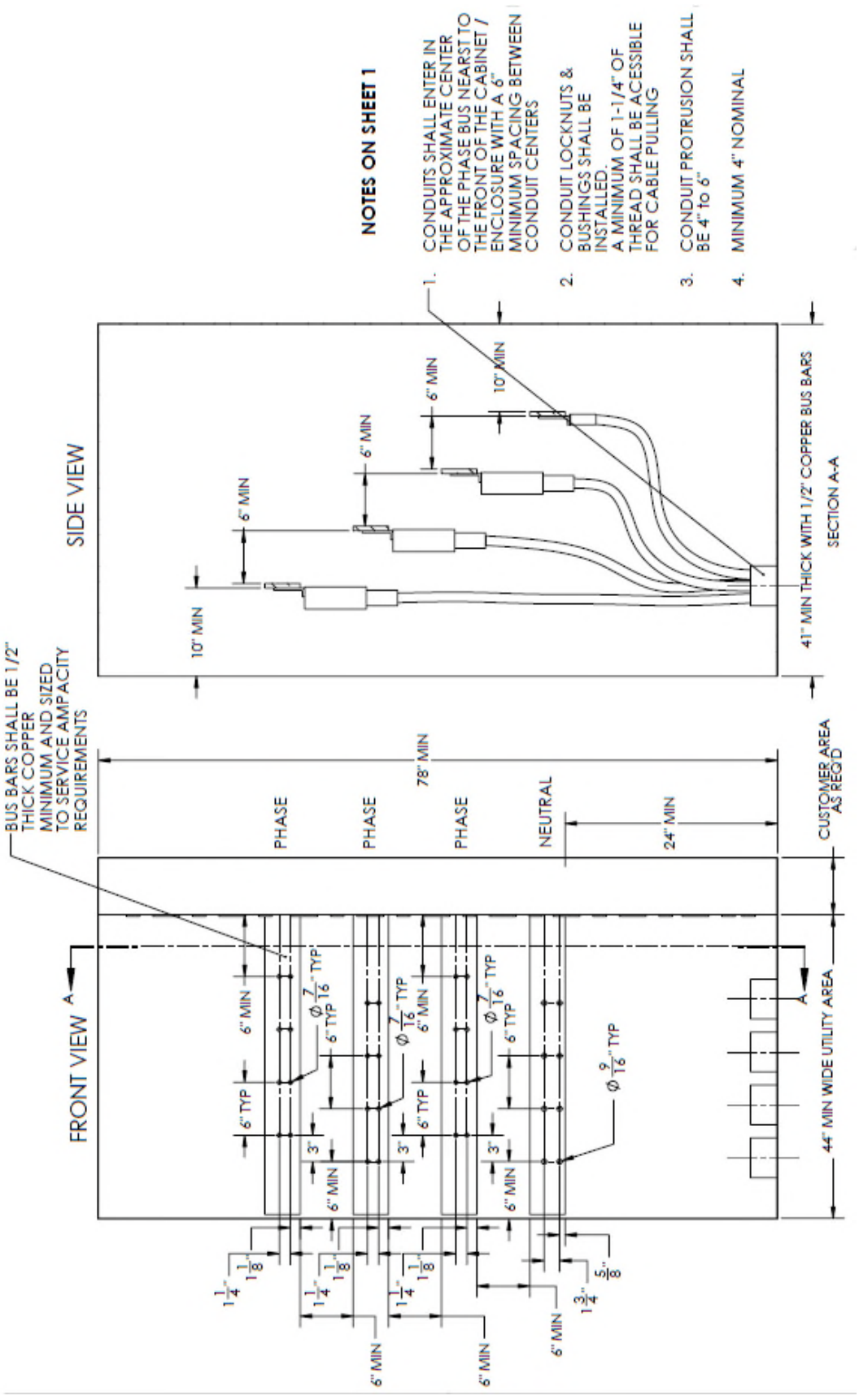


Figure 14 – 1000 to 1600 amperes Limiter Enclosure (Bottom Entry from Floor)

2. Service Conduits:

a. The junction between customer owned and installed conduits and Company owned and installed conduits shall be at a mutually agreed upon location

b. Shall be minimally 4 inch nominal

c. Number of service conduits and spare conduits shall be determined by the Company

d. Customer shall be responsible for all building foundation penetrations

e. All conduits containing company owned conductors that penetrate the building foundation shall be Rigid Galvanized steel

f. All exposed conduits containing company owned conductors and/or conduits before (up-stream of) metering equipment shall be Rigid Galvanized steel

g. Conduit sweep radii shall be minimally 36 inches

3. Conductor wire-ways / troughs before metering:

a. Customer installed and owned

b. Shall not contain metered or load side conductors

c. Shall be Rigid Galvanized steel, Lockable wire-way / troughs, or incorporated into a securable enclosure

d. Shall be sized in accordance with NEC requirements

4. Service Equipment / Main Disconnect:

a. Customer installed and owned

b. Shall contain only a Single Disconnecting Device before Metering Equipment

c. Shall have a minimum short circuit withstand rating of 100,000 amperes RMS symmetrical

d. Main Over-current Protection shall meet required withstand rating and applicable NEC requirements and listings

5. Metering Equipment:

a. Shall be Cold Sequenced

b. Shall be located as close as possible to the Service Equipment / Main Disconnect in one central location

c. No unmetered conductors shall be installed beyond the central metering location

d. Refer to ESB 750 for appropriate specifications

3.0 NETWORK SERVICES FROM CUSTOMER-OWNED TRANSFORMER VAULTS

3.1 GENERAL

Regardless of customer's projected demand, main switch sizes larger than the capacity limitations of the area general network will require the installation of Customer-owned transformer vaults. Capacity limitations are dictated by each particular network system and geographic locations.

For 208Y/120 volt service, installation configurations may consist of two or more Customer-owned transformer vaults with provisions to interconnect with the area general network (Figure 15) or two or more Customer-owned vaults in a spot network arrangement (Figure 16). The Company will determine if a vault is to be interconnected with the area general network or is to be spot network.

All 480Y/277 volt services networks shall require two or more Customer-owned transformer vaults (Figure 16). Minimum service size of 480Y/277 volt services shall be 1200 amperes with monthly billing demand as estimated by the Company of not less than 750 kVA.

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

Not all service sizes can be supplied from network facilities in all areas.

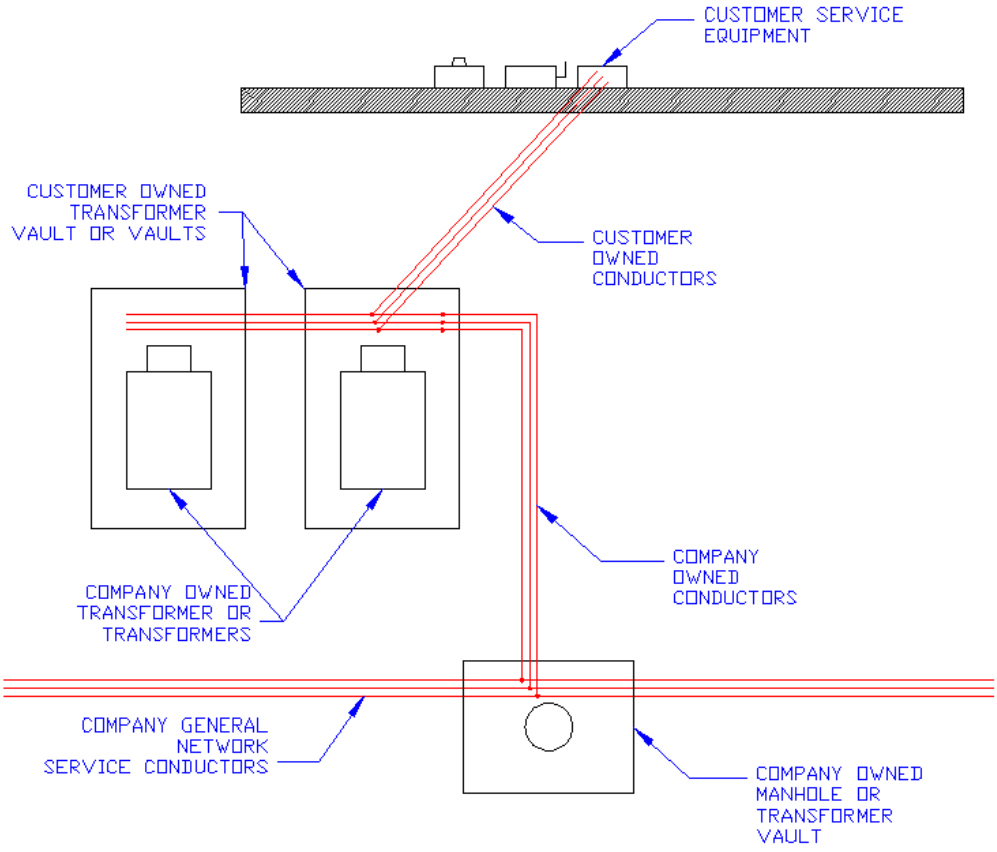


Figure 15 – Customer-Owned Transformer Vaults with Interconnection to General Network

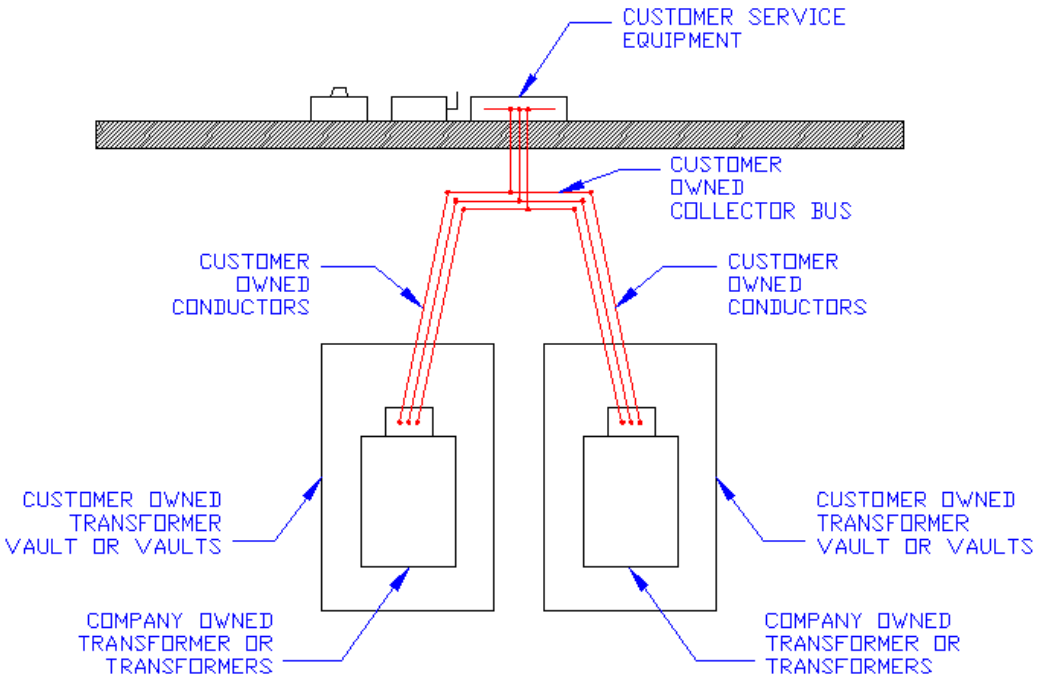


Figure 16 – Spot Network Customer-Owned Transformer Vaults

3.1.1 Service Details for Network Services from Customer-Owned Vaults

The complexity associated with the design and installation of network services from Customer-owned vaults necessitates consultation with the company in the early stages of the project.

3.1.2 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 volts 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

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

Project details shall include:

- Service Capability:
- Number of transformers to be installed
- 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
- Motor Starting: maximum allowable inrush for starting any motor or combination of motors
- Customer Construction: details of the equipment plus facilities required for Company use to be installed and maintained by the Customer
- Estimation 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 estimation of charges and delays to the project.

3.2 LOCATION AND ARRANGEMENT OF SERVICE FACILITIES

3.2.1 Location of Service Conductors

The Company reserves the right to designate the location from the public right-of-way where the Company's service conductors enter the Customer's property. This will be determined by the location and suitability of the Company's existing facilities.

3.2.2 Location of Network Transformers

Network transformers are typically installed in either free-standing above-grade vaults located indoors or below-grade vaults located outdoors. The Company reserves the right to designate the location of network transformers.

The location of network transformers and service equipment shall be as close as practical to minimize the length of secondary voltage conductors.

3.3 REQUIREMENTS, APPROVALS, AND INSPECTIONS

3.3.1 Requirements

This information is in addition to requirements of the National Electrical Safety Code, and supplements the article concerning "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 a Customer-owned transformer vault. It is not intended to be a comprehensive document, and should be used only as a guide.

3.3.2 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.

3.3.3 National Grid Approval

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

3.3.4 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.

3.4 VAULT EASEMENT AGREEMENT

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

3.5 DIVISION OF RESPONSIBILITIES

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

- Vault(s), complete with ventilation, lighting, and other accessories 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)
- Secondary conductors between Customer's service equipment and the vault(s)
- For spot network application - secondary collector bus
- For 480Y/277 volt spot network application - ground fault protection system

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

- Transformers and accessory equipment
- Primary cables
- For 208Y/120 volt vault(s) interconnected with the general network - secondary collector bus and secondary cables to interconnect the vault with the general network.

3.6 SERVICE CAPABILITY

Refer to the following table for service capability. Maximum service capability varies depending on the actual location in each specific network. The number of transformer units required for each particular location will vary depending on the specific network. The Company shall be consulted for requirements specific to the location for which service is requested.

The maximum number of main disconnecting devices shall be reviewed by the Company prior to the purchase of equipment.

Service Capability	Service Voltage	Maximum Number of Transformer Units
≤ 3000 A	208Y/120 V	2
3001 A – 6000 A	208Y/120 V	3
6001 A – 8000 A	208Y/120 V	4
1200 A – 4000 A	480Y/277 V	3
4001 A – 8000 A	480Y/277 V	4
Notes 1. Maximum service size shall be 8000 amperes. Services shall be limited to two 4000 ampere main disconnects. 2. Service capability limitations and variations are dependent on actual location in specific network. The number of transformer units required for each particular location will vary depending on the specific network. The Company shall be consulted for requirements specific to the location for which service is requested. 3. Not all service sizes can be supplied from network facilities in all areas.		

Table 1 – Service Capability

3.7 VAULT DESIGN, LOCATION, AND ACCESS

3.7.1 All Vaults

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

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.[4] 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 his expense,

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

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'.

3.7.2 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 access.

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 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 transformer units and other associated heavy equipment.

Access for personnel, which may be via another route, shall be at least 4' wide x 7' 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 incremental labor expenses incurred by the Company will be billable to the Customer.

Refer to Table 2 and the applicable figures in the appendix for standard vault arrangements and dimensions.

Maximum Number of Transformer Units	Maximum kVA for each Transformer Unit	Maximum Primary Voltage	Service Voltage	Applicable Figures
2	1000	15 kV	208Y/120 V	17
3	1000	15 kV	208Y/120 V	18
4	1000	15 kV	208Y/120 V	19
2	1500	15 kV	480Y/277 V	20
3	1500	15 kV	480Y/277 V	21
4	1500	15 kV	480Y/277 V	22
2	2000	15 kV	480Y/277 V	23
3	2000	15 kV	480Y/277 V	24
4	2000	15 kV	480Y/277 V	25
2	2500	15 kV	480Y/277 V	26
3	2500	15 kV	480Y/277 V	27
4	2500	15 kV	480Y/277 V	28
2	1000	23 kV	208Y/120 V	29
3	1000	23 kV	208Y/120 V	30
4	1000	23 kV	208Y/120 V	31
2	1000	23 kV	480Y/277 V	29
3	1000	23 kV	480Y/277 V	30
4	1000	23 kV	480Y/277 V	31
2	1500	23 kV	480Y/277 V	32
3	1500	23 kV	480Y/277 V	33
4	1500	23 kV	480Y/277 V	34
2	2000	23 kV	480Y/277 V	35
3	2000	23 kV	480Y/277 V	36
4	2000	23 kV	480Y/277 V	37
2	2500	23 kV	480Y/277 V	38
3	2500	23 kV	480Y/277 V	39
4	2500	23 kV	480Y/277 V	40
2	1500	35 kV	480Y/277 V	41
3	1500	35 kV	480Y/277 V	42
4	1500	35 kV	480Y/277 V	43
2	2000	35 kV	480Y/277 V	44
3	2000	35 kV	480Y/277 V	45
4	2000	35 kV	480Y/277 V	46
2	2500	35 kV	480Y/277 V	47
3	2500	35 kV	480Y/277 V	48
4	2500	35 kV	480Y/277 V	49

Table 2 – Standard Arrangements - Building Vaults and Free-Standing Above-Grade Vaults

3.7.3 Below-Grade Vaults Located Outdoors

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.

The vault shall have access openings located to allow truck approach with boom or crane installation for initial delivery and replacement of transformers 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.

Refer to the latest edition of National Grid material specification MS 3492 and MS 3493 for acceptable pre-cast below-grade vault dimensions and access requirements. An individual below-grade vault is required for each transformer. Refer to Figure 50 in the Appendix.

For specialized installations or installations in which a pre-cast vault cannot be used, refer to Table 3 for minimum access requirements for transformer units and other associated equipment.

Maximum kVA for each Transformer Unit	Maximum Primary Voltage	Service Voltage	Minimum Clear Opening for Equipment Access (width x length)
1000	15 kV	208Y/120 V	6’-0” W x 11’-7” L
1500	15 kV	480Y/277 V	6’-2” W x 12’-3” L
2000	15 kV	480Y/277 V	6’-10” W x 13’-0” L
2500	15 kV	480Y/277 V	7’-4” W x 14’-8” L

Table 3 – Minimum Access Requirements for non-precast Below-Grade Vaults

3.8 CONSTRUCTION

3.8.1 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

The Customer shall refer to the Company’s specifications and requirements for precast transformer vaults, hatchways, ladders, and accessories. This information will be provided separately.

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.

3.8.2 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.

3.8.3 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 silicone-filled equipment in a building. Silicone is a “less-flammable” insulating fluid.

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. The consultation of a licensed design professional is encouraged.

3.8.4 Walls, Roof, and Floor

3.8.4.1 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 51 in the Appendix)
- 4500 psi Concrete – 8" thick reinforced with #4 bars @ 10" grid (Figure 52 in the Appendix)
- CMU – 12" thick, fully grouted, reinforced with 2 - #4 bars @ 8" OC (Figures 53 & 54 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 55 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 should 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 3.8.4.2. 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 should 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.

3.8.4.2 Below Grade Vaults Located Outdoors

Below-grade vaults located outdoors shall be either field cast (reinforced concrete minimum thickness 12") or precast units. Both styles shall have removable access panels, hatchway gratings, and personnel access hatchways and/or manhole covers in locations 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. The customer shall equip the vault with all related accessories such as ladders, lighting, and pull-eyes. All materials shall be in accordance with the Company's Construction Standards and Material Standards.

All covers, grating, and removable panels located at grade shall be designed to meet H-20 tractor-trailer loading requirements as outlined in Figure 56 in the Appendix.

All steel grating and field covers shall have anti-slip surface treatment in compliance with the GALVAGRIT™ Specification on Page 70 in the Appendix.

3.8.5 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 5.

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 and rods 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/120 V	Up to 23 kV	Up to 1000	18,000 lbs
480Y/277 V	Up to 23 kV	Up to 1000	18,000 lbs
480Y/277 V	Up to 23 kV	1500	20,000 lbs
480Y/277 V	Up to 23 kV	2000 & 2500	32,000 lbs
480Y/277 V	34.5 kV	Up to 2500	32,000 lbs

Table 4 – Network Unit Weights

3.8.6 Doors (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 doors to allow quick egress, and (d) lock sets to accept the Company's standard cylinder, which will be furnished by the Company.

Depending on service area and application the company's standard cylinder will be either a Wilson Bohannan (WB) cylinder or a Best®, figure eight, seven pin cylinder.

The number, location, and clear opening of doors required will be specified by the Company. Refer to Figures 17 through 49. Additional doors for personnel access may be required and shall be a minimum of 7'-0" high x 3'-0" wide.

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.

3.8.7 Ladders (Below-Grade Vaults)

For below-grade vaults, ladders must be permanently installed. All ladders installed for the purpose of entering a transformer vault shall comply with OSHA 190.27 for “Fixed Ladders” and OSHA 3124 for “Stairways and Ladders” unless the specifications outlined in the following section are more stringent.

1. Ladders are to be constructed of a non-corrosive material or be treated to resist corrosion (hot-dipped galvanized). Wood is unacceptable for use in vaults. The ladder shall be constructed entirely of the same material; this prevents electrolytic action.

2. Ladder loading shall be in accordance with OSHA 3124.

3. Ladders in transformer vaults shall have side rails. Individual rung ladders are unacceptable.

4. Ladders shall be angled as dictated by OSHA 1910.27(e)(1) – “preferred pitch” but shall not exceed an 85 degree angle. Refer to Figure 41 below.

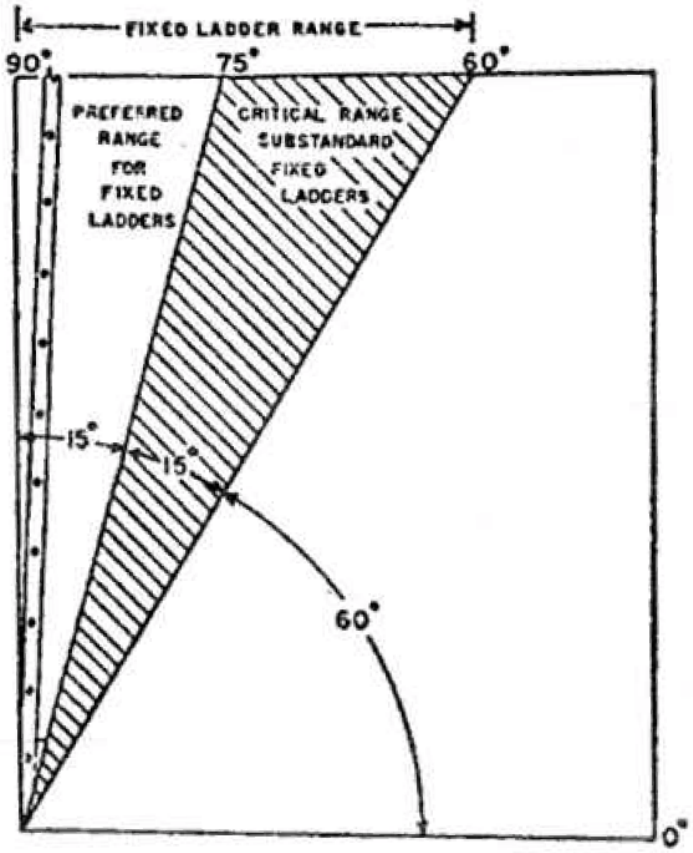


Figure 41 – OSHA Figure D-11 – Pitch of Fixed Ladders

5. Rung spacing and design shall comply with OHSA 1910.27(b)(1). Refer to Figure 42. Rungs shall be spaced at 12 inches. The rungs shall be a minimum of ¾ inches in diameter. Rungs shall be a minimum of 16 inches in length. The distance between the centerline of the rungs to the nearest permanent object shall be 7 inches.

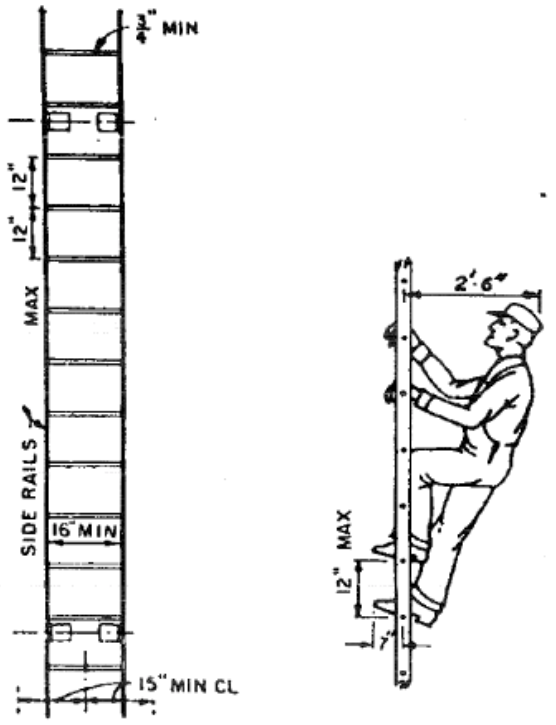


Figure 42 – OSHA Figure D-2

6. The ladder shall extend to within 1 inch of the entrance hatchway in order to provide safe stepping transition to the ladder.

7. An extension device shall be attached at the top or be integral part of the ladder that will extend a minimum of 42" above the top rung of the ladder. The device is to be constructed of a non-corrosive or corrosive resistant material. An example of a device that attaches to the ladder is the Bilco – "ladderup" unit. Refer to Figure 43.

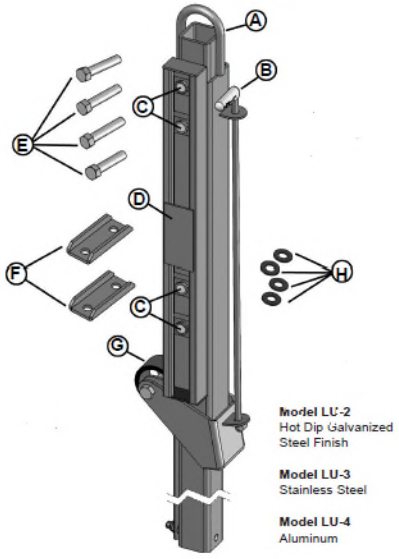


Figure 43 – Ladder Extension

3.8.8 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.

Lighting shall be designed for a minimum of 10 foot-candle illumination. Fixtures must be provided in the area opposite each network protector.

3.8.9 Ventilation

3.8.9.1 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 and personnel 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:

10' x 22' (inside dimensions) vault – 63 square feet of net free air space.

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.

3.8.9.2 Air Conditioning

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

3.8.9.3 Forced Ventilation

The Customer will, at his 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, 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. 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	Service Size	Heat Dissipation Rate (BTU/min)
208Y/120 V	≤ 3000 A	1200
208Y/120 V	4000 A	1350
208Y/120 V	4001 A - 6000 A	2400
208Y/120 V	6001 A - 8000 A	2900
480Y/277 V	≤ 2000 A	1200
480Y/277 V	2001 A - 3000 A	1350
480Y/277 V	4000 A	2400
480Y/277 V	5000 A	2500
480Y/277 V	6000 A	3600
480Y/277 V	8000 A	5000

Table 5 – Required Vault Heat Dissipation

3.8.10 Conduit and Equipment Foundations

The Customer will, at his 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 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.

3.8.11 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.

3.8.12 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/120 V	Up to 15 kV	Up to 1000	400
208Y/120 V	23 kV	Up to 1000	500
480Y/277 V	Up to 15 kV	Up to 1500	500
480Y/277 V	Up to 15 kV	2000 & 2500	650
480Y/277 V	23 kV	Up to 2500	650
480Y/277 V	34.5 kV	Up to 2500	700

Table 6 - Fluid Volume

3.8.13 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 his 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 C57.12.40, Standard Requirements for Secondary Network Transformers - Subway and Vault Types (Liquid Immersed).

3.9 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.

3.9.1 Design and Installation

3.9.1.1 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 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.

3.9.1.2 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 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.

3.9.1.3 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.

3.9.1.4 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.

3.9.1.5 Where possible while still meeting code requirements, the system shall be designed so that sprinkler discharge does not reach the secondary collector bus or any other live uninsulated parts. Location of Company equipment will be shown on drawings after the vault electrical design is complete.

3.9.1.6 Scaled and dimensioned drawings, prepared and sealed by the Customer's design professional, shall be provided showing location of sprinkler heads in the electric vault and calculated range of water dispersion from sprinkler heads relative to the Company's secondary collector bus. All equipment shall be accurately located on the plans.

3.9.2 Construction

3.9.2.1 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.

3.9.3 Variances

3.9.3.1 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.

3.9.4 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 oil or silicone 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.

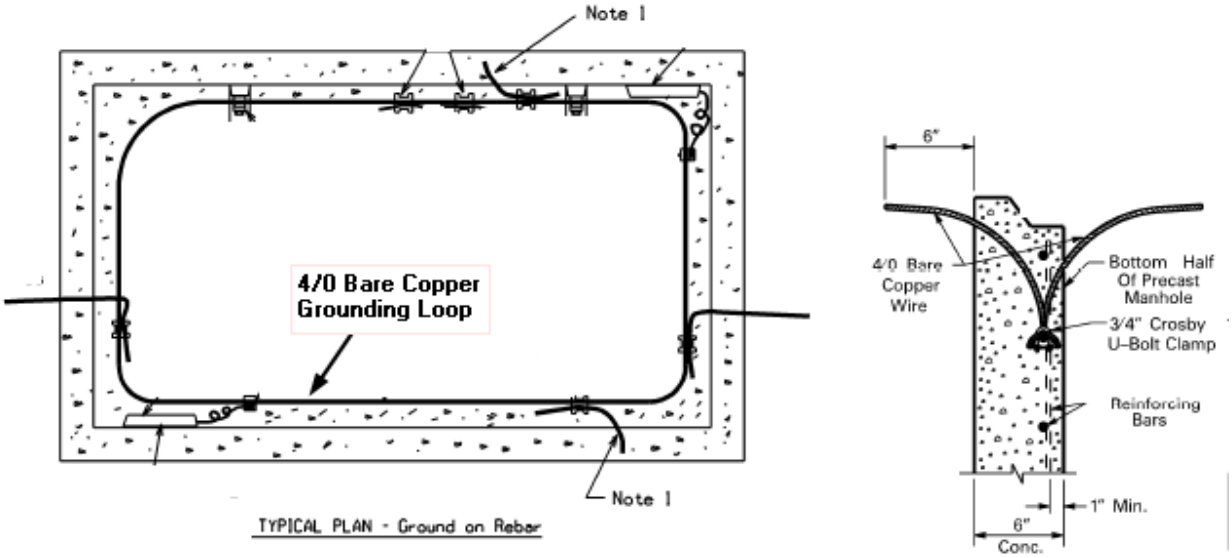
3.10 ELECTRICAL

3.10.1 Grounding

The following grounding criteria are for the sole purpose of grounding Company-owned equipment in the vault.

The Customer shall provide a galvanized steel conduit with two (2) 500 kcmil copper 600 volt insulated conductors therein from the vault to the street side of the building water meter for use by the Company. The conductors are to attach to the water service pipe at the street side of the water meter and have "tails" in the vault of sufficient length to allow easy unspliced attachment to the vault ground bus. Where the water supply is non-metallic or not accessible, exothermic bonding to building steel is acceptable per applicable state and local codes.

Additionally, for below-grade or freestanding vaults, pigtails shall be taken from the structure's reinforcing steel as shown in Figure 44.



Note 1 – Minimally two 4/0 tails bonded to 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 44 – Vault Grounding Loop

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

3.10.2 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 will be as follows:

- For 208Y/120 V network services with customer owned vaults interconnected with the General Network - as provided by the Company's Engineer. Maximum available calculated short-circuit current will not exceed 200,000 amperes.
- For 208Y/120 V or 480Y/277 V spot network service - see Table 8

Spot Network Service Voltage	Spot Network Maximum Service Capability	Maximum Available Short Circuit Current (calculated symmetrical amperes)*
208Y/120 V	≤ 3000 A	120,000
208Y/120 V	4000 A	135,000
208Y/120 V	6000 A	180,000
208Y/120 V	8000 A	240,000
480Y/277 V	≤ 2000 A	100,000
480Y/277 V	4000 A	104,000
480Y/277 V	6000 A	112,000
480Y/277 V	8000 A	186,000
*Calculated at the customer connection with Company owned equipment (Refer to Division of Responsibilities section)		

Table 7 - Spot Network Service - Available Short Circuit Current

3.10.3 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 will be by Company personnel.

Secondary conductors shall be XHHW type, soft drawn copper. The Customer shall provide the required connectors. Terminal lugs shall be compression-type tinned copper, 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.

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.

3.10.3.1 Secondary Collector Bus – 208Y/120 volt Interconnected with the General Network

The Company will install, own, and maintain the secondary collector bus.

3.10.3.2 Secondary Collector Bus – Spot Network

The Customer will design, construct, install, own, and maintain the secondary collector bus. The bus shall be located outside the vault.

The combined strength of the conductors and insulating material together with the supporting members shall be capable of withstanding the forces exerted by a three phase fault of the magnitude specified by the Company.

Neutral bus conductor ampacity shall be equal to the phase conductor ampacity.

3.10.4 Protective Device Coordination

It is essential that the Customer's main switch or fuse coordinate with the Company's protective devices. Upon request, the Company will provide the Customer with time-current characteristics with which their main switch must coordinate.

3.10.5 Ground Fault Protection System - 480Y/277 volt Network Service

In order to provide ground fault protection on the "line side" of the Customer's ground fault sensors (i.e. main service disconnecting devices), the Company requires the installation of a scheme that will trip all of the Company-owned Network Transformer's "Low-side" network protectors for an arcing ground fault between the Company-owned Network Transformers and the Customer-owned main service disconnecting devices.

The Customer shall furnish, design, install, own, and maintain a ground fault protection scheme on the "line side" of the Customer's ground fault sensors (i.e. main service disconnecting devices) except that the Company will perform all work within the manholes and vaults including installation of the Customer's current transformer, where required, in each of the network transformer bond connections.

The Customer, in furnishing this protection, assumes the sole risk and responsibility for damage to his own equipment as would be the case if he supplied his own network protectors.

The Customer shall reimburse the Company for all costs incurred by the Company in the installation of the Ground Fault Protection scheme.

The Customer shall provide a Ground Fault Study for the Company's review including drawings and proposed settings. Drawings shall be submitted for review by the Company in advance of ordering materials.

The scheme shall be subject to the following requirements (also refer to Figures 57, 58 and 59 in the Appendix for reference):

Ground Fault Relay (GFR) & Lockout Relay (LOR) Requirements:

- The GFR shall have a pick-up range of 100 – 1200 Amperes.
- The GFR shall trip a lock-out relay (GE Model HEA or equivalent). The LOR shall be "Hand" reset style.
- When possible the GFR and LOR shall be supplied from a 120 volt utility power source. If a 120 volt utility power source is not readily available, the customer shall provide 120 volt power from the source side of the main disconnect.

Current Transformer Requirements:

- The points at which the neutral is grounded and the current transformer locations should be chosen so that unbalanced load currents and zero sequence harmonics due to phase-to-neutral loads are not seen by the ground relays.
- The customer is responsible for selecting current transformers that will fit properly around the Company's neutral to ground bond conductor(s). Neutral to ground bond conductors will be either rectangular bar or multiple insulated conductors.

A 500 watt load with a push button momentary make switch in series shall be connected to the line side of the Customer's main disconnect device through a fuse (a strip heater is acceptable). It shall be connected in the circuit Phase A to ground, but have the ability to be reconnected to either of the other phases. This will facilitate restoration of service by the Company should the ground fault protection system operate.

Installation:

- The Company will perform all work within the manholes and vault including installation of the Customer's current transformer(s).

Testing Requirements:

- The system shall provide the capability to test with and without interruption of service.
- All installed current transformers shall be readily accessible by National Grid for the purpose of testing.
- Upon completion of a new or revised 480V spot network installation, National Grid will set and test the system.

3.10.6 Arc Flash Mitigation - 480Y/277 volt Network Service

To provide arc flash mitigation within the vault and on the line side of the Customer's main disconnecting device on 480Y/277 volt network services, the Company will specify devices to be installed, owned, and maintained by the customer.

3.10.7 Fire Pump Service

A separate service "ahead of the main" for fire pumps and/or emergency lights, if required by the local and state building code and fire protection code, will be permitted. Such a service will be separately metered and billed. The Customer must notify the Company if such a service is required so that it can be incorporated into the Company's vault electrical design.

3.11 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.

3.11.1 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.

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

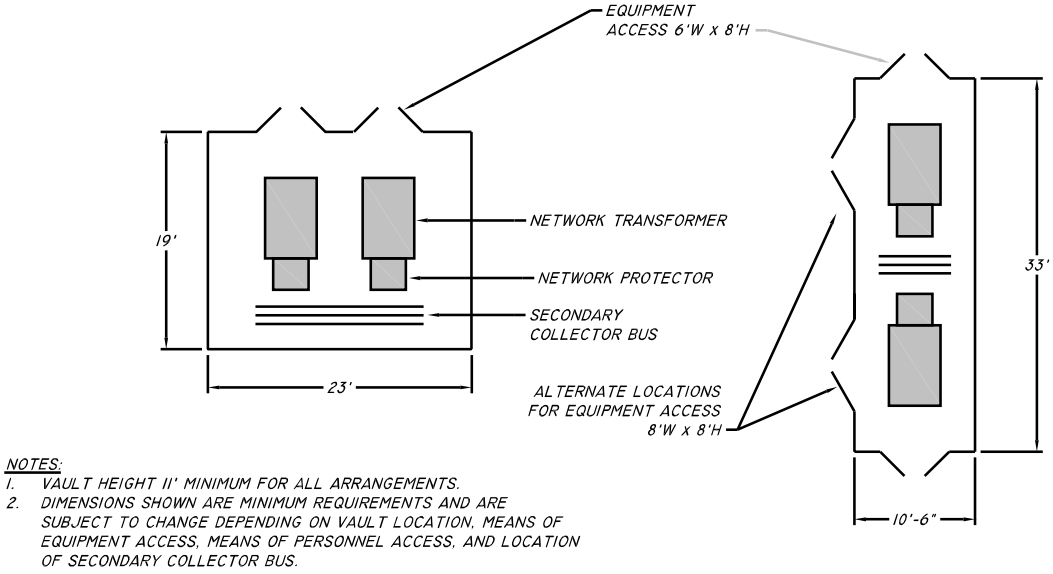
The Company's control of electric spaces in Customer-owned electric facilities is for the sole purpose of protecting the integrity of the Company's energy supply and security of the utility metering equipment. Any costs shall be determined by the Company's filed tariff. In these requirements, "Customer" 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 their de-energized 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, it is understood they are doing so without any supervisory or oversight capacity relative to the Customer.

3.12 APPENDICES

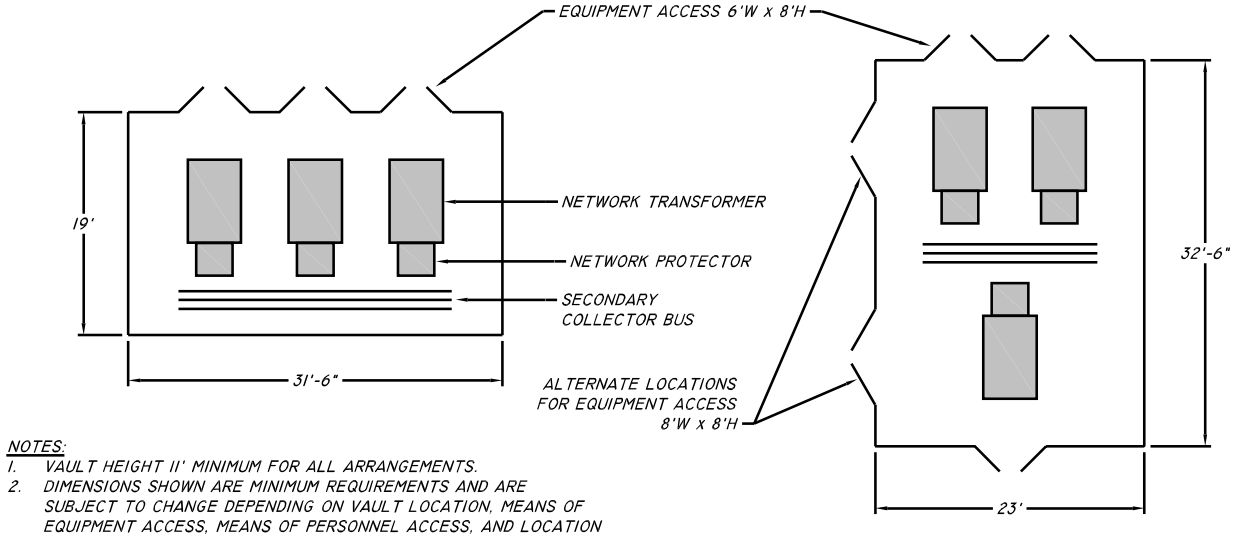
STANDARD ARRANGEMENTS - AC NETWORK VAULT
2-UNIT BUILDING VAULT - 208Y/120 V SERVICE
FOR MAXIMUM OF 2 - 1000 KVA TRANSFORMERS, 15 KV PRIMARY



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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 17 – Building & Free-Standing Vault Standard Arrangements, 2 – 1000 kVA, 15 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
3-UNIT BUILDING VAULT - 208Y/120 V SERVICE
FOR MAXIMUM OF 3 - 1000 KVA TRANSFORMERS, 15 KV PRIMARY



NOTES:
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Figure 18 – Building & Free-Standing Vault Standard Arrangements, 3 – 1000 kVA, 15 kV

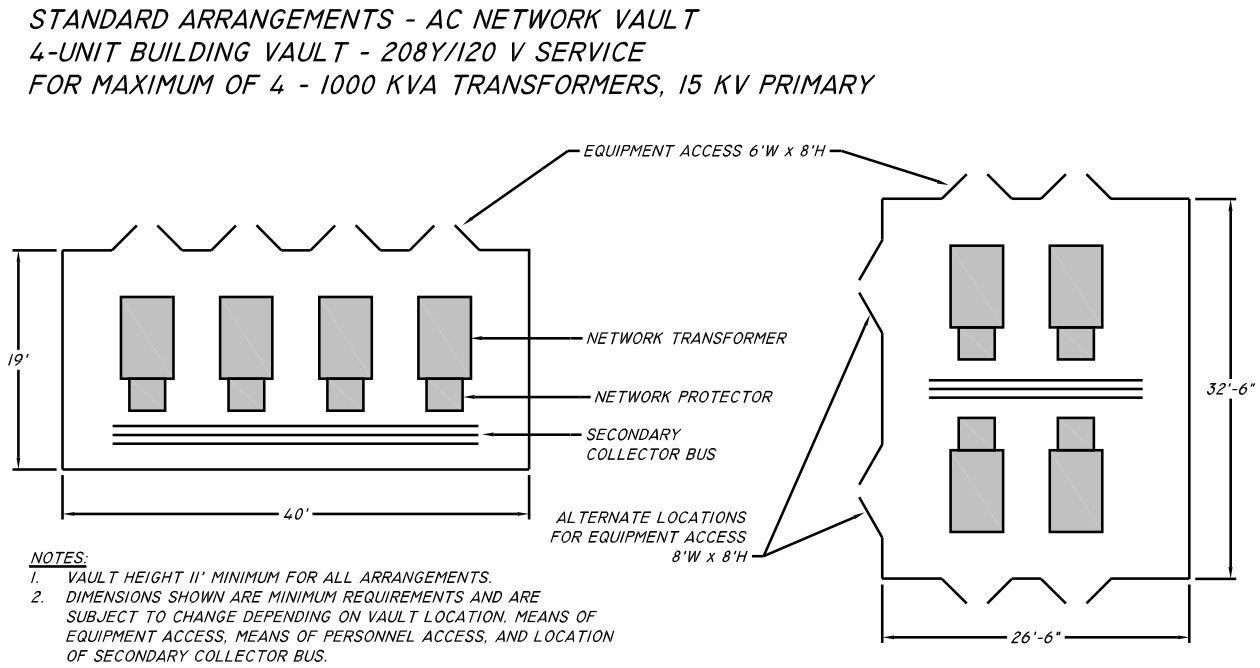


Figure 19 – Building & Free-Standing Vault Standard Arrangements, 4 – 1000 kVA, 15 kV

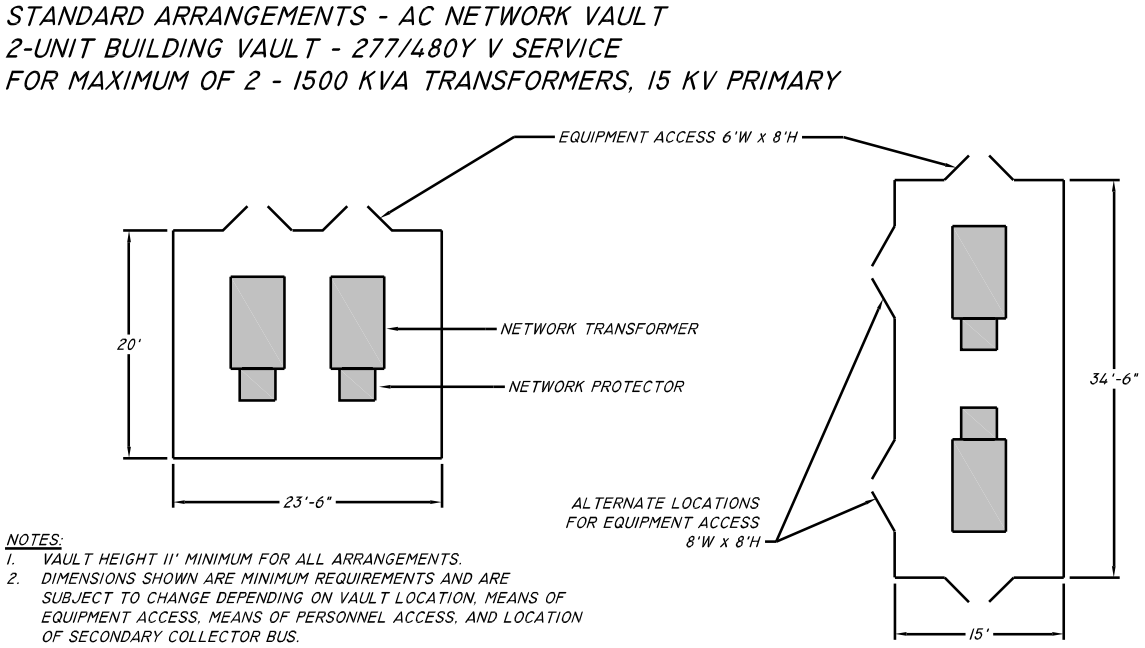
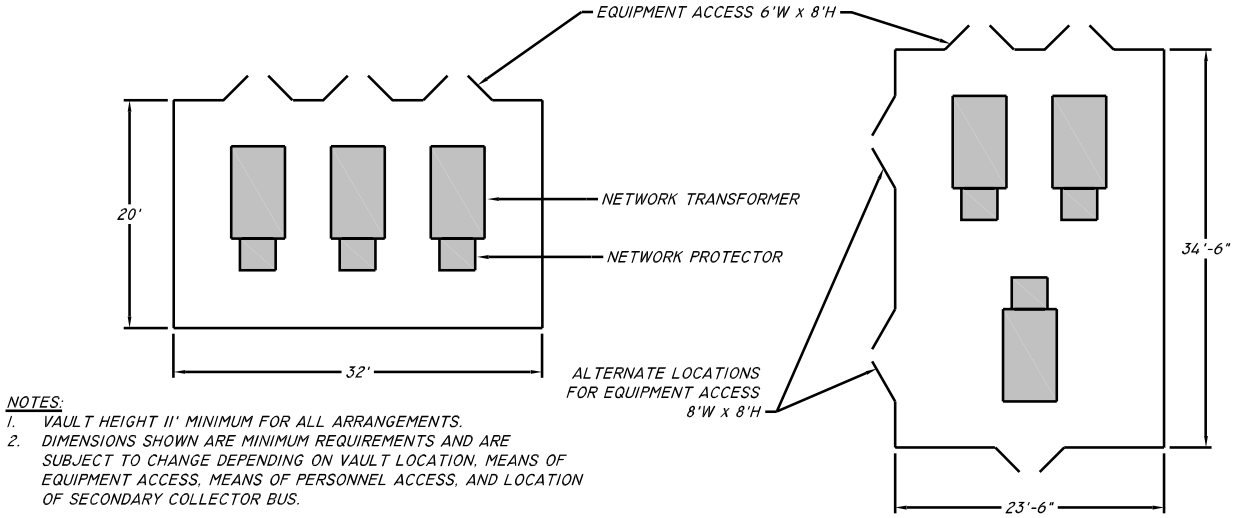


Figure 20 – Building & Free-Standing Vault Standard Arrangements, 2 – 1500 kVA, 15 kV

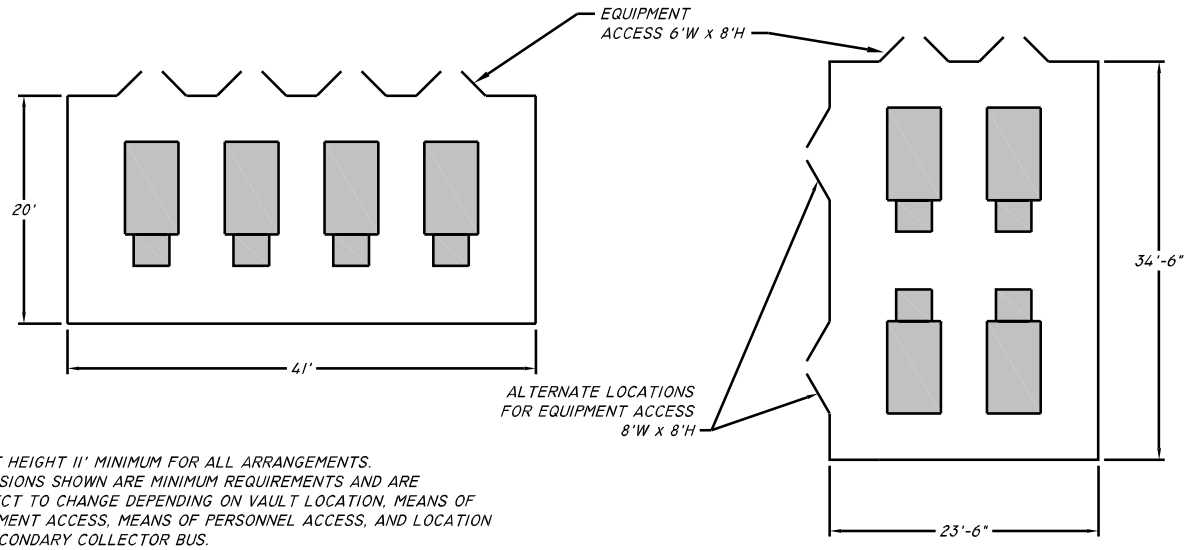
STANDARD ARRANGEMENTS - AC NETWORK VAULT
3-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 3 - 1500 KVA TRANSFORMERS, 15 KV PRIMARY



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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 21 – Building & Free-Standing Vault Standard Arrangements, 3 – 1500 kVA, 15 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
4-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 4 - 1500 KVA TRANSFORMERS, 15 KV PRIMARY



NOTES:
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2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 22 – Building & Free-Standing Vault Standard Arrangements, 4 – 1500 kVA, 15 kV

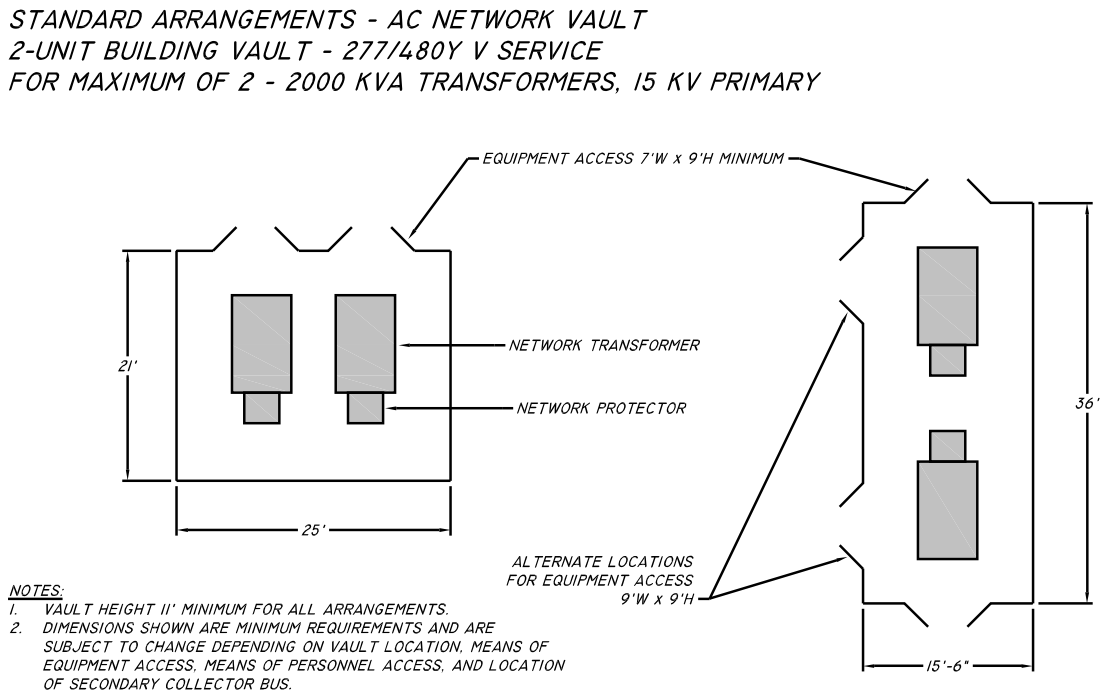


Figure 23 – Building & Free-Standing Vault Standard Arrangements, 2 – 2000 kVA, 15 kV

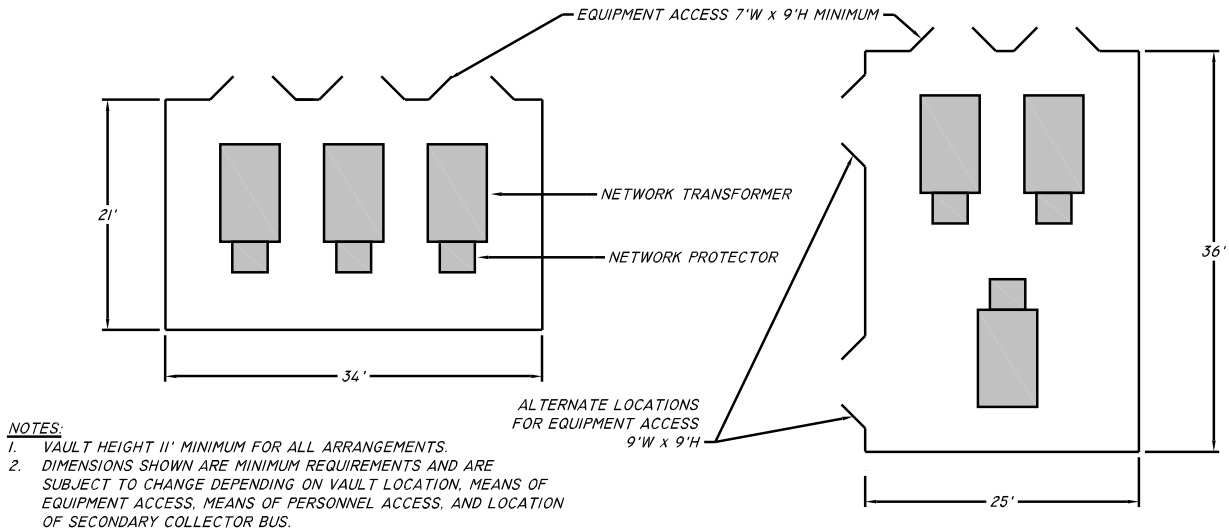


Figure 24 – Building & Free-Standing Vault Standard Arrangements, 3 – 2000 kVA, 15 kV

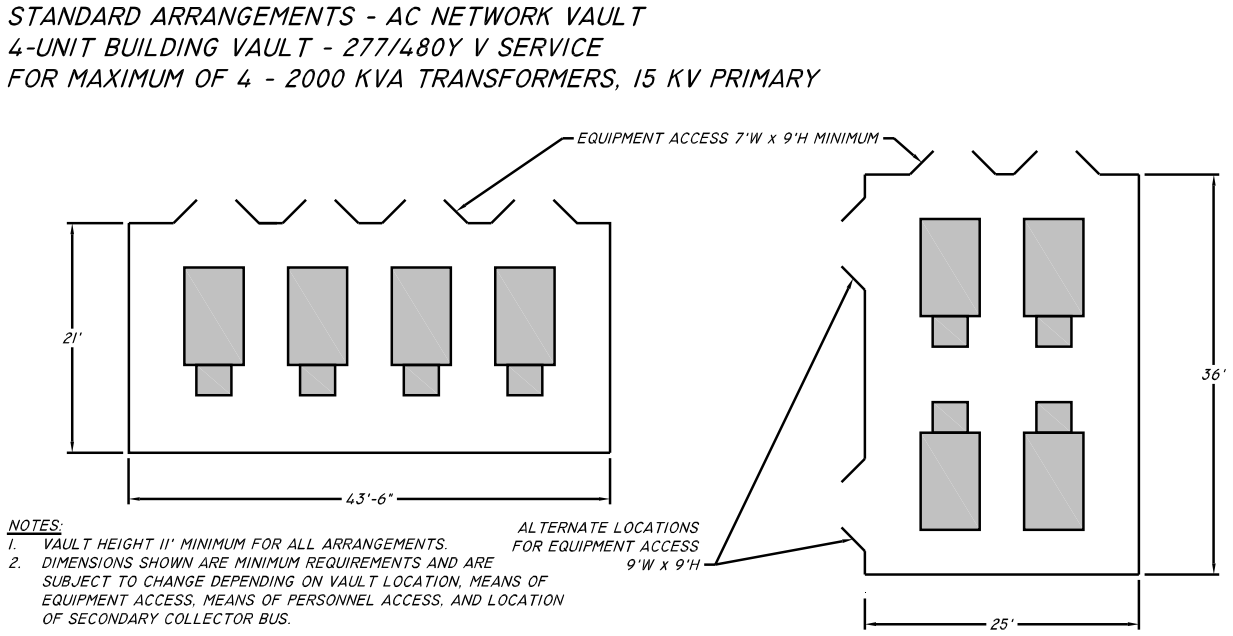


Figure 25 – Building & Free-Standing Vault Standard Arrangements, 4 – 2000 kVA, 15 kV

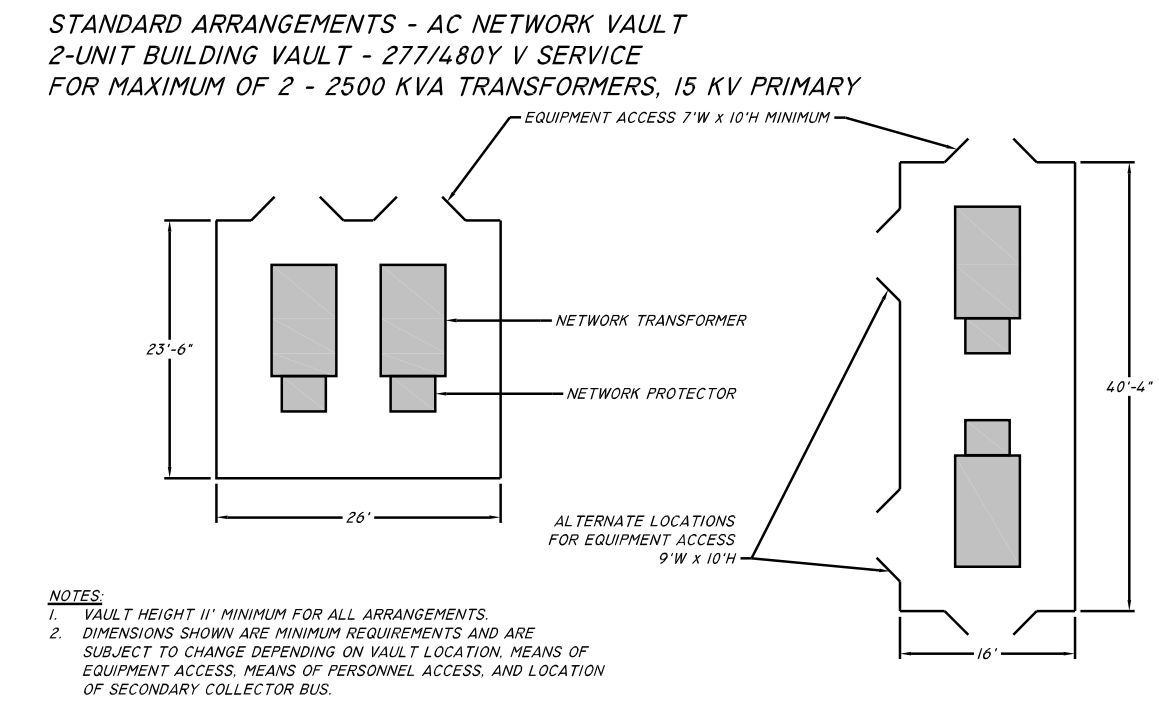


Figure 26 – Building & Free-Standing Vault Standard Arrangements, 2 – 2500 kVA, 15 kV

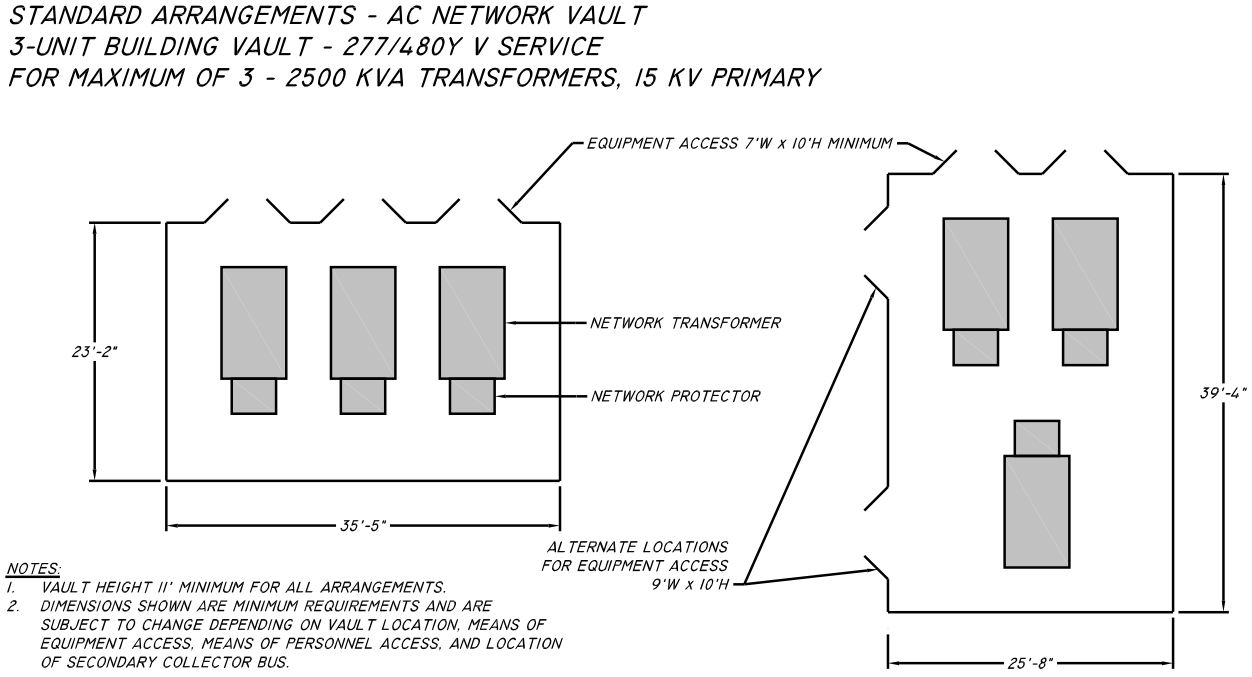


Figure 27 – Building & Free-Standing Vault Standard Arrangements, 3 – 2500 kVA, 15 kV

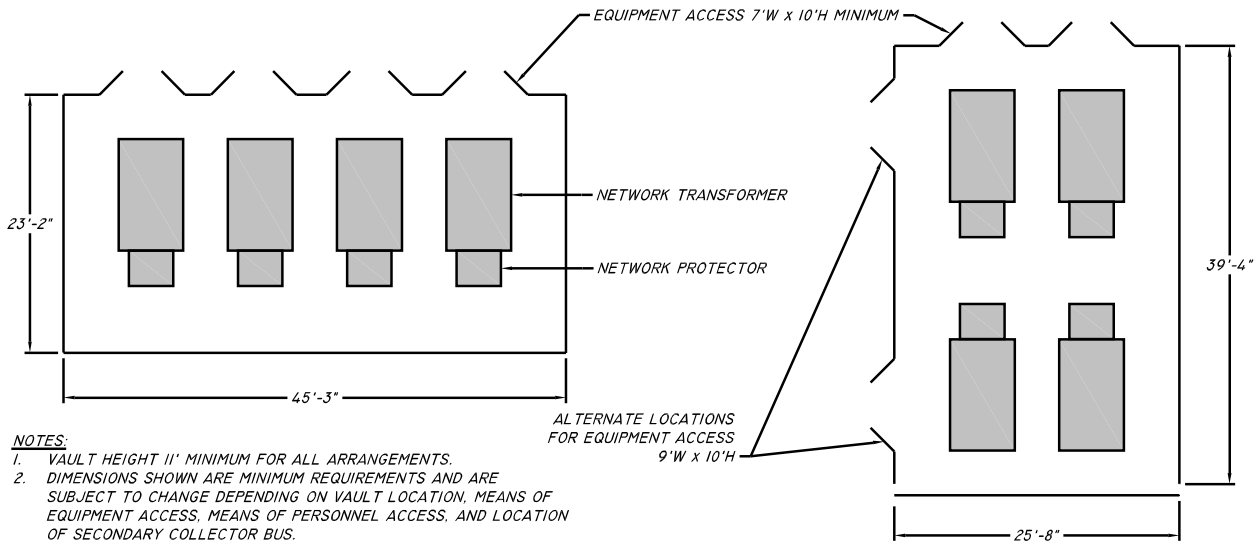


Figure 28 – Building & Free-Standing Vault Standard Arrangements, 4 – 2500 kVA, 15 kV

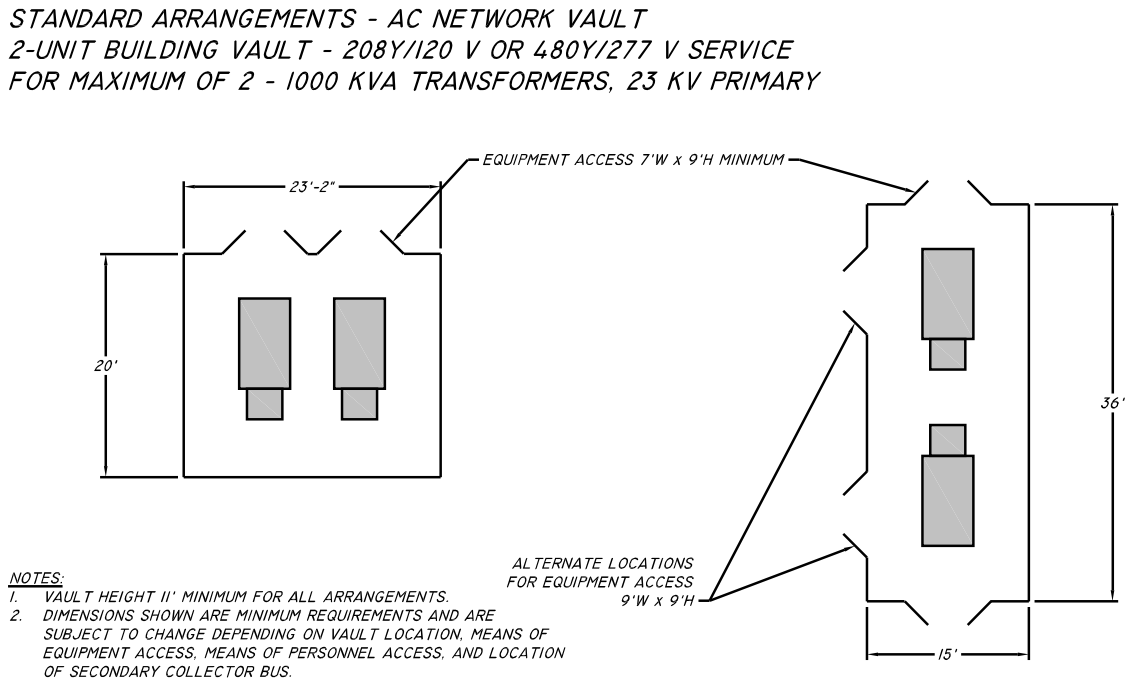


Figure 29 – Building & Free-Standing Vault Standard Arrangements, 2 – 1000 kVA, 23 kV

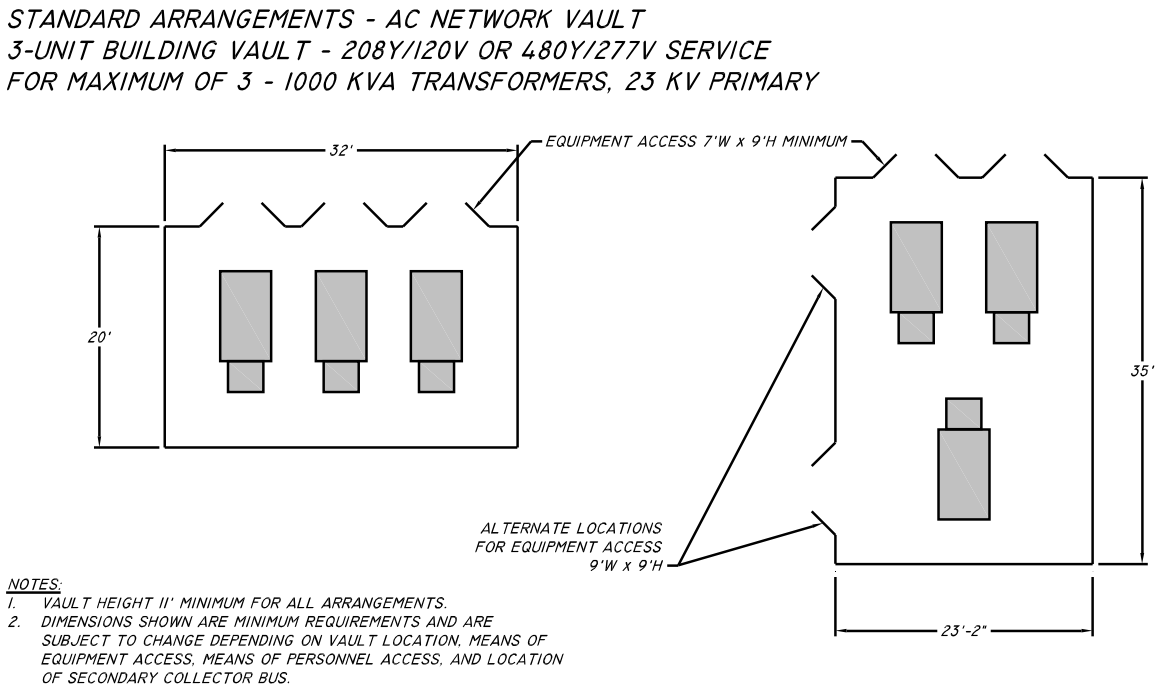
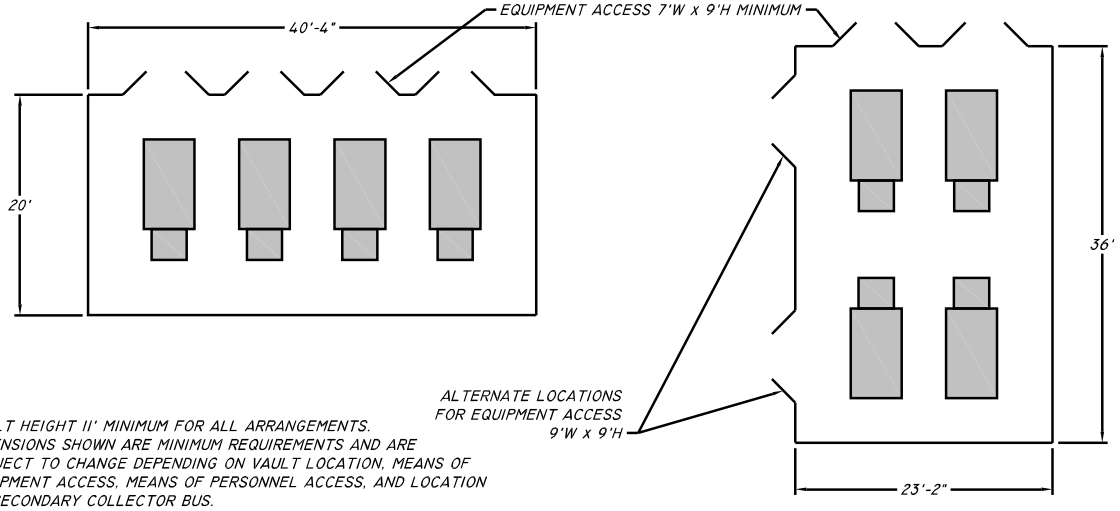


Figure 30 – Building & Free-Standing Vault Standard Arrangements, 3 – 1000 kVA, 23 kV

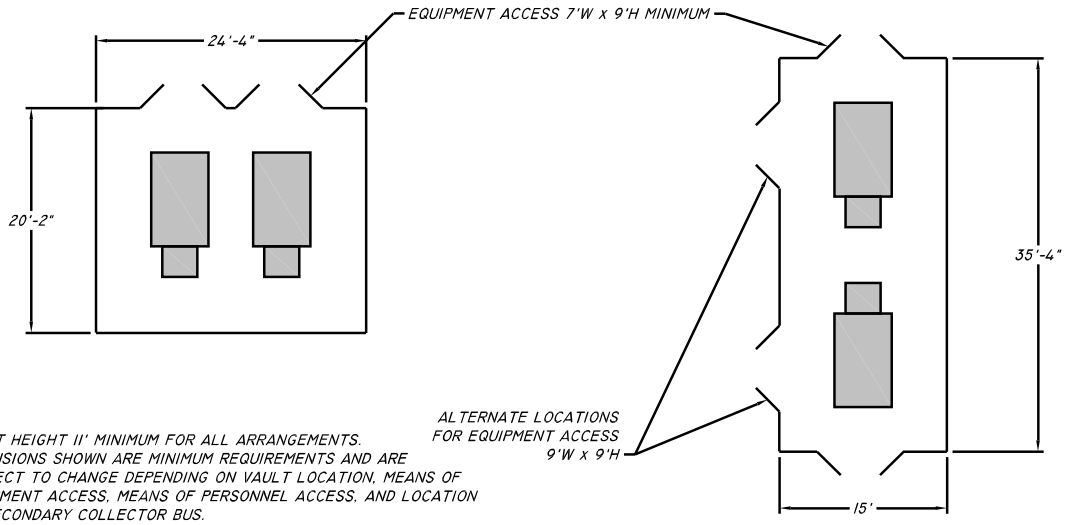
STANDARD ARRANGEMENTS - AC NETWORK VAULT
4-UNIT BUILDING VAULT - 208Y/120V OR 480Y/277V SERVICE
FOR MAXIMUM OF 4 - 1000 KVA TRANSFORMERS, 23 KV PRIMARY



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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 31 – Building & Free-Standing Vault Standard Arrangements, 4 – 1000 kVA, 23 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
2-UNIT BUILDING VAULT - 480Y/277 V SERVICE
FOR MAXIMUM OF 2 - 1500 KVA TRANSFORMERS, 23 KV PRIMARY



NOTES:
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Figure 32 – Building & Free-Standing Vault Standard Arrangements, 2 – 1500 kVA, 23 kV

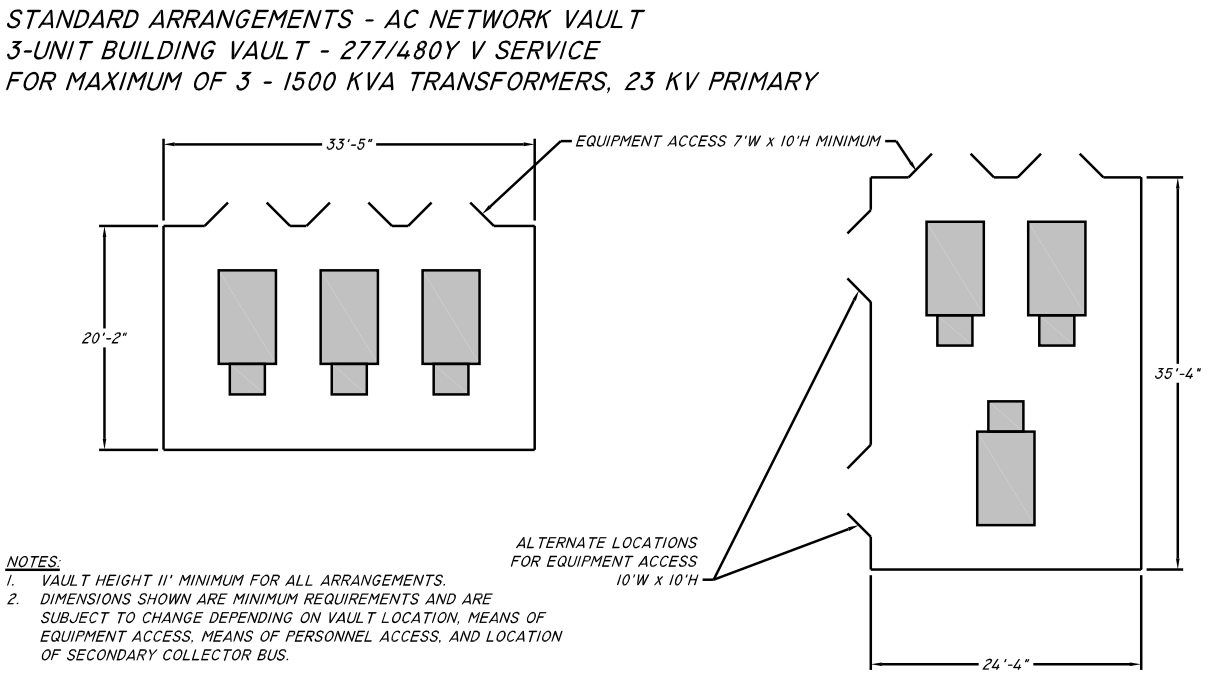


Figure 33 – Building & Free-Standing Vault Standard Arrangements, 3 – 1500 kVA, 23 kV

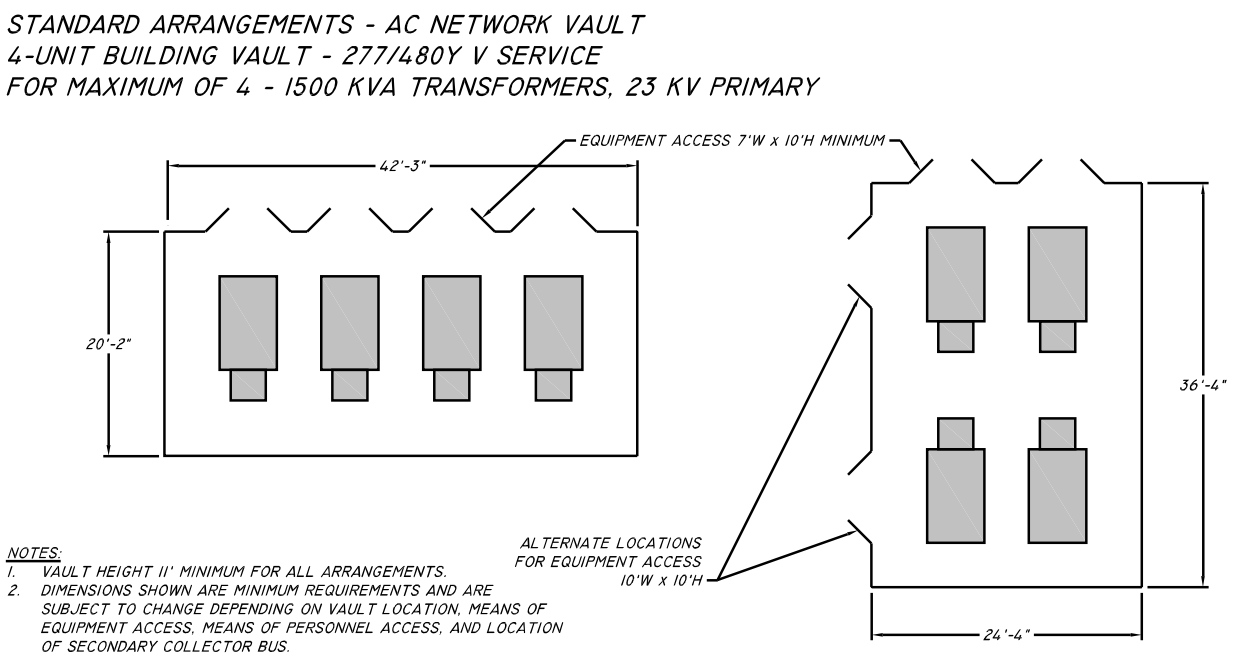


Figure 34 – Building & Free-Standing Vault Standard Arrangements, 4 – 1500 kVA, 23 kV

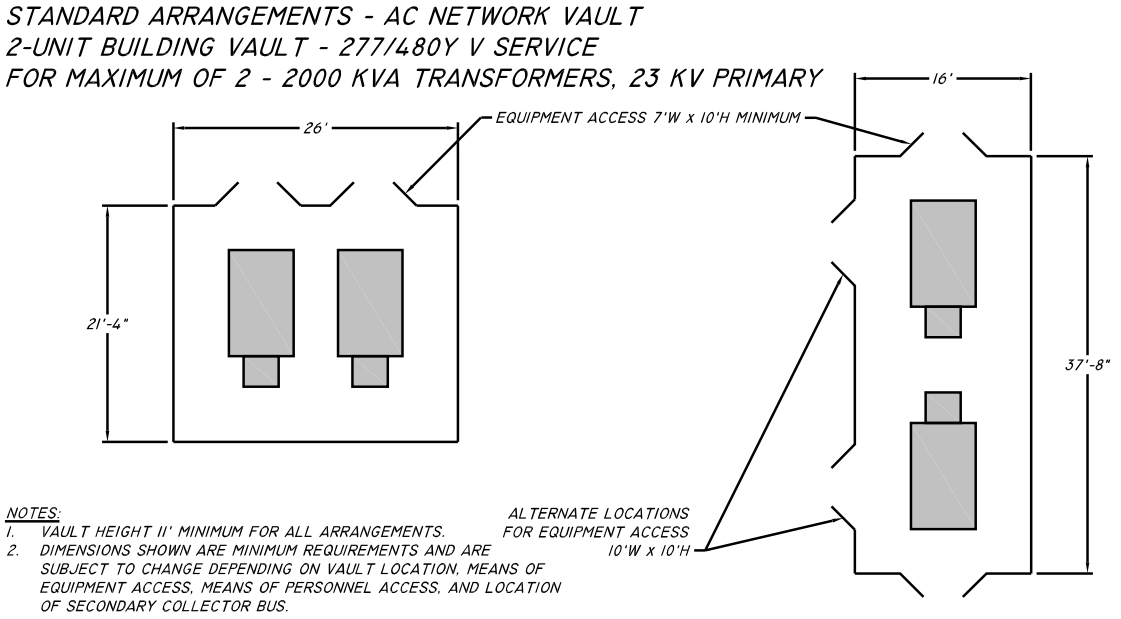


Figure 35 – Building & Free-Standing Vault Standard Arrangements, 2 – 2000 kVA, 23 kV

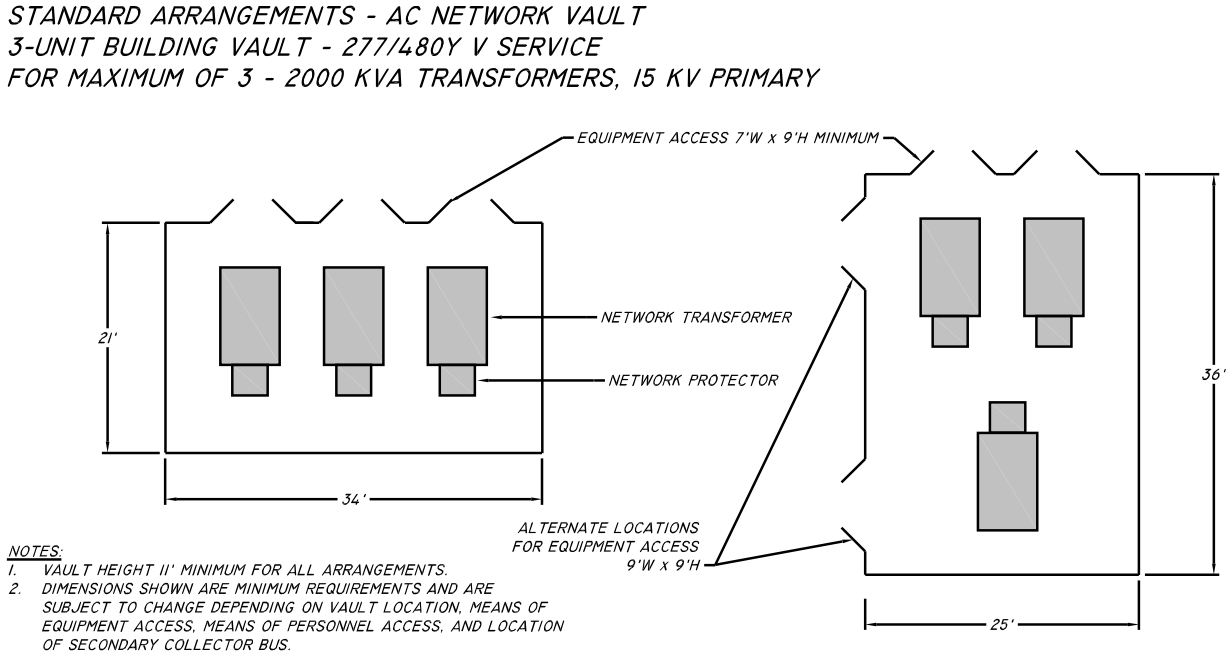


Figure 36 – Building & Free-Standing Vault Standard Arrangements, 3 – 2000 kVA, 23 kV

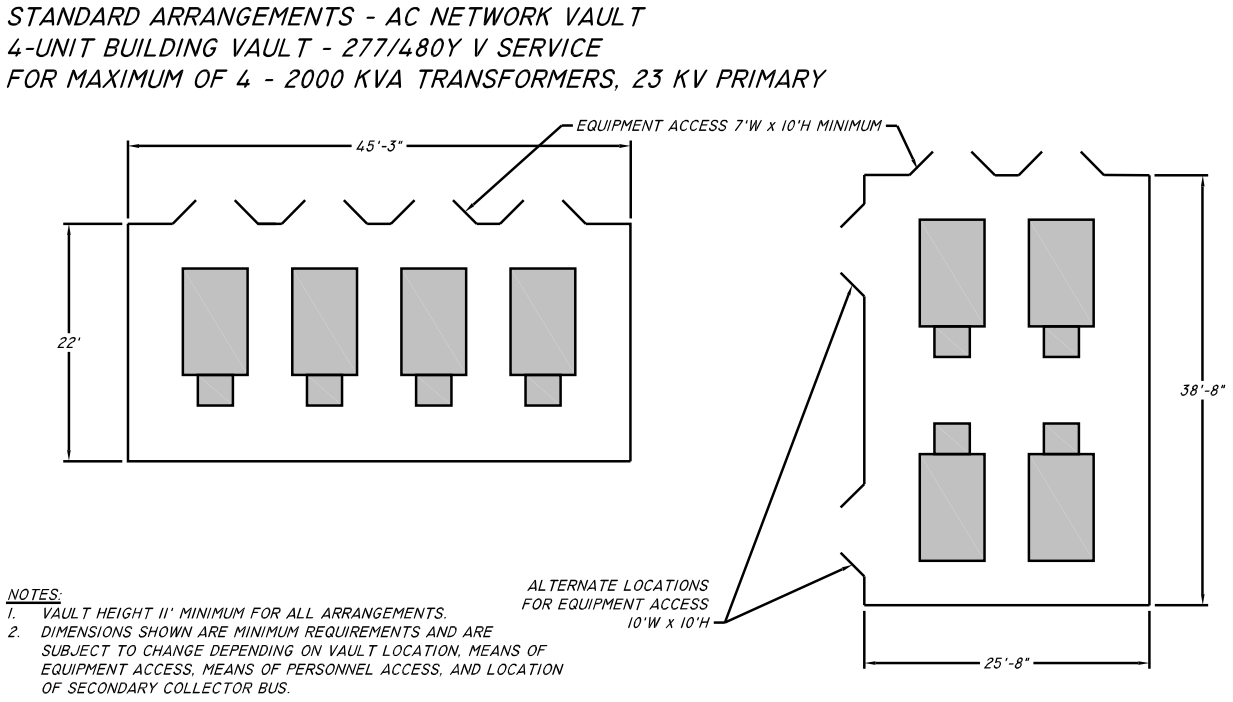


Figure 37 – Building & Free-Standing Vault Standard Arrangements, 4 – 2000 kVA, 23 kV

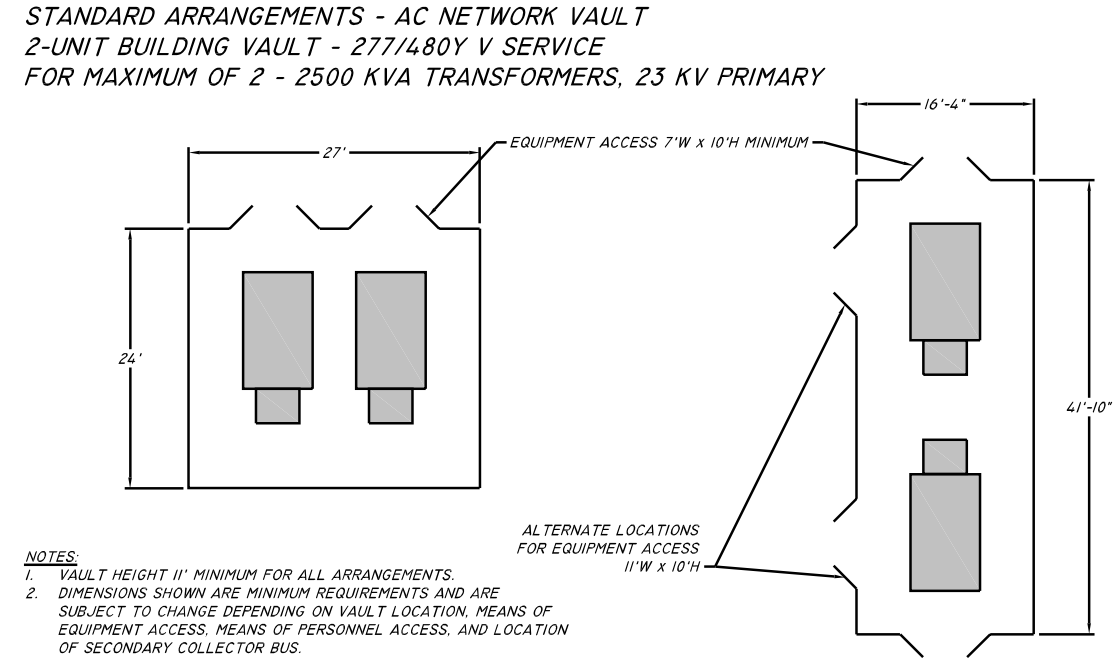
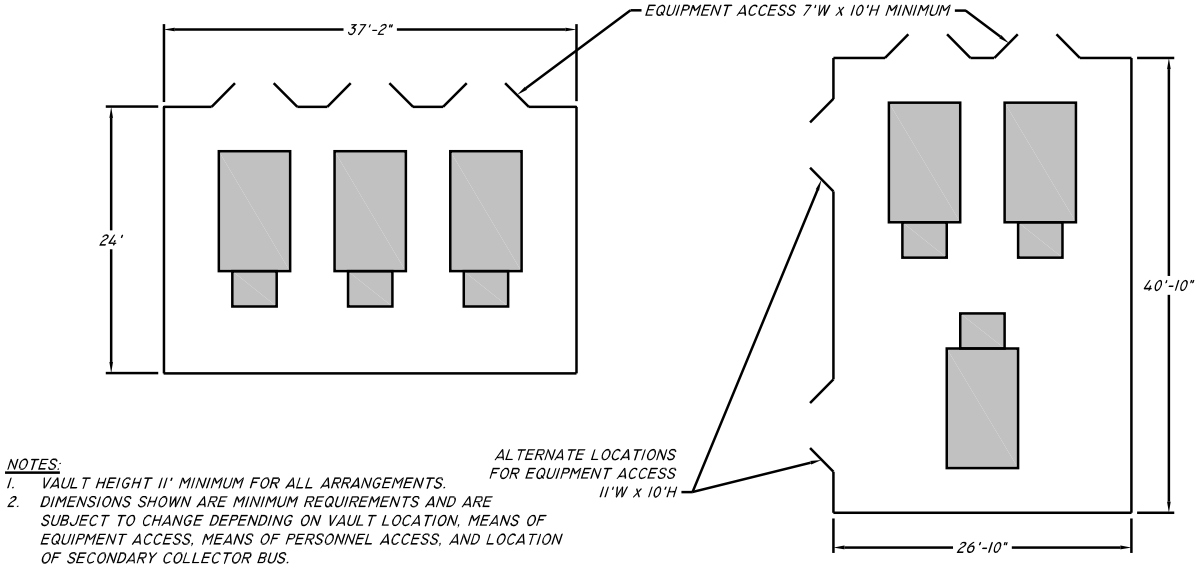


Figure 38 – Building & Free-Standing Vault Standard Arrangements, 2 – 2500 kVA, 23 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
3-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 3 - 2500 KVA TRANSFORMERS, 23 KV PRIMARY



NOTES:
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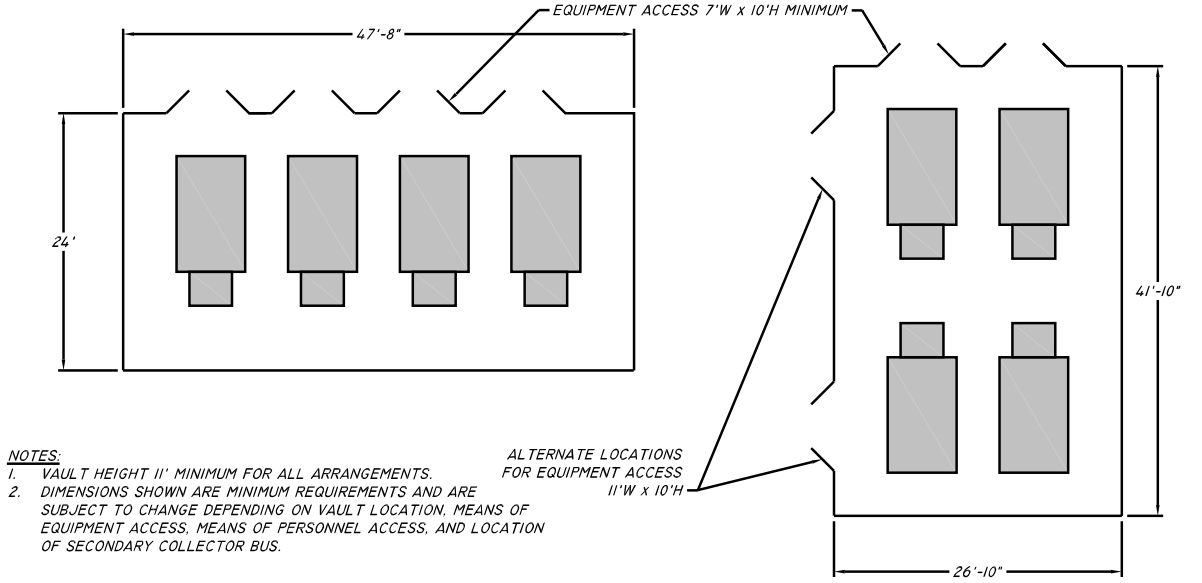
2. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND ARE SUBJECT TO CHANGE DEPENDING ON VAULT LOCATION, MEANS OF EQUIPMENT ACCESS, MEANS OF PERSONNEL ACCESS, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 39 – Building & Free-Standing Vault Standard Arrangements, 3 – 2500 kVA, 23 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
4-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 4 - 2500 KVA TRANSFORMERS, 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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 40 – Building & Free-Standing Vault Standard Arrangements, 4 – 2500 kVA, 23 kV

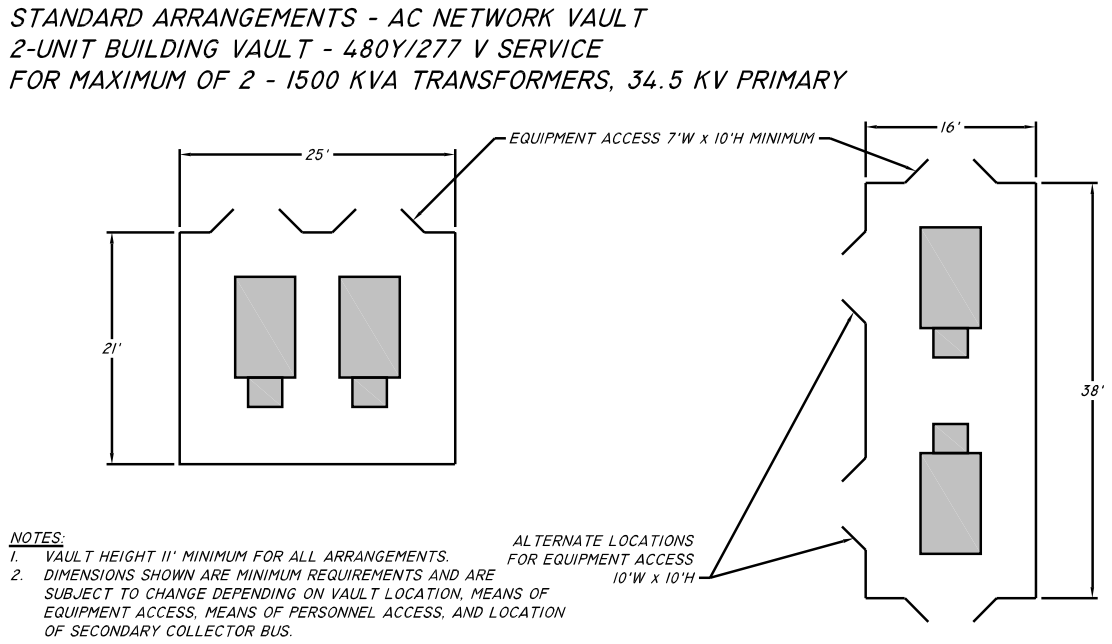


Figure 41 – Building & Free-Standing Vault Standard Arrangements, 2 – 1500 kVA, 34.5 kV

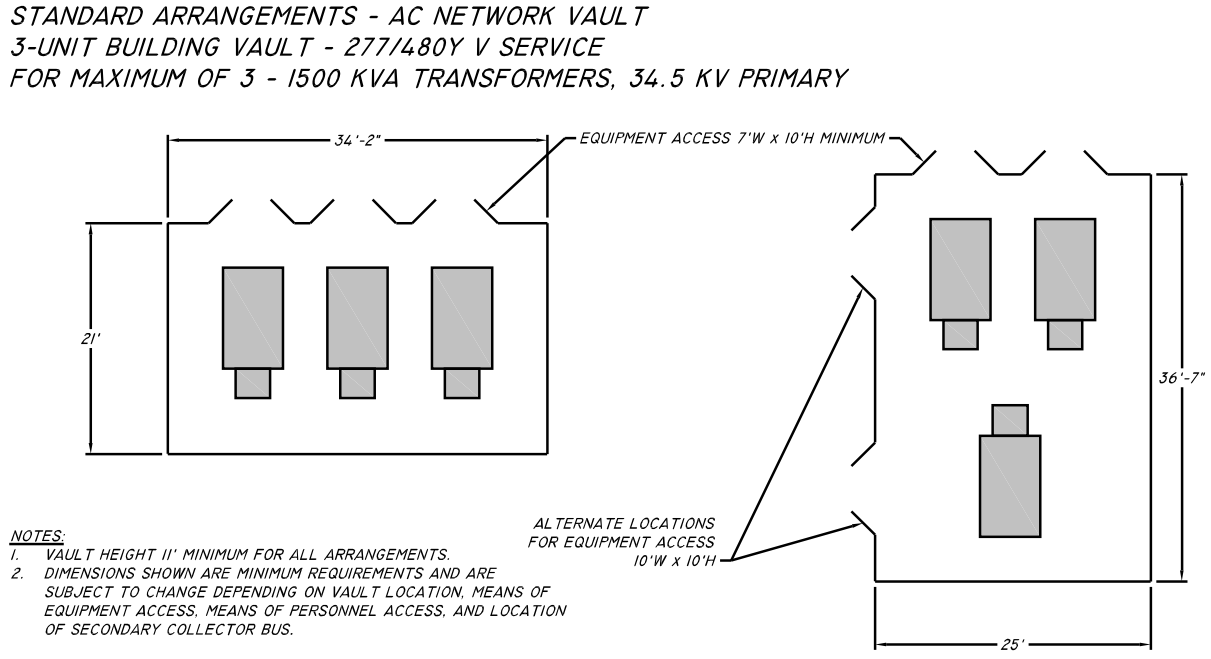


Figure 42 – Building & Free-Standing Vault Standard Arrangements, 3 – 1500 kVA, 34.5 kV

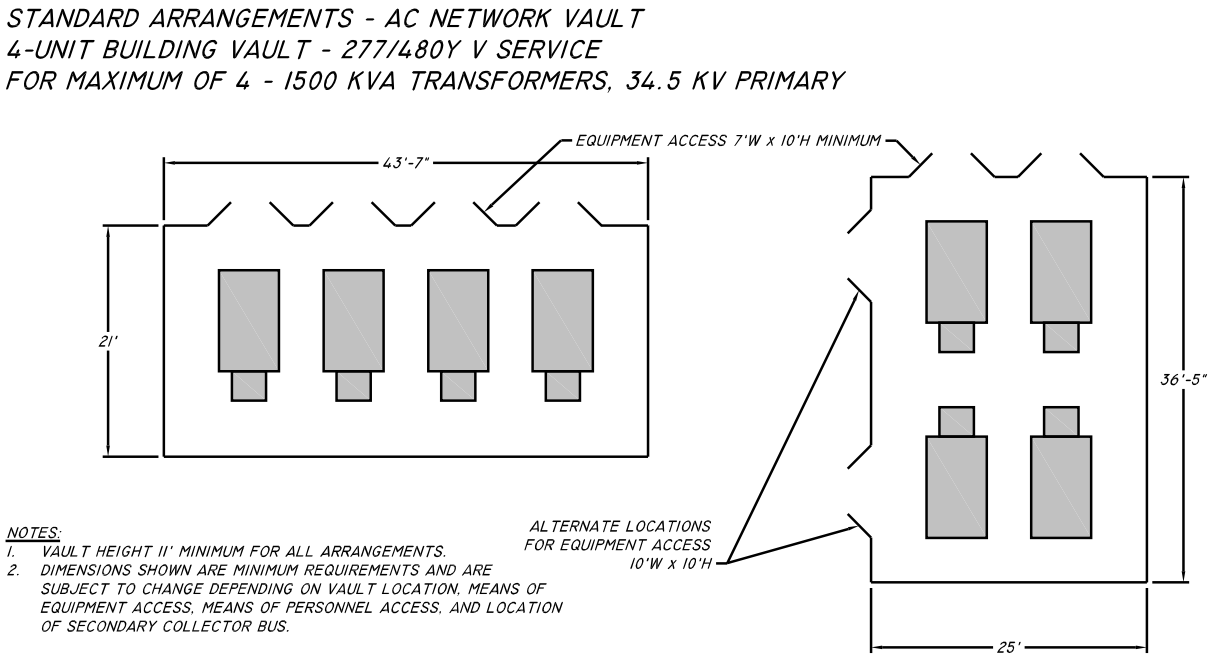


Figure 43 – Building & Free-Standing Vault Standard Arrangements, 4 – 1500 kVA, 34.5 kV

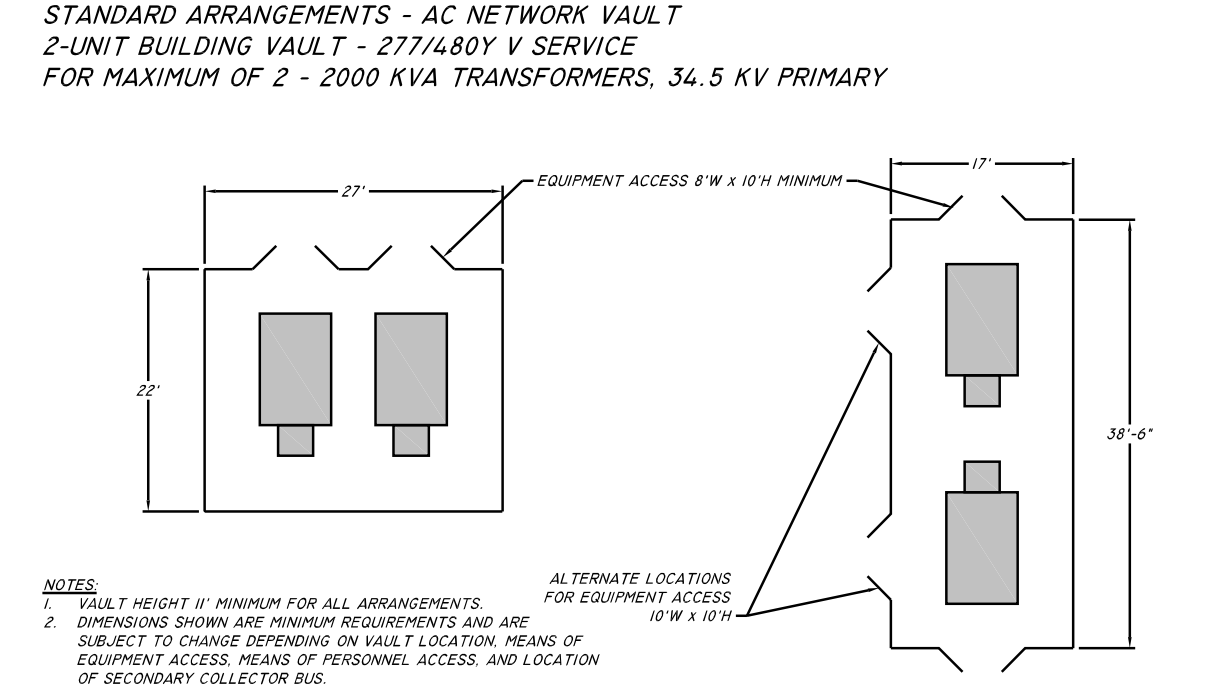
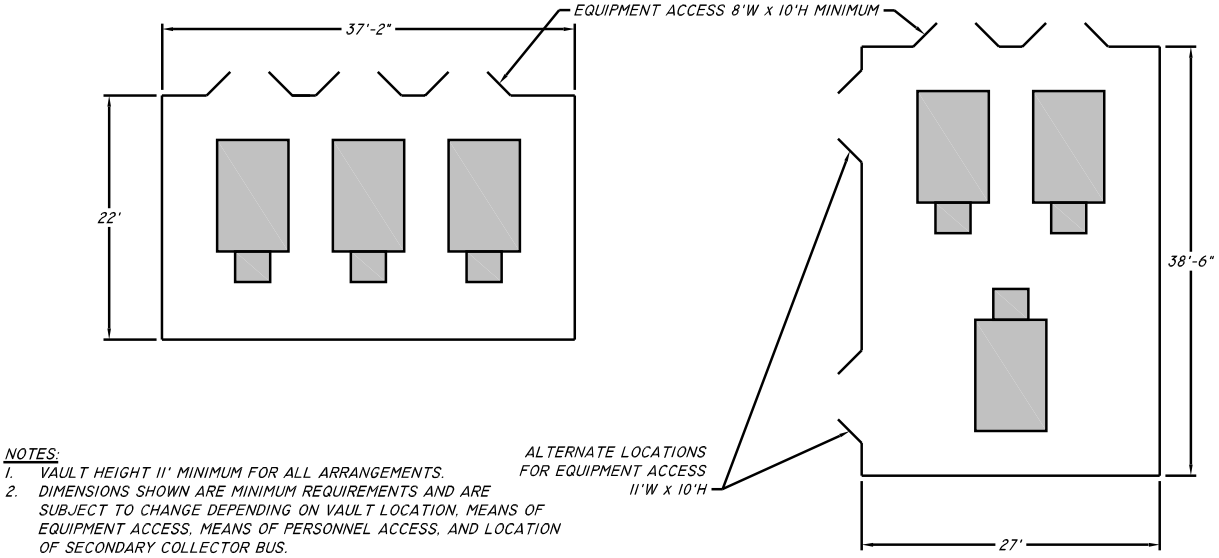


Figure 44 – Building & Free-Standing Vault Standard Arrangements, 2 – 2000 kVA, 34.5 kV

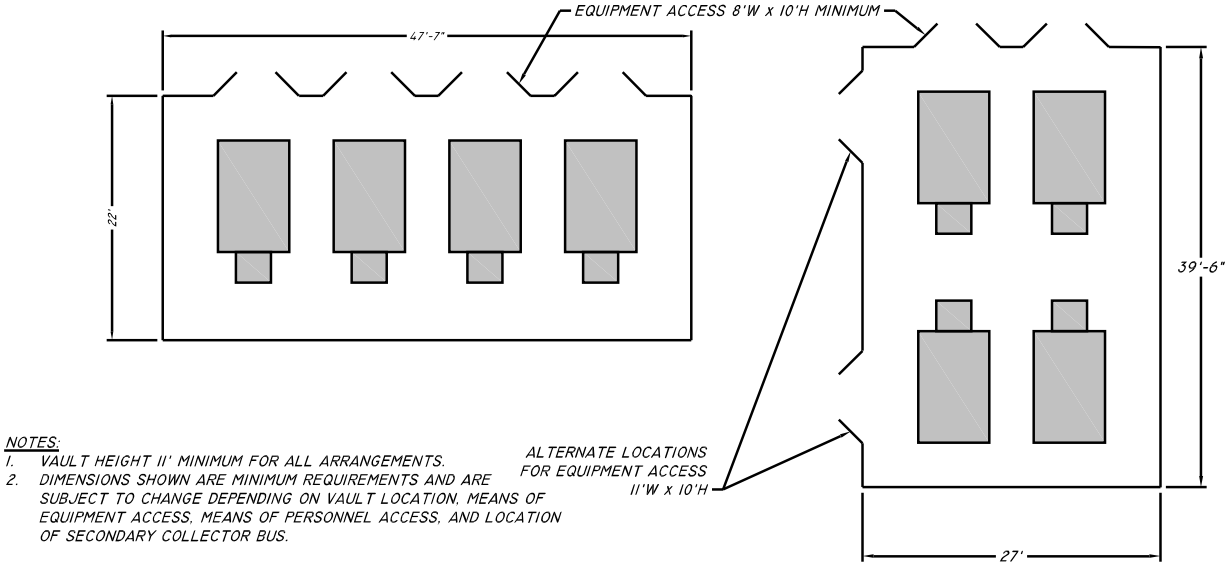
STANDARD ARRANGEMENTS - AC NETWORK VAULT
3-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 3 - 2000 KVA TRANSFORMERS, 34.5 KV PRIMARY



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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 45 – Building & Free-Standing Vault Standard Arrangements, 3 – 2000 kVA, 34.5 kV

STANDARD ARRANGEMENTS - AC NETWORK VAULT
4-UNIT BUILDING VAULT - 277/480Y V SERVICE
FOR MAXIMUM OF 4 - 2000 KVA TRANSFORMERS, 34.5 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, AND LOCATION OF SECONDARY COLLECTOR BUS.

Figure 46 – Building & Free-Standing Vault Standard Arrangements, 4 – 2000 kVA, 34.5 kV

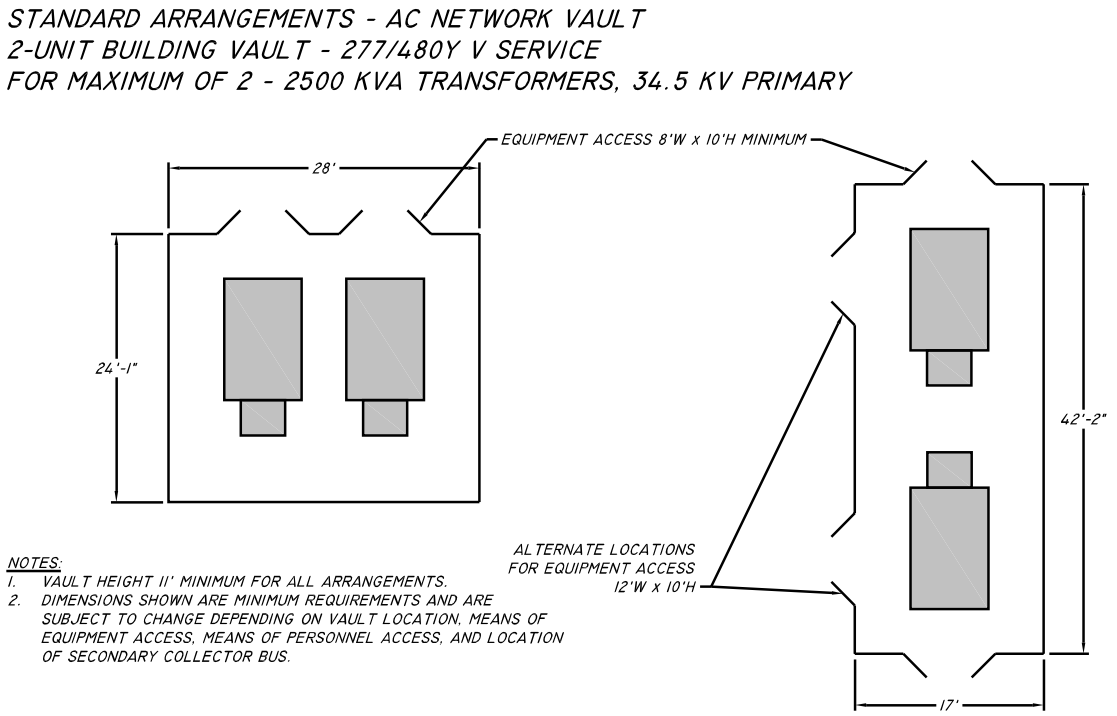


Figure 47 – Building & Free-Standing Vault Standard Arrangements, 2 – 2500 kVA, 34.5 kV

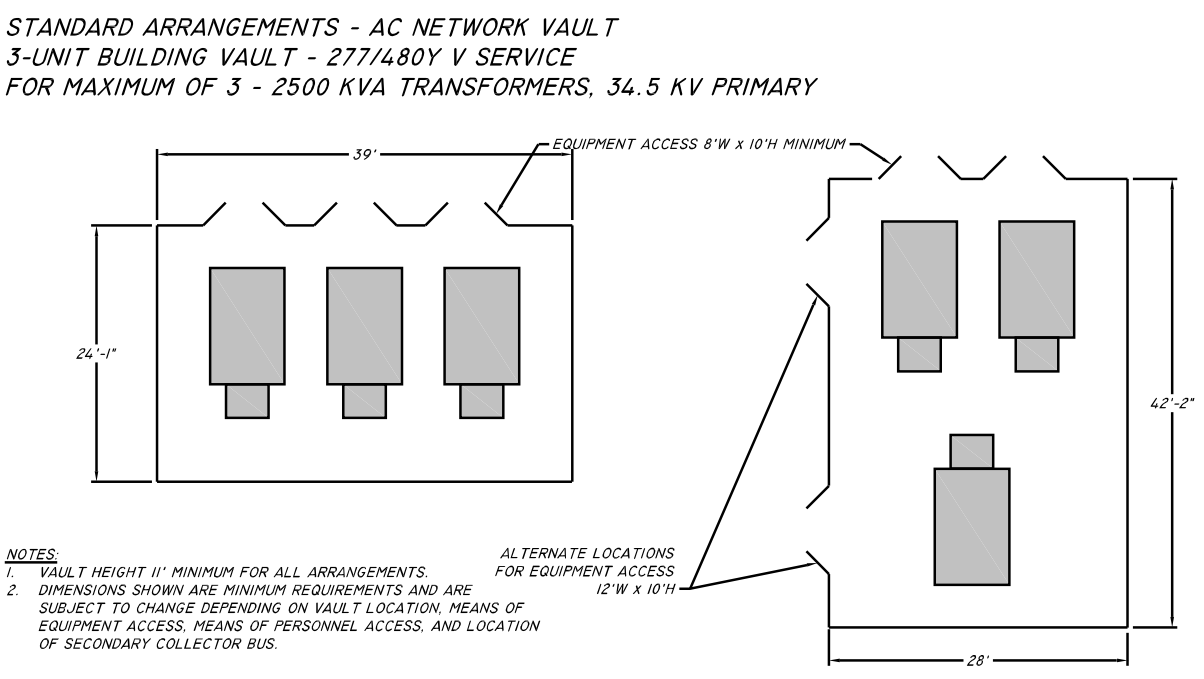


Figure 48 – Building & Free-Standing Vault Standard Arrangements, 3 – 2500 kVA, 34.5 kV

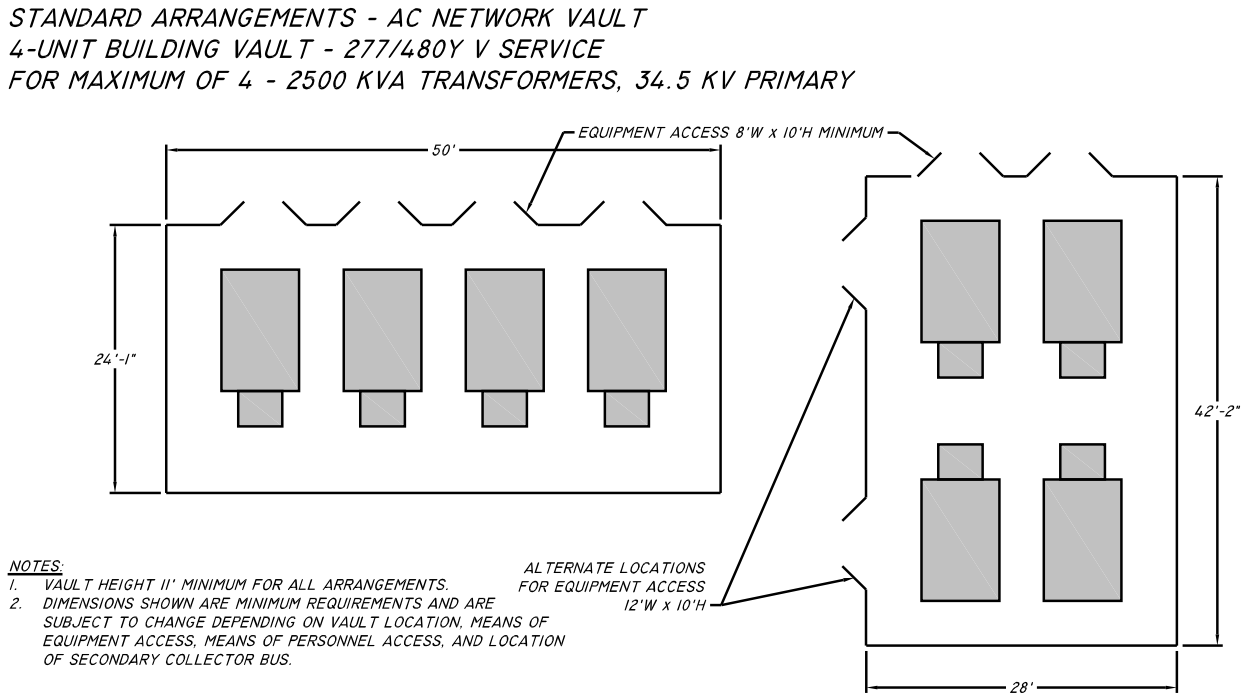


Figure 49 – Building & Free-Standing Vault Standard Arrangements, 4 – 2500 kVA, 34.5 kV

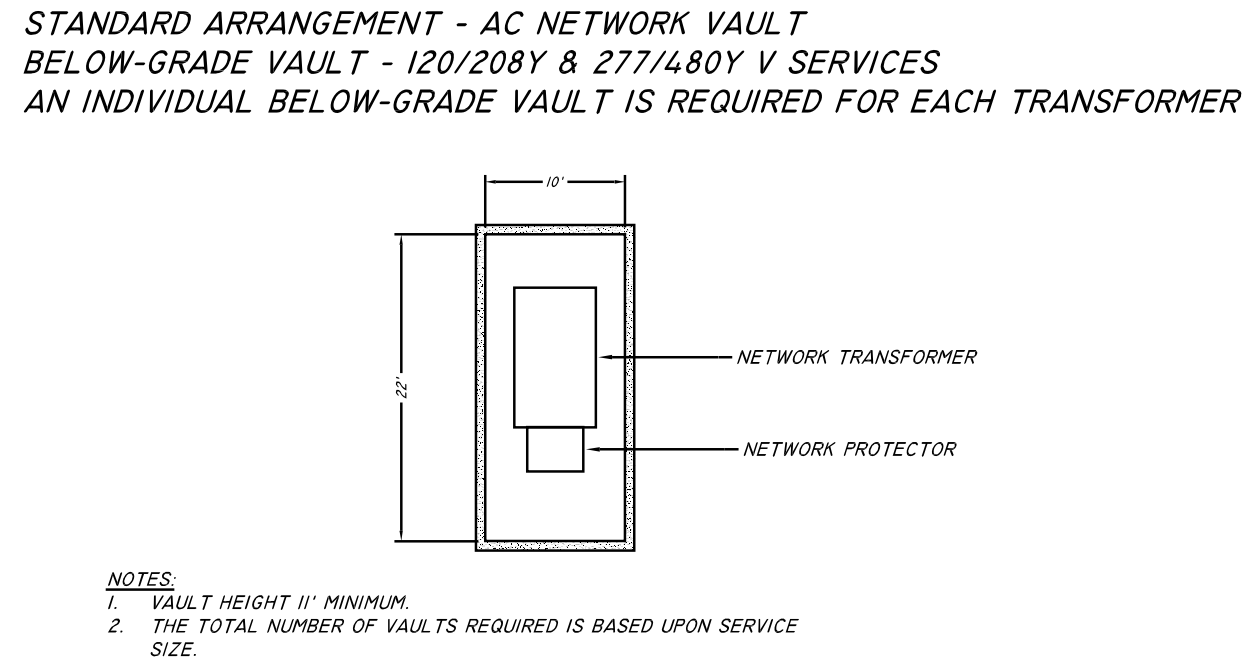


Figure 50 – Below-Grade Vault Located Outdoors Standard Layout

1. Wall, Floor, and Roof Reinforcing Details:

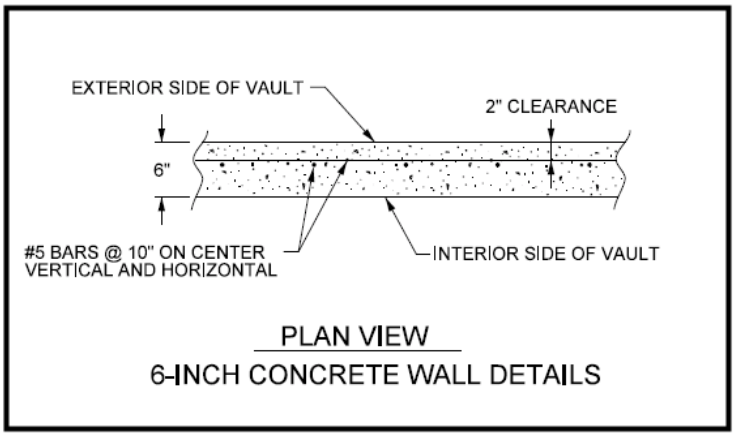


Figure 51 – 6" Concrete Wall Minimum Standards

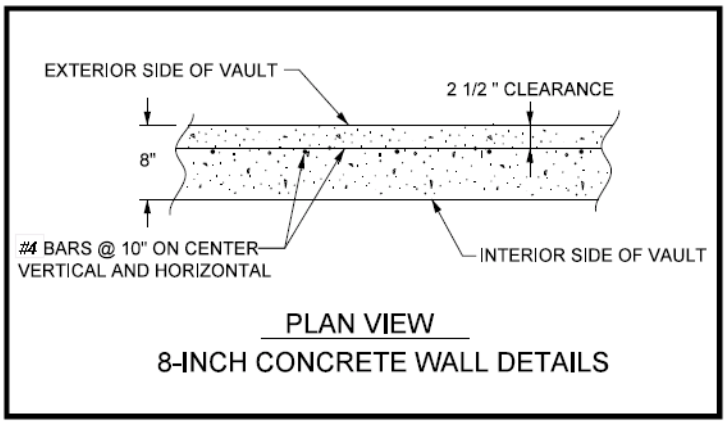


Figure 52 – 8" Concrete Wall Minimum Standards

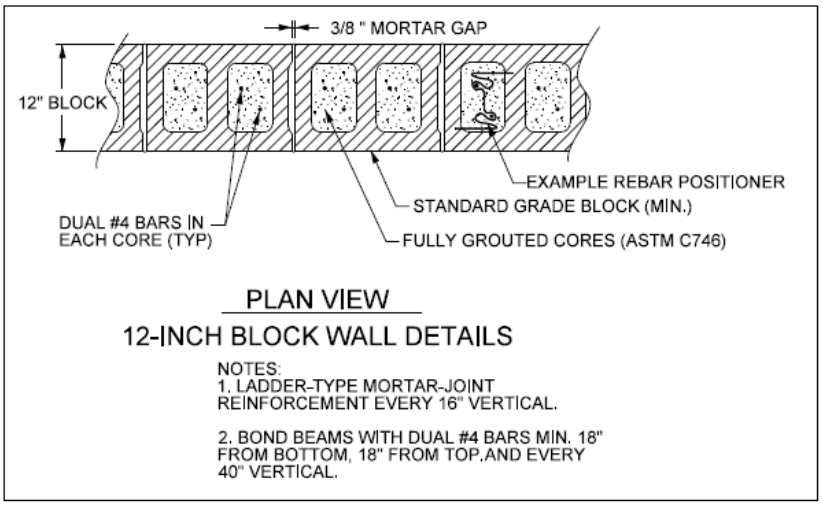


Figure 53 – CMU Wall Minimum Standards Plan View

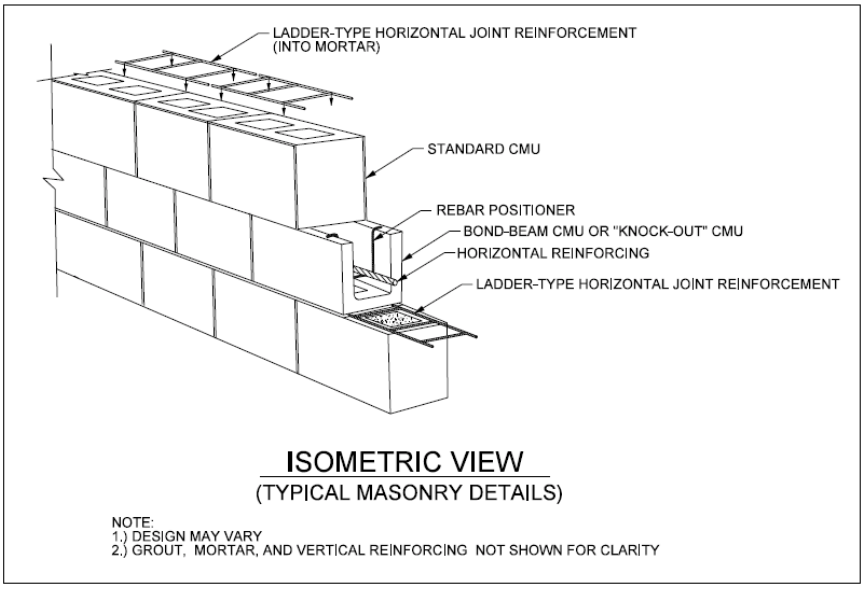


Figure 54 – CMU Wall Minimum Standards Isometric View

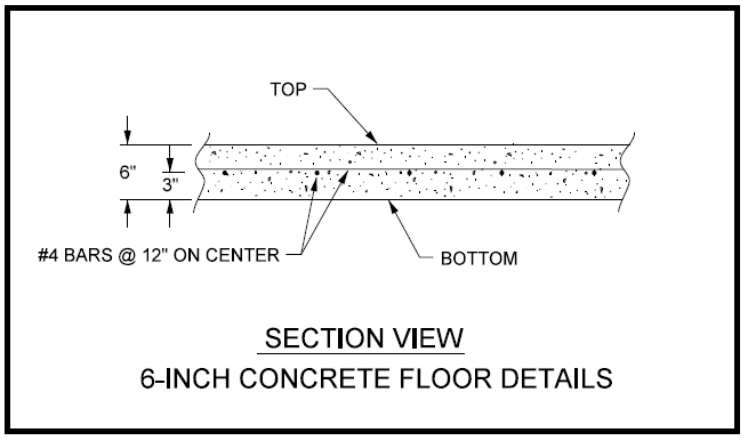


Figure 55 – Concrete Floor Minimum Standards

2. Company and NESC Structural Design Requirement:
A. Strength
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.

1. 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.

2. Live loads shall be increased by 30% for impact.

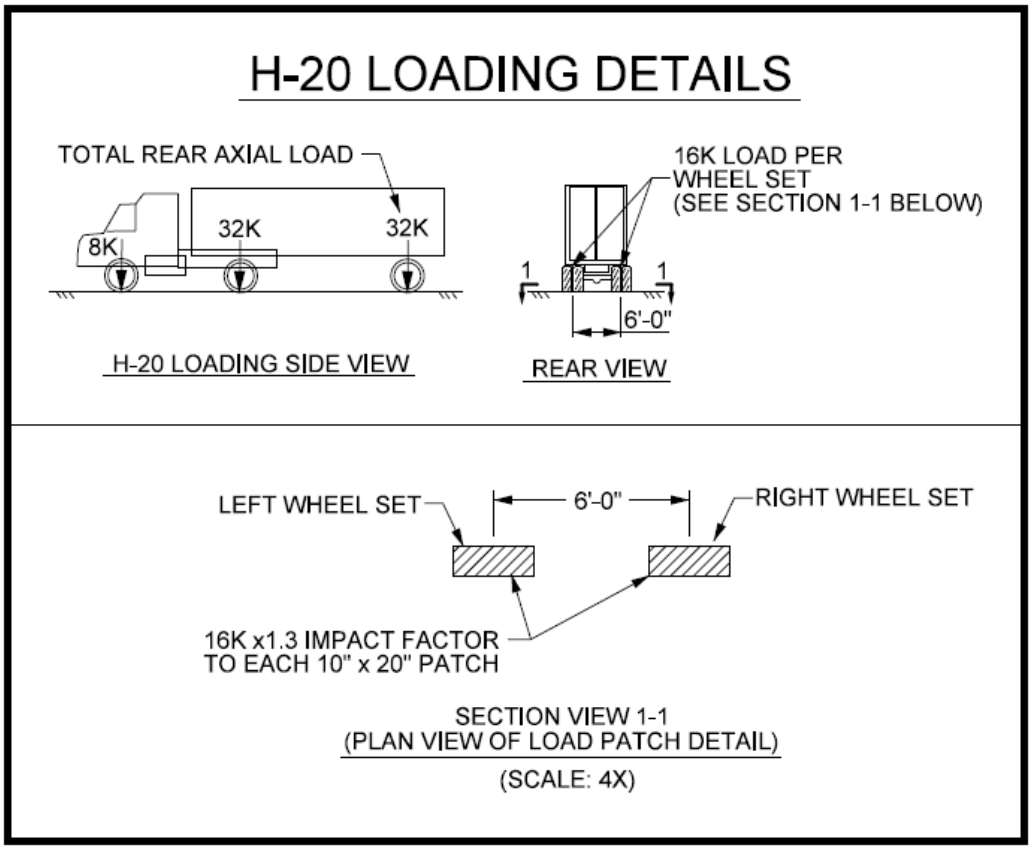


Figure 56 – Below Grade Vault Loading (Detail Common to NESC 2012 and AASHTO 2012)

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.

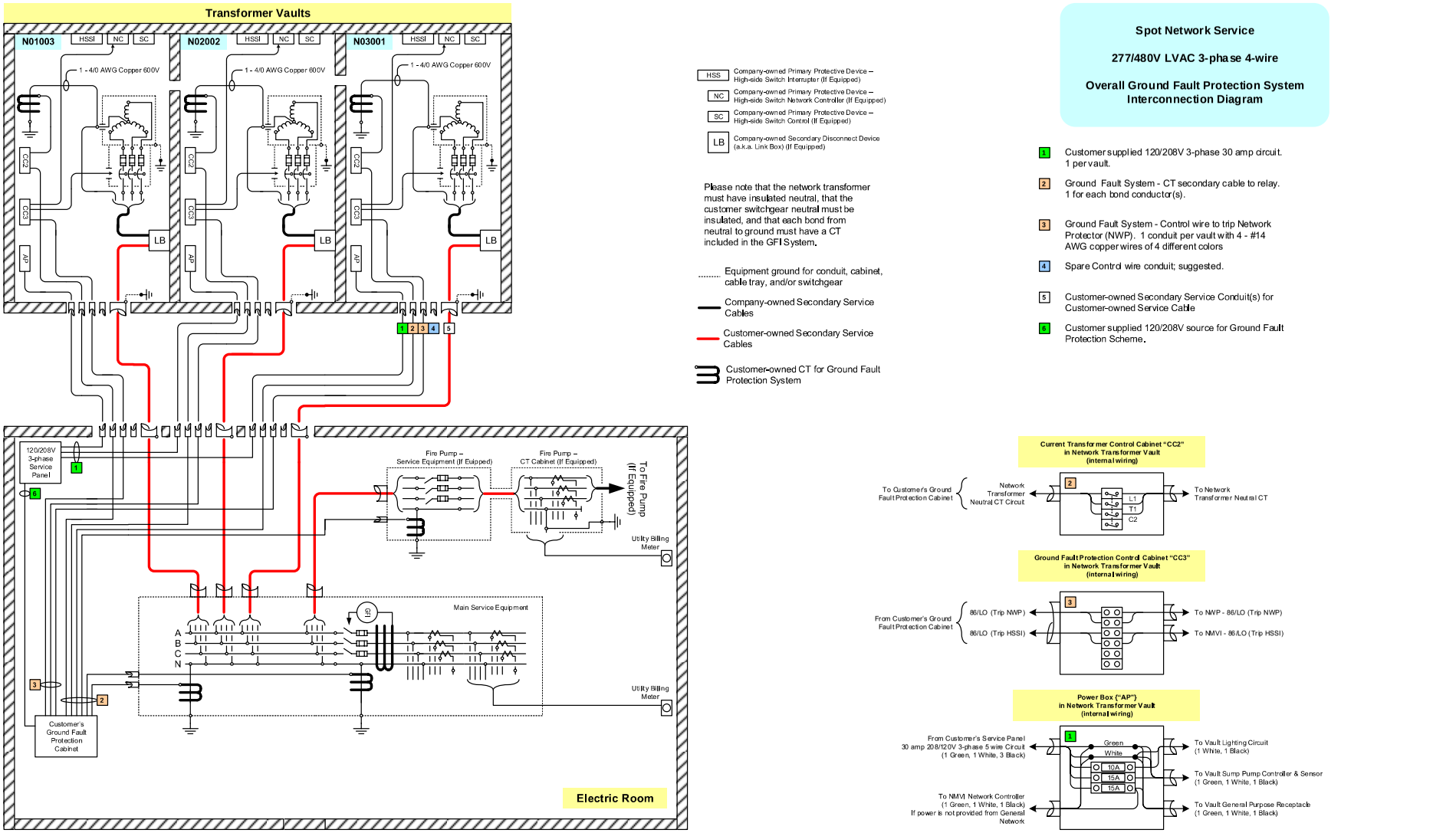


Figure 57 – Ground Fault Protection Interconnection Example

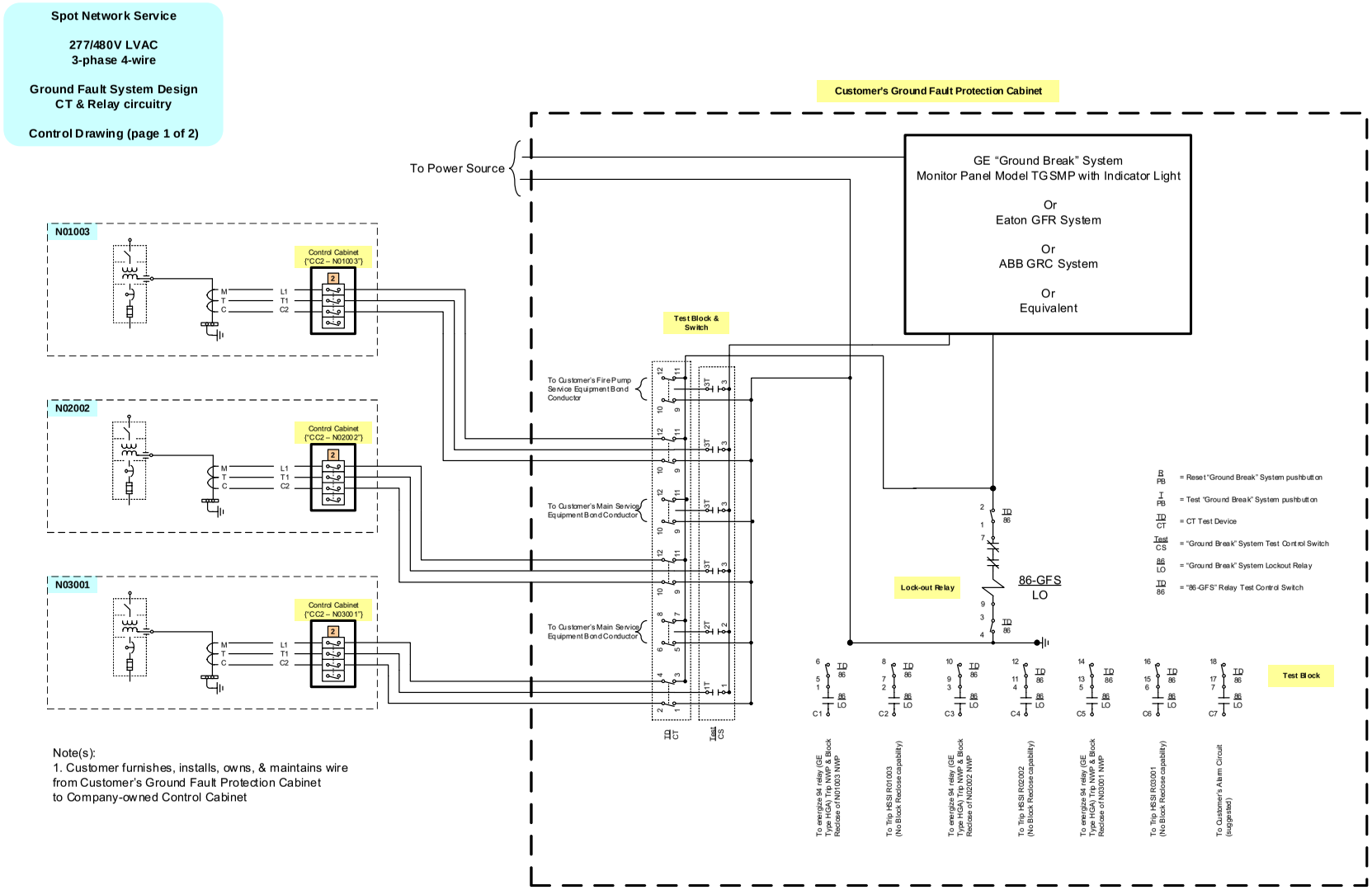


Figure 58 – Ground Fault Protection Control System Example Sheet 1

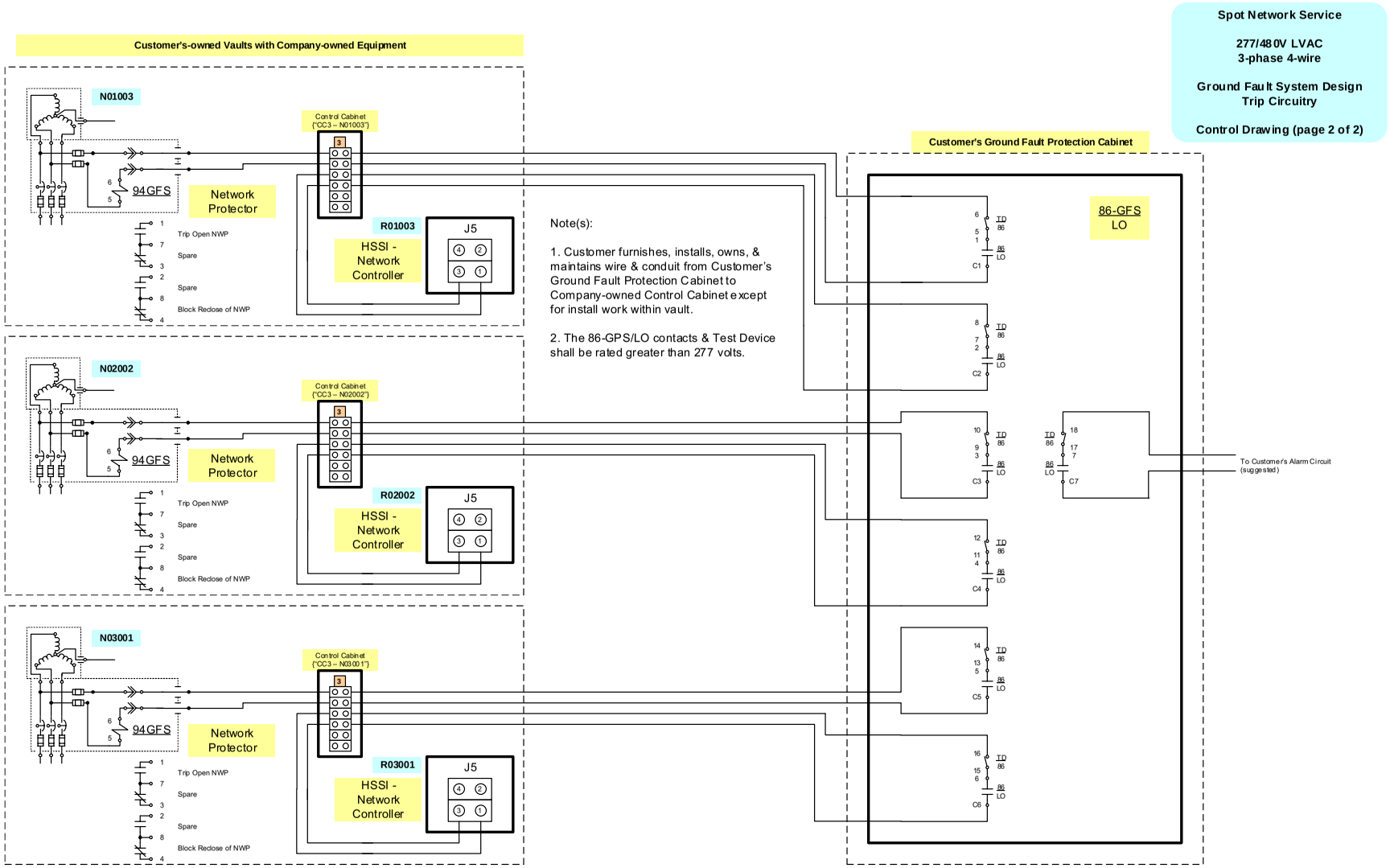


Figure 59 – Ground Fault Protection Control System Example Sheet 2

SUPPLEMENT TO SPECIFICATIONS FOR ELECTRICAL INSTALLATIONS

PRIMARY SERVICE TO METAL ENCLOSED GEAR

ELECTRIC SYSTEM BULLETIN #758

JANUARY 1985

NIAGARA MOHAWK POWER CORPORATION

NIAGARA MOHAWK POWER CORPORATION

SUPPLEMENT TO

SPECIFICATIONS FOR ELECTRICAL INSTALLATIONS

PRIMARY SERVICE TO METAL ENCLOSED GEAR

ELECTRIC SYSTEM BULLETIN # 758

This supplement provides general recommendations for a Customer who will take service at 2400 to 13200 GRD.Y/7620 volts to Customer-owned primary service equipment of the switchgear type either indoor or outdoor.

Additional information concerning the route of the primary service lateral will be furnished separately. For this purpose, the architect should furnish the Company three preliminary prints of the plot plan. The Company will return one print marked with the location to which the primary conduit should be extended and the recommended location of necessary handholes. The architect should add this information to his electrical plan.

Contents

Drawings

A. INTRODUCTION

1. These requirements supplement Niagara Mohawk Power Corporation "Specifications for Electrical Installations". They provide more complete information for a CUSTOMER-OWNED electric service installation where the supply voltage designated by the Company is at 2,400 to 13,200 GRD.Y/7620 volts. Their purpose is to assure that the electric service facilities will render satisfactory service to the Customer and will not interfere with the electric supply to others served by the Company's system.

2. In this supplement, "Company" means Niagara Mohawk Power Corporation.

3. These requirements do not cover the Customer's complete electrical installation design but concern only those points in which the Customer, his consulting engineer, electrical contractor, equipment manufacturer and the Company have a mutual interest.

4. For a specific electric service installation, it is essential that the Company meet with the Customer, his consulting engineer, contractor, or equipment manufacturer to mutually establish the arrangement and location of the proposed facilities. As a result of this meeting, the voltage, current and interrupting ratings and type of equipment will be designated by the Company.

5. Specific information furnished by the Company shall be subject to review by the Company if significant changes are made in the design or scheduling of the project.

6. The complexity of modern electrical installations makes it essential that there be continuous close cooperation between all parties involved.

B. CODES, STANDARDS AND WIRING ADEQUACY

7. The Customer's electric service equipment and its installation shall conform to the requirements of the latest edition of the National Electrical Code, American National Standards Institute, Insulated Power Cable Engineers Association, National Electrical Manufacturer's Association, Institute of Electrical and Electronics Engineers, all local ordinances, building codes and Company requirements and specifications. The Customer, his engineer, contractor and supplier should aim to provide a modern, adequate electrical installation with ample provision for future needs.

C. APPROVAL AND INSPECTIONS

8. THE CUSTOMER SHALL SUBMIT HIS PLANS TO THE COMPANY BEFORE ORDERING EQUIPMENT OR STARTING WORK, to insure that the proposed design for the electric service installation conforms to Company requirements. The company normally limits its check of the plans to the details of the service lateral,

the service protective means, and the location of metering equipment. The Customer should consult his insurance carrier for any special safeguards which the carrier may require for the transformer or switchgear installations.

9. The Company will designate the pole or manhole from which the primary cable will be extended. The Customer shall furnish three (3) preliminary prints of this plot plan showing the preferred location of his service equipment. The Company will return one print, marked to show a suggested route for the service lateral conduit, and recommend handhole locations.

10. The Customer shall furnish, for review by the Company, information as follows:

Portions of the Architect's drawings and specifications relating to electric service equipment and transformers (3 copies).

Manufacturer's proposed specifications relating to primary service equipment and transformers (3 copies).

Manufacturer's approval prints relating to the physical arrangement of the primary service equipment, particularly the installation of primary metering transformers where used (3 copies).

Manufacturer's certified prints of drawings and material lists describing service equipment and transformers (3 copies).

11. To protect the Customer's interests, as well as its own, the Company requires the Customer to furnish satisfactory evidence of the safe condition of his entire electrical installation before the company will energize his service. This may be in the form of an approval or certificate from the New York Board of Fire Underwriters, or other inspection organization acceptable to the Company. When wiring is altered or extended, an approval or certificate shall also be obtained to assure compliance with safety requirements. Application for inspection should be made before work is started.

D. SUPPLEMENTAL INFORMATION

12. It is the Company's desire to assist the Customer in understanding details of his electrical service installation. When the information is not in this booklet, the company invites inquiries from the customer, his consulting engineer, his electrical contractor, or his equipment manufacturer.

E. CONTRIBUTIONS BY CUSTOMER

13. The Company's Consumer Relations Department will advise the Customer concerning any contribution which may be required from him for materials supplied and work performed by the Company.

F. ACCESS TO PREMISES BY AUTHORIZED POWER COMPANY EMPLOYEES

14. Facilities shall be provided so that authorized Company employees may have access to the Customer's electric service installation and metering facilities at any reasonable time.

G. OPERATING PROCEDURES

15. The Customer is responsible for performing the actual operating functions for his service equipment. The Customer should arrange to have trained personnel on duty at all times for the proper and safe operation of his service equipment. Personnel training should cover correct operating procedures which shall include use of rubber gloves; replacement of high voltage fuses; the opening, resetting and closing of switches and circuit breakers; and the sequence of operations for interlocked equipment.

16. The Customer shall provide such operating equipment as tongs, insulating sticks, rubber gloves, grounds, voltage detection equipment, etc., needed for the safe performance of operating functions. This equipment shall be properly maintained for the safety of the Customer's personnel.

17. The Customer is responsible for maintaining all equipment under his ownership. Proper and continuous maintenance is important to the operation of the equipment. NFPA Standard No. 70B on "Electrical Equipment Maintenance" is one publication that could be helpful in setting up a dynamic maintenance program.

H. PRIMARY CABLE IN CONDUIT

18. The Company will specify the type and size of the primary cable. The Company will furnish, install, own, and maintain this cable from its line to the Customer's primary disconnect switch. The Company will make the primary connections to the switch. At least 36 inches is required within the switchgear for termination of the cable. The customer shall provide a NEMA standard two-hole pad on his switch for this connection. The installed cost of this cable shall be borne by the customer.

19. Where conduit is required, it shall be either rigid non-metallic conduit encased in a 3-inch concrete envelope or galvanized rigid steel conduit. The Customer shall furnish, install, own, and maintain the primary conduit from the Company's pole to the switchgear. Where the supply is from an underground line, the Customer shall install this conduit from his property line to the switchgear. The conduit shall be at least 4 inches in diameter and shall slope at least 2 inches per 100 feet toward a handhole for drainage. It is recommended that a spare conduit be installed. These conduits shall normally be buried to a depth of at least 30 inches below final grade. The Customer shall install a pull wire in each conduit. The conduits should be capped or plugged until needed.

20. The riser at the pole shall consist of a 42-inch radius 90° bend and a 10-foot vertical length, both of galvanized rigid steel conduit. The riser shall be grounded by bonding to an approved ground clamp on the top of the conduit. A conductor of sufficient length shall be provided to extend 24 inches beyond the Company's neutral. The conductor shall be #4 copper minimum or larger as required by the National Electrical Code. If the riser is located next to the street, it must be galvanized rigid steel conduit; however, if the riser is located off the street and in a location where the riser would not be subjected to physical damage, rigid, non-metallic conduit-PVC Schedule 80 may be used at the discretion of the Company. The Company will designate the location from which the service will be taken.

21. One or more handholes may be required by the Company to facilitate cable pulling or to drain the conduit. Handholes shall be of masonry or concrete construction. The minimum size shall be 3 feet wide X 6 feet long X 4 feet deep, inside dimensions. A pulling iron of #6 bar and a ground rod, 5/8 inch X 8 feet, shall be installed at each end of the handhole. The handhole floor shall be sloped toward a sump, 18-inch diamter X 18 inches deep, filled with crushed stone. The conduits shall enter the handhole directly opposite each other on the three-foot walls. Conduit bells shall be installed on each conduit. The centerline of the conduit shall be approximately 6 inches from the 6-foot wall and 15 inches above the floor. Metallic conduit shall be bonded together and to the ground rods.

Handholes located in roads, driveways or sidewalks will have a three-section cover and be capable of withstanding an H-20 loading. Handholes located in other areas may be designed for a light load capability. The design of the handhole shall be approved by the Company.

22. Maximum cable pulling lengths shall be as follows:

a. Straight run with one 90° bend at each end -200 feet
b. Straight run handhole to handhole -425 feet
c. As in (b) except one 90° bend at the feed-in end -400 feet
d. As in (b) except one 90° bend at the pulling end -225 feet

I. PRIMARY DIRECT BURIED CABLE

23. Direct buried primary cable may be used by the Company where field conditions permit. The company will specify the size and type of this cable. The Company will furnish, install, own, and maintain this cable from its line to the Customer's disconnect switch. The Company will make the primary connections to the switch. At least 36 inches is required for termination of the cable. The Customer shall provide a NEMA standard two-hole pad on his switch for this connection. The installed cost of this cable shall be borne by the Customer.

24. The Customer shall install two conduit bends at the equipment pad and extend them, if necessary, to clear curbs and obstructions with straight sections of conduit installed at a minimum depth of 30 inches to the point where the cable will be directly buried.

25. Conduit sections up to 25 feet in length shall consist of two direct buried 4-inch minimum, 36-inch minimum radius, 90° bends, and necessary straight sections all Underwriters Laboratories labeled, PVC conduit. For longer lengths, up to 100 feet, conduits of the same material except with 42-inch radius bends shall be used (no more than two bends permitted). All conduit of this material shall be encased in 3 inches of concrete. If longer lengths of conduit are required, regular cable-in-conduit service shall be used. All conduits shall be capped or plugged until needed.

26. From the end of the above conduit to the Company's riser pole or other specified structure, the Customer shall provide a suitable trench for the cable and backfill, after the cable is installed. The trench shall be dug to a depth of at least 36 inches below final grade and shall be free from soft spots or large stones and a 2-inch bedding of sand or rock-free sandy loam shall be used. The minimum depth to the top of the cables shall be 30 inches. The backfill shall consist of a 4-inch layer of sand and 6-inch layers of rock-free soil placed in 6-inch layers and mechanically tamped. The Customer shall furnish backfilling the trench as required to meet local loading requirements.

J. GROUNDING

27. For outdoor installations, a ground grid shall be installed by the Customer consisting of bare copper conductor, minimum size #4/0 AWG, buried six-inches deep in the pattern of an outer loop around the switchgear pad. The loop shall be connected to at least two drived ground rods. Maximum ground resistance shall be 10 ohms. Two grounding connections shall be provided by the Customer from the ground grid to the switchgear ground bus. The metallic conduits shall be grounded by the Customer to the ground grid. Where practicable, the ground grid shall be bonded by #4/0 copper to a continuous metallic water system.

28. For outdoor installations, two grounding connections shall be provided by the Customer from the switchgear ground bus to a suitable ground. Where practicable, the ground shall be bonded by #4/0 copper to a continuous water system.

K. PANIC HARDWARE

29.. It is required that doors to switchgear rooms or walk-in metalclad switchgear be equipped with panic hardware. The lock preventing access to these rooms shall not prevent egress.

L. SERVICE EQUIPMENT

30. Scope - The Customer's service equipment must provide for receiving the service lateral conductors, a circuit isolating means, a disconnecting means for safe planned interruption of the service for all conditions of loading, a protective means for automatic interruption of short circuits, and mounting and connections for billing meter facilities. The function of each cubicle shall be identified by an external permanent nameplate.

31. Multiple Sources - When Customer's service equipment is supplied by multiple sources, each source shall be provided with its own disconnecting and protective means. Company shall be consulted for additional requirements.

A means such as an accessible bare lug shall be provided for grounding each phase of the bus on both line and load side of the metering transformers.

32. Company Requirements - The Customer's service equipment will be located, arranged, and installed as agreed upon by the Company and the Customer. The Company will advise the Customer concerning requirements for the protective devices, limitations for current inrush, metering facilities, and terminal sizes to accommodate the service lateral conductors.

The cable shall enter the service receiving equipment from below. A minimum vertical distance of 36" from the top of the conduit at the base of the receiving cubicle to the bus attachment point is required for cable termination. Where the distance exceeds 36", a cable grip must be provided to adequately support the cable. The receiving bus shall be drilled to receive a NEMA standard two-hole pad. The cable terminal connection to the bus will be made by the Company. The receiving equipment shall have a minimum BIL rating of 95kV. For some services, power fuses cannot provide satisfactory coordination of protective equipment and circuit breakers may be required.

33. Isolating Means - All equipment in the Customer's switchgear shall be so arranged that it can be isolated from the Company's system by a main disconnecting switch or draw-out circuit breaker. The switch shall be group operated causing separation by a clearly visible air gap. Where the Customer utilizes fuses as the overcurrent protection, the disconnecting switch shall be of loadbreak design. The switch or breaker compartment shall have provisions for dual locking of the door to allow access by either the Customer or the Company.

34. In indoor or outdoor metal enclosed switchgear installations, these switches shall be physically isolated by steel enclosures. Switches in steel enclosures shall be accessible through a hinged door. The door shall have provision for padlocking.

35. An accessible lug shall be provided on the line side of each phase of the isolating device as an attachment point for grounding or testing. A ten foot clear space shall be made available in front of this lug. A "ground and test device" (grounding truck) may be provided in lieu of the lug when a draw-out circuit breaker is used.

36. Lightning Arresters - Lightning arresters shall be installed on the load side of the main switch. Rating shall be as shown on the single-line diagram. Consult with Company for arrester location on dual primary service (2 feeds).

37. Disconnecting Means - A means must be provided for opening each service circuit quickly, effectively, and safely under all conditions of loading. Among satisfactory disconnecting means are:

a. A circuit breaker used as the service circuit protective means may also serve as the disconnecting means.

b. A load interrupter switch used as the isolating means may also serve as the disconnecting means.

38. Protective Means - An automatic fault protective device shall be provided for each service circuit. The device shall have an interrupting capacity at the service voltage and frequency of not less than that specified by the Company. The two most commonly used protective means are circuit breakers or loadbreak switch and fuse combinations.

39. Power Fuses - Where power fuses can be used as the service equipment protective means, their type shall be approved by the Company. Their current rating, time-current characteristic, and interrupting capacity will be specified by the Company. The Customer should arrange to have at least four spare fuse units on hand at all times. The Company does not stock the types and sizes of fuses that would be required to replace the Customer's service fuses.

40. Power fuses shall not be inserted or removed from their mountings unless the mountings are completely de-energized. Fuse compartment shall be key interlocked with main disconnect switch. The Customer shall provide such switch sticks, rubber gloves, etc., as are needed for safe handling of the high voltage power fuses.

41. Circuit Breakers - Where circuit breakers are used as the service equipment protective means, the specification of the complete tripping circuit including the current transformer ratio and the relay type and range must be submitted for approval to the Company. The Company will then recommend a relay setting for the main circuit breaker only. No ammeter switch may be connected in the secondary of current transformers used to actuate the relays.

42. Circuit breakers in service equipment must be mechanically and electrically trip free.

43. The Company recommends that no undervoltage tripping device be used in service receiving equipment, except for automatic transfer to an emergency supply.

44. A current transformer of adequate relaying accuracy must be provided with each pole of the service equipment circuit breaker for use with the overcurrent devices. No current transfer switches shall be connected in the secondary circuits of these current transformers.

45. An overcurrent device shall be provided for each ungrounded phase of the service equipment to initiate tripping of the circuit breaker for fault current protection. Dash pots on direct trip are not accepted. Where the service supplies motors with individual rating over 100 horsepower, or where it is necessary to provide for selective tripping between the service equipment circuit breaker and those in load circuits, time delay induction type overcurrent relays without instantaneous trip attachments should be used on the main and time delay induction type overcurrent relays with instantaneous trip attachments should be used on the downstream breakers.

46. Upon notification by the Customer of the type tripping scheme to be used, the Company will specify the type and range of the relays associated with the service equipment and their settings. The Company will specify test devices, where required, connections, and associated current or potential transformer ratio.

47. Acceptable circuit breaker tripping energy sources are:

a. Control storage batteries, rated not less than 48 volts, float charged by suitable charging equipment.

b. A.C. tripping reactor. Where these are used, the supplier shall be responsible for matching ohmic value of tripping reactors and breaker trip coils for reliable tripping response. Control circuits shall be completely wired and connected with one current transformer secondary and supplying reactors and trip coils.

c. Current transformers connected to series current trip coil where such tripping method can be used. See paragraph 44.

d. A control circuit, used only for operating the circuit breaker may be connected on its line side providing the tap is protected by high interrupting capacity fuses of a type acceptable to the Company.

e. Other sources of tripping energy should not be used unless approved by the Company.

M. METERING

48. The Company will furnish all meters, metering transformers and test devices required for billing purposes.

49. The Company will specify the quantity, type, rating and primary connections of all current and potential transformers for billing purposes. The current and potential transformers for the Company's billing meters shall not be used to operate any other devices.

50. A separate enclosing compartment, 36-inches wide minimum, shall be provided solely for the billing metering transformers. Where it will facilitate design, the current transformers with connections may be located in their own separate compartment. The metering transformers shall be so arranged as to be fully accessible and protected by hinged and padlocked doors. Where the metering equipment compartment is located in an unheated building, provisions shall be made for heating the compartment to prevent condensation.

51. The Customer shall provide space and support for the Company's current and potential transformers as part of the service entrance equipment. The supports shall be drilled for mounting bolts in accordance with dimension information concerning this equipment furnished to the Company for the design of his installation. Removable bus bars shall be furnished by the Customer to permit installation and removal of current transformers. A ten foot clear space shall be made available in front of this compartment. A means shall be provided for grounding each phase of the bus on the line and load side of the metering transformers.

52. The Customer shall furnish, install, own, and maintain conduit for the wiring from the metering transformers to the billing meter panel. The conduit should be at least 1-1/2 inch galvanized steel or equivalent approved by the Company. The conduit should be run by the shortest practicable route, using conduit bends instead of conduit fittings and of reasonable overall length (normally not exceeding 100 circuit feet with a maximum of two 90 conduit bends).

53. The Customer shall provide a panel for billing meters, together with mounting for the panel. The panel may be one of the following:

a. 3/4 inch thick painted or stained plywood panel, wall mounted, 48 inches x 48 inches. For installation of 2,000 KW and above, a 48 inches x 60 inches panel shall be provided.

b. 3/4 inch minimum thickness Benelex #70 panel or other approved insulating material, switchgear mounted, 30-inches wide and 60 inches high minimum. The switchgear cubicle must be 36-inches wide minimum.

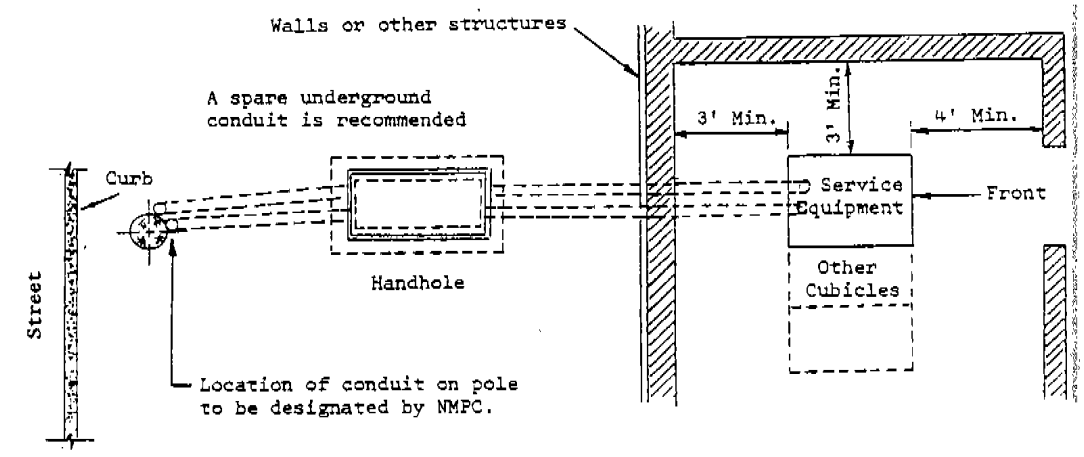
54. The billing meter panel should be located indoors in a heated and lighted location conveniently and safely accessible to authorized Company employees. The location should be clean, dry, and free of corrosive atmosphere. Provide 120 volt, 20 ampere receptacle at this location.

The wall-mounted plywood panel (53a above) shall be located with lower edge 30 inches up from the floor and so that there is a clear working space of not less than 48 inches from the panel front.

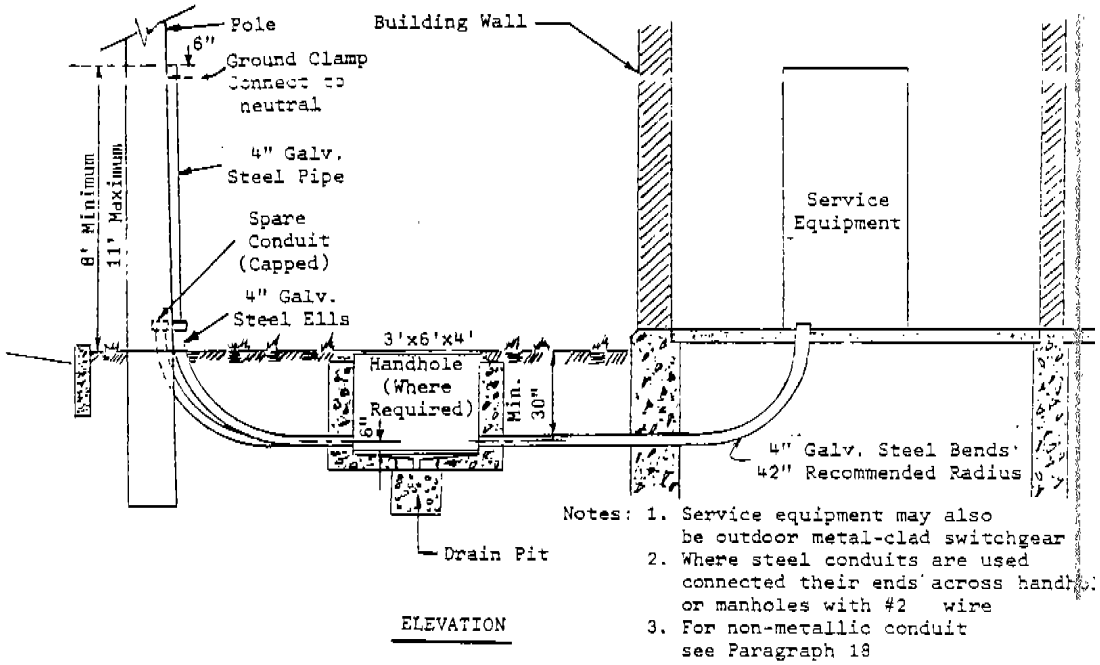
The switchgear mounted panel (53b above) should have offset hinges and a meter projection clearance of at least 16 inches from the front of the panel and stud projection clearance of at least 9 inches from the rear of the panel. There shall be a clear working space of not less than 48 inches from the panel front. This type of panel can only be furnished in an indoor location or in walk-in aisle type switchgear.

55. Where the Customer elects to install outdoor metalclad switchgear not of the walk-in aisle type, the Customer shall provide a separate walk-in cubicle, 36-inches wide minimum, to be used solely for the billing meters. The billing meters shall be located on a Benelex #70, or other approved insulating material panel furnished and installed on the back wall of the cubicle by the Customer.

The cubicle shall have a hinged door capable of being opened from the inside of the cubicle. The door shall be locked with a power company padlock. The panel shall be in one piece and a minimum of 3/4-inch thick x 30-inches wide x 60-inches high, mounted with the center point 48 inches above the floor. The cubicle shall be safely and conveniently accessible to authorized Company employees, clear of all obstructions, clean, dry, free of corrosive atmosphere, heated, ventilated, lighted, and with a 20 ampere, 120 volt single-phase convenience receptable, served from the Customer's distribution panel, and installed at the meter panel loation.



PLAN



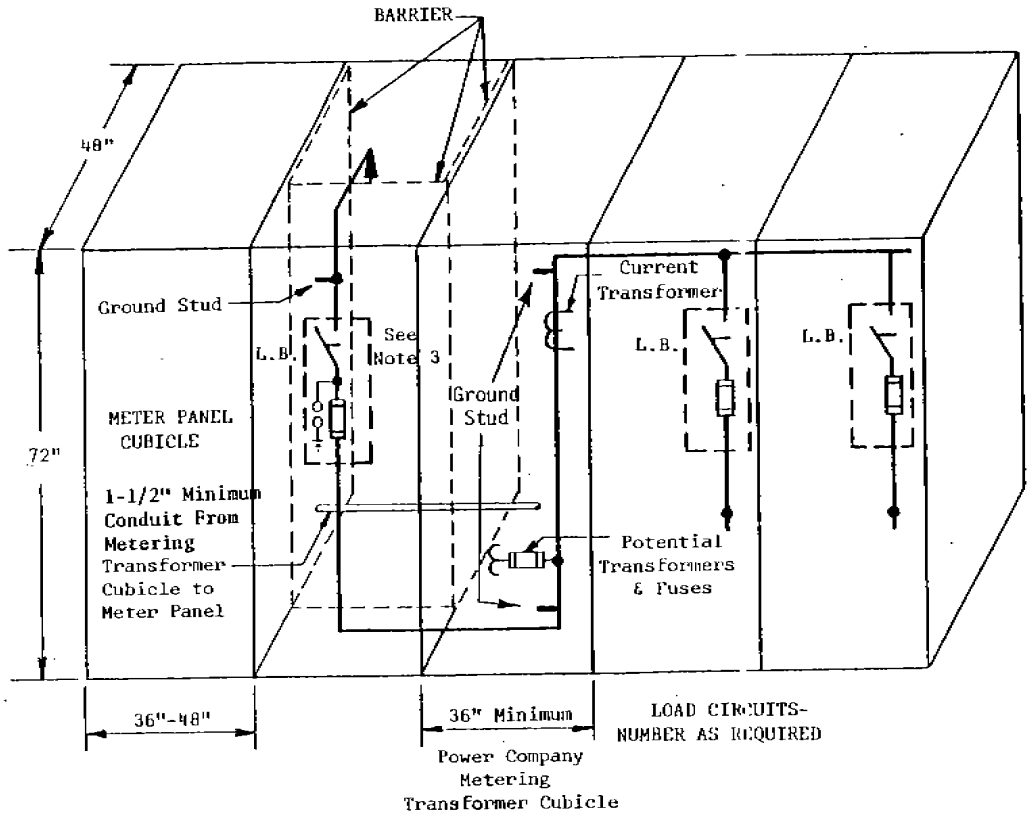
ELEVATION

1/85

TYPICAL UNDERGROUND SERVICE INSTALLATION

FIG. 1

ESB 758



Typical Metal Enclosed Switchgear Installation
Fig. 2

NOTES

1. Meter panel cubicle shall hav
   A. Adequate heaters
   B. Light - 75 watt minimum
   C. 20 Ampere, 120 volt receptacle
   D. Provisions to padlock door - 48"± from ground
   E. Plywood Panel - Mtd. on rear wall of cubicle
   F. See Par. #51
2. Meter Transformer compartment shall have provisions for padlocking door, 48"± from ground.
3. See detail below for drawout circuit breaker instead of fuse.

DRAWOUT CIRCUIT BREAKER DETAIL

1/85

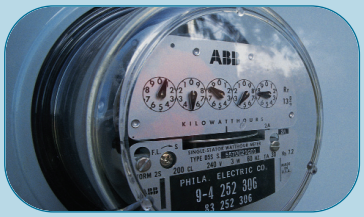
ESB 75A

Supplement to

Specifications for Electrical Installations

Underground Residential Distribution (URD) Installation and Responsibility Guide

Electric System Bulletin No. 759A
July 2010
(Supersedes all previous versions of ESB 759)



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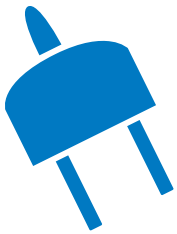

For the latest authorized version, please refer to the company's website at **http://www.nationalgridus.com/electricalspecifications**.

TABLE OF CONTENTS

URD Specifications and Installation Guide Acknowledgement (Job Spec/Signoff Forms)

The requirements and specifications outlined in this guide book must be strictly followed. Any requirements not adhered to can pose safety problems, can be detrimental to the installed system and must be corrected before final acceptance. The *Customer* will bear full cost to make corrections to sub-standard installations.

The *Customer* is responsible to provide enough lead time for the *Company* to design job, provide inspections and install *Company* equipment where applicable.

Typical lead times are shown below.

	Lead-Time	**Notes**
Design and Layout	Eight weeks	Company receives all required plans, load data and easement information
Trench, Conduit and Equip-ment Inspection New England (New York where applicable)	Three days	Company inspector
Company Installation	Four weeks	After all inspections are approved and permits/ easements are procured
Material Pick up (New Hampshire only)	10 Days	Company inspector
NOTE: The above times are estimates only.		

Project Title_____

Location_____

Owner/Developer_____

Customer's Representative _____ Date_____

Company Representative_____ Date_____

Company's Copy

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Company Representative_____ Date_____

Customer's Copy

4 For the latest authorized version, please refer to the company's website at **http://www.nationalgridus.com/electricalspecifications**.

1.0 Scope

The purpose of this specification is to define, interpret and clarify the scope of work and material dealing with providing service to URD's and is a Supplement to Electrical System Bulletin (ESB) 750.

It is important that the Specifications for Electrical Installations book (ESB 750) be obtained and referred to in conjunction with this supplement for these installations. Any reference to the *Company* in this specification shall mean the National Grid. Any reference to the *Customer* or Developer in this specification shall mean the property owner or the designee of the property owner of the URD.

2.0 General Requirements

All electrical wiring to be connected to the *Company* equipment shall be installed in accordance with one or all of the following:

- Local Municipal Inspection Authority
- State's Electrical Code
- National Electrical Code
- National Electrical Safety Code
- Applicable Distribution Construction Standards of the *Company*
- National Grid's Specifications for Electrical Installations

There shall be no attempt to deviate from either the Distribution Standards of the *Company* or the *Company* construction plan without the approval of the *Company*. Any specifications noted shall supersede the Specifications for Electrical Installations booklet unless otherwise approved by the *Company*.

It is mandatory that the *Customer* and all parties involved attend a documented pre-construction meeting with a *Company* representative to discuss the project and ensure it a timely completion. A *Company* representative will make the necessary arrangements for the pre-construction meeting. *Company* representatives will also be available throughout the job life cycle to discuss construction problems when requested or during a field visit.

References:

- ESB 750 - Specifications for Electrical Installations
- ESB 754 - Outdoor Padmounted or Vault Enclosed Three Phase Transformer

All ESB's are available at http://www.nationalgridus.com/electricalspecifications

The Customer shall be responsible to have all electrical and physical design documents prepared and updated by a design professional, in accordance with Section 1.7 of ESB 750 for the trenching, conduit, transformer pad, and handhole installations.

3.0 Type of Service

Electric service shall be single phase, three wire, 120/240V supplied from a padmount transformer or handhole to be located on the *Customer's* premises. The primary electrical service to the URD will be supplied from a pole or cable system owned by the *Company*.

4.0 Plans

When municipal approval is required, the *Company* shall receive final town approved development plans on a scale not less than one inch equal to one hundred feet in both hard copy and CAD format prior to engineering construction plans. Information regarding the total number of houses to be built in subdivision, and whether the development will be installed in phases shall also be provided. The property site plan shall show all proposed and existing overhead and underground utilities, i.e. electric, water, gas, sewer, cable television, telephone, etc.

A copy of a street light proposal must also be provided for the development, approved by the municipality, or written notice from the municipality that street lighting will not be required. If installation is requested after construction is complete, additional costs, including the *Company's* tax liabilities, may be borne by the municipality and/or *Customer* if the tariff does not collect all costs of construction.

Direct Burial Systems in general: the *Company* specifies an arrangement whereby the *Company's* power cables may run parallel with communication and other power cables, but not parallel with other utilities e.g. water, gas, sewer. These utilities shall be in a separate trench. The other utilities must maintain clearances as outlined in the NESC or by mutual agreement. National Grid gas is permitted in the same trench with the following requirements: gas shall be at a minimum depth of 18" and shall maintain a minimum separation of 12" between all other utilities.

Conduit Systems in general: the *Company* requires a spare conduit for all *Company* owned duct systems, as shown in *Company* plans. Other utilities must maintain clearances as outlined in the NESC.

5.0 Permits

In general, all applicable permits necessary to trench and excavate, including street openings and environmental permits, shall be obtained by the *Customer* and made available upon request of *Company* prior to design. The *Customer* shall be responsible for including these padmount and conduit/trench specifications with the wetlands application for developments located in or near wetlands. A copy of the wetlands permit may be requested by the *Company* prior to acceptance of the conduit/trench system by the *Company*.

The *Customer/Company* doing the excavation shall obtain the required DIGSAFE permits before any excavation may take place in a public way. The *Customer/Company* doing the excavation is urged to obtain copies of the applicable statute and become familiar with its requirements. Similarly, the *Customer/Company* shall determine if the municipality in which the excavation is to be done requires that water, sewer or other utility, municipal or private, be contacted separately due to the possibility they may not be members of DigSafe® (for New England) or Dig Safely (for New York). The *Customer* is also responsible to notify the company of all asbuilt changes that may conflict with design).

The *Customer* shall certify to the *Company* that areas in which the *Company* is to perform installation or maintenance work is free of preexisting contamination by hazardous wastes or materials and to indemnify the *Company* for any claims, costs, expensed, suits, demands, citations, fines or damages of any kind arising from the presence of any such contamination.

6.0 Division of Responsibility

The division of ownership and responsibility shall be as outlined below by state. Typical installation specifications to reflect installation practices are shown in the back of this guide.

Massachusetts and Rhode Island

a. The Company will:

- i. Develop the plan to provide underground electric service,
- ii. Supply a list of approved manufacturers and their part numbers for equipment to be supplied by the *Customer*, (See Pages 39-41)
- iii. Designate the location of all *Company* owned equipment,
- iv. Provide *Company* owned street light foundations and any cable-in-conduit required for street light applications,
- v. Provide, install, own and maintain all transformers, *Company* owned street lights, primary and secondary cable, except services,
- vi. Make all connections to *Company* equipment,
- vii. Inspect the underground conduit system and equipment foundations installed by the *Customer*,
- viii. Determine if oil containment shall be required for padmount transformer installation.

b. The *Customer*, at no cost to the *Company*, will:

- i. Provide, prior to the start of the *Company's* construction, all applicable documents required for the *Company* to prepare easements for its facilities to be installed on private property,
- ii. Install foundations and cable-in-conduit, provided by the *Company*, for *Company* owned street lights;
- iii. Provide and install all other required handholes, box pads, splice boxes, grounding systems, and conduit including spacers, galvanized conduit and sweep for riser pole including bonding clamps and neutral tap, glue and pulling tape, marking tape, etc. as indicated on the *Company's* plan and related construction documents,
- iv. Supply copies of all invoices, when requested, indicating manufacturer and part number for all such equipment listed above; equipment that is not approved shall not be used without the prior written consent of the *Company*,
- v. Install, own and maintain all secondary services and service conduit from the *Company's* equipment to each designated meter location,
- vi. Turn over ownership of the conduit system, excluding the service conduit, to the *Company* upon inspection and acceptance of the conduit system by the *Company*,
- vii. Provide and install material for oil containment under padmounted transformers where required.

New Hampshire

a. The Company will:

i. Develop the plan to provide underground electric service,

ii. Designate the location of all *Company* owned equipment,

iii. Provide *Company* owned street light foundations and any cable-in-conduit required for street light applications,

iv. Provide, install, own and maintain all transformers, *Company* owned street lights, primary and secondary cable, except services,

v. Make all connections to *Company* equipment; and inspect the underground conduit system and equipment foundations installed by the *Customer*, after *Company* acceptance of conduit system,

vi. Determine if oil containment shall be required for padmount transformer installation,

vii. Provide required handholes, boxpads, splice boxes, grounding systems, and conduit including spacers, galvanized conduit and sweep for riser pole including bonding clamps and neutral tap, glue and marking tape, etc. as indicated on the *Company's* plan and related construction documents.

b. The *Customer*, at no cost to the *Company*, will:

i. Provide, prior to the start of the *Company's* construction, all applicable documents required for the *Company* to prepare easements for its facilities to be installed on private property,

ii. Install foundations and cable-in-conduit, provided by the *Company*, for *Company* owned street lights,

iii. Install all required handholes, boxpads, splice boxes, grounding systems, and conduit including spacers, galvanized conduit and sweeps for riser pole including bonding clamps and neutral tap, glue and pulling tape, etc. as indicated on the *Company's* plan and related construction documents,

iv. Install, own and maintain all secondary services and service conduit from the *Company's* equipment to each designated meter location,

v. Turn over ownership of the conduit system, excluding the service conduit, to the *Company* upon inspection and acceptance of the conduit system by the *Company*,

vi. Provide and install material for oil containment under padmounted transformers where required.

New York

a. The *Company* will:

i. Develop the plan to provide underground electric service,

ii. Supply a list of approved manufacturers and their part numbers for equipment to be supplied by the *Customer* (See Pages 39-41),

iii. Designate the location of all *Company* owned equipment,

iv. Provide and install *Company* owned embedded streetlight poles and any direct buried cable required for street light applications,

v. Provide and install all other required handholes, boxpads, splice boxes, grounding systems, conduit (where applicable) including spacers, galvanized conduit, and sweeps for riser pole, including bonding clam and neutral tap, glue and pulling tape, warning tape, etc. as indicated on the *Company's* plan and related construction documents,

vi. Provide, install, own and maintain all transformers, *Company* owned street lights, primary and secondary cable, except services,

vii. Make all connections to *Company* equipment,

viii. Inspect the underground conduit system and equipment foundations where applicable installed by the *Customer*, prior to backfilling,

ix. Inspect the underground cables and equipment foundations where applicable installed by the *Customer*, prior to backfilling,

x. Determine if oil containment shall be required and install if deemed necessary for padmount transformer installation.

b. The *Customer*, at no cost to the *Company*, will:

i. Provide, prior to the start of the *Company's* construction, all applicable documents required for the *Company* to prepare easements for its facilities to be installed on private property,

ii. In certain circumstances (i.e. road/water crossings), install *Company*-provided conduit and cable per request and specification of *Company*,

iii. Supply copies of all invoices, when requested, indicating manufacturer and part number for all such equipment listed above; equipment that is not approved shall not be used without the prior written consent of the *Company*,

iv. Install, own and maintain all secondary services and service conduit from the *Company's* equipment to each designated meter location,

v. Turn over ownership of the conduit system, excluding the service conduit, to the *Company* upon inspection and acceptance of the conduit system by the *Company*,

vi. Install oil containment for padmounted transformers where required.

7.0 Easements

In general, *Company*-owned equipment shall not be installed on the *Customer's* property prior to the execution of suitable easement(s). The *Customer* will have to provide to the *Company* (for the purposes of securing an easement) the following items, including but not limited to:

- Copy of property deed showing: owner, date, book number, page number county registry, and survey and/or plan of record, if available.

  Note: When electronic maps are used, the Customer must consult the Company for submittal.

- Copy of mortgages showing: holder, date, book number, page number and county registry.

- Copy of any applicable trusts showing: date, book number, page number and county registry, and who is authorized to sign legal documents on behalf of the Trust.

Easement application forms are located on Page 35. Refer to Sections 3.1.3 and 4.1.1 in ESB 750 for further easement requirements applicable to the Applicant or Customer.

8.0 Trench Construction Requirements

a. Layout and Grading

   i. Final grades shall be established and the binder coat installed, and easement boundaries, street, lot and trench lines staked by the *Customer* before any trenching is started (except for *Company* inspected road crossings).

b. Trenching and Backfilling

   i. The Customer shall adhere to the construction plan specifying trench locations and depths, with any deviation being subject to approval by the *Company.*

   ii. Minimum burial depths specified for all electrical conduit and direct burial trenches shall be maintained during all phases of construction. Temporary mechanical protection over buried conduit during construction to prevent conduit crushing or damage due to unusually heavy construction equipment shall be the responsibility of the *Customer*.

   iii. Trench detail shown in attached *Company* Standards shall be adhered to. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble or any conditions not suitable for a stable foundation shall be reported to the *Company* Representative for recommendation. Pockets of unsuitable soil shall be replaced with compacted sand.

   iv. For work done by *Customer*, a *Company* representative shall be notified in advance of the backfilling of any electric facility, i.e., conduit, foundation, handhold, pull-box, cable-in-conduit, grounding, cables, etc.

   If any facility is backfilled without the *Company's* prior approval, the *Company* reserves the right to require re-excavation of the facility.

      aa. Sand for conduit installation - A minimum of three inches of sand shall be placed, under, beside, around and on top of all electric conduit. The sand shall pass through 3/8 inch mesh screen and shall not contain any sharp stones.

Sand shall be placed and suitably tamped over installed conduit in reasonably small quantities (not a front end loader bucketful all at once) to avoid conduit damage. Sand shall be evenly distributed between and around all electric conduits.

bb. Sand for direct burial installation - A minimum of two inches of sand shall be placed at the base for the cables to be installed on top of. A minimum cover of four inches of sand be placed on top of the cables. The sand shall pass through 3/8 inch mesh screen and shall not contain any sharp stones.

Sand shall be placed and suitably tamped over installed cable in reasonably small quantities (not a front end loader bucketful all at once) to maintain minimum cover. Sand shall be evenly distributed between and around all electric cables.

v. Remainder of backfill shall not contain stones greater than once inch and shall not contain ashes, cinders, shell, or frozen material,

vi. Trenches shall be immediately backfilled following cable or conduit system inspection and approval by authorized Company representative,

vii. Backfilling shall be accomplished in a continuous manner from one terminal, i.e., riser pole, foundation, handhold, etc. to the next,

viii. Backfilling shall not take place over any open-ended (unplugged) conduits,

ix. Company approved red cable “Warning” or “Marking” tape shall be installed in the trench 12 inches below finished grade and directly above the cable or conduit.

9.0 Trench and Conduit System Inspection

In the applicable area, a designated *Company* inspector shall be responsible for the inspection of the trench and/or conduit system being prepared and installed by the *Customer* at various stages of installation. The *Customer* shall provide the *Company* inspector with a minimum of 24 to 72 hours notice.

Inspections shall be conducted:

1) After conduit, ground system are completed; but before concrete is poured

2) After concrete is poured, but before backfilling if applicable

3) After backfilling

The inspection shall include, but not be limited to the following:

- All trenches and excavations
- All material supplied by the *Customer*
- All backfill and base sand material during or after installation as applicable
- All foundations, pull-boxes, boxpads, handholes, and other facilities, after setting in place, but prior to backfilling

- All galvanized steel riser pole and sweep conduit installations, all conduit, including cemented joint, bends, sweeps, bell-ends, and conduit spacers, prior to backfilling, or concrete encasement
- All conduit terminations and supports at boxpads, pull-boxes, handholes, riser poles, streetlight foundations, and at other applicable locations
- The pouring of any required concrete encasement and subsequent backfilling around the conduit runs
- All backfilling operations
- Witnessing mandrelling of all conduits

10.0 Conduit Installation

a. Conduit shall be installed in accordance with Standards and Construction Plans which accompany this specification package.

b. Plastic spacers shall be used to separate all duct where more than one duct is installed. Spacers shall not exceed eight foot intervals. Spacers shall be placed at each coupling. Spacers are required to maintain proper separation from adjacent conduits and to aid in proper sand placement for thermal reasons.

c. Type DB conduit shall be employed whether duct is direct buried or encased in concrete.

d. All galvanized steel sweeps at risers shall have a minimum radius of 36 inches. 48 inch radius sweeps are required at transformer foundations and secondary handholes. See Page 17 for details.

e. Curves and bends in conduit runs shall be gradual, and the radius of curvature shall not be less than 40 feet. Only five Degree Angled Couplings shall be used to make these gradual bends.

f. Conduit grade shall be such as to cause all ducts to drain toward one or both equipment foundations, pullboxes or handholes. Minimum pitch shall be three inches per 100 feet. Pullboxes may be required near riser pole if grade at pole is low compared to the first boxpad to alleviate water buildup in riser.

g. Conduit shall have a maximum penetration inside walls of pull/splice boxes, equipment foundations or handholes of three inches. All unused conduits and conduit knockouts shall be sealed with conduit plugs. Bell ends shall be installed at the end of all conduit runs.

h. The minimum separation between electrical conduit and foreign conduit or pipes shall be as follows:

- Communication systems – 12 inches
- Water, Gas and Sewer – 12 inches where the paths of these utilities intersect electrical conduits at approximately right angles. A minimum separation of 24 inches shall be maintained between parallel placement of any of these utilities and electrical conduits.

i. All road crossings shall, when practical, be perpendicular to the sidelines of the road.

j. All road crossings shall have 30 inch minimum burial depth, top of conduit to finished grade, for primary and 24 inch minimum for secondary voltages. (including street lighting cable-in-conduit) Main electric trench shall maintain conduit depths as shown in on Page 32.

k. Where foreign objects threaten to interfere with the installation of conduit in the sidewalk area or other areas, the Company may require concrete encasement of the conduit.

11.0 Direct Burial Installation NY

a. Cable installation shall be installed in accordance with Standards and Construction Plans which accompany this specification package.

b. All primary cable rising up a pole shall be installed in a galvanized steel pipe and galvanized sweep with a minimum radius of 36 inches. (3" conduit for single phase conductor and 4" conduit for three phase installations)

c. The minimum separation between electrical cables and foreign cables, conduit or pipes shall be as follows:

- Communication systems – 12 inches
- Water, Gas, Sewer – 12 inches where the paths of these utilities intersect electrical conduits at approximately right angles. A minimum separation of 24" inches shall be maintained between parallel placement of any of these utilities and electrical cables.

d. All road crossings shall, when practical, be perpendicular to the sidelines of the road and installed in conduit.

e. All road crossings shall have 30 inch minimum burial depth, top of conduit to finished grade, for primary and 24 inch minimum for secondary voltages. (including street lighting C-I-C) Main electric trench shall maintain conduit depths as shown in on Page 32.

f. Where foreign objects threaten to interfere with the installation of cable in the sidewalk area or other areas, the *Company* may require the cable to be installed in conduit concrete encased.

12.0 Transformer Box Pad Installation

- All foundations shall be level and installed in accordance with drawing on Pages 16-17.
- A minimum of four inches base course of crushed stone (3/4 in maximum stone size) shall be placed under all transformer foundation excavations and thoroughly compacted using a vibratory compactor. Certain soil conditions may require removal below normal depth and subsequent additional clean sand or stone added and compacted to insure sound base course for foundation. For direct burial cable installation, cables are to be surrounded by at least 4" of sand at base area crossing from the trench into the box pad.
- Transformer foundation top surfaces shall be four inches above final grade. In no instance shall final grades hamper proper access or operation of equipment.
- A buried ground grid shall be installed in accordance with details shown on Pages 18 and 19. Ground loop around transformer to be buried 12" below finish grade (not at foundation base depth). Telephone Company bond wires shall be tied to the ground grid. Such bonding or connection shall not interfere with connecting *Company* equipment.
- Retaining walls or other devices shall be installed where slopes exist that would undermine or cover equipment, such as transformers due to sharp drop-off or rise.

> ***NOTE:*** *In most instances, the Company shall require that equipment easements on private property be reasonably level. Also, all retaining walls shall fall outside of equipment easements and in no case shall they hamper door openings or placement of such equipment. Retaining wall design shall be approved by the Company.*

- Upon completing the installation of the transformer foundation, the top opening shall be securely sealed with a suitable matching cover.
- Transformer foundation shall be completely backfilled prior to commencing any cable pulling.

In some locations oil containment may be required for box pad installation, Pages 24 and 25 show installation procedure.

13.0 Transformer Secondary

Customer secondary service wires entering the box pad shall be in accordance with the NEC and shall be approved by the wire inspector or AHJ (Authority Having Jurisdiction) of the town or city involved. Maximum size of secondary cable to be physically connected to the *Company's* pad-mounted transformer is 500 kcmil. No more than six secondary services shall be connected at any *Company* supply point. Cables shall be left with five feet of slack coiled inside the pad in order to reach to the secondary connection points on the transformer.

14.0 Transformer Grounding and Bonding

The ground grid shall be number 2, bare, soft drawn, seven strand copper wire. The wire shall be installed 12 inches below finished grade and located around the transformer pad as shown on Page 18. Bond to all exposed metallic conduit and leave three feet of wire above pad for grounding transformer.

Two $\frac{5}{8}$ inch diameter, eight feet long copper weld ground rods and approved connectors shall be installed to 12” below finished grade. Leave the ground rods and grid exposed until inspected by the *Company*. The ground grid is to be complete and backfilled prior to energizing the transformer. Connections to ground grid to be made with compression connectors as shown on Pages 18 and 19. However exothermic welding ("cad weld") shall be an acceptable alternative to a compression connection. Bolted connectors are only acceptable for the ground grid connections to the ground rods. The *Company* shall install the ground taps onto the transformer.

15.0 Spacing of Boxpads, Pullboxes, and Handholes

All communication boxes shall be a minimum of 2’ away from any *Company* boxpad, pullbox or handhole. Also, communication equipment shall not be placed in front of any *Company* equipment.

16.0 Proper Transformer Pad and Conduit Layout

Figure 16.0-1 Preferred Location of Equipment in Easement Area

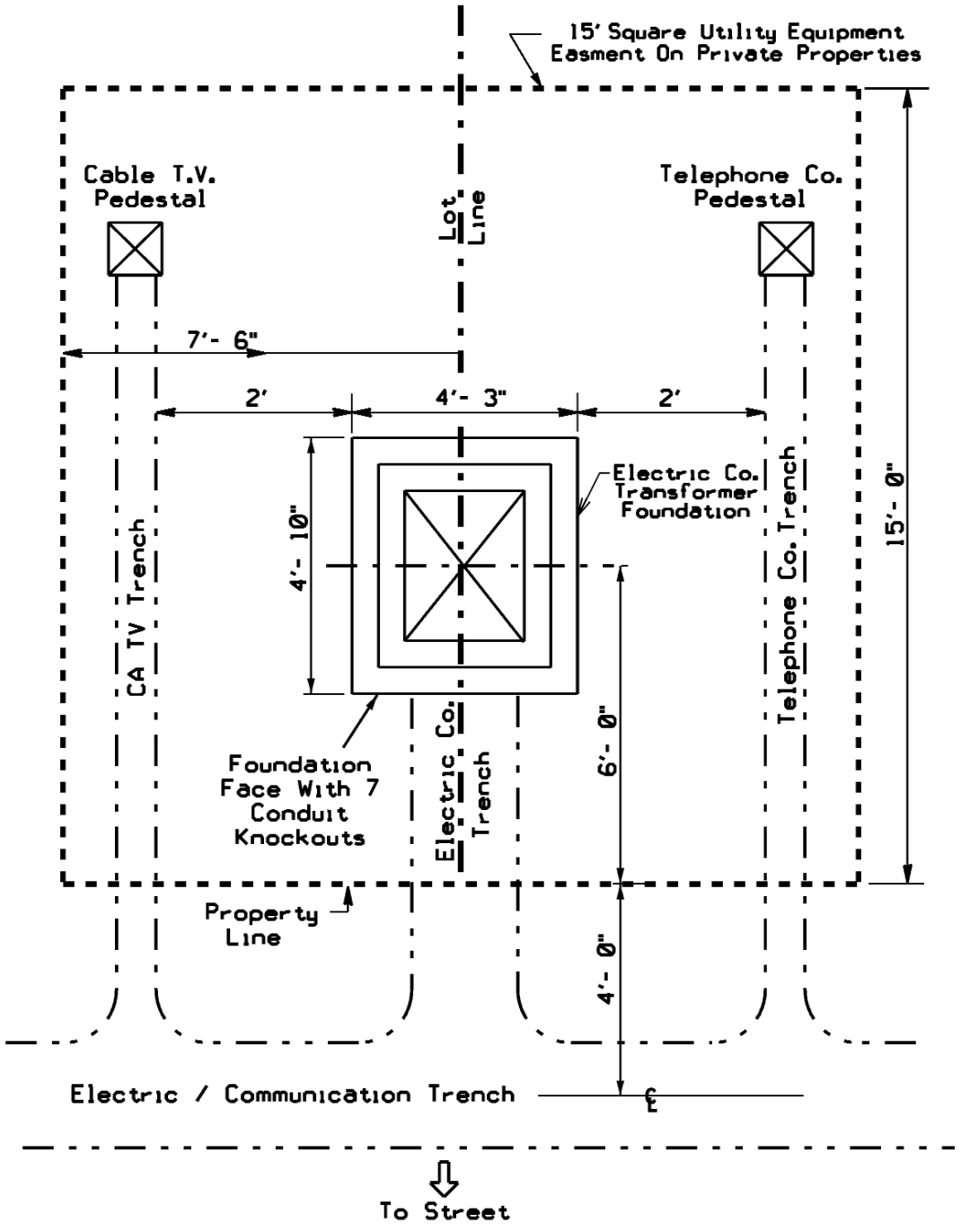
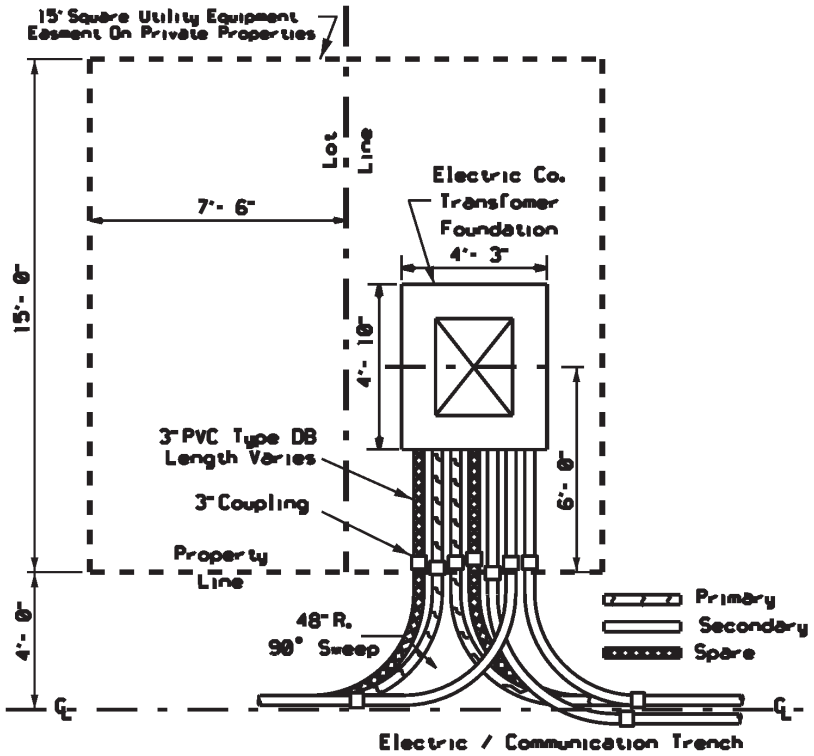
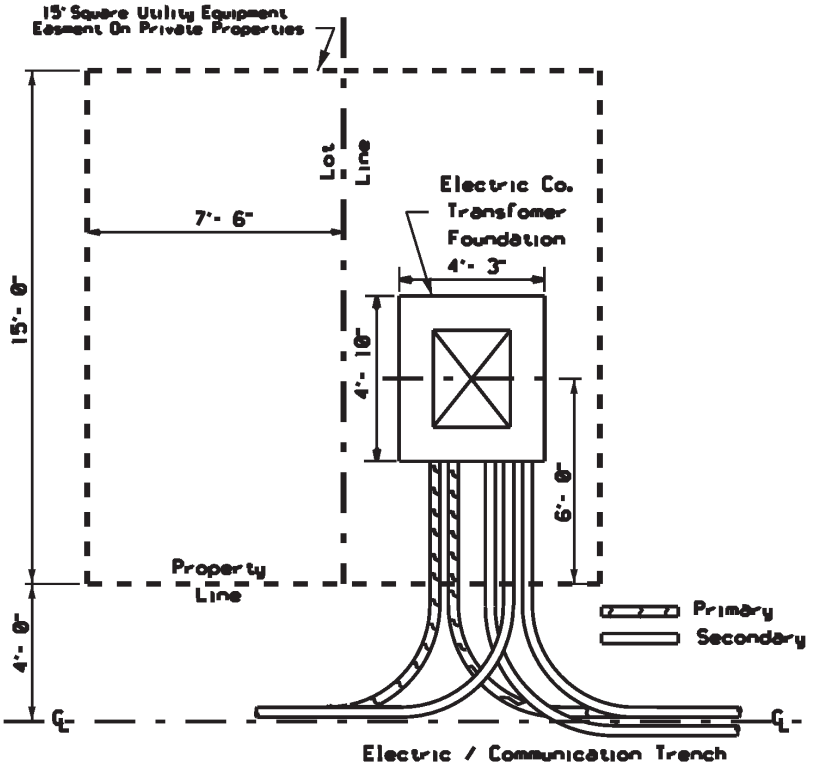


Figure 16.0-2 Single Phase Padmount Transformer — Typical Layout

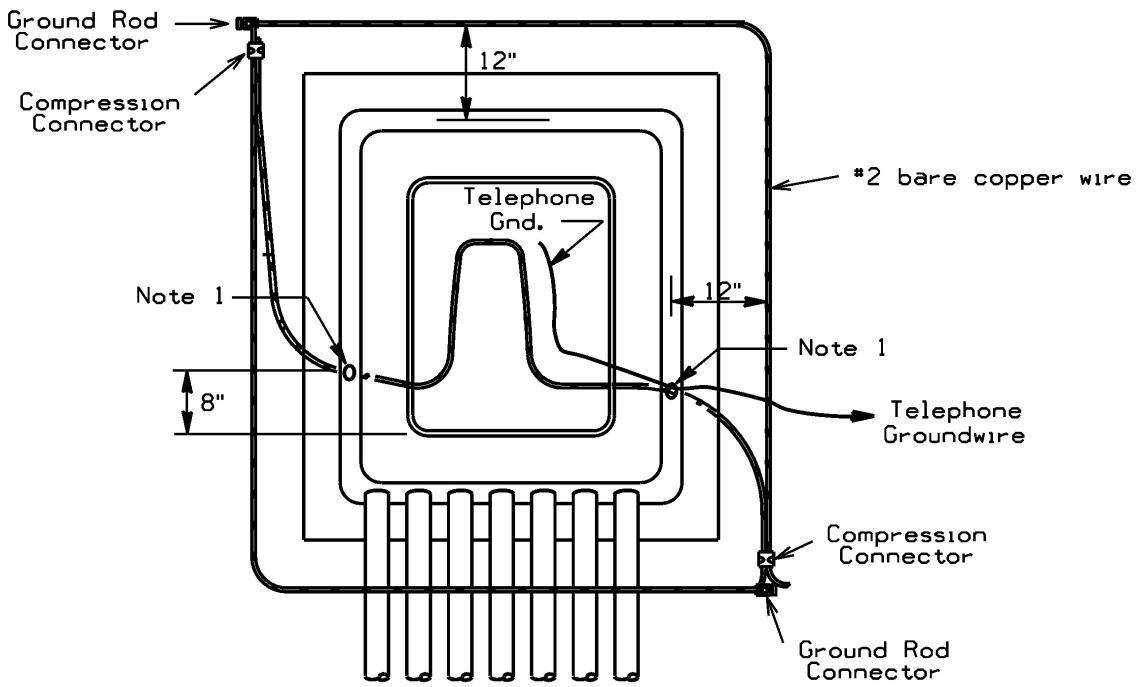


16.0-3 Single Phase Padmount Transformer — Direct Burial Layout



17.0 Transformer Ground Grid Bonding

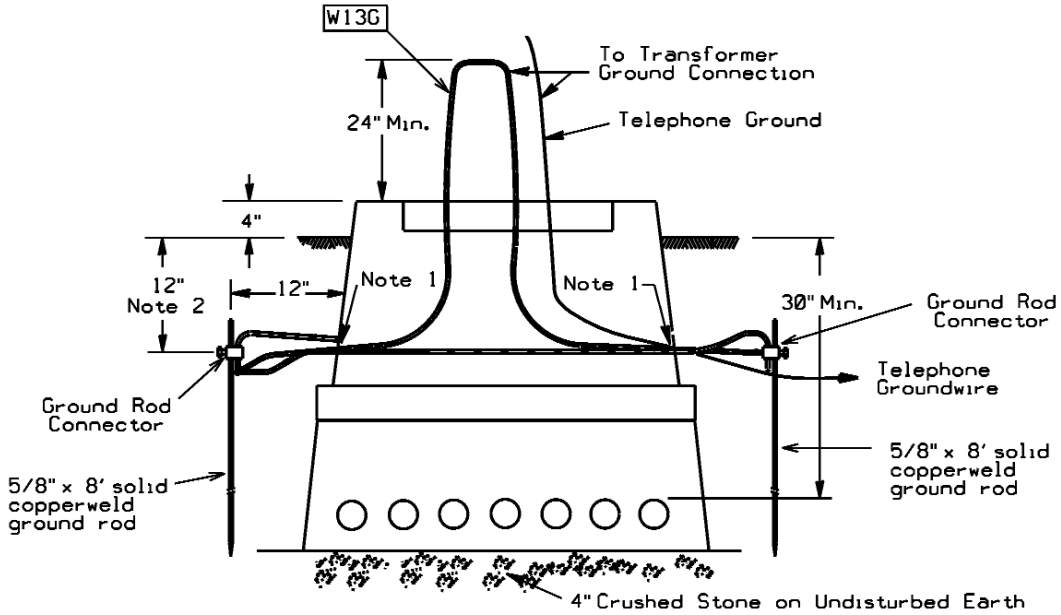
Figure 17.0-1 Single Phase Padmount Transformer Ground Grid



Notes:

1. Drill 5/8 inch diameter holes as shown in sides of foundation if not provided by foundation manufacturer.
2. Ground loop around foundation to be buried 12 inches below finish grade.
3. Although conduit system is shown, direct buried systems shall incorporate the same ground grid.

Figure 17.0-2 Single Phase Padmount Transformer Ground Grid — Front Elevation



Notes:

1. Drill 5/8 inch diameter holes as shown in sides of foundation if not provided by foundation manufacturer.
2. Ground loop around foundation to be buried 12 inches below finish grade.
3. Although conduit system is shown, direct buried systems shall incorporate the same ground grid.

18.0 Proper Transformer Pad and Conduit Installations

18.0-1 Proper Conduit Bank Installation (Pre-Backfill)

18.0-2 Proper Installation of Conduit with Pullbox used for Drainage (Pre-backfil)

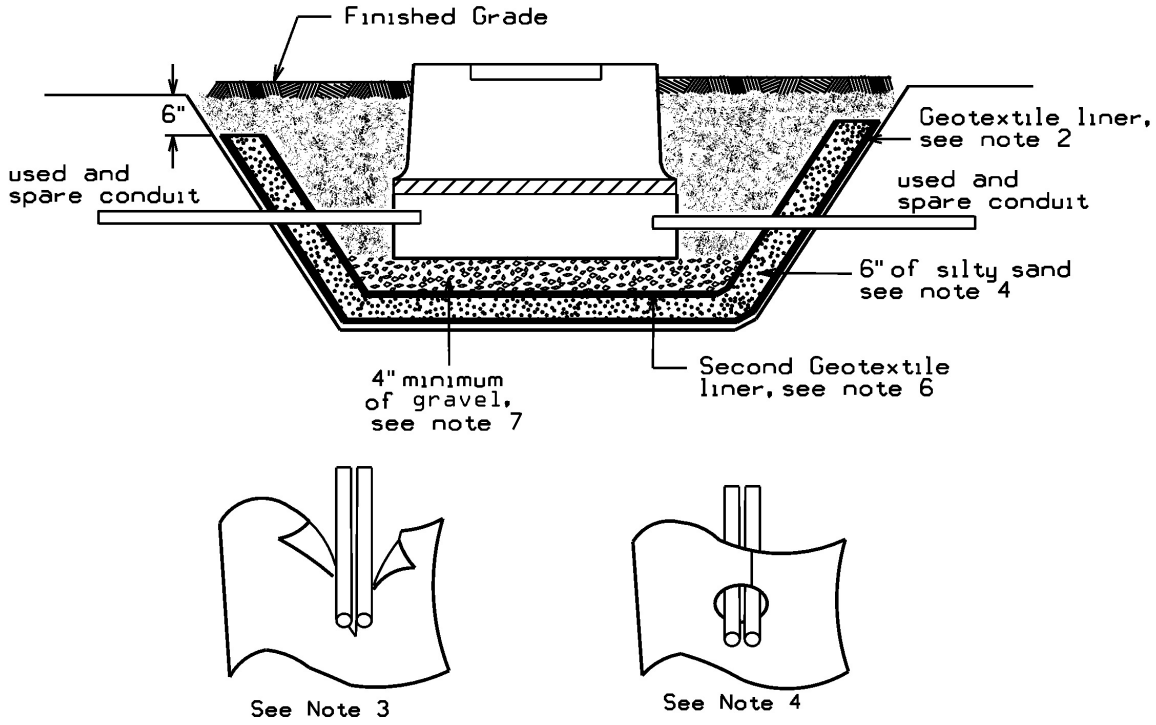
18.0-3 Proper Conduit and Handhole Installation (Pre-backfil)

18.0-4 Properly Completed Transformer Installation (Final Grade)

18.0-5 Properly Completed Handhole Installations (Final Grade)

19.0 Transformer Oil Containment

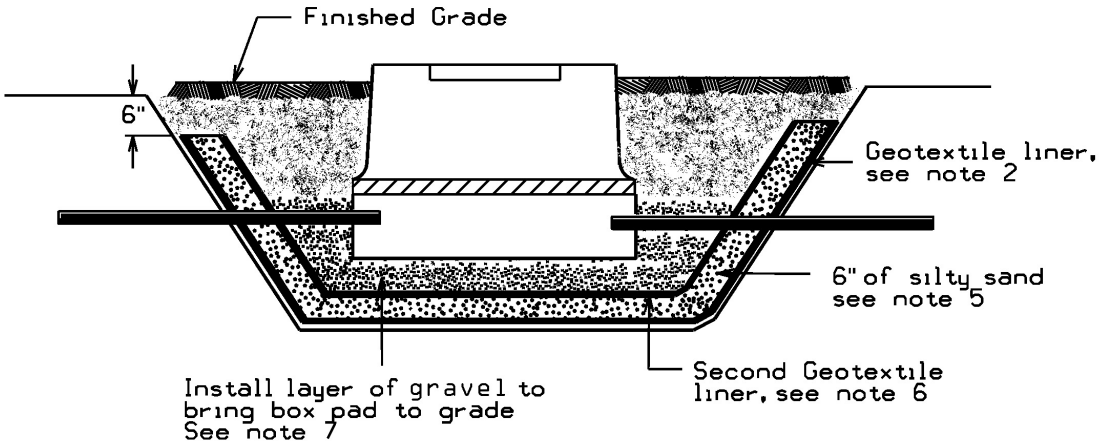
Figure 19.0-1 Single Phase Oil Containment for Cables in Conduit

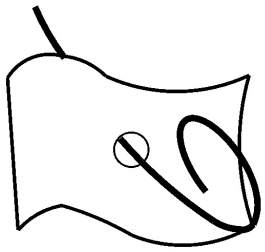


NOTES:

1. Dig out at least an additional foot on bottom and sides for boxpad area and stub conduits out into the pit.
2. Install geotextile liner in pit along the bottom and sides up to 6" from finished grade.
3. Make vertical cuts in liner to accomidate conduits.
4. Overlap the liner flaps around the conduit and seal both liner seam and in between conduits with expanding foam.
5. Fill in area with 6" of compacted silty sand.
6. Install second layer of geotextile liner by repeating steps 2 and 3.
7. Install 4" minimum of gravel base for boxpad to be at propper grade.
8. Set boxpad and make up conduits into it.
9. Install ground grid, and backfill after company inspection.

Figure 19.0-2 Single Phase Oil Containment for Direct Buried Cables





NOTES:

1. Dig out at least an additional foot on bottom and sides for boxpad area and stub conduits out into the pit.
2. Install geotextile liner in pit area to and along the sides to 6" from finished grade.
3. Make small holes in the liner, feed liner through holes into pit.
4. Once cable it pulled, seal the liner around the cable with expanding foam.
5. Fill in area with 6" of compacted silty sand.
6. Install second layer of geotextile liner and cut holes for cables as in note 2.
7. Install layer of gravel for cable routing and bass for boxpad to be at proper grade.
8. Set boxpad, train cables into boxpad and fill on top of cables with sand.
9. Install ground grid, and backfill after company inspection.

Geo-textile Liner
Generic name is: 16 oz. polypropylene geotextile. Also called filter fabric weighing 16 oz./square yard.

Brand names / Suppliers are:

AME1680 available from
American Engineering Fabrics (AEF), Inc.
(Emphasize polypropylene not polyester)
New Bedford, MA
1-617-965-0007 / 1-800-770-2666 or from

Vellano Bros. Lancaster, NY
1-716-684-7222
Several other locations in New York, Massachusetts, Rhode Island and New Hampshire
www.vellano.com

Synthetic Industries ST 160 available from
Spartan Mills Inc
Spartanburg, NC
1-803-576-2353

Carthage Mills FX-160HS
US Construction Fabrics LLC
90 Range Road
Windham, NH 03087
1-603-898-0532

20.0 Riser Pole

The *Company* shall designate conduit riser locations on the pole. All primary risers shall be Galvanized Steel, this includes the 90 degree sweep. Per NESC all steel risers must be bonded 6" from top and the bond must be at least 8' high from finished grade.

The *Customer* is responsible for providing and installing the bond clamps and the tap. The *Company* will make the bond connection from the riser bond tap to the ground system on the pole. Spare riser sweep shall be bonded also. In NewYork direct buried applications, riser sweep shall be concrete encased. Approved materials reference is located on Page 39.

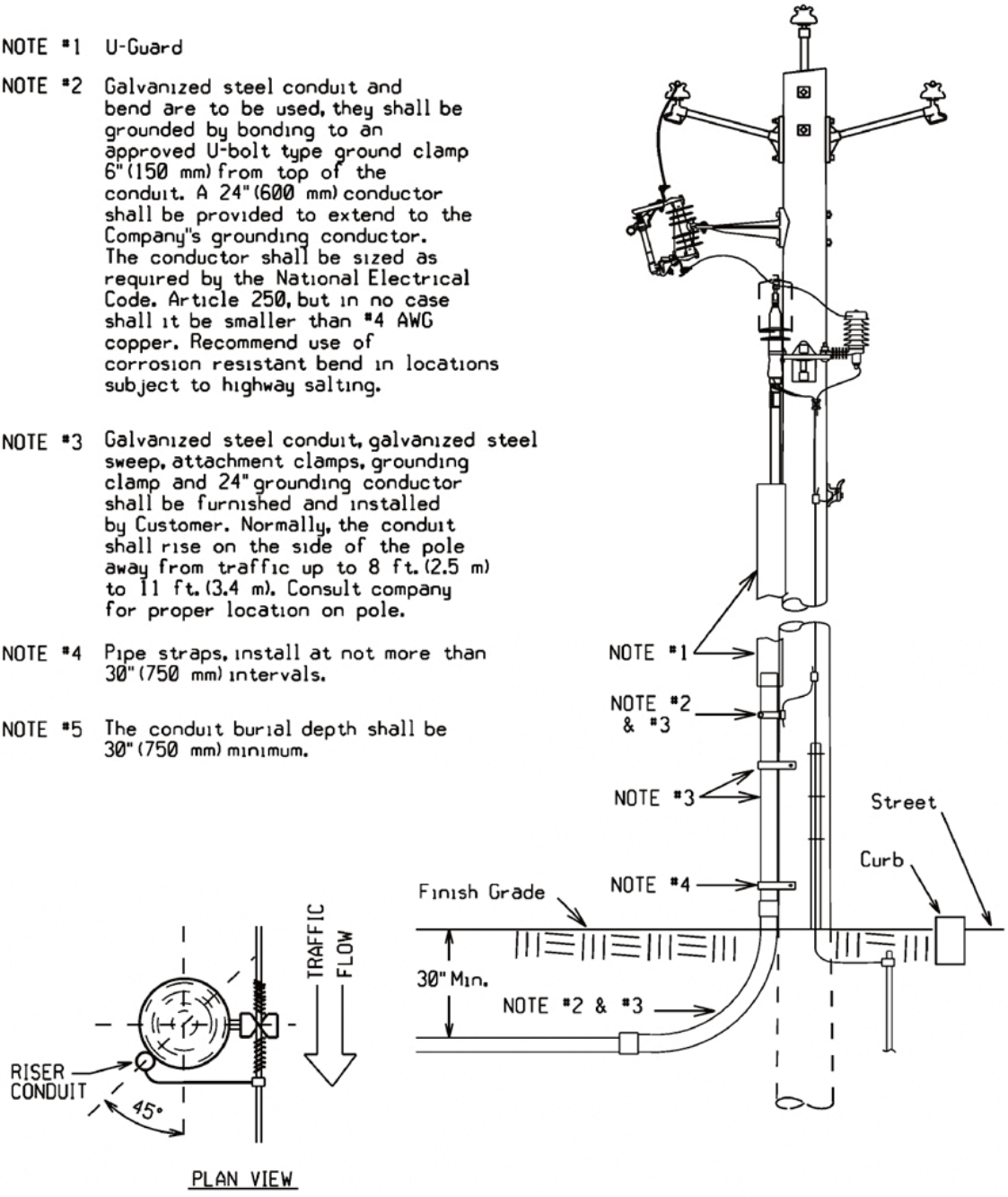
NOTE #1 U-Guard

NOTE #2 Galvanized steel conduit and bend are to be used, they shall be grounded by bonding to an approved U-bolt type ground clamp 6" (150 mm) from top of the conduit. A 24" (600 mm) conductor shall be provided to extend to the Company's grounding conductor. The conductor shall be sized as required by the National Electrical Code. Article 250, but in no case shall it be smaller than #4 AWG copper. Recommend use of corrosion resistant bend in locations subject to highway salting.

NOTE #3 Galvanized steel conduit, galvanized steel sweep, attachment clamps, grounding clamp and 24" grounding conductor shall be furnished and installed by Customer. Normally, the conduit shall rise on the side of the pole away from traffic up to 8 ft. (2.5 m) to 11 ft. (3.4 m). Consult company for proper location on pole.

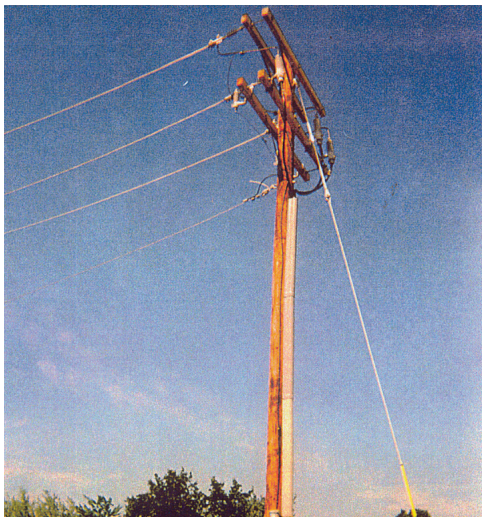
NOTE #4 Pipe straps, install at not more than 30" (750 mm) intervals.

NOTE #5 The conduit burial depth shall be 30" (750 mm) minimum.



Properly Installed Primary Risers

Riser Pole Bonding
Rigid Galvanized Steel. Bond higher than 8' and at least 6" from top.

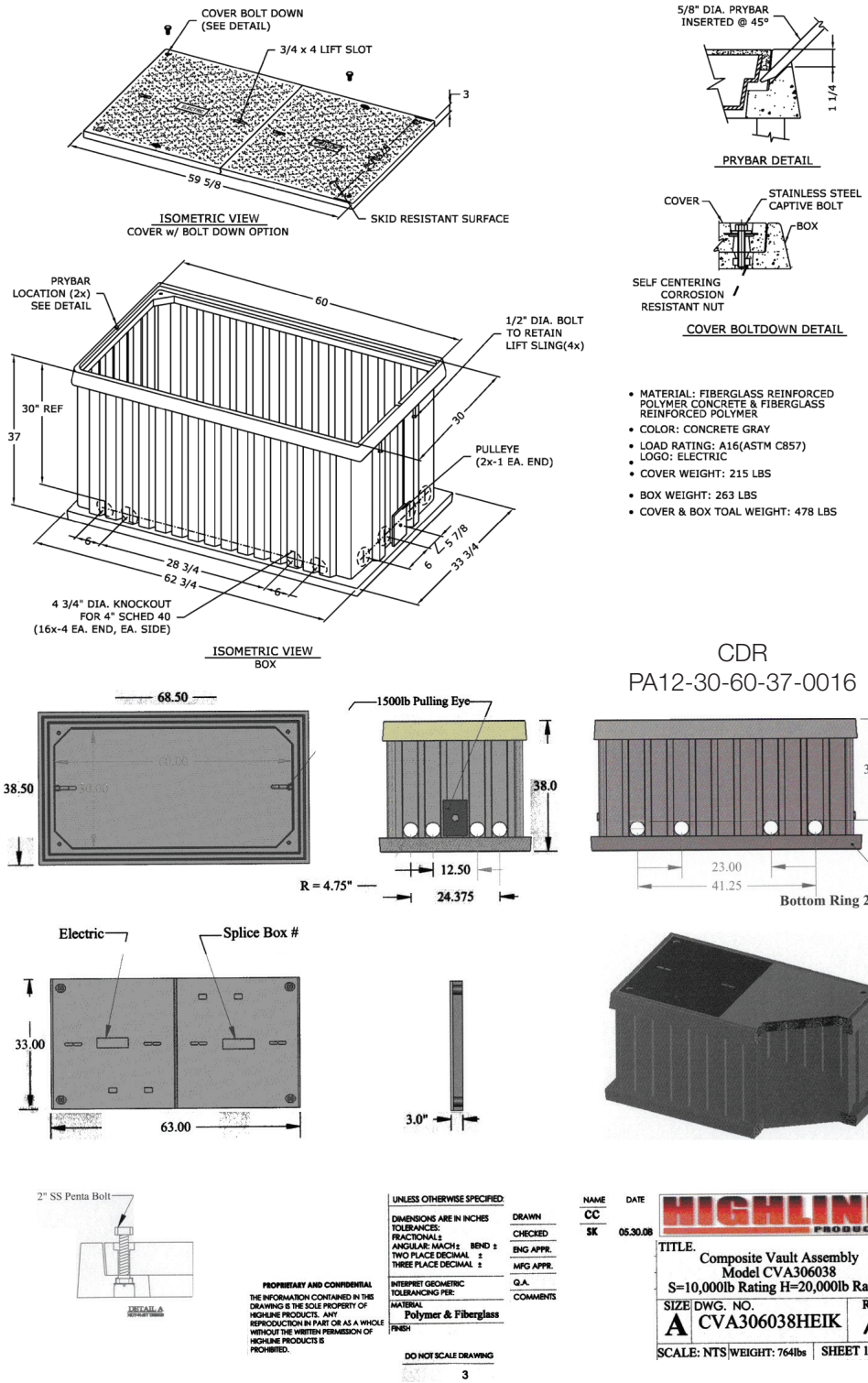


Completed Riser Pole
The Company will specify on which quarter of the pole the riser shall be installed, away from traffic.

Spare Riser Sweep
Spare sweep shall be bonded to down ground and capped at riser pole.

21.0 Primary Cable Pull/Splice Box

This primary conduit equipment may be specified in the design for installation in sidewalks or grass plot areas where duct length or design requires extra pulling locations or splices. The splice box is H20 rated and shall be installed in locations not frequently traveled over by vehicles. Pull/splice boxes are supplied and installed by the *Customer*.



Properly Installed Primary Pullbox

22.0 Trench Requirements

Final grades shall be established, the surface rough graded within 6" of finished grade, and roadway and property boundaries shall be staked or marked by the *Customer* before any trenching is started.

The *Customer* shall adhere to the construction plan and specifications regarding trench locations, trench depth, and concrete encasement. Any deviation shall be subject to approval by the *Company*.

The *Company* shall be notified in advance of the backfilling of any electric facility. The *Company* reserves the right to require re-excavation of the conduits and foundations if the *Customer* fails to have inspection done or backfills before inspection.

For special circumstances that call for concrete encasement, such as crossing a culvert or stream, trenches shall not be backfilled until concrete has set (for at least two hours) and after approval by authorized *Company* personnel. All backfill shall be sand or gravel containing stones less than 1" in any dimension. Backfilling shall not take place over any open-ended (unplugged) conduits. Company approved red "Warning" tape shall be installed directly above the *Company's* cable eight to 12 inches below finished grade. Laying the warning tape directly on the cable, concrete or conduit is not acceptable. Certain installations in the public way may require flowable fill instead in place of normal backfill.

22.1 Trench Depth New York/New England Concrete Encased Conduit

Burial depths for electrical conduit shall be maintained not less than 30" from the top of the concrete encasement to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble, or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (maximum 2" stone). At riser pole, end concrete encasement just before riser sweep.

22.2 Trench Depth Conduit Direct Buried New York (under certain circumstances agreeable with the Company)

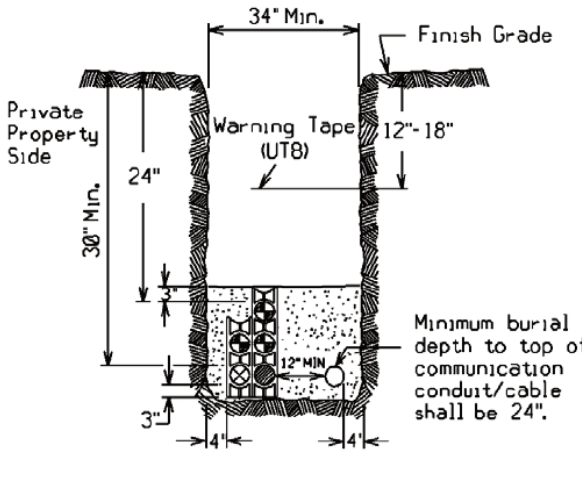
Burial depths for electrical conduit shall be maintained not less than 30" from the top of the conduit to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble, or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (maximum 2" stone).

22.3 Trench Depth Direct Buried New York and Nantucket

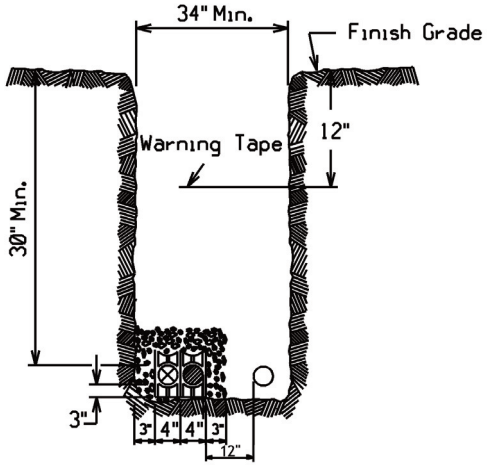
Burial depths for electrical cable shall be maintained not less than 30" to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (maximum 2" stone). Then 2" minimum of sand shall be the base to lay the cable on top of with another 4" minimum of sand to cover cable.

Figure 22.0-1 Typical Trenches

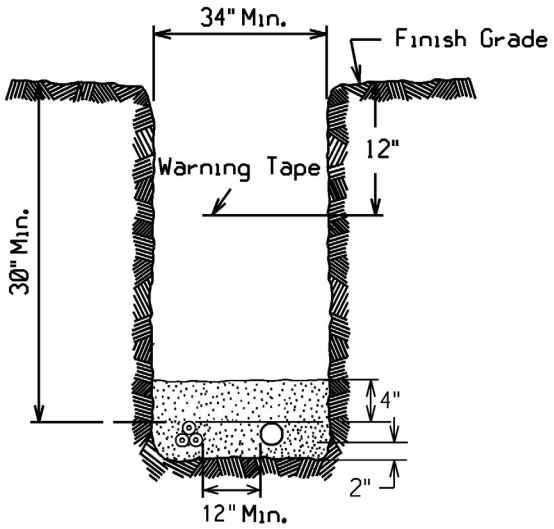
Conduit Trench



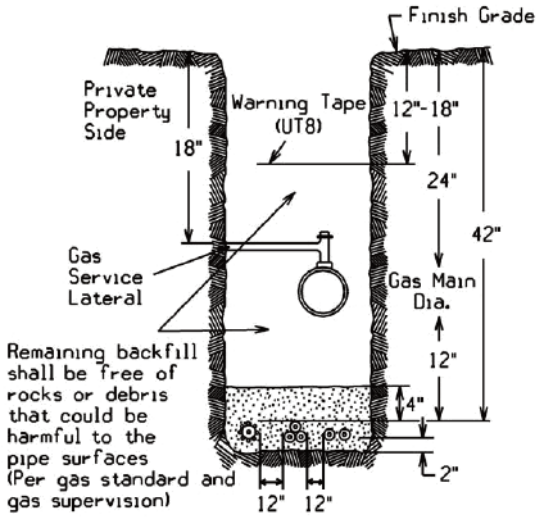
Conduit in Concrete Trench



Direct Burial Trench

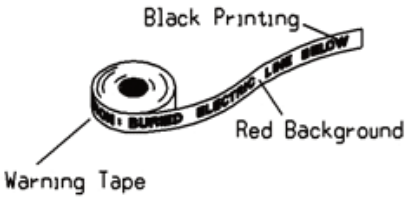


Direct Burial Trench w/National Grid Gas



LEGEND

- Base Spacer
- Intermediate Spacer
- Secondary Electric Duct
- Primary Electric Duct
- Communication Duct or Cable
- Spare Duct
- Nat. Grid Electric Primary Cable
- Nat. Grid Electric secondary and/or Street Light Cable
- Communication Cable
- Sand or Rock-Free Sandy Loam (Clay shall not be acceptable. Site material may be reused if sand or rock free sandy loam.)



23.0 Conduit Requirements

New England:

The *Customer* shall be responsible for all trenching, excavation, backfilling, and installation of the primary duct system. The *Customer* is also responsible to supply and install any necessary pullboxes. Concrete encasement shall be provided and installed by the *Customer* as specified by the *Company* when required.

New York:

New York primarily employs direct buried cable installations. For applications deemed necessary by the *Company* to install conduit, the *Company* shall be responsible for all trenching, excavation, backfilling and installation of the primary duct system. The *Company* is also responsible to supply and install any necessary pullboxes. Exceptions to this are road crossings, culvert crossings, or any cable run requiring concrete encasement. In these situations trenching excavation, backfilling and installation responsibilities will revert back to the *Customer*. Also, in the event of one of these exceptional circumstances, the *Customer* shall adhere to trench inspection guidelines highlighted on Page 11. Once all civil work is deemed satisfactory by the *Company*, the *Company* shall install cable.

23.1 Pulling Tape

All conduits shall have a pulling tape, also known as “Mule Tape.” This tape is to be rated for 2,500 lbs. of tensile strength. Manufacturers of this tape are listed on Page 41.

23.2 New England and when applicable in New York:

The Customer shall ascertain the requirements of the specific municipality in which the development is located. For example, some municipalities may require that the *Customer* employ a licensed electrician to direct the installation of all conduit intended for electric facilities.

Temporary mechanical protection over buried conduit and encasements is recommended to prevent crushing or damage during construction, and is the *Customer’s* responsibility.

All road crossings shall, when practical, be perpendicular to the sidelines of the road.

The minimum conduit size shall be 4” for three phase and 3” for single phase cable installations. All sweeps at foundations and risers shall have a minimum radius of 36 inches. The riser sweep shall be galvanized steel. The *Customer* shall install conduit plugs in all unused conduits and pulling tape. At the riser pole, the galvanized rigid steel sweeps and the PVC/steel adaptors shall not be concrete encased (In contrast, New York Direct buried applications require the sweeps to be encased). The *Customer* shall be responsible to install rigid galvanized steel straight conduit up the pole high enough to meet NESC code referenced on the riser pole requirements on Page 25, including conduit ground straps, up the riser pole (unless directed otherwise by the *Company*). The *Company* will specify on which quarter of the pole the riser shall be installed, usually away from oncoming traffic.

Except as noted on construction prints, curves and bends in conduit shall be gradual, and the radius of curvature shall not be less than 40 feet. All curves shall be formed with five-degree couplings. The minimum length between single, five-degree couplings is 42".

Conduit grade shall be such as to cause all ducts to drain toward one or both equipment foundations or pullboxes. Minimum pitch shall be three inches per 100 feet.

The *Customer* shall insure that clearances are met and maintained, and that they are inspected by the Company. Unless local jurisdictions require greater clearances, the minimum clearances shall be as follows:

23.3 Communication Systems – *Company* conduit shall not be directly above or below communication conduit, except when crossing below communication conduit at approximately right angles. *Company* conduit and communication conduit shall be separated by a minimum of 3" of concrete encasement.

23.4 Non-Company Water, Gas and Sewer – *Company* conduit shall not be directly above or below any of these foreign utilities, except when crossing above these utilities at approximately right angles. Where the paths of these foreign utilities cross under *Company* conduits at approximately right angles, the minimum separation is 12". A minimum separation of 24" shall be maintained between parallel placement of any of these utilities and electrical conduit.

A six-inch clearance shall be between conduit envelopes and major subsurface pipes (e.g. drainage pipes).

The *Customer* shall rod and mandrel all primary conduits to insure their integrity before the *Company* shall attempt to pull any primary cable. The *Customer* shall furnish and install an approved synthetic, 2,500 pound test tape in each primary conduit run including risers. Pulling tape installation and rodding the duct shall be witnessed by the Company.

Company-owned duct shall not share a concrete encasement with foreign utilities (e.g. do not place communication or private electrical duct in the same concrete encasement as Company duct).

At those locations where manholes or above ground switchgear are required, additional specifications will be provided by the *Company*.

24.0 Metering

Refer to the Company's Specification for Electrical Installations book for the type of installation. Division of work and material will be performed with the approval and authorization of the Company's Metering Services department.

25.0 Easement Applications (New England and New York forms)

NEW ENGLAND EASEMENT APPLICATION FORM

FOR NATIONAL GRID'S USE ONLY			
Application for Easements (check one):	❒ OH (jointly owned or solely owned)	❒ UG	❒ Electric
	❒ Padmount transformer only	❒ URD	❒ Gas
Work Request Number_____			
Utility Engineer's Name:_____	Telephone Number: _____		

Please complete **ALL** of the sections below so that we may prepare an easement for your signature. Do not leave any sections unanswered. If a section does not apply to you simply put **"n/a"** on that line. Incorrect or incomplete information will delay service installation.

Property Owner(s): _____

Property Owner Mailing Address	**Property Address of Easement** (if different from mailing address)
Address: _____	Address: _____
City: _____	City: _____
State & County _____	State & County _____
Zip _____	Zip _____

Customer Contact Person: _____

Daytime Phone(s): _____

Re: Subdivision Title: _____

1. Provide us with a **RECORDED** copy of the present owner's deed, Book_____ Page_____

   a) If multiple deeds make up the whole parcel, please include all deeds.

   b) If the Property Owner is a b1) CORPORATION, b2) TRUST, b3) PARTNERSHIP, or b4) LIMITED LIABILITY COMPANY, provide the following which is applicable:

   b1) President Name: _____ Treasurer Name: _____
   See Footnote[1] Below

   Or

   Vice President:_____ Asst. Treasurer:_____

[1] If neither "Name Combinations" is available, the person(s) signing the easement must have a Corporate vote authorizing them to sign on behalf of the Corporation.

b2) Trust: No. Of Trustees:_____Name(s): _____

Name of Trust:_____

b3) Partnership: Number of Partners:_____Name(s):_____

b4) LLC: Authorization to Sign, Name(s):_____

2. a) Provide us with an approved: "Definitive Subdivision Plan"

Plan Book:_____ Plan:_____ Dated:_____

b) If there is no recorded subdivision plan please include the following information:

Assessor's Map:_____Block:_____ and Lot:_____

3. Is your property mortgaged (circle one)? YES NO

If "YES", please complete this section:

a) Name of Bank/Company/Person holding mortgage(s):_____

b) Address of mortgage holder(s): _____

c) Date and recording information of mortgage(s): _____

Date:_____County Recorded:_____Book:_____Page:_____

Additional Comments: _____

Please contact your Account Manager or Service Administrator if you have any questions regarding this form.

NEW YORK EASEMENT APPLICATION FORM

Application For Utility Electric/Gas Distribution Easement

This Portion to be Completed by National Grid Representative
Application Date Received:_____
Type of Easement: ❒ OH (jointly owned or solely owned) ❒ UG Electric ❒ Gas ❒ Padmount transformer only ❒ URD
National Grid Representative_____ **Telephone**_____

Requestor of Service

Please complete **ALL** of the sections below so that we may prepare an easement for your signature. Do not leave any sections unanswered. If a section does not apply to you, simply put "n/a" on that line. (Incorrect or incomplete information will delay service installation.)

Property Owner(s): _____

Property Owner Mailing Address

Address: _____

City/Town: _____

State: _____

Zip Code: _____

Telephone: _____

Property Address of Easement
(if different from mailing address)

Address: _____

City/Town: _____

State & Country: _____

Zip Code: _____

Name of Subdivision: _____

Telephone: _____

Contact Person: _____

Daytime telephone(s): _____

1. Provide us with a **RECORDED** copy of the present owner's deed (and survey) if available. If multiple deeds make up whole parcel, please include all deeds.

   Book: _____ **Page:**_____

2. Tax map number of property where service is to be installed (SBL): _____

3. Recording reference to approved subdivision plan:

   Plan Book: _____**Plan:** _____ **Date:** _____

4. If the property owner is a (a) CORPORATION, (b) TRUST, (c) PARTNERSHIP, or (d) LIMITED LIABILITY COMPANY, provide the following which is applicable:

(a) CORPORATION NAME: _____

President:_____Treasurer:_____

Vice President: _____Assit. Treasurer: _____

(If none of the Officers listed above are available, the person(s) signing the easement must have a corporate vote authorizing them to sign on behalf of the Corporation.)

(b) TRUST NAME:_____

Number of Trustees:_____Names: _____

_____

(c) PARTNERSHIP NAME: _____

Number of Partners:_____Name(s):_____

(d) LIMITED LIABILITY COMPANY (LLC) NAME: _____

Authorization to sign – Name(s):_____

Note: As a public utility, National Grid is required to provide electric/gas service; however, you, the customer, are required to provide National Grid with all the easement rights necessary to install your electric/gas service, including any easement rights which must be acquired from others.

Please return or fax this document and the requested information to:

{National Grid Representative}

{Company name}

{Location: Street name}

{Location: City/Town, State, Zip Code}

{Fax number}

26.0 Approved Material – Underground Residential Installations

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
		Conduit—Straight		
2010404	Conduit, 4", PVC	Carlon: 48815	IPEX: 8741	Cantex: A79EA42
2011024	Conduit, Galvanized, 4"	By Description		
5692158	Conduit, 3", PVC	Carlon: 48815	IPEX: 08731	AMERICAN PIPE TC7215752
5692107	Conduit, Galvanized, 3"	BAYNEJONES 300R		
		Conduit—Blends		
5690446	Bend, Galvanized, 4" 36”	BaynesJones 400R9036	Conditmfg TUB490D36RGA LEL	
5690493	Bend, PVC Sch 40, 4", 90 Degree, 36" Rad.	Carlon: UA9FNB	Cantex: 5233842	
5690436	Bend, Galvanized, 3" 36”	BaynesJones 400R9036	Conditmfg TUB490D36RGA LEL	
5690419	Bend, PVC DB, 3", 90 Degree, 36" Rad.	Carlon: PF9FL	Cantex: 5123872	Certisaft 59734
		Spacers		
5646963	Spacer, 4", Base	GS Industries: 186-1	IPEX: 29573	
5646960	Spacer, 4", Inter.	GS Industries: 185-1	IPEX: 29557	
5646958	Spacer, 3", Base	GS Industries: 157-1	IPEX: 29569	
5646956	Spacer, 3", Inter.	GS Industries: 156-1	IPEX: 29553	

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
		Conduit Accessories		
5641210	Riser Strap, 4"	Electrical Materials: 50-4 USHD	BaynesJones MINRLAC HD-296	
5641205	Riser Strap, 3"	Electrical Materials: 50-3 USHD	BaynesJones MINRLAC HD-294	
7011830	Lag Screw, 1/4" x 2"	Elect. Materials: 106 or 106M	Joslyn J26486.1	PLH LSNW-142
3503074	Pipe Grd. Connector, 4" and 5"	T & B: (0)3905-BU	Burndy GAR3905-BU	
3503075	Pipe Grd. Connector, 2.5" and 3.5"	T & B: (O)3904-BU	Burndy: GAR3904-BU	
2010424	Duct Plug, 4" DB	Carlon: P258NT	GAR3905-BU	
5645682	Duct Plug, 3" DB	CANTEX : 5315260	CARLON: P258L	CERTIFSAFT: 59653
2011254	Duct Plug Galvanized 4”	Crousehind PLG105		
9201659	Duct Plug Galvanized 3”			
2010434	Adapter, Female, PVC-Steel, 4"	Carlon: E942N	Cantex: 5140052	Scepter FA55
2010433	Adapter, Female, PVC-Steel, 3"	Carlon: E942N	OZGEDNEY: PLG-300C	
5693359	Coupling, 5 Degree, Bell-Spigot, 4"	Carlon: E244N	Cantex: 6151452	Certisaft 59544
5693356	Coupling, 5 Degree, Bell-Spigot, 3"	Cantex: 6151450	Carlon: E244L	
2010444	Coupling, 5 Degree, Bell-Bell, 4"	Ameripipe: FT518	Carlon E2440NF	Scepter 7604360040

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
5100696	Coupling, 5 Degree, Bell-Bell, 3"	Ameripipe: NS141	Carlon 6151458	
2010454	Straight Coupling, 4", EB/DB	Carlon: E240N	Cantex: 6151450	
2010453	Straight Coupling, 3", EB/DB	Cantex: 6151450	CARLON : E2544L	

Grounding Accessories

961285	Grounding Bushing, 4" and 5"	Burndy GAR3905-BU	T&B: (0)3905-BU	
3500313	Grounding Rod 5/8' x 8' Solid Copperweld	Galvin 6258	ERITECH 615880	Joslyn: J8338
4015032	#2 AWG, 7 strand, soft drawn	South Wire - By description		
3503328	Ground Rod Clamp	Burndy: GRC58	Blackburn: JAB58H	Electromotion EM58DBW
5960412	"C" Connector, 2/0 – 2/0	Burndy: YC26C26TN		

Primary Pullbox Secondary Handoles

5640808	Primary Pull/Splice Box	CDRSYSTEM: PA12-3060-37	Highline: CVA306038HEIK	
5643082	Handhole (NE, for conduit)	Highline: PA10-1730-30-0319	Highline: CHA173030SE1-NG	NORDICFIB: GS-37-23-30-NEPS
5430126	Handhole (Nantucket, square conduit)	CDRSYSTEM: CCE-0101PA10-1730-30	BAYNEJONES: PA10-1730-24	
0810695	Handhole 13"x22.5 (direct buried NY)	PENCELL: PE-20HD-2X	CARSON: 1324-153HGE20AVO	Highline: 1324-15 P2P
0810696	2" extension ring for item #0810696	Carson: 1324PR-100		
5643077	Handhole 17x30 (direct buried NY)	Pencell: PE-30-HDX-GREEN	CARSON: 1730-DP2P	Fargo: B-138AG

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
		Other Materials		
	Secondary Connections	Burndy	Richards	
	Pulling Tape	Arnco: DLWP25	Condux: 08096303	Neptco: WP2500P

27.0 Job Checklists

URD CONDUIT INSPECTION CHECKLIST

Do not back fill BEFORE conduit system inspection and approval by the Company have been obtained. Every item below must be inspected and checked off by the Company representative. Any item found unacceptable must be initialed and rectified by Customer by next inspection.

N*	Y*	
		PRE-TRENCH
❒	❒	Final Grade established
❒	❒	Surface rough graded
❒	❒	Roadways staked
		TRENCH
❒	❒	Minimum 30” depth from finishing grade to top of primary conduit
❒	❒	Minimum 24” depth from finishing grade to top of secondary conduit
❒	❒	Minimum 12”separation between Electric conduits and Telecommunications conduits
❒	❒	Min, 24” separation between Electric conduits and water, sewer or gas if placing parallel
❒	❒	Minimum 12” separation between Electric conduits and water, sewer or gas if placing perpendicular
❒	❒	Conduit plugs installed
❒	❒	Plastic spacers properly installed no more than every 8’ and at every junction point
❒	❒	4” screened backfill (with less than 1” stones) on-site for backfilling entire trench, (inspector may witness backfilling)
❒	❒	Warning tape installed 12” below finish grade and directly above electrical conduit system
❒	❒	All curves properly formed with five degree couplings
❒	❒	No parallel utilities directly above electrical system
		Secondary Handhole
❒	❒	4” crushed stone under handhole
❒	❒	Handhole covers installed and properly secured with pentahead bolts
❒	❒	Top surface flush with final grade
❒	❒	Conduit plugs installed from the outside in all unused conduit knockouts
❒	❒	No more than 3” of extended PVC into handhole
		Transformer Foundation
❒	❒	4”of crushed stone under transformer foundation
❒	❒	Top surface 4” above final grade
❒	❒	No more than 3” extended PVC through foundation
❒	❒	Pulling eyes properly installed in front and back of box pad (ring part on the inside)
❒	❒	Conduit plugs installed from the outside in all unused conduit knockouts
❒	❒	Two ground rods installed at opposite corners of foundation – exposed for inspection
❒	❒	Ground grid buried 12" below finish grade and placed 12" away from edge of boxpad
❒	❒	Loop ground grid around and into foundation through two sides of foundation
❒	❒	Correct orientation to road and lot lines
❒	❒	All non-Company owned pedestals are a minimum of 2’ away from all sides
		Pullbox
❒	❒	4” or crushed stone under pullbox foundation
❒	❒	Pullbox covers installed and properly secured with pentahead bolts
❒	❒	Top surface flush with final grade
❒	❒	No more than 3” extended PVC into pullbox
❒	❒	Conduit plugs installed from the outside in all unused conduit knockouts
❒	❒	All non-Company owned pedestals are a minimum of 2’ away from all sides
		RISER POLE
❒	❒	90° bend and 10’ straight riser pipe galvanized steel conduit. (3” for single Phase, 4” for three phase)
❒	❒	Steel-PVC adapter and steel sweep shall not be encased in concrete
❒	❒	Ground clamp installed with tap
❒	❒	Install 2500 lb. Pulling Tape in all conduit after rodding with mandrell

**NOTE Y – Acceptable N – Deficient*

URD DIRECT BURIED INSPECTION CHECKLIST

Do not back fill BEFORE direct buried cable system inspection and approval by the Company have been obtained. Every item below must be inspected and checked off by the Company representative. Any item found unacceptable must be initialed and rectified by Customer by next inspection.

N*	Y*	
		PRE-TRENCH
❒	❒	Final Grade established
❒	❒	Surface rough graded
❒	❒	Roadways staked
		TRENCH
❒	❒	Minimum 30” depth from finishing grade to top of cable during all phases of construction
❒	❒	Minimum 24” depth from finishing grade to top of secondary cable
❒	❒	Electric infrastructure on “road” side in all multi-utility trench installations
❒	❒	All road crossings perpendicular
❒	❒	2” minimum of sand in base of trench
❒	❒	All trench spoils shall be stored on field side of exposed trench
		PRE-BACKFILL (After cable is installed)
❒	❒	4” of sand minimum on top of cable
❒	❒	Minimum 12”separation between Electric cable and Telecommunications cable/conduits
❒	❒	Minimum 24” separation between Electric cables and water, sewer or gas if placing parallel
❒	❒	Minimum 12” separation between Electric cables and water, sewer or gas if placing perpendicular
❒	❒	Sand or screened backfill (with less than 1” stones) on-site for backfilling entire trench, (inspector may witness backfilling)
❒	❒	Warning tape installed 12” below finish grade and directly above electrical system
❒	❒	No parallel foreign utilities directly above electrical system
		Transformer Foundation
❒	❒	4”of crushed stone under transformer foundation
❒	❒	Top surface 4” above final grade
❒	❒	Two ground rods installed at opposite corners of foundation – exposed for inspection
❒	❒	Ground grid buried 12" below finish grade and placed 12" away from edge of boxpad
❒	❒	Loop ground grid around and into foundation thru 2 sides of foundation
❒	❒	Correct orientation to road and lot lines
		RISER POLE
❒	❒	90° bend and 10’ straight riser pipe galvanized steel conduit. (3” for single Phase, 4” for three phase)
❒	❒	Steel-PVC adapter and steel sweep shall not be encased in concrete
❒	❒	Ground clamp installed with tap
❒	❒	Install 2500 lb. Pulling Tape in all conduit after rodding with mandrell

**NOTE Y – Acceptable N – Deficient*

28.0 Revision History

Version	Date	Description of Revision
1.0	07/19/10	New document superseding all previous versions of ESB 759.

National Grid is an international energy delivery company. In the U.S., National Grid delivers electricity to approximately 3.3 million customers in Massachusetts, New Hampshire, New York and Rhode Island, and manages the electricity network on Long Island under an agreement with the Long Island Power Authority (LIPA). It is the largest distributor of natural gas in the northeastern U.S., serving approximately 3.4 million customers in Massachusetts, New Hampshire, New York and Rhode Island. National Grid also owns over 4,000 megawatts of contracted electricity generation that provides power to over one million LIPA customers.

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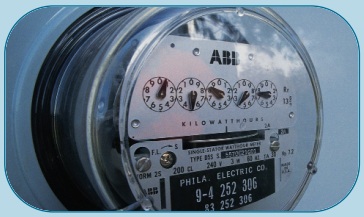
Supplement to

Specifications for Electrical Installations

Underground Commercial Distribution (UCD) Installation and Responsibility Guide

Electric System Bulletin No. 759B
July 2010
(Supersedes all previous versions of ESB 759)



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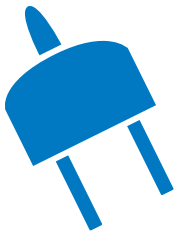


For the latest authorized version, please refer to the company's website at **http://www.nationalgridus.com/electricalspecifications**.

TABLE OF CONTENTS

URD Specifications and Installation Guide Acknowledgement (Job Spec/Signoff Forms)

The requirements and specifications outlined in this guide book must be strictly followed. Any requirements not adhered to can pose safety problems, can be detrimental to the installed system and must be corrected before final acceptance. The customer will bear full cost to make corrections to sub-standard installations.

Customer is responsible to provide enough lead time for the company to design job, provide inspections and install company equipment where applicable.

Typical lead times are shown below.

	Lead-Time	Notes
Design and Layout	Eight weeks	Company receives all required plans, load data and easement information
Pad Inspection NE	One day	Company inspector
Trench Inspection	3 days	Company inspector
Company Installation	4 weeks	After all inspections are approved and permits/easements are procured.
NOTE: The above times are estimates only.		

Project Title_____

Location_____

Owner/Developer_____

Customer's Representative _____ Date_____

Company Representative_____ Date_____

Specifications Issued_____ Date_____

Company's Copy

UCD Specifications and Installation Guide Acknowledgement

The requirements and specifications outlined in this guide book must be strictly followed. Any requirements not adhered to can pose safety problems, can be detrimental to the installed system and must be corrected before final acceptance. The customer will bear full cost to make corrections to sub-standard installations.

Customer is responsible to provide enough lead time for the company to design job, provide inspections and install company equipment where applicable.

Typical lead times are shown below Design and Layout.

	Lead-Time	**Notes**
Design and Layout	Eight weeks	Company receives all required plans, load data, and easement information
Pad Inspection NE	One day	Company inspector
Trench Inspection	Three days	Company inspector
Company Installation)	4 weeks	After all inspections are approved and permits/easements are procured.
NOTE: The above times are estimates only.		

Project Title_____

Location_____

Owner/Developer_____

Customer's Representative _____ Date_____

Company Representative_____ Date_____

Specifications Issued_____ Date_____

Customer's Copy

4 For the latest authorized version, please refer to the company's website at **http://www.nationalgridus.com/electricalspecifications**.

1.0 Scope

The purpose of this specification is to define, interpret and clarify the scope of work and material dealing with services to padmounted transformers and is a Supplement to Electric SYstem Bulletin (ESB) 750). This specification does not cover any primary metering.

It is important that the Specifications for Electrical Installations book (ESB 750) be obtained and referred to in conjunction with this supplement for these installations. Any reference in this specification to the Company shall mean the nationalgrid Company. Any reference to the Customer shall mean the Contractor, Developer or property owner.

2.0 General Requirements

All electrical wiring to be connected to the *Company* equipment shall be installed in accordance with one or all of the following:

- Local Municipal Inspection Authority
- State's Electrical Code
- National Electrical Code
- National Electrical Safety Code
- Applicable Distribution Construction Standards of the *Company*
- National Grid's Specifications for Electrical Installations

There shall be no attempt to deviate from either the Distribution Standards of the company or the *Company* construction plan without the approval of the *Company*. Any specifications noted shall supersede the Specifications for Electrical Installations booklet unless otherwise approved by the *Company*.

Often a pre-construction meeting is helpful to all parties to ensure timely completion of the project. The *Company* Business Service Representative will make the necessary arrangements for a pre-construction meeting, or a meeting to discuss changes. *Company* representatives will be available to discuss construction problems when requested or during a field visit

References:

- ESB 750 - Specifications for Electrical Installations
- ESB 754 - Outdoor Padmounted or Vault Enclosed Three Phase Transformer

All ESB's are available at **http://www.nationalgridus.com/electricalspecifications**

The Customer shall be responsible to have all electrical and physical design documents prepared and updated by a design professional, in accordance with Section 1.7 of ESB 750 for the trenching, conduit, transformer pad, and handhole installations.

3.0 Type of Service

Electric service shall be three phase, four wire, 208Y/120 volts or 480Y/277 volt supplied from a padmount transformer to be located on the Customer's premises. The primary electrical service to the padmounted transformer will be supplied from a pole or cable system owned by the Company, except in New Hampshire. In New Hampshire, the primary service to the transformer shall be customer owned.

4.0 Plans

When municipal approval is required, the *Company* shall receive final town approved development plans on a scale not less than one-inch equal to one hundred feet prior to engineering construction plans. The property site plan shall show all proposed and existing utilities, i.e. water, gas, sewer, cable television, telephone, etc.

Direct Burial Systems in general: the *Company* specifies an arrangement whereby the *Company's* power cables may run parallel with communication and other power cables, but not parallel with other utilities e.g. water, gas, sewer. These utilities shall be in a separate trench. The other utilities must maintain clearances as outlined in the NESC or by mutual agreement. Nationalgrid gas is permitted in the same trench with the following requirements: gas shall be at a minimum depth of 18" and shall maintain a minimum separation of 12" between all other utilities.

Conduit Systems in general: the *Company* requires a spare conduit for all *Company* owned duct systems, as shown in *Company* plans. The *Company* duct system when required must be in **a separate concrete envelope from all other utilities**. Other utilities must maintain clearances as outlined in the NESC.

5.0 Permits

In general, all applicable permits necessary to trench and excavate, including street openings and wetland permits, shall be obtained by the *Customer* and made available upon request if necessary. The *Customer* shall be responsible for including these padmount and conduit/trench specifications with the wetlands application for developments located in or near wetlands. A copy of the wetlands permit may be requested by the *Company* prior to acceptance of the conduit/trench system by the *Company*.

The excavator doing the excavation shall obtain the required DIGSAFE permits before any excavation may take place in a public way. The *Customer/Company* doing the excavation is urged to obtain copies of the applicable statute and become familiar with its requirements. Similarly, the Customer/ Company shall determine if the municipality in which the excavation is to be done requires that water, sewer or other utility, municipal or private, be contacted separately.

The *Customer* shall certify to the *Company* that areas in which the *Company* is to perform installation or maintenance work is free of preexisting contamination by hazardous wastes or materials and to indemnify the *Company* for any claims, costs, expensed, suits, demands, citations, fines or damages of any kind arising from the presence of any such contamination.

6.0 Easements

As a condition of service, the Applicant or *Customer* must provide the *Company* with an easement(s), properly executed by all owners of record drafted by the *Company*, for all Company owned facilities located on private property (to include User or Private Roads (NY) and Private Ways (MA, NH, RI)), whether or not such private property is owned by the *Customer*. The Applicant or *Customer* will provide such easement(s) prior to the start of the *Company's* construction and at no cost to the *Company*. The Applicant or *Customer* shall provide a copy of its mortgage and deed, together with a copy of the survey and/or plan of record, for the Company's use in preparation of the easement(s) as well as any other documents necessary for the Company to prepare such easement(s).

Rights-of-Way, Easements

In UCD, URD, or multiple occupancy building applications, the Customer shall provide the Company with two copies of the approved development map, certified as final by a design professional or licensed land surveyor, which the plan shall have been recorded or filed with the Registry of Deeds. The map shall indicate lot lines, building setback lines, grade lines, sidewalk, roadway, sewer, water, drainage, and

other facilities. The map shall also include the identification and, where appropriate, delineation of sensitive environmental resources including, but not limited to, wetlands, streams, archaeologically sensitive areas, and hazardous waste disposal areas, etc. In addition to this base information, this map shall clearly indicate the easement strips dedicated to the Company and the location of the lots (units) for which electric service is requested. The governmental authority having control over land use shall approve this map. In addition, when electronic maps are used, the Customer must consult the Company for submittal.

Rights-of-way and easements must be cleared of any obstructions at no charge to the Company. The applicant shall grade the right-of-way or easement to within six inches (150 mm) of final grade before the Company commences construction. The applicant must maintain the Company's clearance and grading requirements.

Easement application forms are located on pages 49 and 51.

7.0 Responsibility and Ownership

The division of ownership and responsibility shall be as outlined below by state. Typical installation specifications to reflect installation practices are shown in the back of this guide.

Massachusetts and Rhode Island

The *Company* will:

Supply, install, own and maintain:

primary cable, CT and PT's, Transformer and Meter.

*Note: *company* will not install CT's in CT cabinet.

Check the final torque connections to the transformer's secondary bushings.

Own and maintain:

Primary conduit system (installed by *Customer*).

Secondary cable installed by the customer from transformer to secondary splice box, where required.

The *Customer* will:

Install, own and maintain:

transformer pad, reinforcement and grounding, oil containment where required by the *Company* or local authority, transformer mechanical protection, secondary equipment (including a secondary splice box if required), connect secondary connectors for the transformer, self contained meter box where required by the *Company*.

Supply and install to *Company's* specification:

all primary conduits including concrete encasement, steel riser including 90 degree sweep and bonding clamp with tap, secondary cable from transformer to splice box if required. make up secondary cable ends, including final toque of the secondary cable to the transformer.

Note: The *Customer* will be held accountable for any transformer damage occurring due to improper secondary installation.

New Hampshire

The *Company* will:

Supply, install, own and maintain:

Transformer

CT and PT's and

Meter

* Note: *company* will not install CT's in CT cabinet.

Check the final torque connections to the transformer's secondary bushings.

Own and maintain:

Secondary cable installed by the *customer* from transformer to splice box where required.

The *Customer* will:

Install, own and maintain:

Primary cable and conduit system,

transformer pad, reinforcement and grounding,

oil containment where required by the *Company* or local authority,

transformer mechanical protection, steel riser including 90 degree sweep and bonding clamp with tap.

all secondary equipment (including a secondary splice box if required),

connect secondary connectors for the transformer,

self contained meter box where required by the *Company*.

Supply and install to *Company's* specification:

secondary cable from transformer to splice box if required.

make up secondary cable ends, including final toque of the secondary cable to the transformer.

Note: The *Customer* will be held accountable for any transformer damage occurring due to improper secondary installation.

New York

The *Company* will:

Supply, install, own and maintain:

primary cable,

transformer and

Meter.

Supply and maintain

CT and PT's

Check the final torque connections to the transformer's secondary bushings.

The *Customer* will

Install, own and maintain:

primary conduit and concrete encasement when required,

transformer pad, reinforcement and grounding,

oil containment where required by the *Company* or local authority,

transformer mechanical protection,

all secondary equipment (including a secondary splice box if required),

connect secondary connectors for the transformer,

self contained meter box where required by the *Company*,

steel riser including 90 degree sweep and bonding clamp with tap.

Supply to *Company's* specification when required:

open trench

Install to *Company's* specification when required:

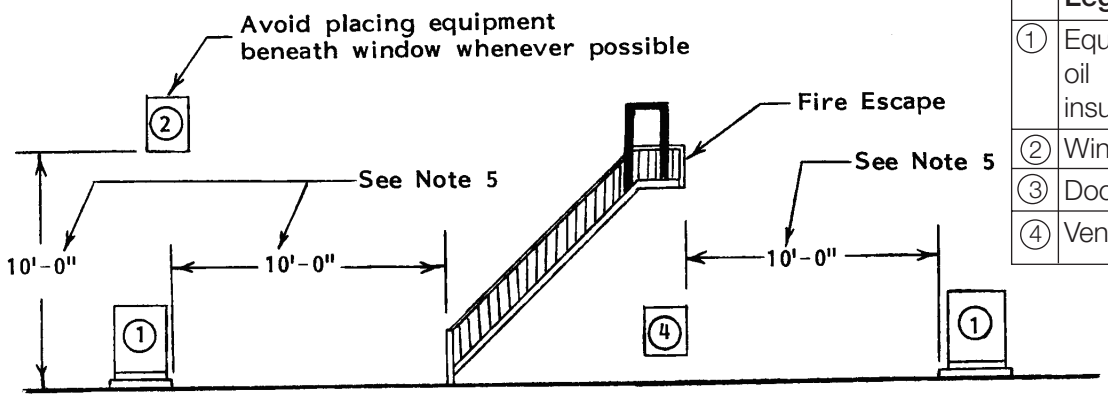
CT's and PT's

make up secondary cable ends, including final toque of the secondary cable to the transformer.

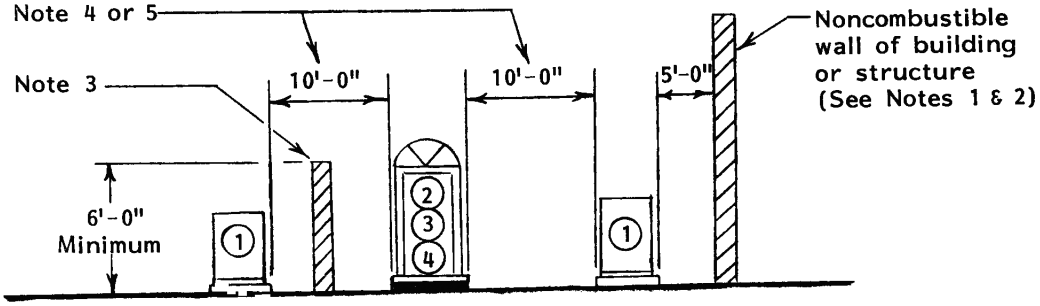
Note: The *Customer* will be held accountable for any transformer damage occurring due to improper secondary installation.

8.0 Transformer Clearance From a Building

Oil insulated equipment shall be located in compliance with the minimum clearances indicated below. For existing buildings, the transformer shall not block access to existing building systems, such as wall mounted fire sprinkler systems. The building owner's and/or tenants fire insurance carrier or local inspection authority may restrict the proximity of the equipment to doors, windows or combustible materials. It is the customer/developer's responsibility to determine the acceptability of the proposed location of the equipment.



	Legend
①	Equipment, oil insulated
②	Window
③	Door
④	Ventilating Duct



Notes:

1. Noncombustible material is defined as a material that will not ignite, burn, support combustion or release flammable vapors, when subjected to fire or heat, or as described by the latest edition of the NFPA-220.
2. No portion of a building or building structure shall overhang any part of the pad-mounted equipment.
3. In cases where required distances cannot be met, a noncombustible barrier, 6 foot minimum height, shall be constructed. This barrier shall be designed to provide adequate fire protection to the existing structure. A design for this structure shall be prepared and sealed by the customer's Professional Engineer or Registered Architect and shall further be approved by the local authority having jurisdiction of building code enforcement.
4. For exits from a public assembly room, such as an auditorium, a 10 foot minimum clearance should be increased to 25 feet, unless there is a barrier.
5. This requirement may vary between individual states. Refer to the building code regulations for the state involved.

9.0 Transformer Clearance From Objects

Clearances from objects:

A. An area measuring 10 feet from any point of the transformer pad shall be kept free of all:

- buried water lines, storm drainage lines, gas lines, other electric lines;
- underground fuel storage tanks; and
- above grade fire hydrants, cell towers, self contained diesel or diesel byproduct fueled generators, and outdoor enclosed generators.

Note: The 10 ft. clearance may be reduced with a noncombustible barrier (see Note 3) and shall not be less than five (5) feet from the edge of the transformer pad. The *Customer* or their authorized representative shall obtain this clearance reduction approval from the *Company* and the local AHJ(Authority Having Jurisdiction), as necessary, prior to the noncombustible barrier installation.

B. An area measuring 25 feet from any point of the transformer pad shall be kept free of all:

- exposed water lines, gas piping, sewer lines;
- open conductor electric lines; and
- above grade gas meters or regulator vents, fuel storage tanks or dispensing units, and non-enclosed gasoline/ propane / LP or LNG gas fueled generators.
- chemical storage silos / tanks.

Note: The 25 ft. clearance may be reduced to 10 ft. with a noncombustible barrier (see Note 3) and shall not be less than five (5) feet from the edge of the transformer pad. The *Customer* or their authorized representative shall obtain this clearance reduction approval from the *Company* and the local AHJ(Authority Having Jurisdiction), as necessary, prior to the noncombustible barrier installation.

10.0 Transformer Accessibility

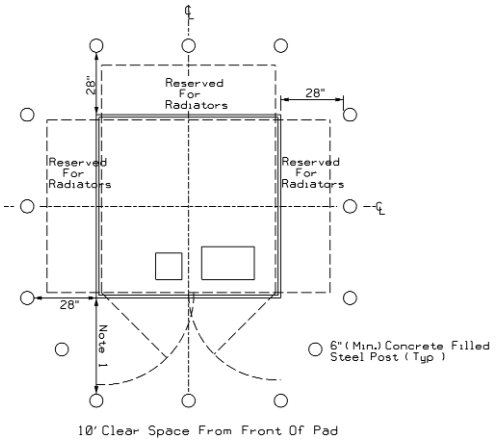
Equipment shall be located within 10 feet of a way open to vehicular traffic and a minimum distance from any structure such as poles, fences, etc. as a means to permit accessibility for installation and maintenance. A minimum of 10 feet of clear space shall be maintained in front of the equipment doors to permit installation and removal of separable connectors and fuses with shotgun stick.

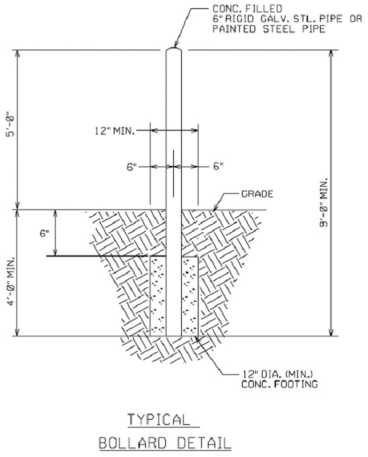
11.0 Transformer Mechanical Protection/Bollards

Whenever possible, equipment should be located so it is not subject to vehicular damage. If this is not feasible, adequate guards such as concrete filled pipes (Bollards) shall be placed to protect the equipment.

Bollards shall consist of 6 inch minimum diameter hot dip galvanized or painted steel pipes filled with concrete. When Bollards can not be painted at the time of installation, painted covers shall be installed. Page 56 shows manufacturer. Bollards are to be 5 feet above the ground and a minimum of 4 feet below the ground. Bollards to be set in a concrete footing as shown in detail below. Concrete is to be crowned on top of all bollards. Bollards shall be installed with due care to avoid interfering with ground grid and conduits. Refer to Pages 37 thru 40 for Transformer Pad dimensions. For switchgear locations, see pages 34 and 35.

The number, type (galvanized or steel) and locations of bollards shall be determined by Distribution Design/Planning, taking into account proximity to traffic and to buildings as well as other barriers to traffic. Other factors such as salt spray and fertilizers may impact type of bollard required. Suggested bollard locations and dimensions are shown below. The location of bollards shall not impede a door opening of 100 degrees.





Blow up drawing detailing this is located on page 44

Bollards Required	●
Bollards Not Required	Ⓧ

Picture of Bollard cover, use for when Bollards can not be painted.

Notes:

1. *Six foot minimum clearance from front of pad.*
2. *Distribution Design/Planning shall designate the number and location of Bollards by marking the Bollards of this drawing as follows:*
3. *Bollards shall be supported with a 12" minimum diameter concrete footing 6" below grade to base of the bollard.*
4. *For installations around oil containment curbs, install bollards six feet minimum on all applicable sides.*

12.0 Transformer pad

The *Customer* shall provide and install a concrete transformer foundation in accordance with the *Company* standards. Precast concrete transformer foundations built to *Company* standards are available from a variety of vendors listed on page 53. Spec sheets of the different size pads are shown on pages 37 thru 40.

Cast in place pads shall meet the following specifications. Concrete shall be a Mix M-4 detailed specifications are on pages 45 thru 48. Reinforcing in pad shall be # 5 grade 60 bars and shall conform to ASTM STANDARD A 615 of latest date. Reinforcing rods are to be located in center of the slab, with a minimum of 2 inches of clearance from face of concrete. All transformer pads must have and adequate base of 2 inches of sand and 12 inches of gravel as shown on pages 37 thru 40. The gravel shall be thoroughly compacted and the sand thoroughly wetted immediately before placing the concrete.

Massachusetts, New Hampshire and Rhode Island

The location of the concrete transformer pad, on the *Customer* premises, shall be approved by the *Company* in advance of the construction. The *Company* must, with sufficient notification (24 hours minimum) from the *Customer*, inspect the forming and reinforcing of the pad, the sub grade preparation, and the ground grid **prior** to the pouring of concrete. This requirement is critical. Failure to have inspection done may result in the need to remove and rebuild the concrete foundation

New York

The location of the concrete transformer pad, on the *Customer* premises, shall be approved by the *Company* in advance of the construction.

13.0 Transformer Secondary

Size and number of secondary cables shall be in accordance with the NEC and shall be approved by the electrical inspector or AHJ of the town or city involved. Maximum number of secondary cables to be physically connected to the Company's pad-mounted transformer is outlined below:

4 Hole Spades	6 sets 750 kcmil Max.
6 Hole Spades	8 sets 750 kcmil Max.
10 Hole Spades	10 sets 600 kcmil or 8 sets of 750 kcmil

Secondary cable requirements greater than this, will require a separate compartment, handhole, or bus duct.

Secondary cable shall not be installed until pad mount transformer has been set to ensure adequate length of secondary cable and connections.

All acceptable spade terminals are shown in Figures 1, 2 and 3. Minimum terminal thickness is to be ¼ inch, with 9/16 inch holes.

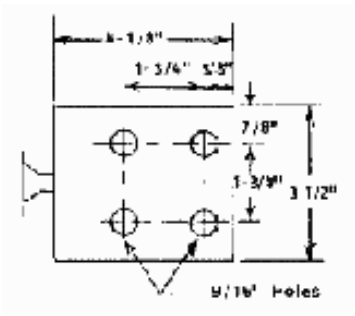


Figure 1

kVA Rating	L.V. Rating
75 – 300	208Y/120
75 – 500	480Y/277

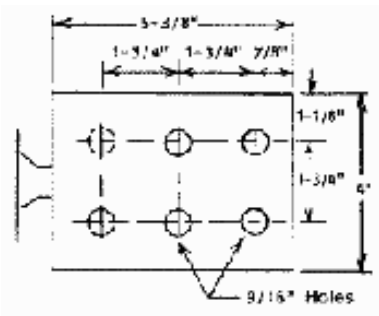


Figure 2

kVA Rating	L.V. Rating
500	208Y/120
750 – 1500	480Y/277

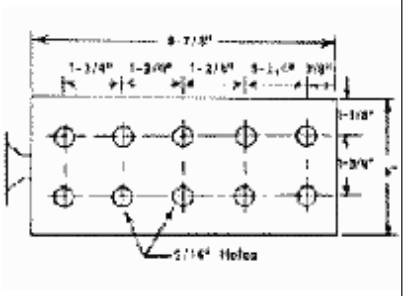


Figure 3

kVA Rating	L.V. Rating
750 – 1000	208Y/120
2000 – 2500	480Y/277

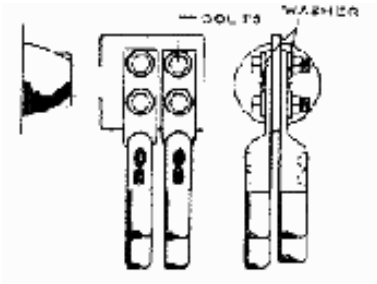


Figure 4
4 Cables – 500 kcmil & Below

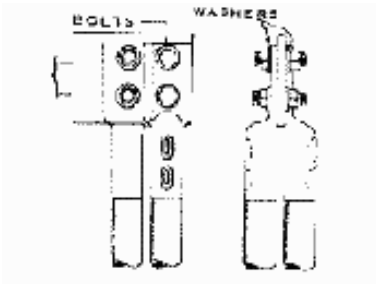


Figure 5

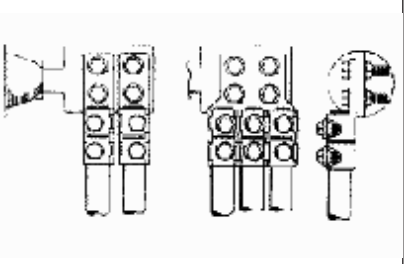


Figure 6

Notes:

1. *Figure 4 – Compression connections will accommodate up to four cables with a maximum individual lug width of 1¼ inch.*
2. *Figure 5 – Compression connections will accommodate two cables with lug greater than 1¾ inch width.*
3. *Figure 6 – Typical example of bolted connections for two, four or six cables to maximum capacity of lug.*
4. *Metering (CT's) mounted inside the padmounted transformer may reduce the number of sets of secondary that can be installed by blocking off some holes on the secondary spade. In some cases the customer may be required to purchase a secondary splice box.*
5. *A list of a few manufacturers that supply the connectors is located on page 56.*

13.1 Transformer Secondary Connections

All connectors and connector fasteners shall be furnished, installed, owned and maintained by the customer/developer. Connectors shall be approved by the *Company* prior to purchase. Final electrical connection to the transformer secondary terminals shall be inspected by the *Company*. The customer/developer shall make all final connections to the spades of the pad-mount transformer to a final torque of 40 foot pounds. Size and number of secondary cables shall be in accordance with the NEC and shall be approved by the electrical inspector or AHJ for the town or city involved.

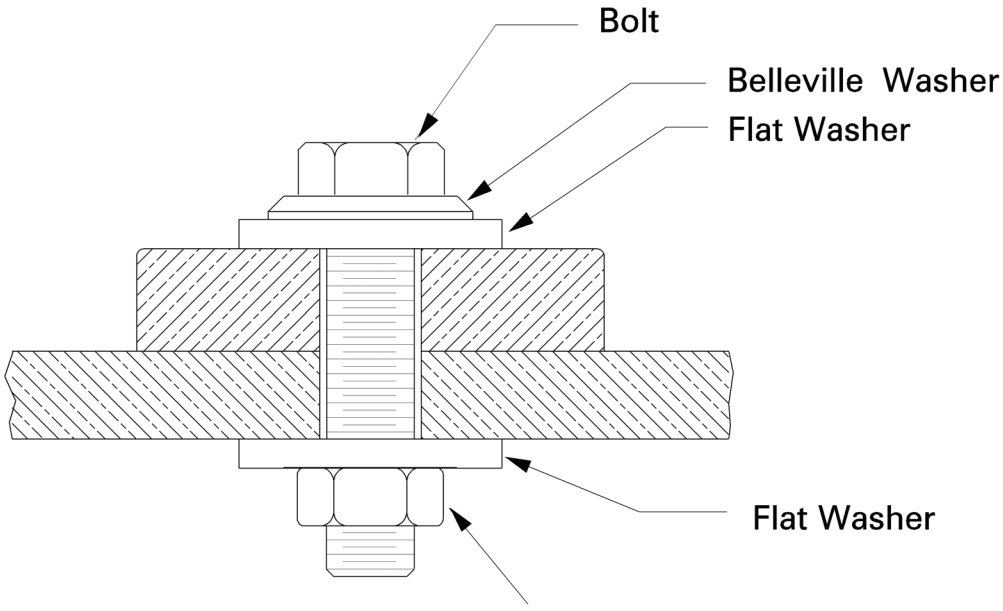
13.2 Secondary Bolt Assembly

The customer/developer shall supply and install aluminum connectors for use with aluminum cable or copper connectors for use with copper cable. Tin plated connectors can also be used as an alternate connector for aluminum and copper connectors. Connector shall be a cable to flat clamp or compression type connector, with a minimum of two holes in the flat pad and two clamping elements or two compressions per cable, and must be approved by *company* representative. Bolts and flat washers shall be grade 304 stainless steel. Belleville washers shall be grade 301 stainless steel. Nuts shall be waxed grade 316 stainless steel.

A. A flat washer is placed between the concave side of the belleville washer and the surface of the member being joined. The belleville is thus captured between the head of the bolt and the large flat washer. The flat washer should have an outside diameter greater than the flattened belleville's such that no overhand results. Select a flat washer that is twice as thick as the belleville for strength. (If not available, stack two or three thinner washers to achieve the same effect).

B. With the belleville washer captured between the flat washer and the bolt head, fit the assembly into its hole. When the washers are fitted in position, there should be no interference with washers of adjacent bolts and no overhang over surface edges.

C. Tighten the nut on the bolt (with a washer of its own) until a sudden, noticeable increase in torque is required to continue. The belleville washer is now flat. It is not necessary to "back off" the nut after tightening to this point.



13.3 Secondary Splice Box

A secondary splice box may be required where the customer's number of secondary cables exceeds the maximum allowed amount on the transformer. Supplying and installing this box is the *customer's* responsibility. The cables from the transformer to this box are to be specified by *company's* representative. The *customer* is responsible to supply and install the cables.

Once the service is energized the *company* will take over ownership of only the secondary cables from the transformer to the secondary splice box.

A list of a few manufacturers that supply the secondary splice box is located on page 56.

14.0 Transformer Sweep Entry

Conduit shall be installed as shown on Pages 37 thru 40 before slab is poured. Use 36 inch radius sweeps, with couplings, nipples and bushings as required. Sweeps for primary cables shall be galvanized steel or schedule 40 PVC. Conduits shall be raised a minimum of 1 inch approximately over the concrete slab. Expanding foam Hilti Inc. CF810 shall be used to fill inside the conduits after the primary/secondary is installed. Ownership of cable will determine who installs the foam on each cable. After pulling tape is in, install the expanding foam in any spare/empty conduits. Place a rag into empty conduits prior to the foam as a support for the foam while curing takes place.

After the concrete pad is cured, the remainder of the conduit primary and secondary openings through pad will be sealed with grout. Before sealing steel sweeps, the sweeps must have a bond clamp attached with a #4 Cu tap to connect to the ground grid. Fill the conduit primary and secondary openings with sand (no aggregate) to a grade of approximately 2 inches below the top of the concrete pad. Place a layer of concrete grout (no aggregate) 1 to 2 inches thick on top of the sand layer to seal the conduit entrance. Do not cover the conduit ground clamps with grout. The expanding foam may be used as an alternate for filling in the opening with sand and concrete grout. Ownership of conduits and pad will determine who seals openings. See page 62 for further details in *company* bulletin *09-09 Three Phase Pad-mounted Transformer Sealing*.

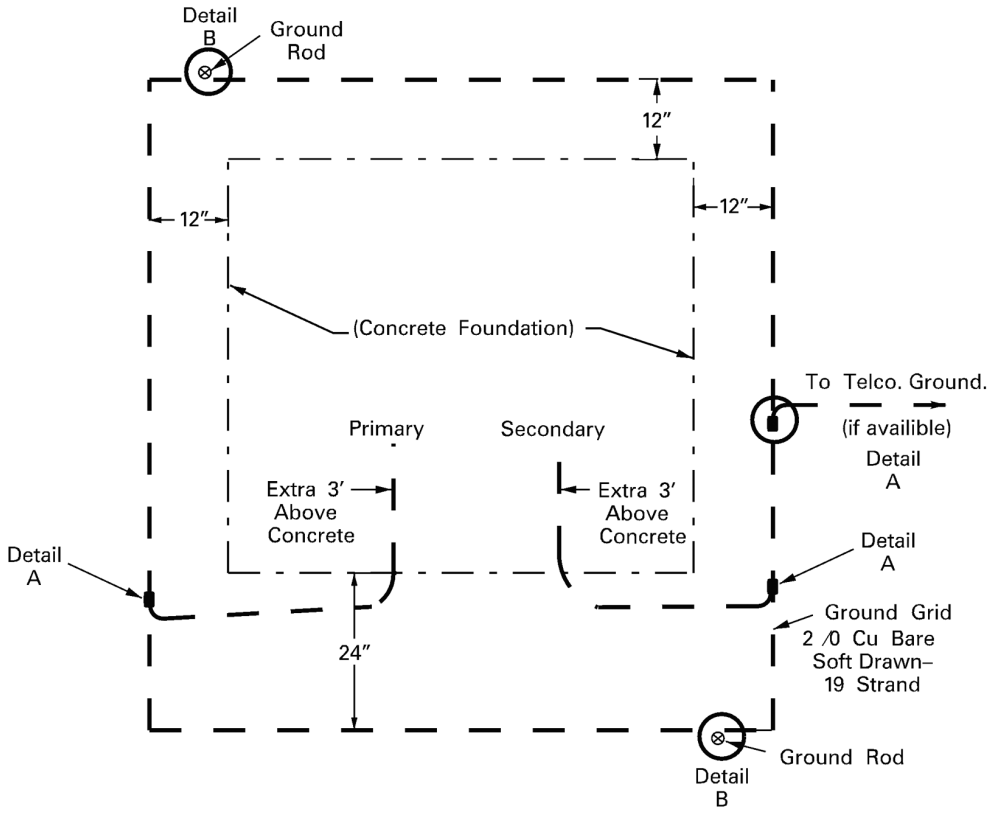
Expanding Foam
CF810 available at
Hilti Inc. 1-800-879-8000
Stuart C Irby Co 1-315-453-2970 and 1-315-329-0038

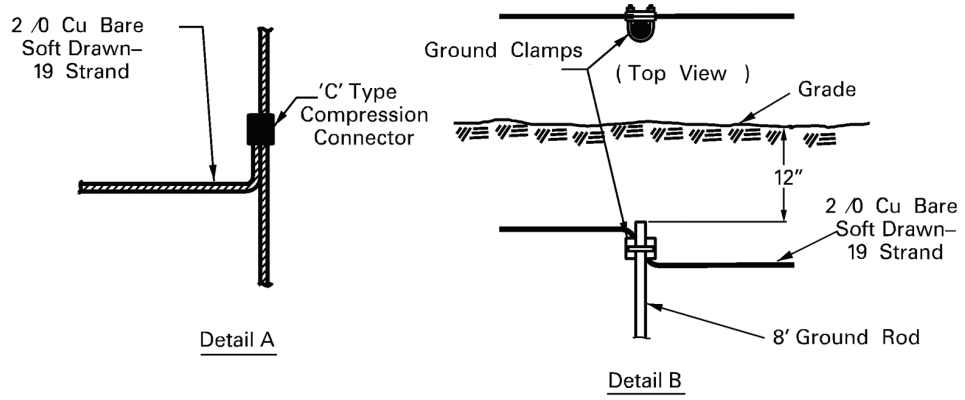
Spare conduits can also be sealed with conduit plugs, see page 54 for a list of manufacturers.

15.0 Transformer Grounding and Bonding

The ground grid shall be 2/0, bare, soft drawn, 19 strand copper wire. The wire shall be installed 12 inches below finished grade and located around the transformer pad as shown on page 17. Bond to all exposed metallic conduit and leave 3 feet of wire above pad for grounding transformer, one lead in the primary conduit window opening and the other lead in the secondary conduit window opening.

Two 5/8 inch diameter, 8 feet long copper weld ground rods and approved connectors shall be installed to 12" below finished grade. Leave the ground rods and grid exposed until inspected the *Company*. The ground grid is to be complete and backfilled prior to energizing the transformer. Connections to ground grid to be made as shown on Details A and B below, except that exothermic welding ("cad weld") shall be an acceptable alternative to a compression connection. Bolted connectors are only acceptable for the ground grid connections to the ground rods. The company will install the ground taps onto the transformer.





16.0 Oil Containment

This is to be used where oil containment is required by local authorities or where otherwise justified. This liner system will significantly slow the migration of oil into the under laying sub grade, allowing additional time to initiate a cleanup response. The polypropylene geotextile allows the passage of water but absorbs small quantities of oil. This design is intended to confine 100% of total transformer oil present, with a 20% reserve margin, for up to 36 hours. If additional confinement is desired consult the company Environmental Engineer. Follow the following installation steps. See Page 19 for construction detail. A precast containment barrier is available as an alternate to casting one in place, check with the precast suppliers on page 53 for availability. Precast curb can be one piece or made up of separate pieces assembled in the field.

Note: *on field assembled pieces. All pieced must be sealed together with rope tar, rubber sealant or equivalent.*

1) Build oil curb, this should be installed with concrete in accordance with Mix #4 per concrete specifications on pages 45 thru 48. Reinforcement to be #4, grade 60 rods minimum, 6 inches on center, bend rods around corners. Curb to be 24" deep with a minimum thickness of 6".
2) Install geotextile liner from top of walls and around bottom of containment area. Areas where conduit crosses overlap liner around conduit and seal with expanding foam.
3) Install 6" of silty sand on top of liner.
4) Install second layer of geotextile liner as noted in step 2.
5) Build up area for transformer pad with 6" of compacted gravel and level.
6) Install ground grid.
7) Set/build transformer pad.
8) Fill in conduit openings with silty sand or expanding foam up to the last two inches of the pad
9) Fill rest of conduit opening with concrete grout or expanding foam.
10) Fill area between slab and curb with 1½ inches uniformly graded crushed rock.

Geo-textile Liner

Generic name is: 16oz polypropylene geotextile also called filter fabric weighing 16oz/sqare yard.

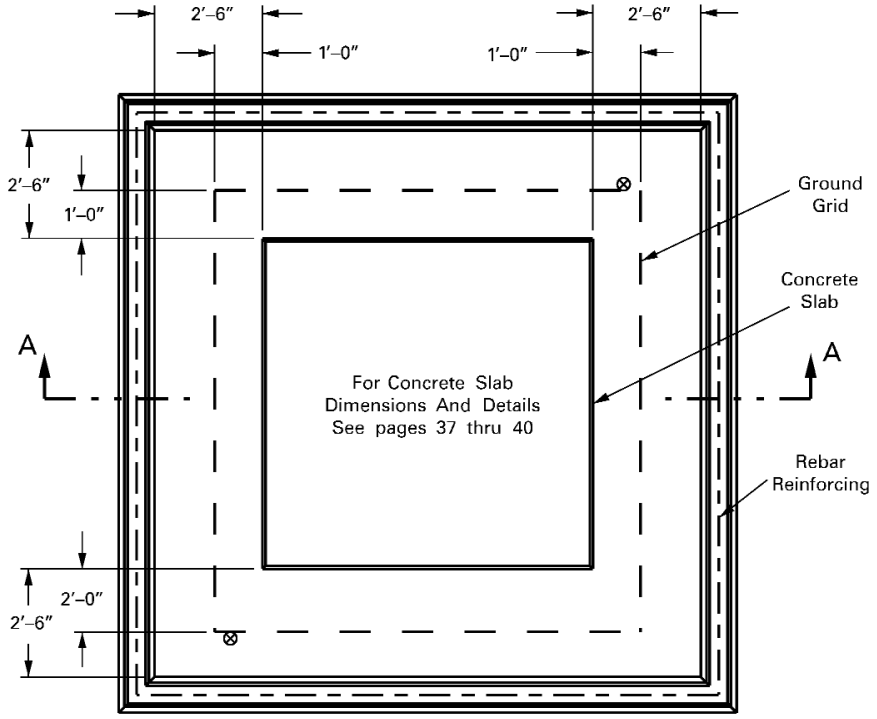
Brand names/Suppliers are:

AME1680 available from American Engineering Fabrics (AEF), Inc.
(Emphasize polypropylene not polyester)
New Bedford, MA@1-617-965-0007/1-800-770-2666 or from
Vellano Bros. Lancaster NY 1-716-684-7222, several other locations in
NY, MA, RI and NH, go to www.vellano.com

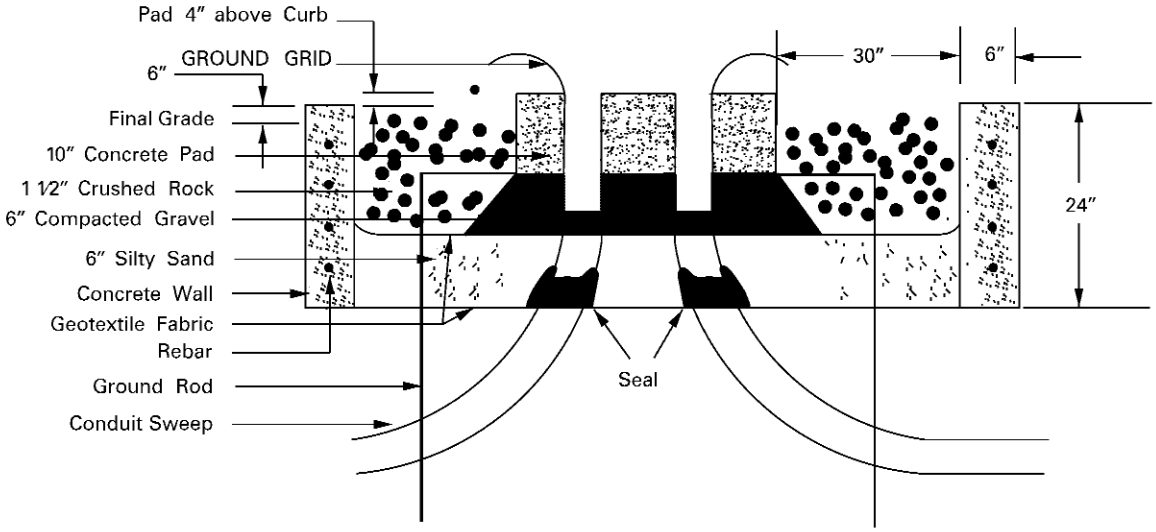
Synthetic Industries ST 160 available from Spartan Mills Inc's, Spartanburg, NC
1-803-576-2353

Carthage Mills FX-160HS / US Construction Fabrics LLC 90 Range Rd, Windham NH 03087
1-603-898-0532

Containment Area Plan View



Typical Cross Section of Containment Pad A-A



17.0 Riser Pole

The *Company* shall designate conduit riser locations on the pole. All primary risers shall be Galvanized Steel, this includes the 90 degree sweep. Per NESC all steel risers must be bonded 6" down from top of riser and the bond must be at least 8' high from finished grade.

The *Customer* is responsible for providing and installing the bond clamps and the tap. The *Company* will make the bond connection from that riser bond tap to the ground system on the pole. Spare riser sweep shall be bonded also. Riser sweep in Direct Buried applications shall be concrete encased. Approved materials reference is located on page 54.

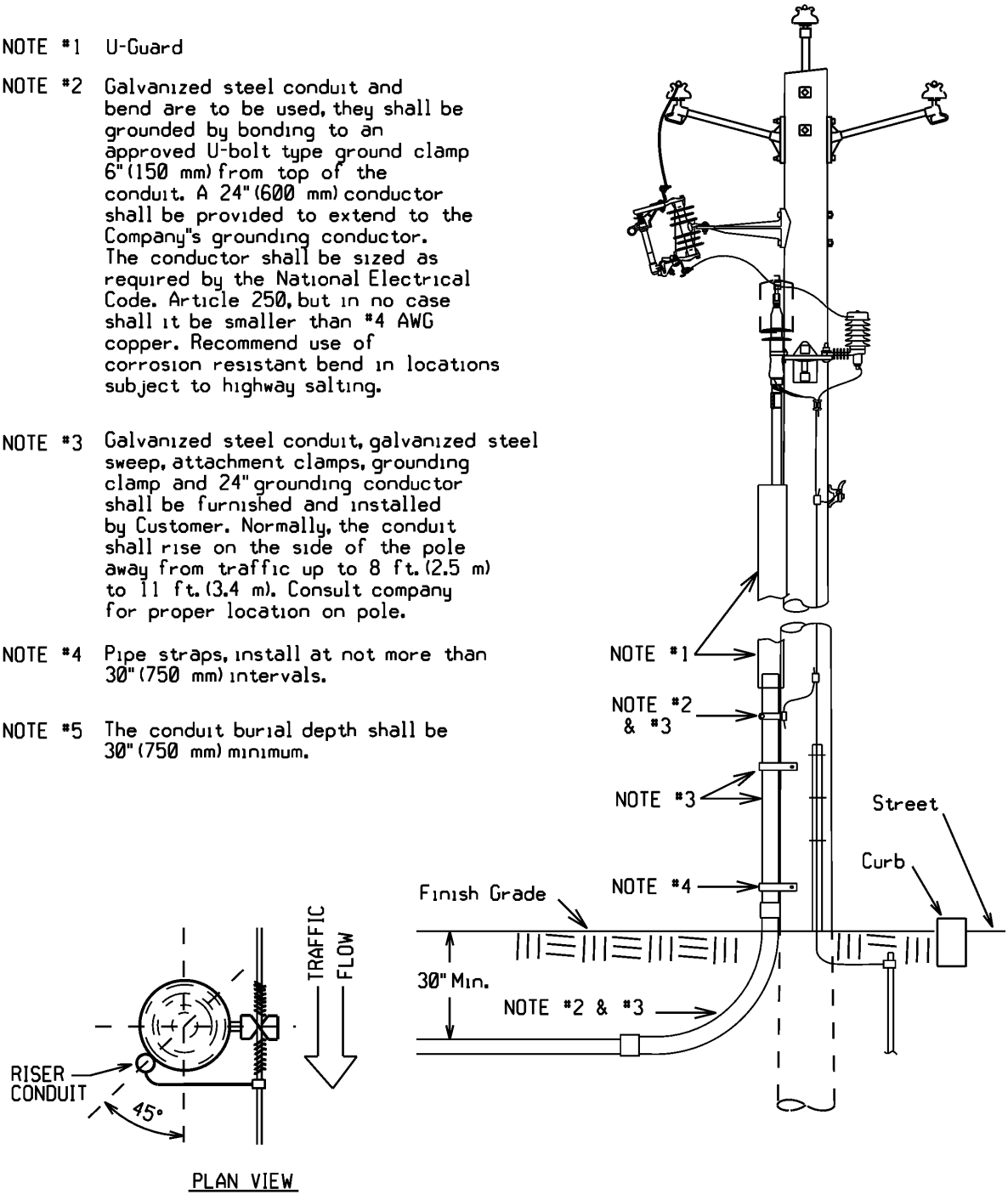
NOTE #1 U-Guard

NOTE #2 Galvanized steel conduit and bend are to be used, they shall be grounded by bonding to an approved U-bolt type ground clamp 6" (150 mm) from top of the conduit. A 24" (600 mm) conductor shall be provided to extend to the Company's grounding conductor. The conductor shall be sized as required by the National Electrical Code. Article 250, but in no case shall it be smaller than #4 AWG copper. Recommend use of corrosion resistant bend in locations subject to highway salting.

NOTE #3 Galvanized steel conduit, galvanized steel sweep, attachment clamps, grounding clamp and 24" grounding conductor shall be furnished and installed by Customer. Normally, the conduit shall rise on the side of the pole away from traffic up to 8 ft. (2.5 m) to 11 ft. (3.4 m). Consult company for proper location on pole.

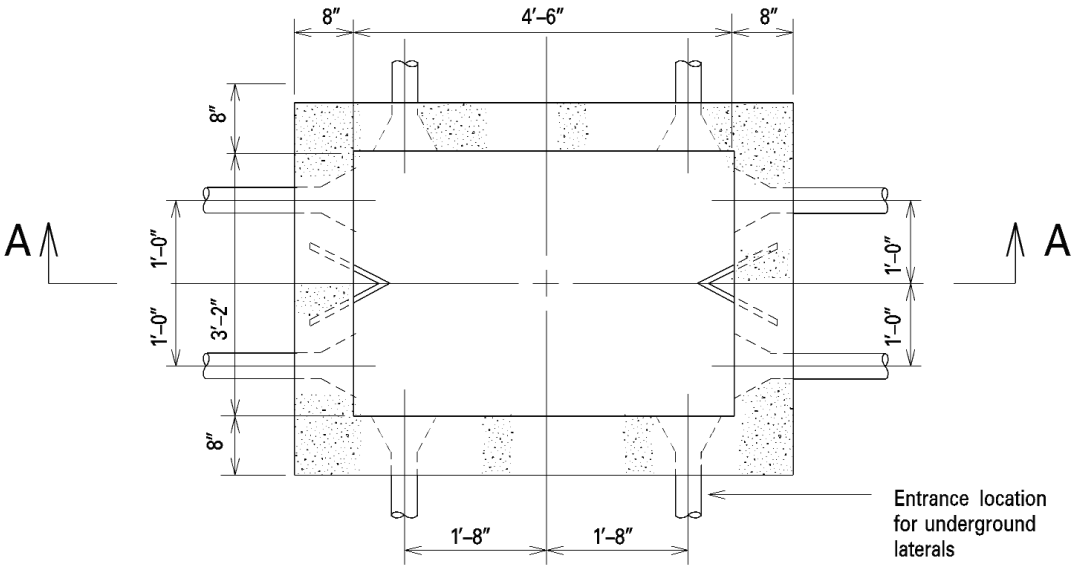
NOTE #4 Pipe straps, install at not more than 30" (750 mm) intervals.

NOTE #5 The conduit burial depth shall be 30" (750 mm) minimum.

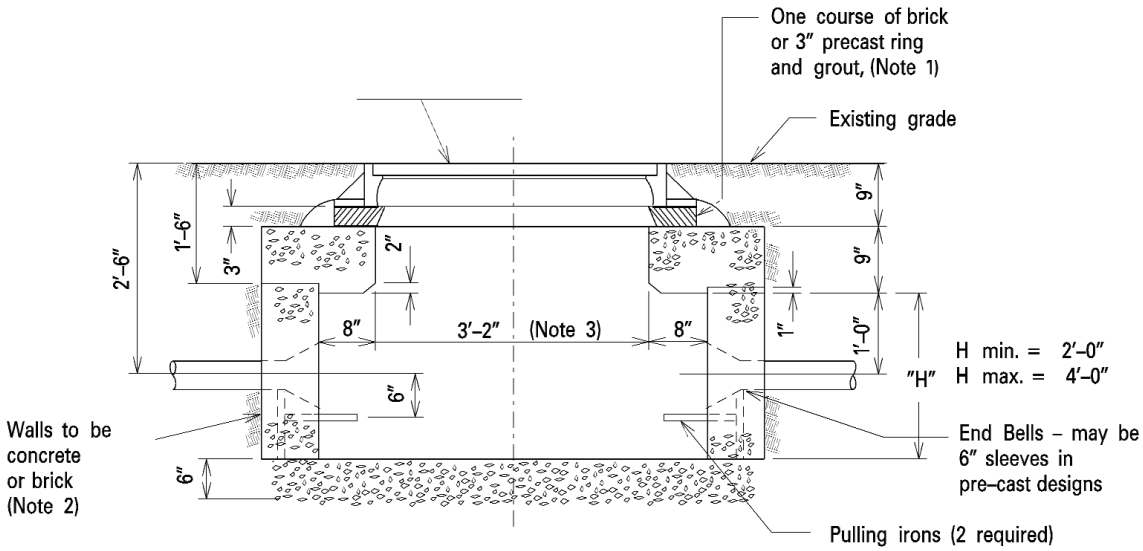


18.0 Heavy Duty Handhole

This primary conduit handhole may be specified in the design for installation in roadways or sidewalks areas where duct length requires extra pulling locations. Heavy duty handholes are supplied and installed by the *Customer*.



PLAN VIEW



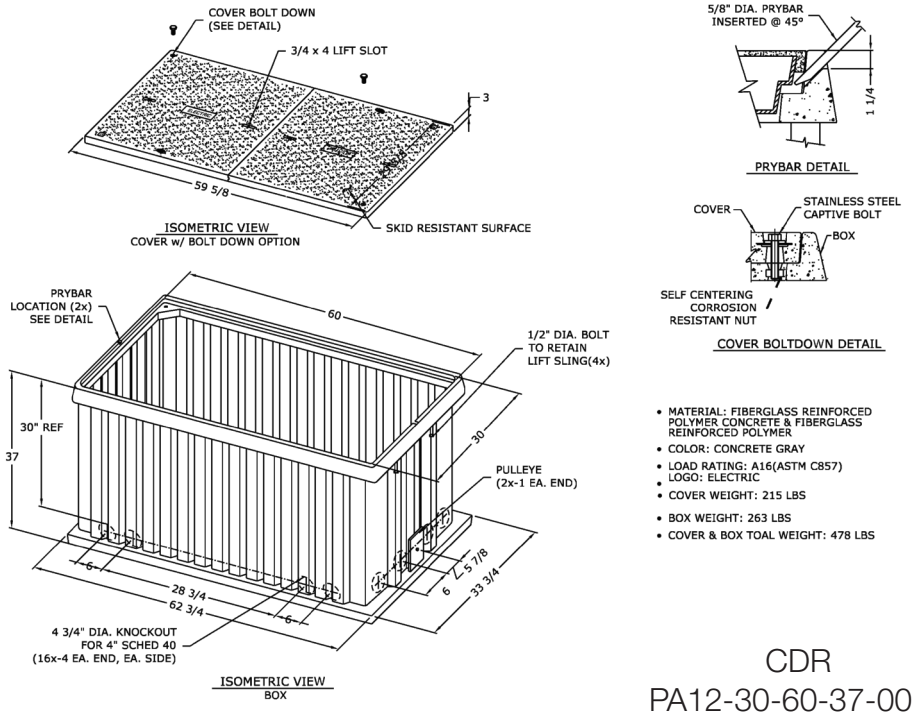
SECTION A–A

Notes:

1. *Chimney height is kept to a minimum to facilitate placing completed splices in handhole from above grade.*
2. *Concrete minimum strength - See pages 45 thru 48.*
3. *Roof opening 3' 2" inches x 3' 2".*
4. *Handhole frame, ring and cover are typically provided by the customer.*

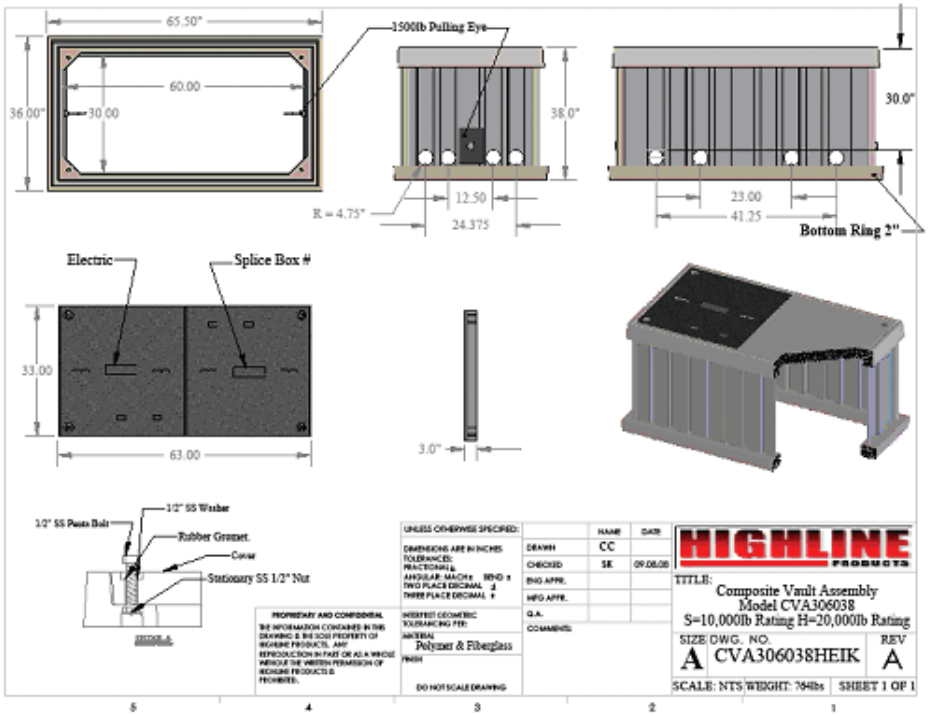
19.0 Primary Cable Pull/Splice Box

This primary conduit Pull/Splice Box may be specified in the design for installation in sidewalks or grass plot areas where duct length or design requires extra pulling locations or splices. The splice box is H20 rated and shall be installed in locations not frequently traveled over by vehicles. Pull/splice boxes are supplied and installed by the *customer*.



- MATERIAL: FIBERGLASS REINFORCED POLYMER CONCRETE & FIBERGLASS REINFORCED POLYMER
- COLOR: CONCRETE GRAY
- LOAD RATING: A16(ASTM C857)
- LOGO: ELECTRIC
- COVER WEIGHT: 215 LBS
- BOX WEIGHT: 263 LBS
- COVER & BOX TOAL WEIGHT: 478 LBS

CDR
PA12-30-60-37-0016



20.0 Trench Requirements

Final grades shall be established; the surface rough graded with in 6" from finished grade, roadway and property boundaries shall be staked or marked by the *Customer* before any trenching is started. Trench spoils shall be kept a distance of 2' minimum from excavated trench.

The *Customer* shall adhere to the construction plan and specifications specifying trench locations, trench depth and concrete encasement. Any deviation shall be subject to approval by the *Company*.

The *Company* shall be notified in advance of the backfilling of any electric facility (e.g. concrete, conduit, manholes, riser bends). The *Company* reserves the right to require re-excavation of the conduits and foundations if the *Customer* fails to have inspection done or backfills before inspection.

Trenches shall not be backfilled until concrete has set (for at least two hours) and until after approval by authorized *Company* personnel. *Note: if trench is subjected to traffic then the trench shall set for at least 12 hours.* All backfill shall be sand or gravel containing stones less than 1" in any dimension. Backfilling shall not take place over any open-ended (unplugged) conduits. *Company* approved red "Warning" tape shall be installed directly above the *Company's* cable eight to twelve inches below finished grade. Laying the warning tape directly on the cable, concrete or conduit is not acceptable. Certain installations in the public way may require flowable fill instead in place of normal backfill.

20.1 Trench Depth New York/New England Concrete Encased Conduit

Burial depths for electrical conduit shall be maintained not less than 30" from the top of the concrete encasement to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble, or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (max. 2" stone). At riser pole end concrete encasement just before riser sweep.

20.2 Trench Depth Conduit Direct Buried New York (under certain circumstances agreeable with the *company*)

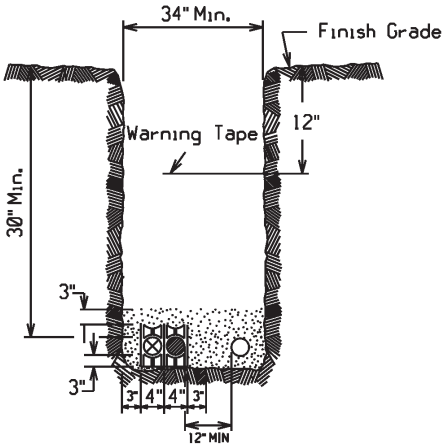
Burial depths for electrical conduit shall be maintained not less than 30" from the top of the conduit to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble, or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (max. 2" stone).

20.3 Trench Depth Direct Buried New York

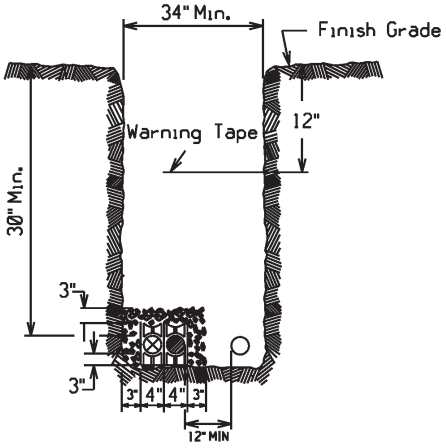
Burial depths for electrical cable shall be maintained not less than 30" to grade during all phases of construction. The trench bottom shall be solid, undisturbed earth. Earth showing signs of peat, cinders, rubble, or any conditions not suitable for a stable foundation shall be reported to the *Company* for recommendation. Small pockets of unsuitable soil shall be replaced with compacted gravel (max. 2" stone). Then 2" minimum of sand shall be the base to lay the cable on top of with another 4" minimum of sand to cover cable.

Figure 20.0-1 Typical Trenches

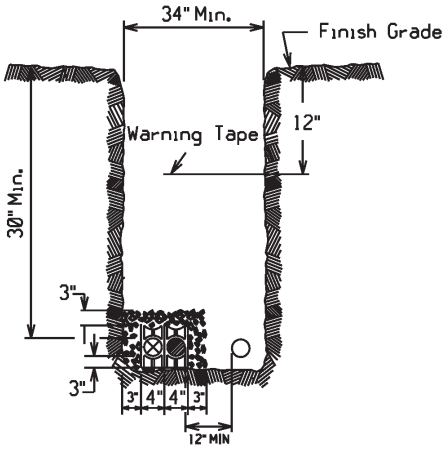
Conduit Trench



Conduit in Concrete Trench



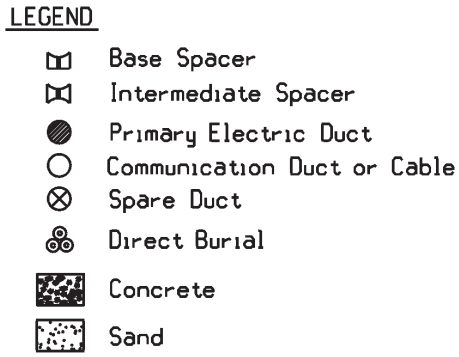
Direct Burial Trench

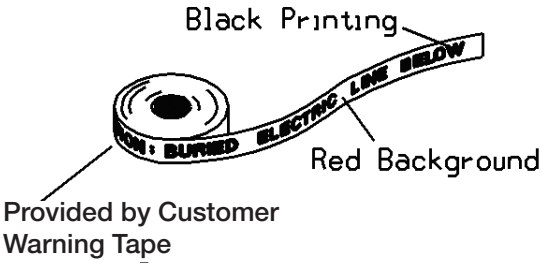


Notes:

1) If more than one set of primary is installed in the trench, separate primary by 6" minimum.
2) Nantucket MA area to use this trench with a spare 4" conduit to be installed at least 6" away from the direct burial cable.

Legend





Provided by Customer
Warning Tape

21.0 Conduit Requirements

The *Customer* shall be responsible for all trenching, excavating, backfilling, and installation of the primary duct system. Exceptions to this shall be in areas where there is an existing manhole and duct system and the limits of trenching by the *Customer* shall be determined by the *Company*. The *Customer* is also responsible to supply and install any necessary manhole, pullboxes, heavy duty handholes, frames and covers. Concrete encasement shall be provided and installed by the *Customer* as specified by the *Company*.

The *Customer* shall ascertain the requirements of the specific municipality in which the development is located. For example, some municipalities may require that the *Customer* employ a licensed electrician to direct the installation of all conduit intended for electric facilities.

Temporary mechanical protection over buried conduit and encasements is recommended to prevent crushing or damage during construction. This is the *Customer's* responsibility.

All road crossings shall, when practical, be perpendicular to the sidelines of the road.

The minimum size conduit shall be 4" schedule 60 DB. All sweeps at foundations and risers shall have a minimum radius of thirty-six inches (36"). The riser sweep shall be galvanized steel. The padmount transformer sweeps shall be galvanized rigid steel or schedule 40 - PVC, with the transformer sweeps rising typically 1" above the concrete pad. The *customer* shall install bell ends on the conduits. The *Customer* shall install conduit plugs in all unused conduits and pulling tape. At the riser pole, the galvanized rigid steel sweeps and the PVC/steel adaptors shall not be concrete encased. The *Customer* shall be responsible to install rigid galvanized steel straight conduit up the pole as shown on page 20, including conduit ground straps, up the riser pole (unless directed otherwise by the *Company*). The *Company* will specify on which quarter of the pole the riser shall be installed, usually away from oncoming traffic.

Except as noted on construction prints, curves and bends in conduit shall be gradual, and the radius of curvature shall not be less than forty feet. All curves shall be formed with 5-degree couplings. The minimum length between single, 5-degree couplings is 42". Heat bending is not allowed.

Conduit grade shall be such as to cause all ducts to drain toward one or both equipment foundations or pullboxes. Minimum pitch shall be three inches (3") per one hundred feet (100').

The *Customer* shall insure that clearances are met and maintained, and that they are inspected by the *Company*. Unless local jurisdictions require greater clearances, the minimum clearances shall be as follows:

Communication Systems – *Company* conduit shall not be directly above or below communication conduit, except when crossing below communication conduit at approximately right angles. *Company* conduit and communication conduit shall be separated by a minimum of 3" of concrete encasement.

Water, Gas, Sewer – *Company* conduit shall not be directly above or below these utilities, except when crossing above these utilities at approximately right angles. Where the paths of these utilities cross under *Company* conduits at approximately right angles, the minimum separation is 12". A minimum separation of 24" shall be maintained between parallel placement of any of these utilities and electrical conduit.

A 6-inch clearance shall be between conduit envelopes and major subsurface pipes (e.g. drainage pipes).

The *Customer* shall mandrel all primary conduits to insure their integrity **before** the *Company* shall attempt to pull any primary cable. The *Customer* shall furnish and install an approved synthetic, 2,500 pound test tape in each primary conduit run including risers. Pulling tape installation and mandrilling the duct shall be witnessed by the *Company*.

***Company* owned duct shall not share a concrete encasement with foreign utilities (e.g. do not place communication or private electrical duct in the same concrete encasement as *Company* duct).**

21.1 Pulling Tape

All conduits shall have a pulling tape, also known as "Mule Tape". This tape is to be to be rated for 2,500#. Manufacturers of this tape are listed on page 54.

21.2 Trench and Conduit System Inspection

In the applicable area, a designated *Company* inspector shall be responsible for the inspection of the trench and or conduit system being prepared and installed by the *Customer*, at stages of installation. The *Customer* shall provide the *Company* inspector with a minimum of 24 to 72 hours notice. Required inspections are:

1) After conduit, ground system, reinforcing bars and forming are completed; but before concrete is poured.

2) After concrete is poured but before backfilling.

3) After backfilling.

The inspection shall not be limited to the above.

22.0 Primary Cable and Electrical Equipment

The majority of installations will have the Company provide, install, and maintain the entire primary electrical system including the transformer, cable, cable accessories, terminations, and other miscellaneous primary electrical system components.

In some areas the *Customer* will (mostly New Hampshire) provide and maintain the entire primary electrical system. The *Company* will provide install and maintain the transformer and other miscellaneous primary electrical system components.

The designation and location of the riser pole(s) shall be determined by the *Company*.

The location of primary cable pull/splice boxes and/or heavy duty handholes shall be determined by the *Company*.

At those locations where manholes or above ground switchgear are required, additional specifications will be provided by the *Company*.

23.0 Secondary Cable and Conduit System

Secondary cables shall be installed underground in customer/developer furnished, installed, owned and maintained conduit system or raceway. Conditions requiring more secondary cables than the *Company*'s transformer secondary terminals can accommodate may require the customer/developer to supply an intermediate splice box to make a transition from National Electrical Code required cable capabilities (required to match main switch), to actual load cable capabilities. Page 56 lists manufacturers of the splice box.

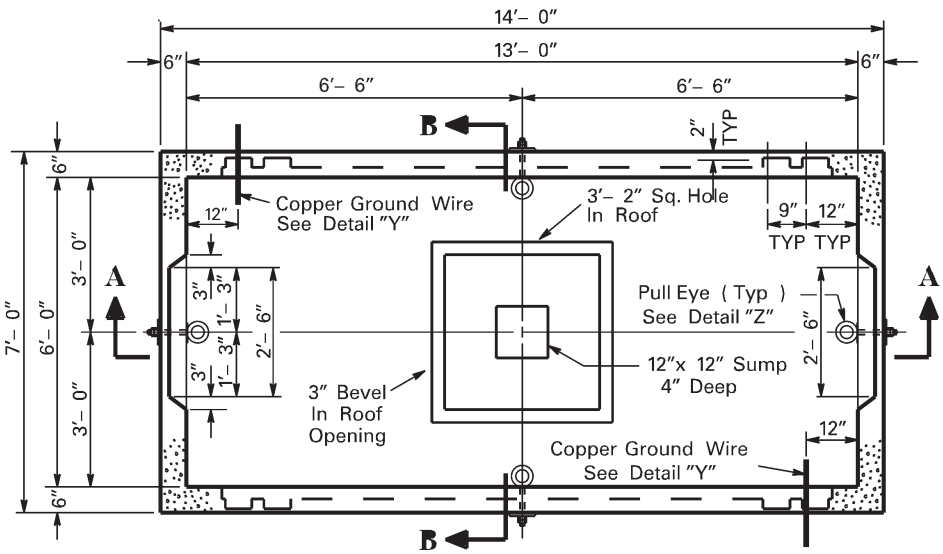
24.0 Metering

Refer to the *Company*'s Specifications for Electrical Installations book for the type of installation. Division of work and material will be performed with the approval and authorization of the *Company's* Metering Services Department.

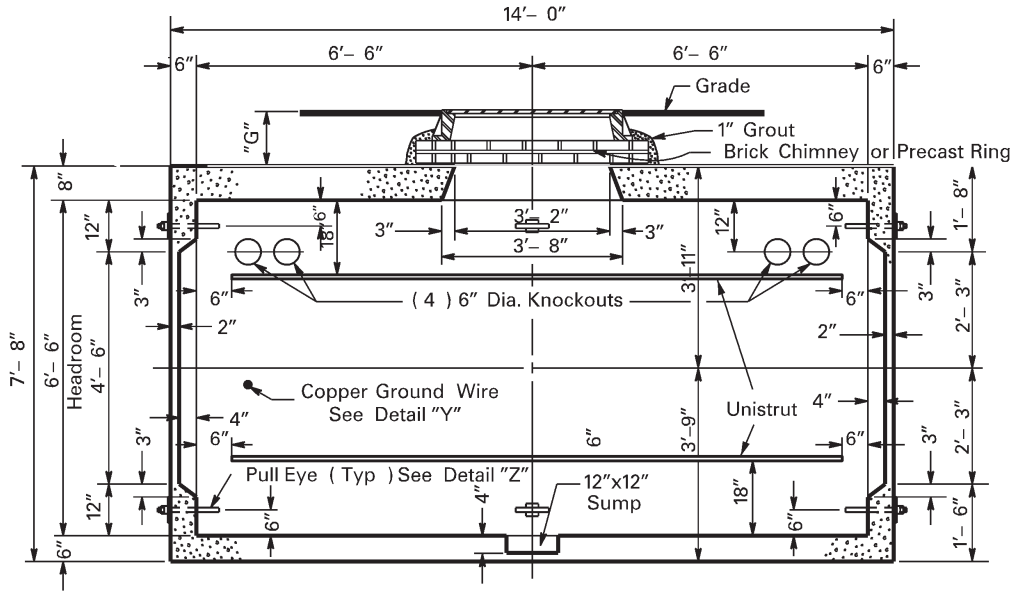
25.0 Manhole

Manhole installation may be required as part of the infrastructure to serve certain customers. The *Customer* shall provide and install the manhole to company specification. On page 53 lists precast concrete providers. Please contact the *company* if details are needed for specifications of manholes.

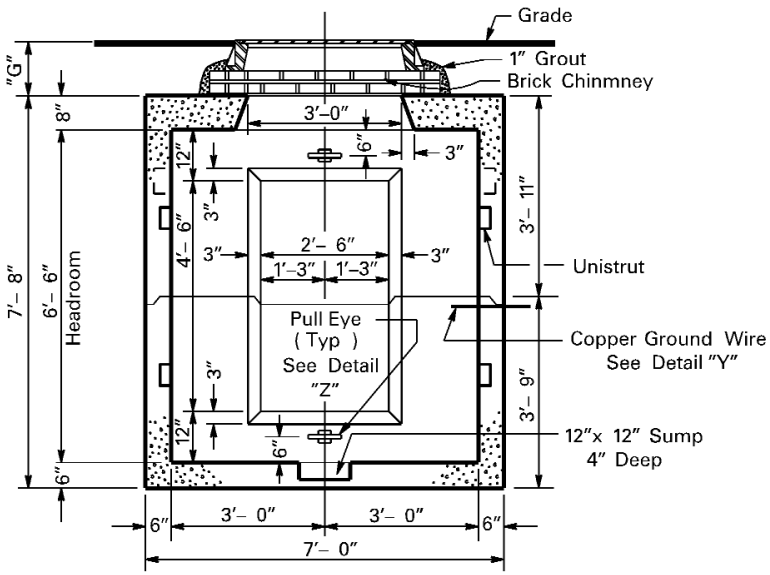
STD Item UM22



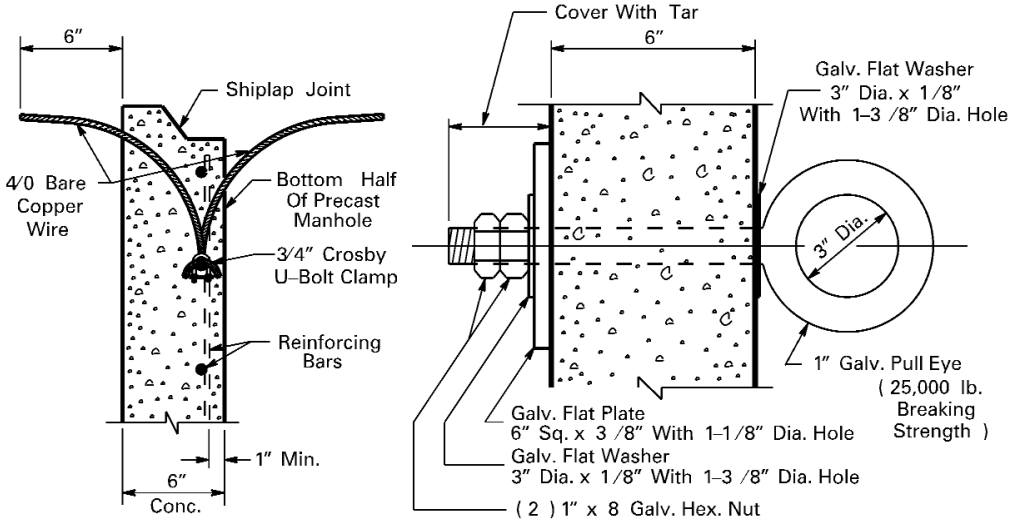
Plan



Section A–A



Section B–B



Detail "Y"
2 Required

Detail "Z"
4 Required

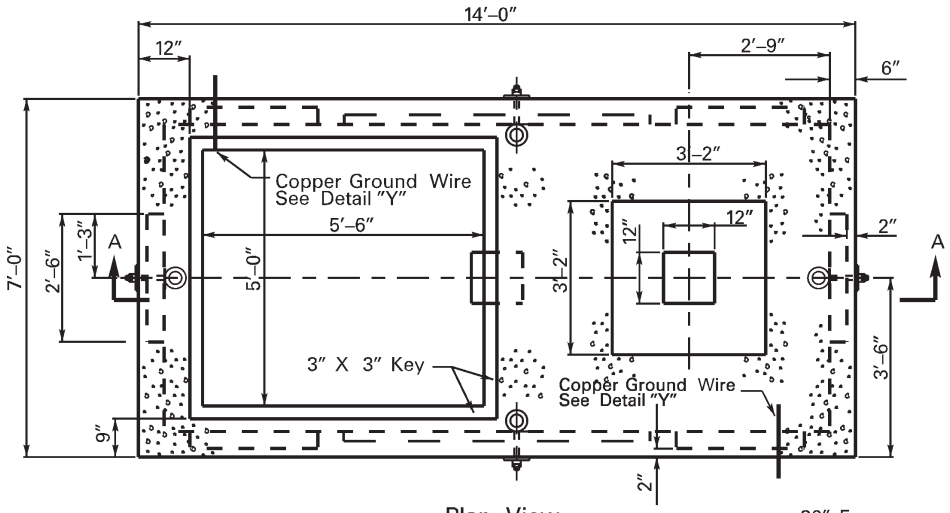
Note: Construction joint to be sealed with asphalt or equivalent.

25.1 Manhole Frame Ring and Cover

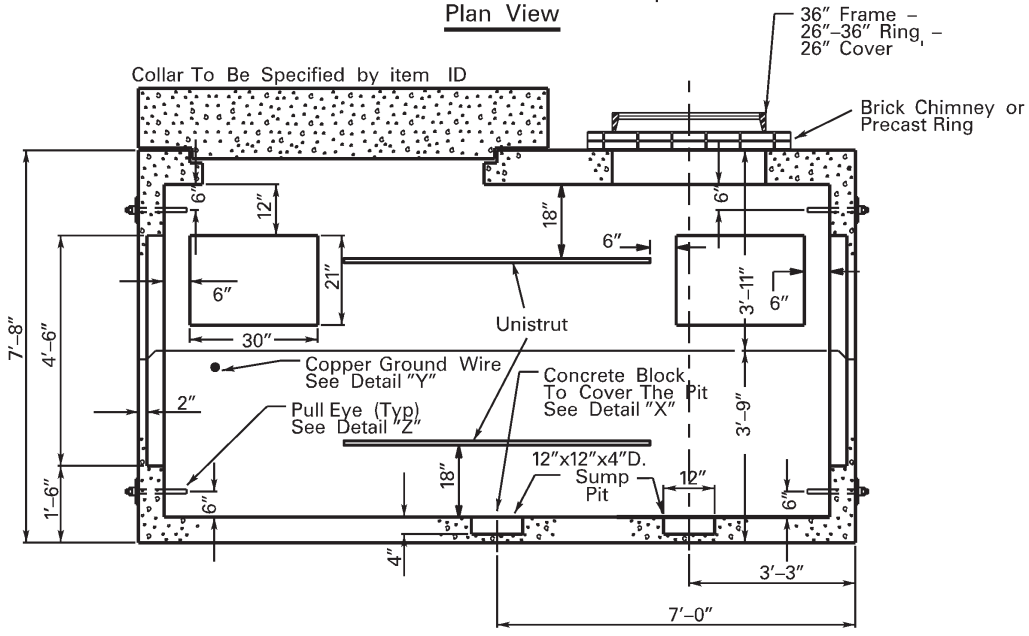
The *customer* shall be responsible for providing and installing the manhole frame ring and cover to finished grade. Approved frame, ring and covers are shown on page 60. Frame shall be installed on a chimney at least 6" in height minimum. The maximum allowable chimney shall be 36" from the top of the roof of the manhole to finished grade.

25.2 Switchgear Manhole

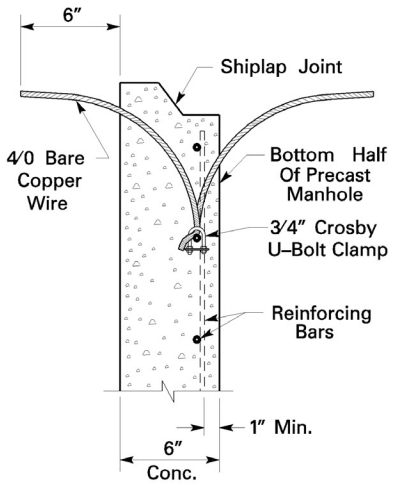
Switchgear installation may be required as part of the infrastructure to serve certain customers. The Customer shall provide and install the switchgear manhole to company specification. On page 57 lists precast concrete providers. The Company shall identify which collar shall be used from the choices on pages 30 and 31.



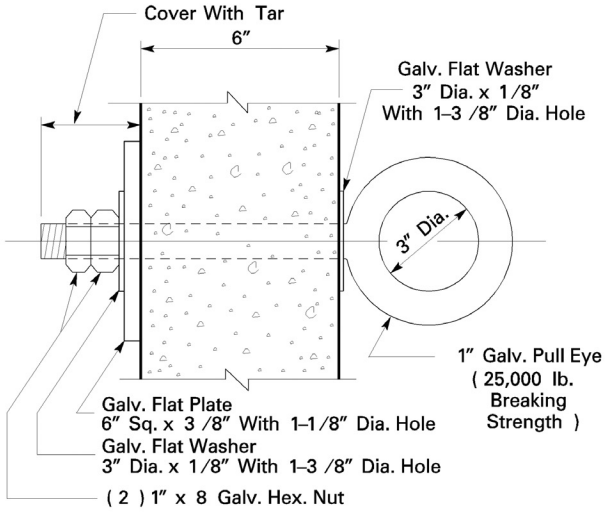
Plan View



Section A–A

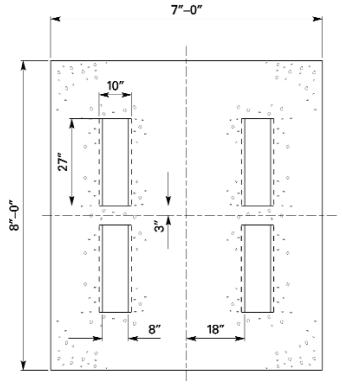


Detail "Y1"
2 Required

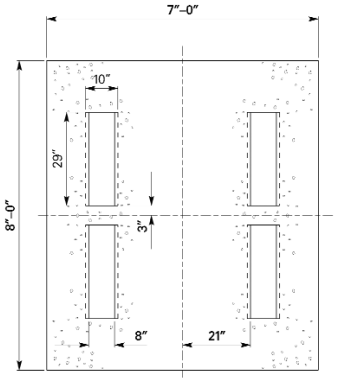


Detail "Z"
8 Required

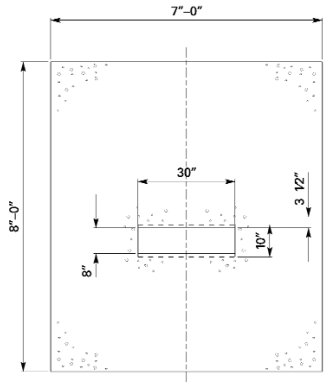
Switchgear collars



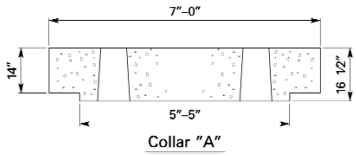
Collar "A"
15kV S/G Collar



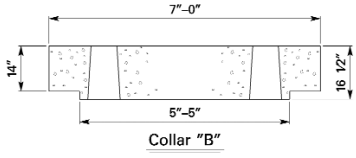
Collar "B"
25/35kV S/G Collar



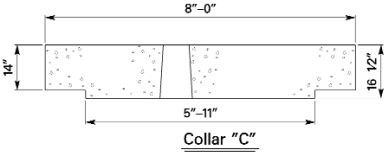
Collar "C"
PWVE Cooper Recloser



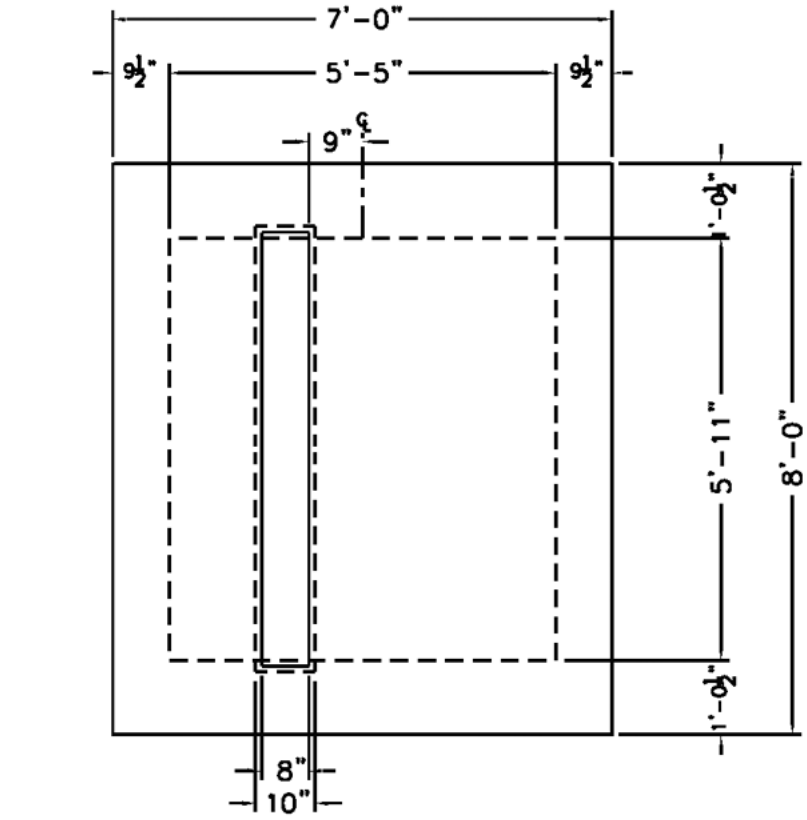
Collar "A"

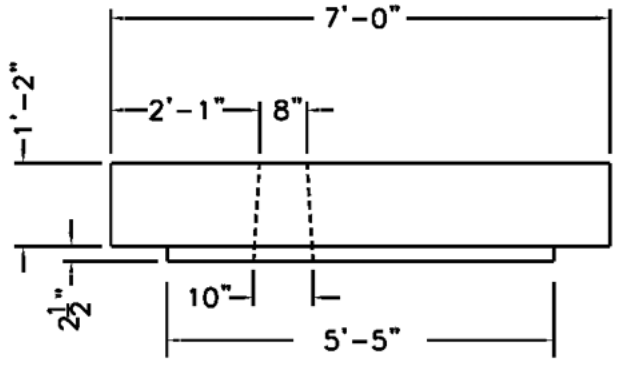


Collar "B"



Collar "C"

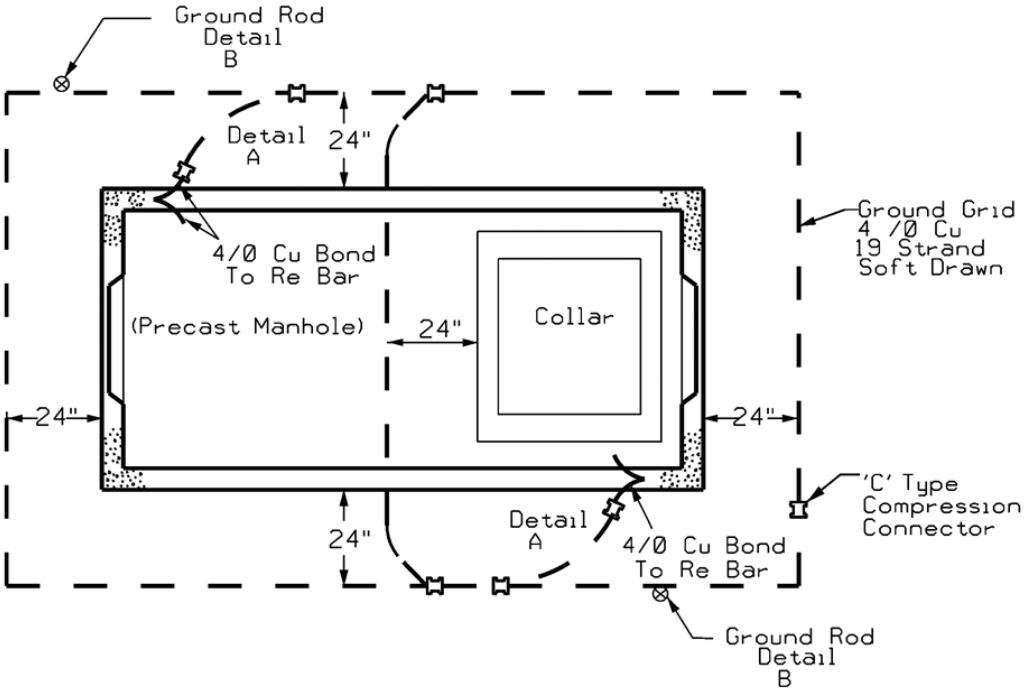




Collar D
35kV Vista Gear 3 AND 4 WAY

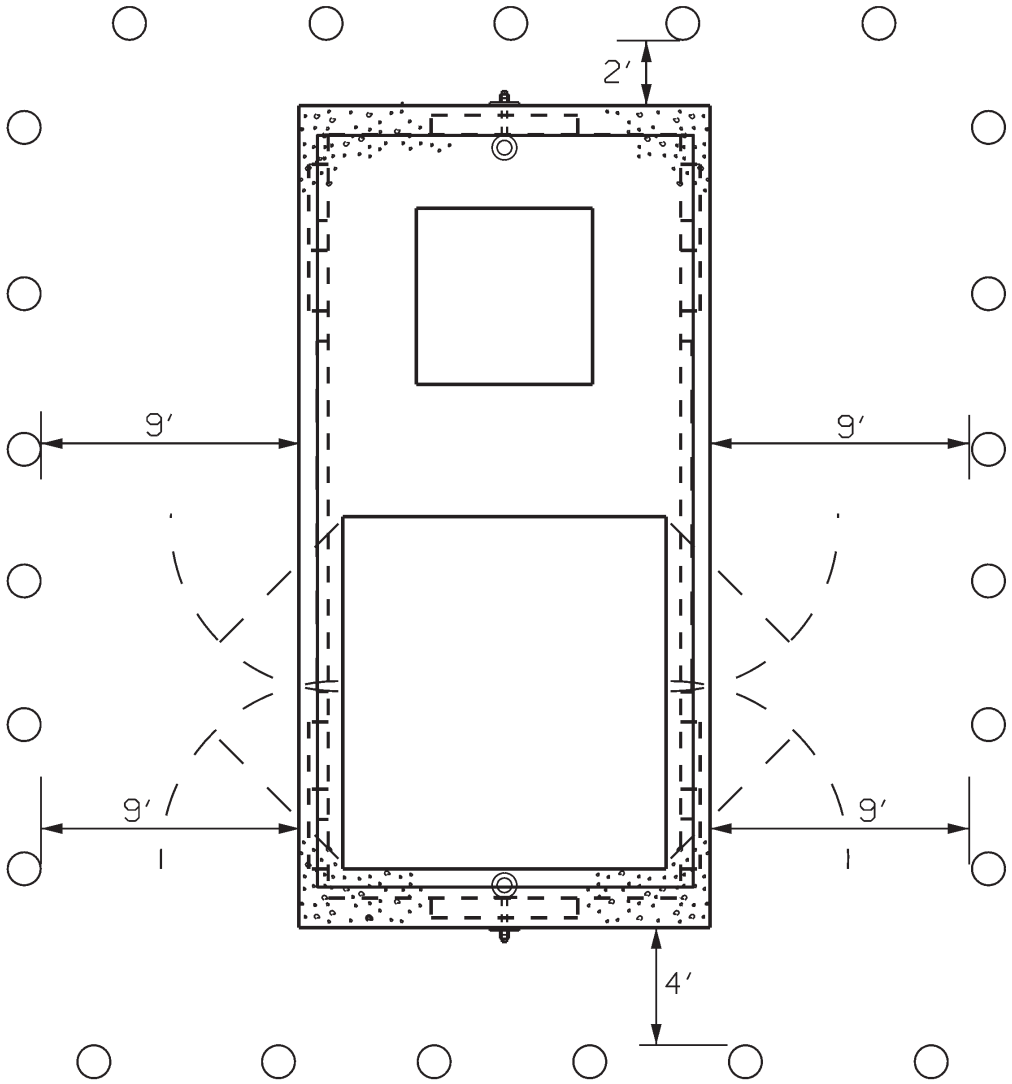
25.3 Switch Gear Manhole Ground Grid

The Customer shall install the ground grid for a switchgear manhole installation as shown in the picture.



25.4 Switch Gear Manhole Bollard Layout

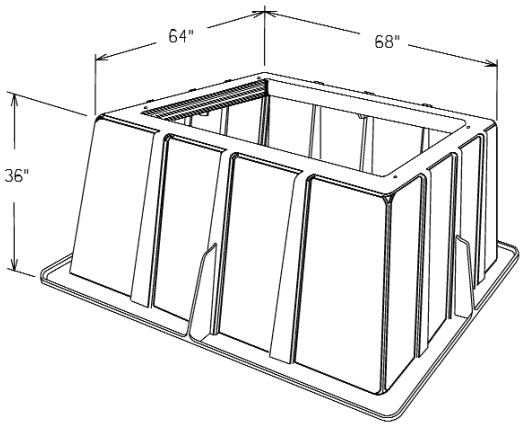
The drawing below depicts the locations for bollard installations around a switchgear manhole. Distribution Design/Planning and or company inspector shall designate the number and location of required bollards for each job. Refer to Transformer Mechanical Protection/ Bollards on page 12 for more details on Bollards.



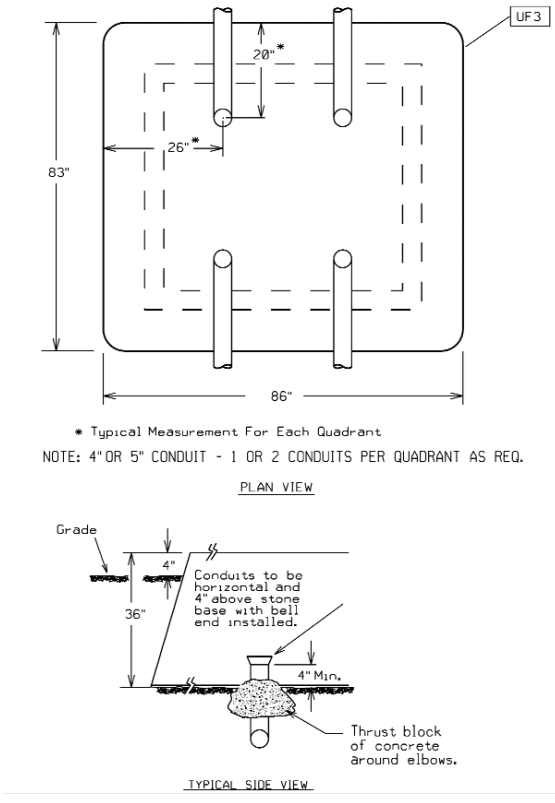
26.0 Fiberglass Switchgear Base with Conduit Entry's

The fiberglass switchgear base can be used as an alternate to the switchgear manhole in locations where allowed by the company. It is not recommended for installations where the primary coming into the base is 500MCM or larger.

***Note**: This base will only accommodate standard PMH-9, PMH 10, PMH 11 and PMH 12 switchgears.*

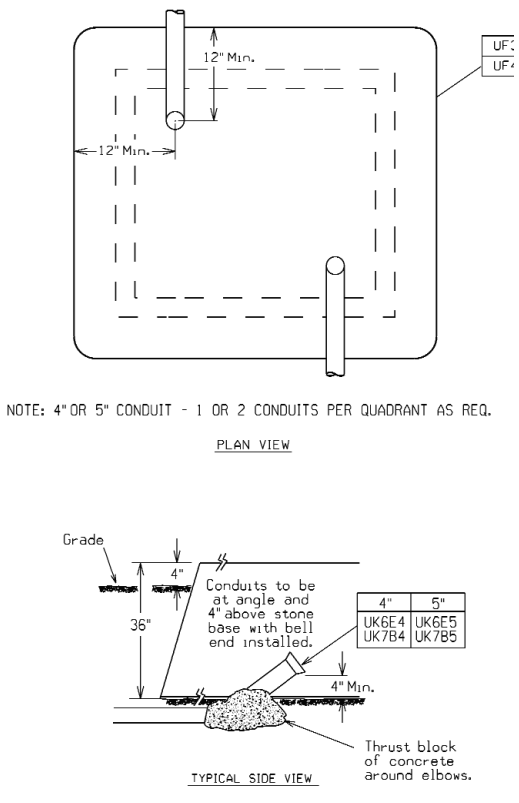


Typical Installation, Vertical Conduit Entry



4" or 5 " conduit

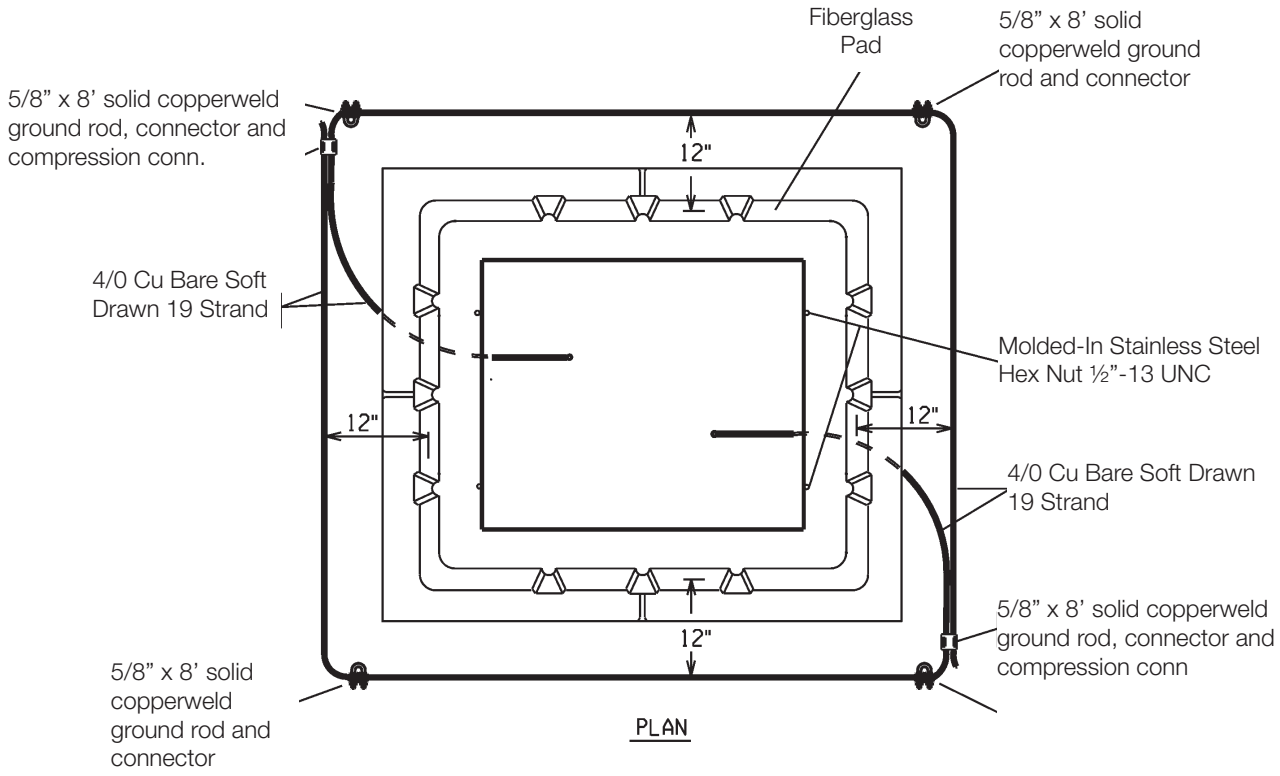
Typical Installation, Horizontal Conduit Entry

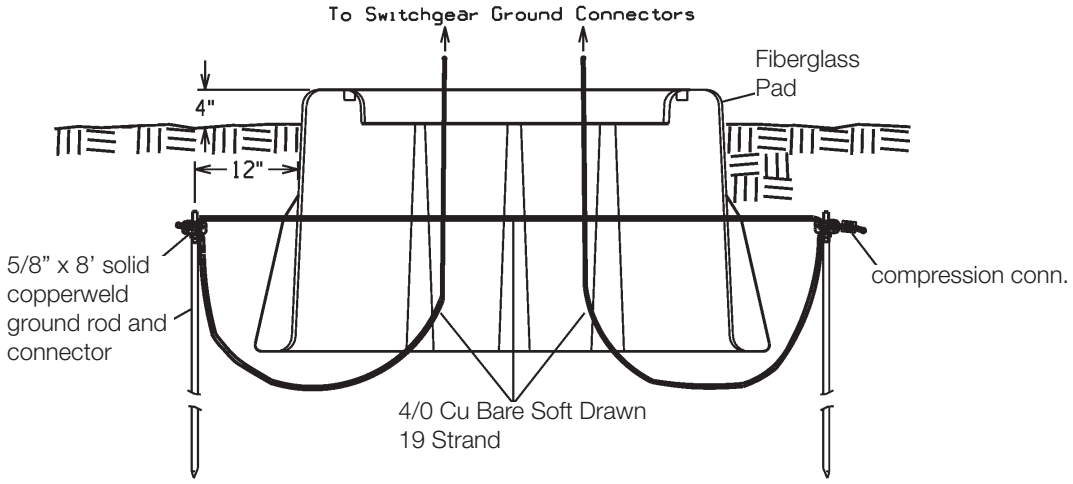


4" or 5 " conduit

26.1 Fiberglass Switchgear Ground Grid

The Customer shall install the ground grid for a fiberglass switchgear installation as shown in the picture.





Front Elevation

26.2 Switch Gear Fiberglass Boxpad Bollard Layout

The drawing below depicts the locations for bollard installations around a switchgear fiberglass boxpad. Bold outline referenced on drawing is the exposed outside sides of the boxpad. Distribution Design/Planning and or company inspector shall designate the number and location of required bollards for each job. Refer to Transformer Mechanical Protection/Bollards on page 12 for more details on bollards. Bold outline referenced on drawing below is the exposed outside sides of the boxpad.

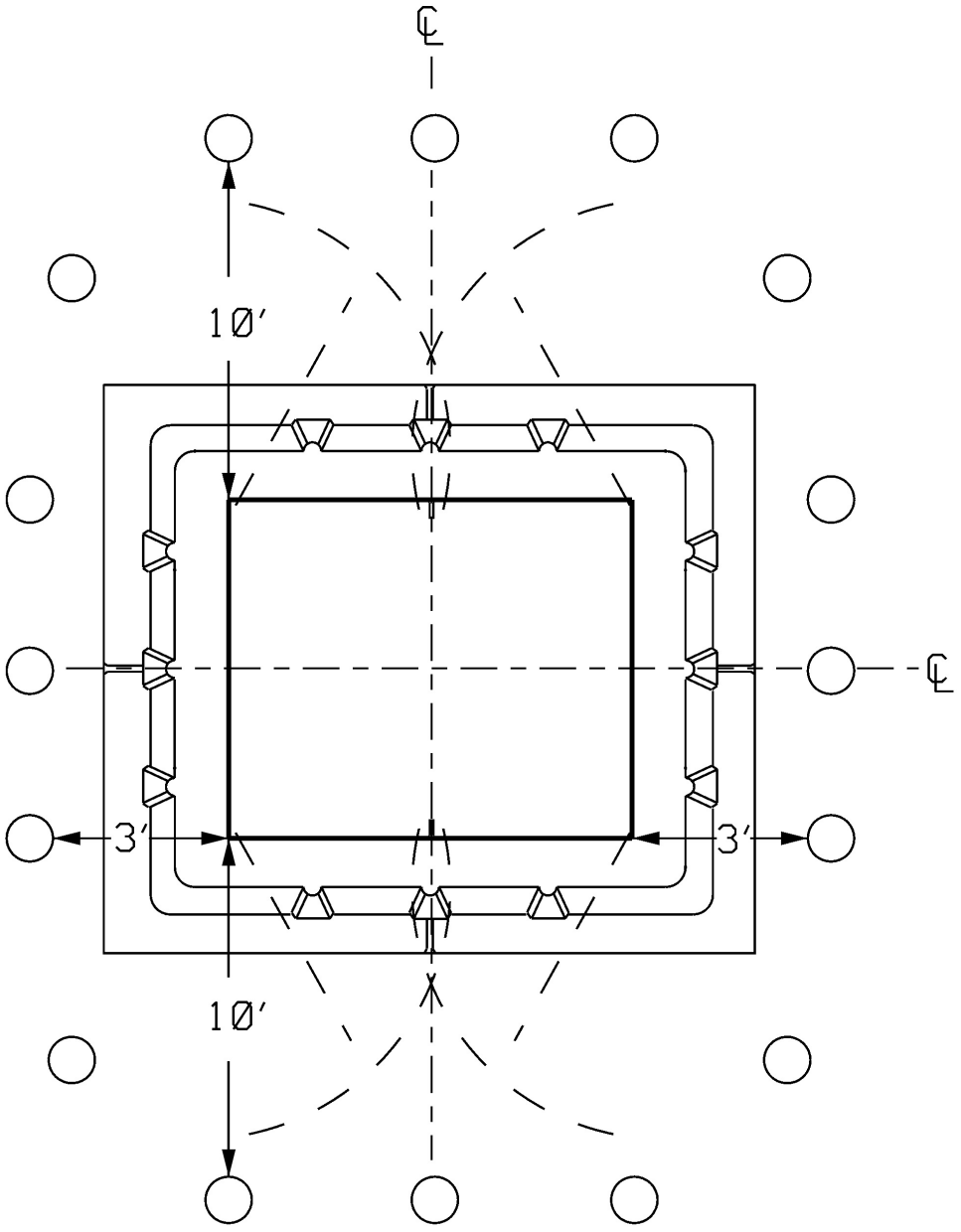


Figure 27.0-1 15kV Transformer Pad 75- 500kVA 44-113 (ref-44-113/UF8A)

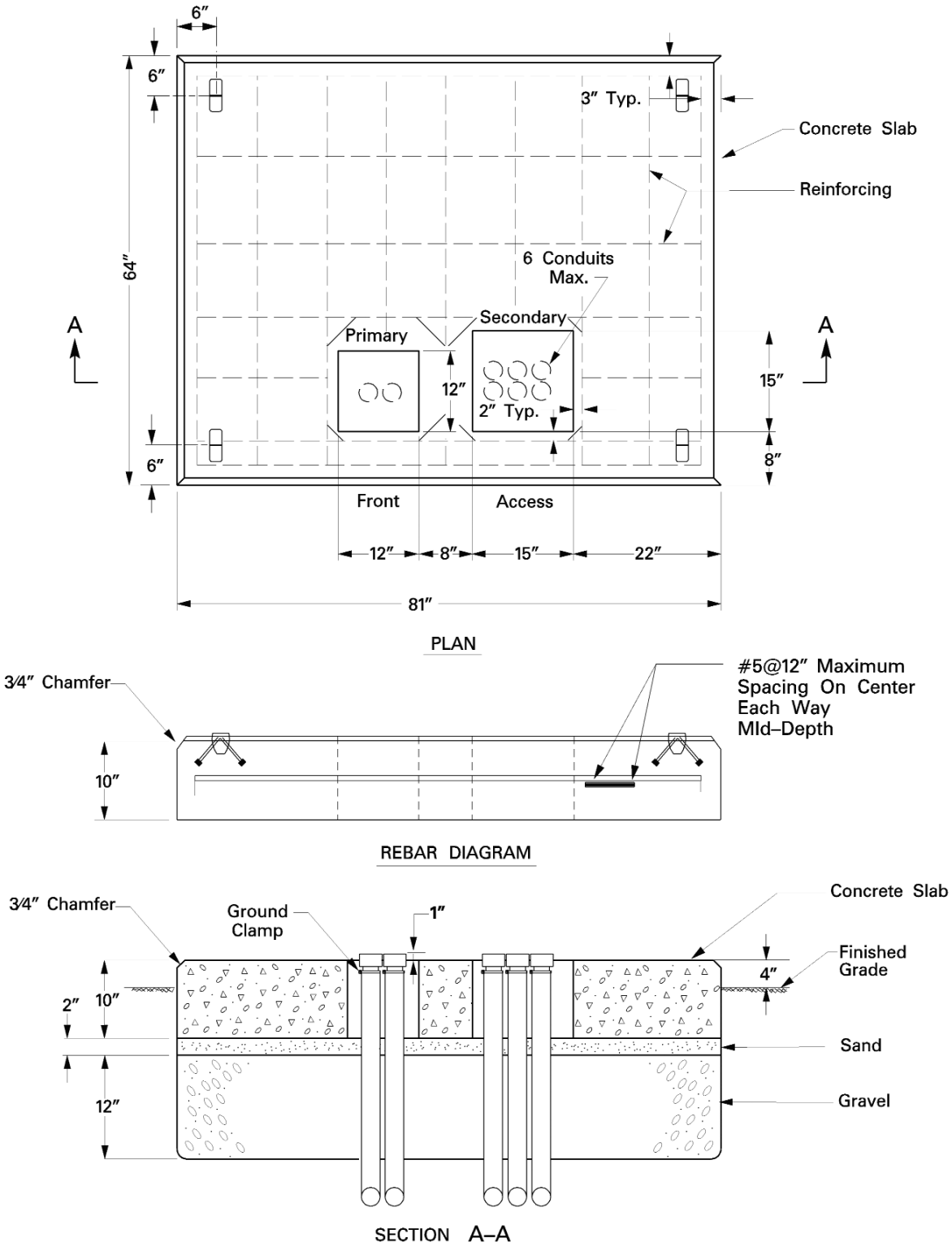
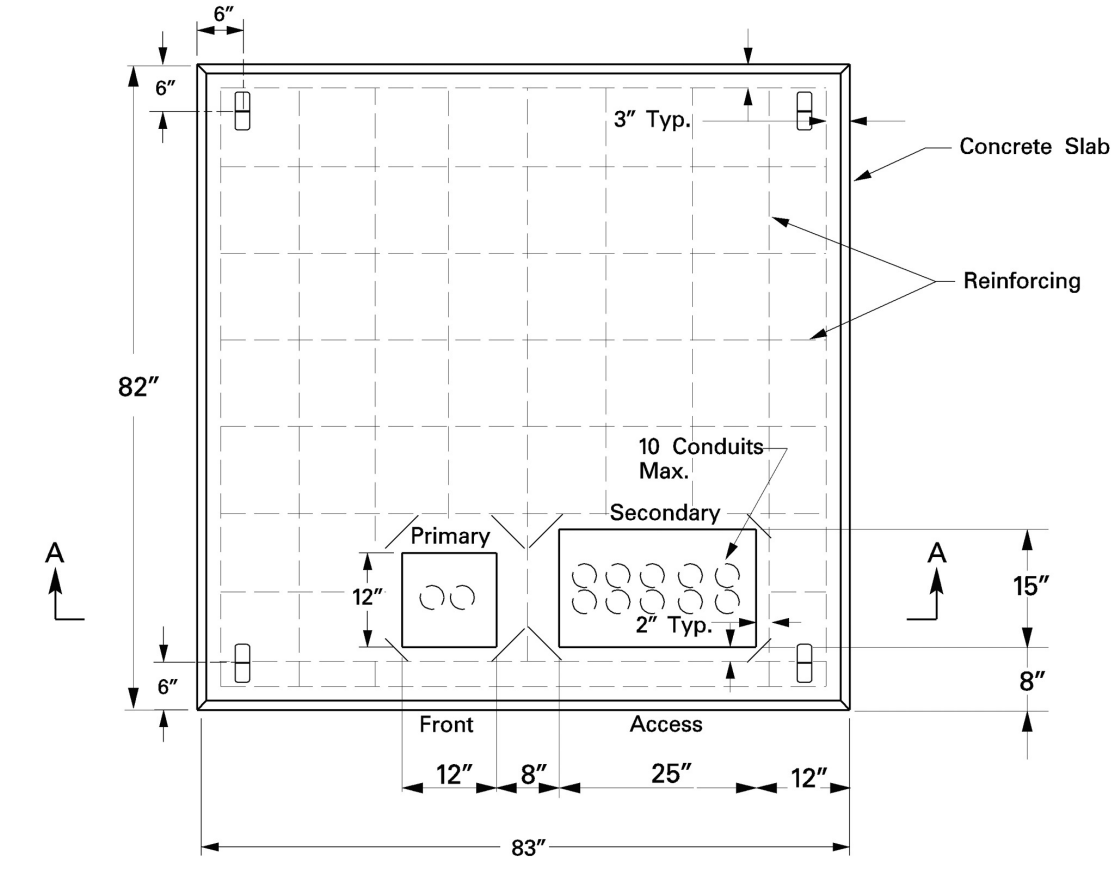
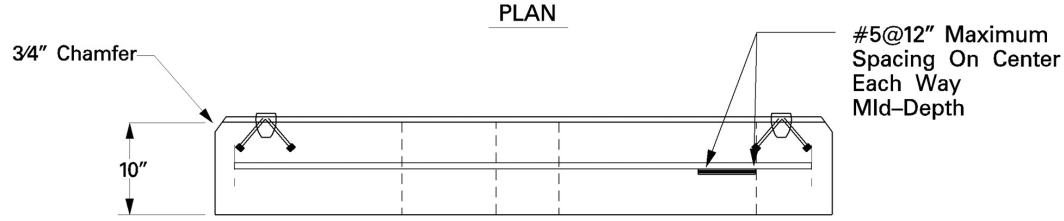


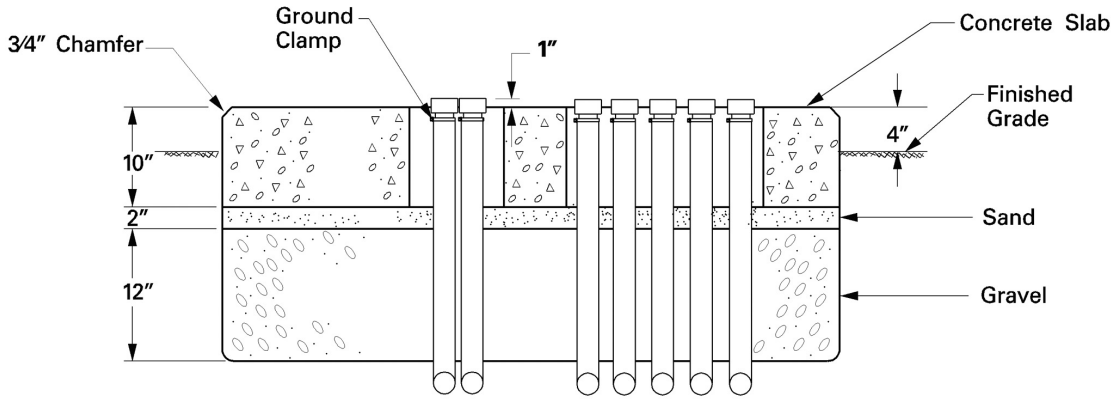
Figure 27.0-2 15kV Transformer Pad 750- 2500kVA 44-114 (ref-44-114/UF8B)



PLAN



REBAR DIAGRAM



SECTION A–A

Figure 27.0-3 25-35kV Transformer Pad 75- 300kVA 44-115 (ref-44-115/UF8C)

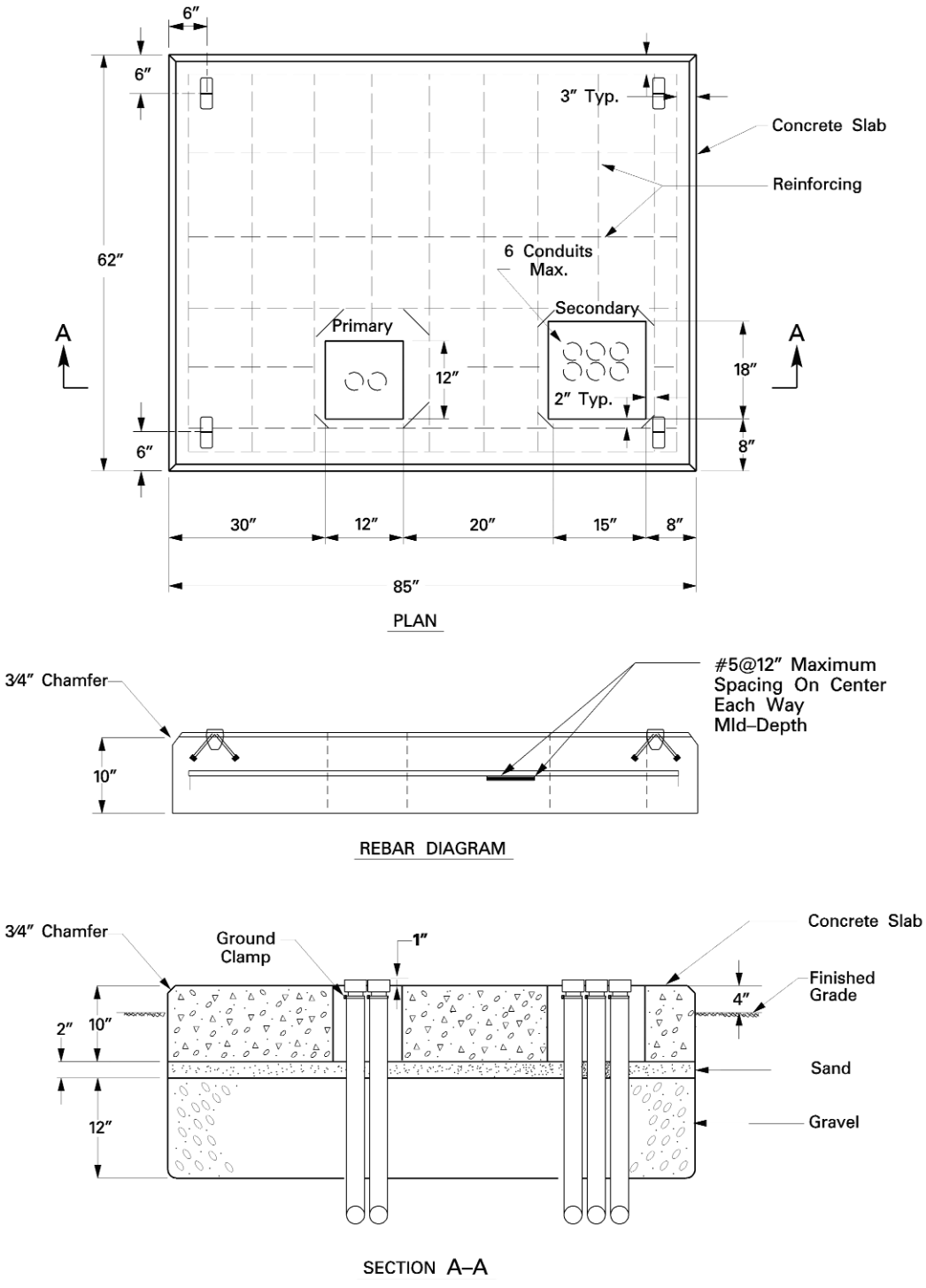
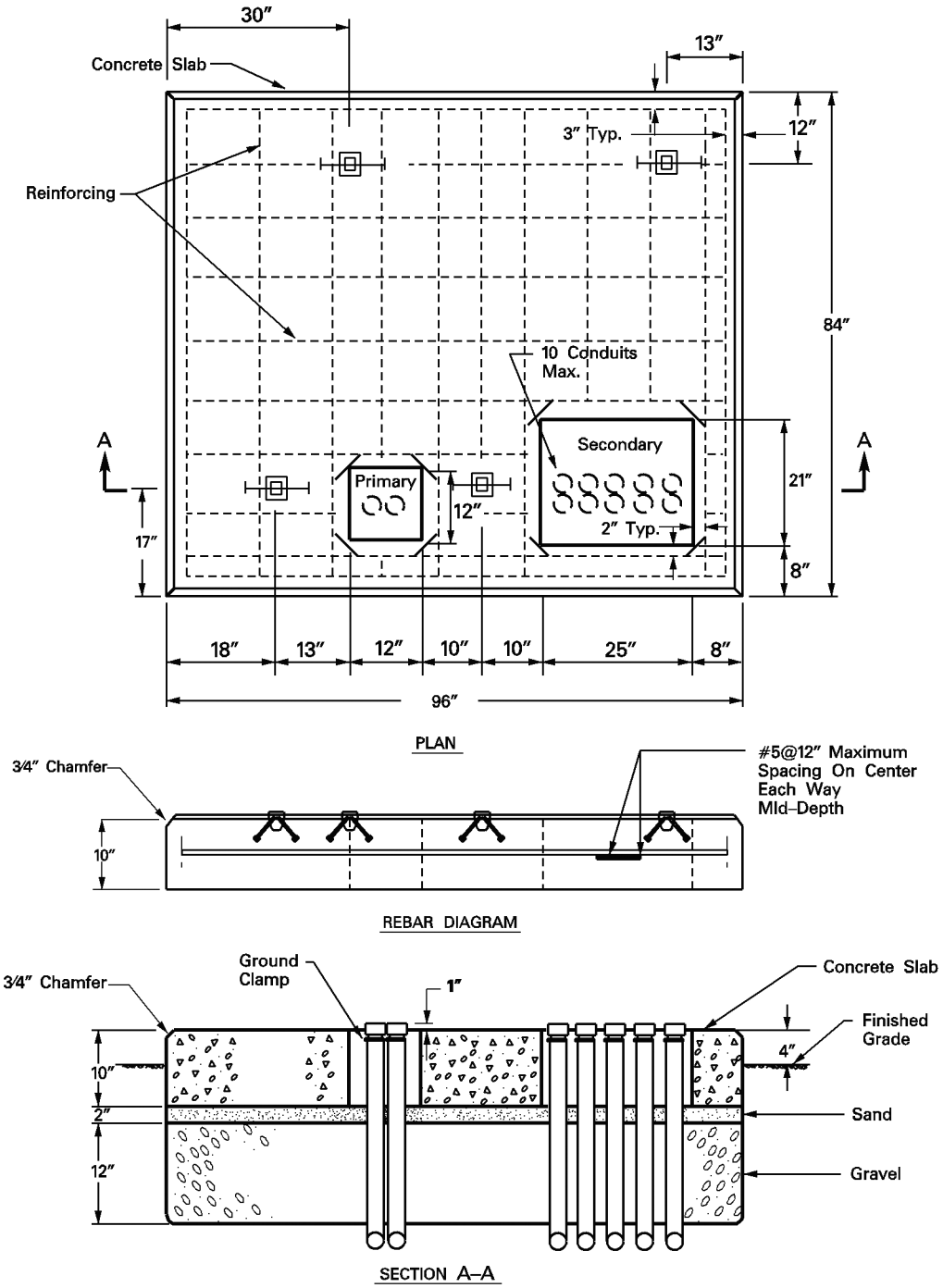


Figure 27.0-4 25-35kV Transformer Pad 500-2500kVA 44-116 (ref-44-116/UF8D)



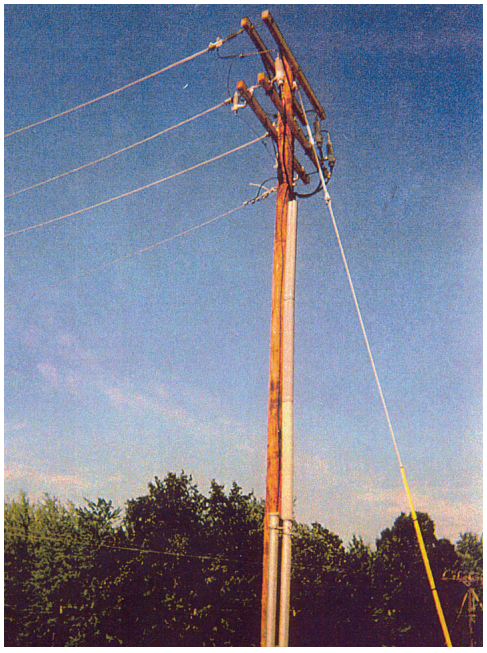
28.0 SAMPLE INSTALLATIONS

Picture of Conduit Installation Before Concrete Pour

Picture of Ballard Installation

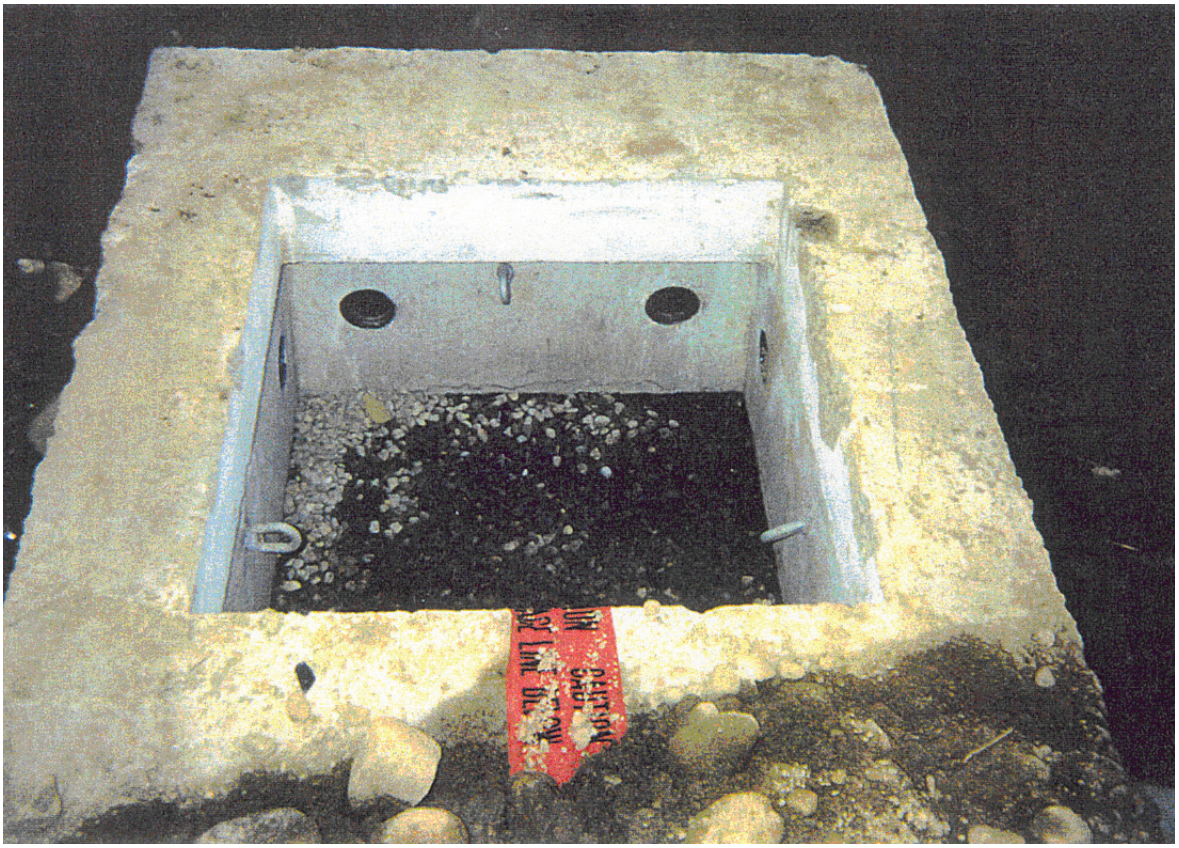
Pictures of a Riser Pole Installation

Riser Pole Bonding
Rigid Galvanized Steel. Bond higher than 8’ and at least 6” from top.

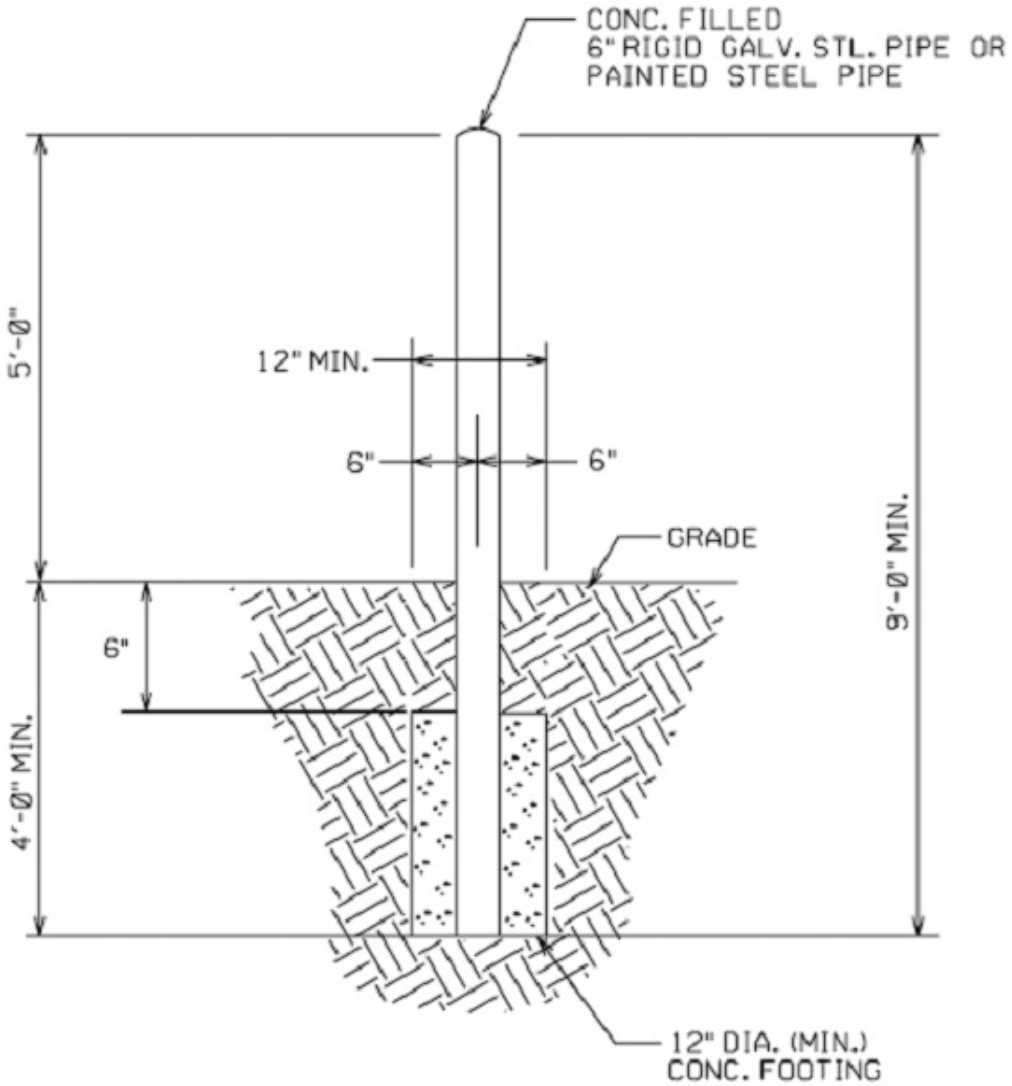


Completed Riser Pole
The Company will specify on which quarter of the pole the riser shall be installed, away from traffic.

Heavy Duty Handhole Installation



29.0 BOLLARD DETAIL



TYPICAL
BOLLARD DETAIL

30.0 CONCRETE SPECIFICATIONS

30.01 **SCOPE** - For general use of reinforced and plain concrete when job specifications are not being issued. Not for use when placing concrete underwater (Tremie concrete).

30.02 **MATERIALS** - Cement shall be a standard brand of Portland Cement Type II conforming to ASTM C150. If concrete is to be in contact with sea water or soils other than clean gravel, or if job conditions require earlier strength development than Type II provides, notify Civil Engineering for use of a higher strength or high-early strength concrete.

Sand shall be sharp and clean and shall conform to ASTM C33, latest revision.

Coarse aggregate shall be of gravel, crushed gravel or crushed stone and conform to ASTM C33, latest revision.

Water shall be from a potable water supply or tested and approved by Civil Engineering, assuring it is clean and free from injurious amounts of oil, acids, alkali, organic materials, or other harmful substances.

30.03 **READY-MIX CONCRETE** - Ready-mix concrete shall be proportioned at the plant. Mixing and delivery shall be in accordance with ASTM C94, latest revision. Mixes shall conform to Table 1 for minimum 28 day strength, nominal maximum size aggregate, and slump.

An air-entraining agent shall be added to concrete mixes in which the surface will be exposed to the elements. No other admixtures shall be used without approval of Civil Engineering. Air- entrainment content shall be as follows:

Mix M2 and M3:	7.0% plus or minus 2.0%	Mix M5:	4.5% plus or minus 1.5%
Mix M4:	5.0% plus or minus 1.5%	Mix M6 and M7:	6.0% plus or minus 1.0%

The Purchaser reserves the right to make tests at any time on materials used and concrete furnished by the ready-mix concrete supplier. The batch plant, equipment, and operating procedures are subject to inspection and approval by Civil Engineering or their qualified representative.

TABLE I - CONCRETE MIXES

Mix Number	Strength Minimum 28 Day Lbs/Square Inch	Aggregate Maximum Size Nominal	Slump Not More Than	Typical Uses
M1	2,000	1-1/2"	2"	Bedrock and Floor Fill
M2	2,000	1/2"	2"	Duct Lines - Tier Method
M3	2,000	1/2"	6"	Duct Lines - Unit Method
M4	3,000	1-1/2"	2"	Footings, Slabs on Ground, Foundation Walls, and Pile Caps
M5	3,000	1"	2"	Floor and Roof Slabs on Forms
M6	4,000	1"	2"	Hi-Strength Slabs and Walls
M7	5,000	1"	2"	Hi-Strength Slabs and Walls

Note: *If a greater slump is required, contact Civil Engineering for an additive to meet the specific job requirements.*

Ready-mix concrete shall be ordered in accordance with this Specification with a copy of same supplied to the ready-mix concrete manufacturer. The cubic yards, delivery point, time schedule, and applicable mix number for the particular application shall be specified on the order.

Delivery of a concrete batch in excess of the rated mixer drum capacity is cause for rejection. The latest drum inspection certificate should be available for verification.

30.04 **CONCRETE - DELIVERY AND MIXING** - In the event that delivery of concrete is called for when the air temperature is below 40º F the following shall apply:

a. When the air temperature is between 30º F and 40º F, the concrete shall be delivered in excess of 55º F.

b. When the air temperature is between 0º F and 30º F the concrete shall be delivered at a temperature in excess of 60º F.

In hot weather concrete shall be delivered at a temperature which will not cause difficulty from loss of slump, flash set, or cold joints. Discharge of concrete at the job site shall be completed within one (1) hour of adding the mixing water.

30.05 **CONCRETE - FORMS** - Formwork shall be designed and constructed in accordance with the American Concrete Institute's "Recommended Practice For Concrete Formwork", ACI 347, of latest date.

Forms shall be built substantially; true to form, lines, dimensions, and grades shown. They shall be braced and tied to maintain position and shape, without yielding to pressure of fluid concrete or other forces, including those produced by vibratory compaction.

Forms shall be constructed of 3/4" BB grade plywood supported with 2 x 4 studs on 16" centers. Forms shall not exceed a 10' pour height and form tie spacing shall not exceed 2'. Form ties and accessories, manufactured by Richmond Screw Anchor Company or equal, shall be used. Prefabricated forms are allowed after approval by Civil Engineering. The forms shall be vertical and symmetrical and in the largest sizes practicable. Sheets showing torn grain, worn edges, hole patches, or other defects, which impairs the texture of the concrete surface, shall not be used.

Forms shall be treated with approved form oil, before erection or reinforcing steel placement, to prevent adhesion of the concrete.

Forms shall be mortar-tight. For surfaces which will be exposed, the form faces shall be smooth and mortar-tight.

Forms shall be removed carefully to avoid damage to the concrete surfaces. The removal time is governed by the concrete's condition, curing temperature, curing time, and the forces the new concrete may be subjected. Under favorable curing conditions, forms may be removed no sooner after placement than the following:

- seven (7) days for supported floor and roof slabs
- 48 hours for wall and columns
- 24 hours for footing walls and piers
- 12 hours for underground duct lines

If high-early strength concrete is used, the above time periods may be reduced by one-half.

These periods presented are the cumulative number of days or fractions thereof, not necessarily consecutive, during which the concrete temperature is above 50º F. Whenever formwork is removed during the curing period, the exposed concrete shall be repaired immediately, finished, and cured as specified under "Concrete - Curing".

30.06 CONCRETE - PLACEMENT - Concrete shall not be placed until the forms, previously poured concrete surfaces, reinforced steel, and embedded parts have been cleaned of laitance, loose or defective concrete, soil on rock surface, and any other foreign materials.

All concrete placed when the air temperature is above 45º F shall be placed at the coolest temperature as practicable. Concrete placement is not permitted when hot weather conditions prevent proper placement and consolidation. Concrete will not be accepted if its temperature is in excess of 80º F.

When the mean daily temperature falls below 40º F, the minimum concrete temperature shall be 55º F and as close to this minimum as possible.

When the air temperature is below 40º F, provide suitable protection so the concrete can be maintained at a minimum of 50º F throughout the curing period. The protection and heat source, shall maintain the required temperature and moisture conditions without injury due to concentration of heat. All materials which the concrete contacts such as reinforcing, forms, ground, etc., shall be free of frost prior to placement.

Concrete temperature changes during and immediately following the curing period shall be as uniform as possible and shall not exceed 5º F in any one hour, nor 40º F in any 24 hour period. When heaters are used, prevent local surface heating and drying and provide adequate ventilation to prevent carbonation damage to exposed concrete surfaces. Thermostatic temperature controls shall be provided to control the heated enclosures to 50º F. Temperatures exceeding 80º F are to be avoided.

Concrete shall not be allowed to fall from the end of a chute, tube, or bucket more than 5 feet to point of deposit and shall have a fall free from obstructions. Chutes shall be metal or metal-lined.

Pumping equipment, pipelines, procedures, etc., shall be in accordance with ACI 304R, latest revision, and Civil Engineering shall be consulted for mix design of any pumped application. Conveying equipment for pumped concrete shall be of suitable kind, without “Y” sections and with adequate pumping capacity. No aluminum pipe shall be used. Placement shall be controlled so there is no separation in the discharged concrete. The maximum loss of slump in pumping equipment shall be 1½”.

Concrete shall be deposited as near to its final position as possible to avoid long flows in the forms. Concrete shall not be moved more than 10' from point of deposit. Concrete shall be placed in successive horizontal layers, ranging in thickness from 6" to 15" maximum. Concrete shall be placed within 1½ hours after addition of cement to the aggregate.

Where conditions make it difficult to place concrete uniformly and perform compaction at the bottom of forms, batches of mortar containing the same proportion of cement to sand as in the concrete mix shall be deposited first and spread over the cleaned surface to a depth of approximately 1".

Segregated, unworkable, and excessive slump concrete shall not be placed or, if placed, shall be removed and wasted as directed. High slump concrete resulting from addition of approved additives is acceptable for placement. Free water accumulating on new concrete during placement shall be removed as directed by the Engineer.

Placement and compaction methods shall ensure homogeneous concrete with maximum consolidation without segregation. Consolidate concrete by internal vibration, spading, or rodding by working it thoroughly around reinforcement, embedded items, and into corners of forms to eliminate all air or stone pockets which cause honeycombing,

pitting, or planes of weakness. Concrete contacting all formed surfaces shall be spaded manually to eliminate air bubbles.

Place horizontal construction joints at uniform vertical spacing unless otherwise shown on the drawings. Concrete shall not be placed to a depth of more than 10 feet in any 24 hour period, unless approved by Civil Engineering. All concrete placements shall be such as to keep cold joints from forming.

Whenever work is suspended on any section for more than one hour, the horizontal edges of the concrete next to the forms shall be brought to a plane perpendicular to the form face, and treated so no irregular, rough, or feathered edge joints show in the finished work. Before placing the next lift, clean the joint surface and remove all laitance. Immediately before placing new concrete wet the joint surface and remove all standing water.

Unless adequate weather protection is provided, do not place concrete during rain, sleet, or snow.

30.07 **CONCRETE - CURING** - Protect freshly deposited concrete from premature drying and hot or cold temperatures. Maintain a constant temperature throughout the curing period without drying.

All exposed concrete surfaces shall be kept continuously moist overnight by ponding, sprinkling, or by use of an approved membrane type curing compound, which conforms to ASTM C309, latest revision, and applied in conformance with the manufacturer's recommendations.

Curing shall continue, using one of the above methods or waterproof paper, for a 7 day period (3 days for high-early strength concrete) maintaining the concrete at a minimum temperature of 50° F as is practicable. Protective covering with tarpaulins, hay, straw, etc. shall be provided to retard moisture evaporation during hot weather and to prevent rain damage before hardening. Protective covering shall be available for immediate use at all times.

During the curing period, the concrete shall be protected from damaging mechanical disturbances, particularly load stresses, heavy shock, and excessive vibration.

30.08 **SURFACE FINISH** - All surface fins shall be removed.

Exposed concrete surfaces shall not be given any special treatment to enhance appearance, such as rubbing with a stone, without permission of Civil Engineering.

30.09 **LOADING OF CONCRETE -** Normal concrete structures shall not be subjected to external loads in less than:

- four days for foundations, manhole floors, and walls
- seven days for floors, roofs, and columns

Each concrete placement shall be allowed to set 48 hours before addition of a subsequent pour upon it. If high-early cement is used this time period may be reduced by one-half.

Trenches containing concrete encased duct lines constructed on undisturbed original ground may be backfilled not less than two (2) hours after placement. Compaction by light tamping equipment may proceed immediately. Loading of the backfill by heavy equipment or traffic is not permitted before 12 hours after placement.

30.10 **WATERPROOFING -** Waterproofing is provided by the density of the concrete mix and the thickness of concrete. Care must be used in placing and compacting the concrete to eliminate all voids and potential leakage paths. When structures less than 8" thick must be waterproof, consult Civil Engineering to revise the mix design to achieve the desired waterproof result.

31.0 Easement Applications

31.1 NEW ENGLAND EASEMENT APPLICATION FORM

FOR NATIONAL GRID'S USE ONLY

Application for Easements (check one): ❒ OH (jointly owned or solely owned) ❒ UG ❒ Electric
❒ Padmount transformer only ❒ URD ❒ Gas

Work Request Number_____

Utility Engineer's Name:_____Telephone Number: _____

Please complete **ALL** of the sections below so that we may prepare an easement for your signature. Do not leave any sections unanswered. If a section does not apply to you simply put **"n/a"** on that line. Incorrect or incomplete information will delay service installation.

Property Owner(s):_____

Property Owner Mailing Address	**Property Address of Easement** (if different from mailing address)
Address:	Address:
City:	City:
State & County	State & County
Zip	Zip

Customer Contact Person: _____

Daytime Phone(s): _____

Re: Subdivision Title: _____

1. Provide us with a **RECORDED** copy of the present owner's deed, Book_____ Page_____

   a) If multiple deeds make up the whole parcel, please include all deeds.

   b) If the Property Owner is a b1) CORPORATION, b2) TRUST, b3) PARTNERSHIP, or b4) LIMITED LIABILITY COMPANY, provide the following which is applicable:

   b1) President Name: _____Treasurer Name: _____
   See Footnote[1] Below

   Or

   Vice President:_____Asst. Treasurer:_____

[1] If neither "Name Combinations" is available, the person(s) signing the easement must have a Corporate vote authorizing them to sign on behalf of the Corporation.

b2) Trust: No. Of Trustees:_____Name(s): _____

Name of Trust:_____

b3) Partnership: Number of Partners:_____Name(s):_____

b4) LLC: Authorization to Sign, Name(s):_____

2. a) Provide us with an approved: "Definitive Subdivision Plan"

Plan Book:_____ Plan:_____ Dated:_____

b) If there is no recorded subdivision plan please include the following information:

Assessor's Map:_____Block:_____ and Lot:_____

3. Is your property mortgaged (circle one)? YES NO

If "YES", please complete this section:

a) Name of Bank/Company/Person holding mortgage(s):_____

b) Address of mortgage holder(s): _____

c) Date and recording information of mortgage(s): _____

Date:_____County Recorded:_____Book:_____Page:_____

Additional Comments:_____

Please contact your Account Manager or Service Administrator if you have any questions regarding this form.

31.2 NEW YORK EASEMENT APPLICATION FORM

Application For Utility Electric/Gas Distribution Easement

This Portion to be Completed by National Grid Representative
Application Date Received:_____
Type of Easement: ❒ OH (jointly owned or solely owned) ❒ UG Electric ❒ Gas ❒ Padmount transformer only ❒ URD
National Grid Representative_____ **Telephone**_____

Requestor of Service

Please complete **ALL** of the sections below so that we may prepare an easement for your signature. Do not leave any sections unanswered. If a section does not apply to you, simply put "n/a" on that line. **(Incorrect or incomplete information will delay service installation.)**

Property Owner(s): _____

Property Owner Mailing Address

Address: _____

City/Town: _____

State: _____

Zip Code: _____

Telephone: _____

Property Address of Easement
(if different from mailing address)

Address: _____

City/Town: _____

State & Country: _____

Zip Code: _____

Name of Subdivision: _____

Telephone: _____

Contact Person: _____

Daytime telephone(s): _____

1. Provide us with a **RECORDED** copy of the present owner's deed (and survey) if available. If multiple deeds make up whole parcel, please include all deeds.

   Book: _____ **Page:**_____

2. Tax map number of property where service is to be installed (SBL): _____

3. Recording reference to approved subdivision plan:

   Plan Book: _____**Plan:** _____ **Date:** _____

4. If the property owner is a (a) CORPORATION, (b) TRUST, (c) PARTNERSHIP, or (d) LIMITED LIABILITY COMPANY, provide the following which is applicable:

(a) CORPORATION NAME: _____

President:_____Treasurer:_____

Vice President: _____Assit. Treasurer: _____
(If none of the Officers listed above are available, the person(s) signing the easement must have a corporate vote authorizing them to sign on behalf of the Corporation.)

(b) TRUST NAME:_____

Number of Trustees:_____Names: _____

_____

(c) PARTNERSHIP NAME: _____

Number of Partners:_____Name(s):_____

(d) LIMITED LIABILITY COMPANY (LLC) NAME: _____

Authorization to sign – Name(s):_____

Note: As a public utility, National Grid is required to provide electric/gas service; however, you, the customer, are required to provide National Grid with all the easement rights necessary to install your electric/gas service, including any easement rights which must be acquired from others.

Please return or fax this document and the requested information to:

{National Grid Representative}

{Company name}

{Location: Street name}

{Location: City/Town, State, Zip Code}

{Fax number}

32.0 Concrete Approved Precast Manufacturers

Arrow Concrete Products
560 Salmon Brook St
Granby,CT 06035
Jim Jurczyk
1-860-653-5063

Fort Miller Company
P.O. Box 98
Schuylerville, NY 12871
Joe O'Malley
1-518-695-5000

Hoytes Concrete Products
7839 New Floyd Road
Rome NY 13440
Thomas Hoytes
1-877-336-7789

Kistner Concrete Products Inc.
5550 Hinman Rd
Lockport, NY 14094
1-716- 434-6157
Old Castle Precast
41 Almeida Rd
Rehoboth MA 02769
Bruce Blackledge
1-508-336-7600

United Concrete
173 Church St.
Yalesville CT 06492
Tom Long
1-203-535-4114

D.A. Collins
101 Route 67
Mechanicville, NY 12118
Andrew Timmis
1-518-664-9855

Grimm - Green Island
Green Island, NY 12183
1-518- 272-1100

Jefferson Concrete
22850 Murrock Circle
Watertown NY 13601
1-315-788-4171

Lakelands Concrete
7520 E. Main St. Lima NY 14485
Carl Ashley
1-585-624-1990

Shea Concrete
87 Haverhill Street
Amesbury, MA 01913
Greg Stratus
1-800-696-7432

Utility Precast Inc.
153 Cranberry Highway
Rochester MA 02770
1-508-291-1314

33.0 Approved Material – Underground Commercial Installations

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
		Conduit—Straight		
2010404	Conduit, 4", schedule 60 DB PVC	Carlon: 48815	IPEX: 8741	Cantex: A79EA42
2011024	Conduit, Galvanized, 4"	By Description		
		Conduit—Blends		
5690446	Bend, Galvanized, 4" 36" radius	BaynesJones 400R9036	Conditmfg TUB490D36RGALEL	
5690493	Bend, PVC Sch 40, 4", 90 Degree, 36" Rad.	Cantex: 5233842	Carlon: UA9FNB	Certifsaft 59734
		Spacers		
5646963	Spacer, 4", Base	GS Industries: 186-1	IPEX: 29573	
5646960	Spacer, 4", Inter.	GS Industries: 185-1	IPEX: 29557	
		Conduit Accessories		
5641210	Riser Strap, 4"	Electrical Materials: 50-4 USHD	BaynesJones MINRLAC HD-296	
7011830	Lag Screw, 1/4" x 2"	Elect. Materials: 106 or 106M	Joslyn J26486.1	PLH LSNW-142
3503074	Pipe Grd. Connector, 4" and 5"	Burndy GAR3905-BU	Thomasbett (0)3905-BU	
2010424	Temporay Duct Plug, 4" DB	Carlon: P258NT	Scepter 57	
2011254	Duct Plug Galvanized 4"	Crousehind PLG105		
2010434	Adapter, Female, PVC-Steel, 4"	Carlon: E942N	Cantex: 5140052	Scepter FA55
5693359	Coupling, 5 Degree, Bell-Spigot, 4"	Carlon: E244N	Cantex: 6151452	Certifsaft 59544
2010444	Coupling, 5 Degree, Bell-Bell, 4"	Ameripipe FT518	Carlon E2440NF	Scepter 7604360040
2010454	Straight Coupling, 4"	Carlon: E240N	Scepter 760443540	
2010464	Bell End Female 4"	Carlon: E997N	Cantex: 5144012	
9202062	Mule Tape	NEPTCO WP2500P	Arnco DLWP25	Condux 08096303
2011254	Plug Galvanized. 4" Threaded for Spare Riser	CROUSEHIND PLG105		
9202201	Plug Conduit 4" with metal loop for mule tape.	Carlon MAEPG7		

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
Transformer Foundations – Precast				
9200896	Three Phase 15 kV 75-500 kVA	Reference 044-113 UF8A	Lakeland UF8A	
9202324	Three Phase 15 kV 750-2500 kVA	Reference 044-114 UF8B	Lakeland UF8B	
9200898	Three Phase 25-35kV 75-300kVA	Reference 044-115 UF8C	Lakeland UF8C	
9200896	Three Phase 25-35kV 500-2500kVA	Reference 044-116 UF8D	Lakeland UF8D	
Grounding Accessories				
2011100	Grounding Bushing, 4"	CROUSEHIND GLL-10C	OZGEDNEY BLG 4122	
3503013	Grounding Rod 5/8" x 8' Solid Copperweld	ERITECH 615880	Galvin 6258	Joslyn: J8338
9201272	2/0 Cu, Bare, Soft Drawn, 19 Strand	By Description		
3503328	Ground Rod Clamp	Burndy: GRC58	Blackburn: JAB58H	Electromotion EM58DBW
5960412	"C" Connector, 2/0 – 2/0	Burndy: YC26C26TN		
3503074	Clamp, ground, conduit 4" heavy duty, Bronze	Burndy GAR3905-BU		
Splice box, Handhole, Switchgear Manhole				
5640808	Splice Box as shown on page 22	CDR Systems PA12-3060-37	Highline CVA306038HEIK	
5643075	Heavy Duty Handhole on page 21	Oldcastle Precast 502600		
9200893	Switchgear Manhole 15kV	OldcastlePrecast 202700/203400/203900		
9200894	Switchgear Manhole 25-35kV	Oldcastle Precast 202700/203400/204000		
2012198	Fiberglass Switchgear Base on page 33	HighLine HL-54		
Precast Oil Containment Wall				
9202153	Three Phase 15 kV 75-500 kVA	Oldcastle 13411	Lakeland TPC UF8A	Arrow S-OCC 134110
9202154	Three Phase 15 kV 750-2500 kVA	Oldcastle 135134	Lakeland TPC UF8B	Arrow S-OCC 135134
	Three Phase 25-35kV 75-300kVA	Oldcastle 13411	Lakeland TPC UF8C	
	Three Phase 25-35kV 500-2500kVA		Lakeland TPC UF8D	

National Grid Item ID	Item Description	Manufacturer 1 Part Number	Manufacturer 2 Part Number	Manufacturer 3 Part Number
	Manhole Frame, Ring and Cover			
5644514	Frame 36” square	Lebaron Foundry LE386	Syracuse Casting	
5644550	Ring 26” to 36”	Lebaron Foundry LE2836X1	Syracuse Casting	
5644360	Cover 26”	Lebaron Foundry L28C11	Syracuse Casting	

34.0 Other Materials/ Suppliers

Secondary connectors

Burndy Co

Richards Co

Utilco

Compression Connection Crimp Tool
(used for ground grids)

Burndy MD7-8 with the extra die set (W-BG).

Stuart C. Irby Co
4583 Buckley Road
Liverpool, NY 13088
Peter Karl
1-315-652-1238

Secondary Splice box

Elliot Industries

A.B.B.

Manhole frame, ring and cover

Lebaron Foundry
1-800-626-4653

Syracuse Casting
1-315-699-2601

Bollard Covers

Part number # BC760YW

Innoplast 1-800-516-9287

The materials in this book can be found at most Electrical supply stores, listed below are a few.

Baynes Electrical Supply
Southern MA and RI
1-800- 242-0911

Electrical Wholesalers
All of New England
1-800-522-3232

Granite City Electric
All of New England
1-800-850-9400

Graybar Electric
All service areas US
1-800-472-9227

Wesco
New Hampshire
1-800-258-5228

35.0 Job Check Off Sheets

35.1 3 PHASE UCD DIRECT BURIAL INSPECTION CHECK LIST NEW YORK

Do not backfill BEFORE trench has been inspected and approval by Company. Every item listed below must be inspected and checked by the company inspector.

N*	Y*	
		PRE-TRENCH *(no inspection)*
❒	❒	Final grade established, surface rough graded, and roadways staked.
❒	❒	Developer has Service Specifications on site.
❒	❒	Easement has been executed.
		TRENCH
❒	❒	Min. 30" depth from existing grade to top of cable during all phases of construction.
❒	❒	Electric infrastructure on “road side”, in all multi-utility trench installations.
❒	❒	Min. separation between electrical conduit and foreign conduits or pipes.
❒	❒	All road crossing perpendicular.
❒	❒	2” minimum of sand in base of trench.
		PRE-BACKFILL *(After cable is installed)*
❒	❒	4” of sand minimum on top of cable
❒	❒	Minimum separation to foreign utilities and subsurface pipes maintained.
❒	❒	Sand or screened backfill (with less than 1” stones) on-site for backfilling entire trench, (inspector may witness backfilling).
❒	❒	Warning tape 8" to 12" below finish grade and directly above electrical system.
❒	❒	No parallel non company utilities directly above or below electrical system.
		RISER POLE
❒	❒	90° BEND AND straight pipe galvanized steel conduit,. 90° Bend Concrete Encased
❒	❒	Steel-PVC adapter and steel sweep shall not be encased.
❒	❒	Ground clamp installed with tap.

**NOTE Y – Acceptable N – Deficient*

35.2 3 PHASE, CONDUIT ENCASED IN CONCRETE INSPECTION CHECK LIST

Do not pour concrete or backfill BEFORE conduit system inspection and approval by company inspector. Every item listed below must be inspected and checked by a company inspector.

N*	Y*	
		PRE-TRENCH *(no inspection)*
❒	❒	Final grade established, surface rough graded, and roadways staked.
❒	❒	Developer has Service Specifications on site.
❒	❒	Easement has been executed.
		TRENCH *(prior to concrete encasement)*
❒	❒	Min. 30" depth from existing grade to top of encasement during all phases of construction.
❒	❒	Electric conduits on “road side”, with 1 spare conduit, in all multi-utility trench installations.
❒	❒	Min. separation between electrical conduit and foreign conduits or pipes.
❒	❒	All road crossing perpendicular.
❒	❒	Conduit plugs installed.
❒	❒	Plastic spacers properly installed every 5 to 8’ intervals' and at every coupling.
❒	❒	All curves properly formed with 5° couplings.
❒	❒	Company conduits to be in separate encasement from all other utilities.
		PRE-BACKFILL *(after concrete encasement)*
❒	❒	Company conduit in separate encasement.
❒	❒	Minimum separation to foreign utilities and subsurface pipes maintained.
❒	❒	Encased concrete thickness > 3" around all conduits.
❒	❒	Sand or screened backfill (with less than 1” stones) on-site for backfilling entire trench, (inspector may witness backfilling).
❒	❒	Warning tape 8" to 12" below finish grade and directly above electrical conduit system.
❒	❒	No parallel non company utilities directly above or below electrical system.
		AFTER BACKFILL *(pre-conductor installation inspection)*
❒	❒	Install 2500 lb. Pulling Tape in all conduit after rodding with a mandrell.
		HEAVY DUTY HANDHOLE
❒	❒	6" of crushed stone under handhole.
❒	❒	Seal around conduit entrances with concrete or mortar.
❒	❒	Manhole cover at finish grade with 2 courses of brick and grout for chimney.
		PULLBOX/SPLICE BOX
❒	❒	4" of crushed stone under pullbox foundation.
❒	❒	Cover left secured to box when unattended.
❒	❒	Flush with sidewalk or slightly above any grassy area.
❒	❒	Installed behind curb or other protection to prevent damage (e.g. snowplow)
		RISER POLE
❒	❒	90° BEND AND straight pipe galvanized steel conduit.
❒	❒	Steel-PVC adapter and steel sweep shall not be encased.
❒	❒	Ground clamp installed with tap.

**NOTE Y – Acceptable N – Deficient*

35.3 3 PHASE UCD CONDUIT INSPECTION CHECK LIST NEW YORK

Every item listed below must be inspected and checked by the company inspector.

N*	Y*	
		PRE-TRENCH *(no inspection)*
❒	❒	Final grade established, surface rough graded, and roadways staked.
❒	❒	Developer has Service Specifications on site.
❒	❒	Easement has been executed.
		TRENCH
❒	❒	Min. 30" depth from existing grade to top of conduit during all phases of construction.
❒	❒	Electric infrastructure on “road side”, with 1 spare conduit if applicable, in all multi-utility trench installations.
❒	❒	Min. separation between electrical conduit and foreign conduits or pipes.
❒	❒	All road crossing perpendicular.
❒	❒	Conduit plugs installed.
❒	❒	Plastic spacers properly installed every 5 to 8’ intervals and at every coupling.
❒	❒	All curves properly formed with 5° couplings.
❒	❒	Company conduits to be in separate from all other utilities.
		PRE-BACKFILL
❒	❒	Company conduit separated from other utilities.
❒	❒	Minimum separation to foreign utilities and subsurface pipes maintained.
❒	❒	Sand or screened backfill (with less than 1” stones) on-site for backfilling entire trench, (inspector may witness backfilling).
❒	❒	Warning tape 8" to 12" below finish grade and directly above electrical conduit system.
❒	❒	No parallel non company utilities directly above or below electrical system.
		AFTER BACKFILL *(pre-conductor installation inspection)*
❒	❒	Install 2500 lb. Pulling Tape in all conduit after rodding with a mandrell.
		HEAVY DUTY HANDHOLE
❒	❒	6" of crushed stone under handhole.
❒	❒	Seal around conduit entrances with concrete or mortar.
❒	❒	Manhole cover at finish grade with 2 courses of brick and grout for chimney.
		PULLBOX/SPLICE BOX
❒	❒	4" of crushed stone under pullbox foundation.
❒	❒	Cover left secured to box when unattended.
❒	❒	Flush with sidewalk or slightly above any grassy area.
❒	❒	Installed behind curb or other protection to prevent damage (e.g. snowplow)
		RISER POLE
❒	❒	90° BEND AND straight pipe galvanized steel conduit.
❒	❒	Steel-PVC adapter and steel sweep shall not be encased.
❒	❒	Ground clamp installed with tap.

**NOTE Y – Acceptable N – Deficient*

35.4 TRANSFORMER FOUNDATION INSPECTION CHECK LIST

Do not pour concrete prior to inspection and approval by Company of the pad forming and reinforcement, the subgrade preparation, and the ground grid. Do not back fill after removing the forms prior to pad inspection. Every item listed below must be inspected and checked off by Company inspector.

N*	Y*	
		PRE-INSTALLATION
❒	❒	Proposed location within 10' of paved way open to vehicular access.
❒	❒	Proposed location has minimum of 10' clear space in front of transformer doors.
❒	❒	Proposed location has minimum clearance to buildings, doorways, windows, ventilation ducts, fire escapes, and other combustibles as per pages 14 and 15 of this guide.
❒	❒	Bollard locations are identified by Company.
❒	❒	Ground grid installation and two ground rods
		PRE-POURING
❒	❒	12" gravel and 2" sand below pad location.
❒	❒	Reinforcing bars.
❒	❒	Concrete forms correct height, size, orientation, opening, etc.
❒	❒	Concrete forms in correct location.
❒	❒	Ground grid installation and two ground rods.
❒	❒	36" radius at all 90° sweeps into pad stopping 1" above pad.
❒	❒	Secondary sweeps in place and proper number.
		AFTER POURING *(after removing forms and prior to backfilling)*
❒	❒	Pad correctly formed and 10" high.
❒	❒	¾" chamfer along the edges. Sweeps 1" above pad.
		AFTER BACKFILL
❒	❒	6" protective bollards are correctly installed.
❒	❒	Pad 5" above final grade.
❒	❒	Pad has 10' of clear space in front of transformer doors, is 10' from an accessible paved way and has the minimum clearance to other structures.

**NOTE Y – Acceptable N – Deficient*

36.0 Cable Installation Maximum Pull Chart

Straight cable pull chart typical maximum pulls						
	15kV Class			35kV Class		
Wire Size	Riser to Pad	Riser to Pull Box	Pull box to Pull Box	Riser to Pad	Riser to Pull Box	Pull box to Pull Box
#2 AL	530	605	750	n.a.	n.a.	n.a.
1/0 AL	n.a.	n.a.	n.a.	320	360	750
2/0 CU	n.a.	n.a.	n.a.	615	695	750
4/0 CU	695	720	750	n.a.	n.a.	n.a.

Note:

1) All Calculations are based on a straight pulls
2) All conduits are 4”
3) Assume 50Lb reel drag
4) Assume .5 for coefficient of friction
5) Pulls are in feet
6) Pulls distances are shown from worst case pulling end.

37.0 Padmount Compartment Sealing Requirement

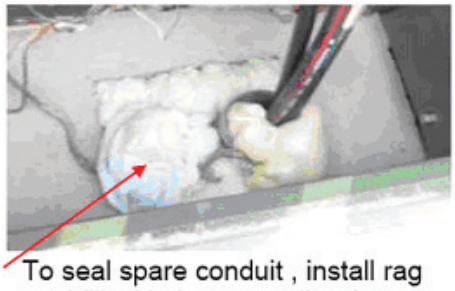
Issued by Standards #09-09

Safety Standards Work Methods

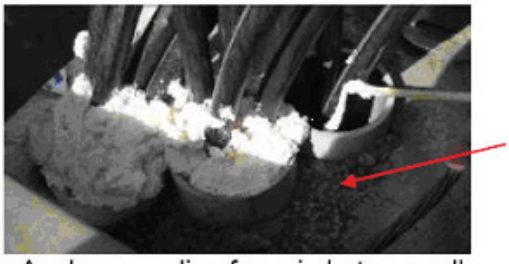
THREE PHASE PADMOUNTED TRANSFORMER SEALING

Padmounted transformer compartment areas shall be sealed to minimize the direct release of transformer fluid into the ground through the primary and secondary compartment areas of the transformer. Sealing the compartment areas will better contain the release, allowing the fluid to be noticed more promptly.

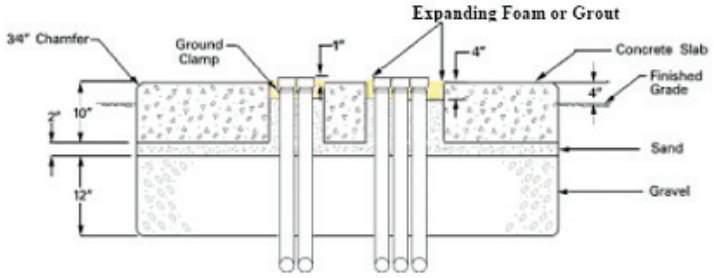
The following describes how to seal the compartments areas. Compartment areas shall be filled with sand to a grade of 4" below the top of the concrete pad. On top of the sand a concrete grout (no aggregate) or expanding foam (STD Item UF10) shall be installed to the top to the concrete pad. The installer of the transformer pad and conduit is required to seal the compartment areas. All conduits shall also be filled in with expanding foam. The customer is required to seal all conduits where they are installing customer owned cables, this includes the spare conduits in that duct bank. The company is required to seal all conduits where they are installing company owned cables, this includes the spare conduits in that duct bank. This detail is further explained in the Underground Construction Standards book in section 44.20. Note: Keep the expanding foam stored in a heated environment to make applying easier.



To seal spare conduit , install rag and fill with the expanding foam.



Apply expanding foam in between all cables to form a complete seal.



Cross section view of a padmounted transformer having primary and secondary compartments filled with sand and Expanding Foam.

38.0 Revision History

Version	Date	Description of Revision
1.0	07/19/10	New document superseding all previous versions of ESB 759B.

National Grid is an international energy delivery company. In the U.S., National Grid delivers electricity to approximately 3.3 million customers in Massachusetts, New Hampshire, New York and Rhode Island, and manages the electricity network on Long Island under an agreement with the Long Island Power Authority (LIPA). It is the largest distributor of natural gas in the northeastern U.S., serving approximately 3.4 million customers in Massachusetts, New Hampshire, New York and Rhode Island. National Grid also owns over 4,000 megawatts of contracted electricity generation that provides power to over one million LIPA customers.

National Grid
40 Sylvan Road
Waltham, MA 02451-1120
1-800-322-3223 New England
1-800-642-4272 New York
www.nationalgridus.com

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CM4518_759B 9/10

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PUC 4-9

Request:

Please provide the process and timeline for a customer seeking to interconnect new load to (a) the National Grid electric distribution system and (b) the National Grid gas distribution system.

Response:

(a) An electric customer seeking to connect to National Grid's distribution system needs to contact the Company via phone, fax, or email to initiate a work order. The customer will be assigned a job owner, who will be the single point of contact for the customer and process the request through to completion. Additional information may be required depending on the type of customer and the size of the request/project and factors including, customer loads, easement information, deed requirements, order of conditions, permits, payment, and/or inspection. The timeline for the request will also depend on the size of the project and required construction. For example, a simple job generally may take up to two weeks, whereas a complex job may take up to 18 months. See Attachment PUC 4-9-1 for a detailed step-by-step process.

(b) A gas customer seeking to connect to the National Grid's distribution system needs to contact the Company via phone, fax, or email to initiate a work order. The customer will be assigned a job owner, who will be the single point of contact for the customer and process the request through to completion. Additional information may be required depending on the type of customer and the size of the request/project (customer loads, easement information, deed requirements, order of conditions, permits, payment, and/or inspection). The timeline for the request will also depend on the size of the project and required construction. For example, a simple job may generally take up to six to eight weeks, whereas a complex job may take up to six months. See Attachment PUC 4-9-2 for a detailed step-by-step process.

Prepared by or under the supervision of: Alfred Amaral, Raymond Rosario, and Ryan Constable

Jan 2016

Electric Service Request Process Lifecycle

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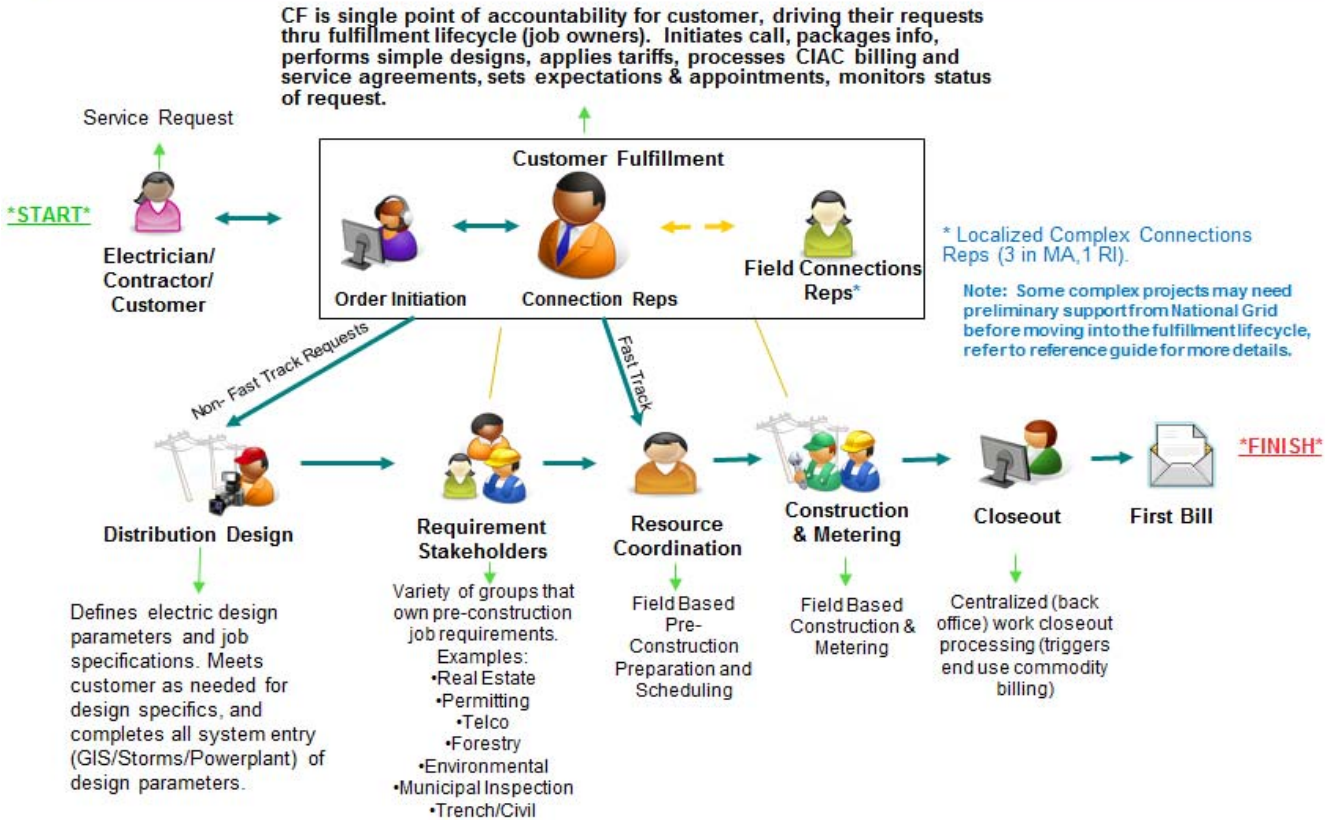
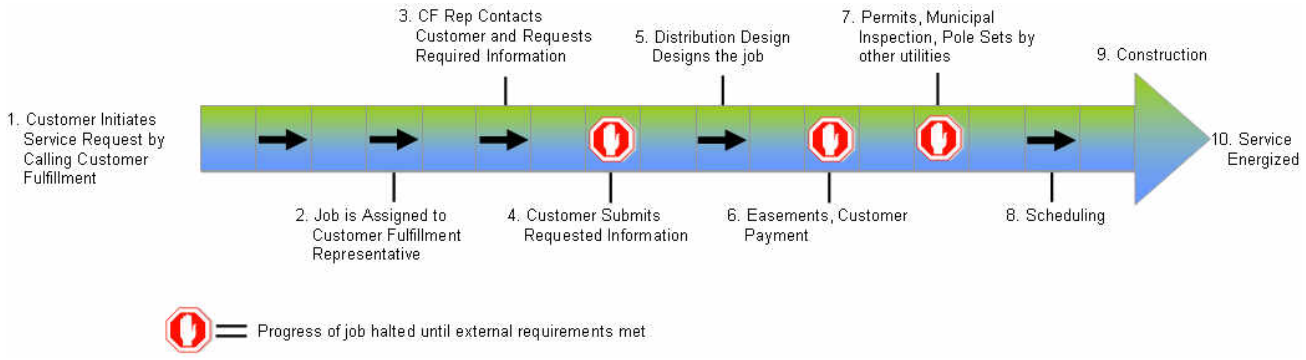


Standard Service Fulfillment Lifecycle



Requests for electrical service originate with our Order Initiation team (New England 800-375-7405 or New York 315-460-7119) [1]. The request is then reviewed and assigned to a Customer Fulfillment (CF) representative

NOTE: Latest Specifications for Electrical Installations can be found at
http://www.nationalgridus.com/electricalspecifications

Jan 2016

[2]. Our CF representatives are trained to manage particular job types - ranging from simple residential service connections to multi-million dollar commercial developments. CF representatives serve as the primary point of accountability for all customer requested, electrical distribution work at National Grid. They are customer advocates with the primary responsibility of overseeing requests across the entire service fulfillment process.

The assigned CF representative will contact the customer (requestor) to obtain necessary information to properly design and construct the service as needed [3]. This information varies based on scope, but can include items such as electrical loading information, site plans, one-line electrical schematics, easement data, etc. The CF representative will also describe the remaining steps of the process along with general timelines to complete the process. Simple service connections can typically be completed within three weeks, while complex jobs that require extensive construction may take several months. They'll also provide contact information, so that the customer (requestor) can address any questions/concerns directly at any time during the process. Please keep in mind that certain requests may require additional information not specifically noted here.

Once the CF representative has obtained all necessary information from the customer (requestor) [4], they'll progress the job to our Distribution Design team. A local designer will then conduct a site visit and determine the design requirements of the job as appropriate. If necessary, the requesting contractor, developer, or electrician can meet and discuss the technical aspects of the job with the designer directly during this phase. Note that some requests such as simple service upgrades may qualify for prescribed programs that bypass phases of the process (i.e., National Grid Connects program). If eligible, these expedited requests will be addressed with the requesting party by the CF representative.

Upon completion of the design [5], a variety of requirements may need to be completed before the job can progress to our construction department. Some of these requirements are dependent upon third parties. For example, easements, municipal inspections, permits, or pole sets managed by other utilities (Verizon, FairPoint, Cox, etc.) may be required and could potentially add to the time it takes to complete the job. Jobs that require customer payment may also take longer (National Grid requires payment, per regulated tariffs, prior to beginning construction.) Once all the job requirements have been met [6,7], the work will be scheduled for construction [8]. The scheduling phase for construction could take a week for simple projects or as long as six weeks for complex projects. Actual construction duration will also vary by job scope [9]. Upon construction completion, the service will be energized by our line or meter department as appropriate.

As a reminder, communication between the customer (requestor) and the CF representative is the best way to stay informed of the job's status throughout the lifecycle of the request. CF will also provide detailed policy and procedural information as needed.

NOTE: Latest Specifications for Electrical Installations can be found at
http://www.nationalgridus.com/electricalspecifications

Gas Service Construction Process

nationalgrid

1 This symbol indicates a step where delays are common. Match the corresponding number to that in the "Unforeseen Issues" document for more information.

STOP This symbol indicates that the process **cannot proceed** until the customer fulfills the requirements in that step.

This symbol indicates that the step requires an action by the customer.

Order Initiation Phase

Target: 3 to 5 days

Customer calls Lead Intake or Customer Connections to apply for new gas service or service upgrade. **1-877-MY-NGRID**.

1

A National Grid Job Owner is assigned after customer's Service Line Agreement is received.

Customer (or their designee) must provide info requested: total connected load, site plan if new construction, need date for service, any pertinent property / facility / easement info.

STOP

2

A review of all underground utilities is performed to determine whether gas infrastructure is in place or needs to be built to serve the new load.

Customer Connections and Ops Supervisor may visit the site to gather additional information.

Design & Engineering Phase

Target: 4 Weeks

This phase is for Non-standard Gas Connections only

Customer Connections sends all info to National Grid Gas Engineering Team to review / design.

National Grid's Gas Engineering team reviews loads and approves design.

Order Processing Phase

Target: 2 Weeks

The Job Owner completes a cost analysis to see if a customer contribution is required.

Customer Connections uses approved design to calculate the customer's financial contribution.

A Service Line Agreement is drafted and sent to the customer.

The Service Line Agreement must be signed by the customer and returned to National Grid.

STOP

3

A Work Order is created and confirming letter is sent to the customer.

An invoice is generated and sent to the customer.

The invoice must be paid in full before the process can proceed.

STOP

4

A customer easement is required only if the new gas service crosses private property or is within a subdivision. If an easement is required, National Grid will draft the easement and send it to the customer for signature. Easements must be executed and returned to National Grid before construction can begin.

STOP

5

Construction Phase

Target: 6-12 weeks**

***depending on project complexity and market demand for new gas services*

National Grid Actions

All relevant permits and environmental requirements related to the customer's private property must be met. These would be listed in any Order of Conditions received with the customer's Building Permit.

STOP

6

National Grid will obtain a "DIGSAFE" before digging on private property or in the public way.

Once all permits are received the service is targeted with a completion date and schedule for construction.

National Grid Gas crews will dig a trench and install gas conduit (pipe) on customer's private property. National Grid crews will also complete any required civil work in the public way.

All National Grid work is weather permitting.

STOP

Service Completion Phase

The timing for this phase is primarily dependent upon the customer.

Target for National Grid to set the gas meter is 3 days.

Customer Actions

Customer performs all plumbing work needed inside the facility receiving the new gas service.

Customer must schedule a municipal plumbing inspection for approval of interior work. The new gas service is "tagged" by the Muni Plumbing Inspector once it's approved.

Customer must inform National Grid once the service has been "tagged". Call **1-800-322-3223**.

STOP

7

Customer initiates meter set by calling National Grid Customer Service at **1-800-322-3223**.

These steps can happen simultaneously

Customer makes arrangements with National Grid to turn the gas on and light their equipment.

STOP

8

PUC 4-10

Request:

Of the 207 positions listed on Schedule MPH-1 (Book 1, pages 91-97), are all of those new hires or are they inclusive of current vacancies being filled.

Response:

The 207 positions listed on Schedule MPH-1 (Book 1, Bates Pages 91-97) are all new hires and are not inclusive of current vacancies being filled.

Prepared by or under the supervision of: Maureen P. Heaphy

PUC 4-11

Request:

Referencing Division 3-8, please also reconcile Ms. Heaphy's new hires count with that of Ms. Little and Mr. Horan.

Response:

With respect to Division 3-8 and the new-hire counts referenced in the pre-filed direct testimony of Company Witnesses Maureen P. Heaphy and Timothy F. Horan, the differences in employee counts are a function of the particular years and individual companies referenced in the respective testimonies.

Specifically, Ms. Heaphy's testimony counts incremental full time equivalents (FTEs) for the Rate Year and Data Years for Narragansett Electric, Narragansett Gas, and National Grid USA Service Company, Inc. (the Service Company). This incremental FTE count is 207 FTEs.

Ms. Little's testimony counts incremental FTEs, vacancies, and retiree positions, only for the Rate Year for Narragansett Electric, Narragansett Gas, and the Service Company. This incremental FTE count is 204 FTEs.

Mr. Horan's testimony counts incremental FTEs for the Rate Year and Data Years, only for Narragansett Gas and Narragansett Electric. This incremental FTE count is 87 FTEs.

Also, please note that Ms. Little's testimony includes vacant and retiree positions, while Ms. Heaphy's and Mr. Horan's testimony does not. Ms. Little's testimony and Ms. Heaphy's testimony includes three incremental FTEs for distributed generation, but Mr. Horan's does not.

Please refer to Attachment PUC 4-11, which reconciles Ms. Heaphy's new-hire counts with those of Ms. Little and Mr. Horan.

Prepared by or under the supervision of: Maureen P. Heaphy

RIPUC Docket 4770
Reconcile Narragansett FTE's - DIV 3-8 & RIPUC 4-11
per submitted Testimony

	T. Horan				M. Little				M. Heaphy			
	RY 2019	**DY 1**	**DY 2**	**Total**	**RY 2019**	**DY 1**	**DY 2**	**Total**	**RY 2019**	**DY 1**	**DY 2**	**Total**
Total FTE's	**68**	**9**	**10**	**87**	**204**	**-**	**-**	**204**	**178**	**15**	**14**	**207**
Details below:												
Gas												
- Incremental FTE's	36	7	5	48	36	-	-	36	36	7	5	48
- Retiree's	-	-	-	-	(6)	-	-	(6)	-	-	-	-
- Vacancies	-	-	-	-	9	-	-	9	-	-	-	-
Total Gas	**36**	**7**	**5**	**48**	**39**	**-**	**-**	**39**	**36**	**7**	**5**	**48**
Electric												
- Incremental FTE's	32	2	5	39	35	-	-	35	35	2	5	42
- Retiree's	-	-	-	-	(3)	-	-	(3)	-	-	-	-
- Vacancies	-	-	-	-	26	-	-	26	-	-	-	-
Total Electric	**32**	**2**	**5**	**39**	**58**	**-**	**-**	**58**	**35**	**2**	**5**	**42**
Service Co.												
- Incremental FTE's	-	-	-	-	107	-	-	107	107	6	4	117
- Retiree's	-	-	-	-	-	-	-	-	-	-	-	-
- Vacancies	-	-	-	-	-	-	-	-	-	-	-	-
Total Service Co.	**-**	**-**	**-**	**-**	**107**	**-**	**-**	**107**	**107**	**6**	**4**	**117**

Comment			
Electric	Job title Distributed Design. Department Distributed Generation Solar. 3 FTE's - not included in Electric RY 2019 Incremental FTE's	Job title Distributed Design. Department Distributed Generation Solar. 3 FTE's - are included in Electric RY 2019 Incremental FTE's	Job title Distributed Design. Department Distributed Generation Solar. 3 FTE's - are included in Electric RY 2019 Incremental FTE's

PUC 4-12

Request:

Referencing the Rosario Joint Testimony on pages 18 and 19, please indicate when the vacancies will be filled.

Response:

For Narragansett Electric, of the 26 positions referenced in the testimony, the following has occurred:

- 13 positions are filled;
- Four positions are scheduled to be filled as of March 2018;
- One position is scheduled to be filled by mid-2018 (during this proceeding);
- Four positions are seasonal and are scheduled to be hired for six to nine months beginning in February 2018; and
- Four positions are vacant and are not scheduled at this time.

For Narragansett Gas, all nine of the positions referenced in the testimony have been filled.

Prepared by or under the supervision of: Alfred Amaral, Raymond Rosario, and Ryan Constable

PUC 4-13

Request:

Please provide the capital structure of National Grid, plc at the end of the Test Year and projected at September 1, 2018.

Response:

National Grid plc's financial statements are prepared in accordance with International Financial Reporting (IFRS) standards, and National Grid plc does not regularly report its capital structure in accordance with US Generally Accepted Accounting Principles (GAAP) standards. Since there are several differences between the two accounting standards, National Grid plc has previously prepared an "adjusted capital structure" to assess the comparable gearing of National Grid plc and US operating companies. As provided in Attachment PUC 4-13, the most recent adjusted capital structure was prepared based on financial statements as of March 31, 2016, and National Grid plc's capital structure was comprised of approximately 49.3 percent equity and 50.7 percent debt (excluding gross short term debt). National Grid plc's adjusted capital structure has not been prepared for the Test Year or projected at September 1, 2018.

Prepared by or under the supervision of: Joshua Nowak

NATIONAL GRID PLC'S CAPITAL STRUCTURE

The following table presents the 'adjusted capital structure' of NG plc, which is used to assess the comparable gearing of the group for the purposes of US rate cases. An explanation of the reason/source of the adjustments is provided below the table.

		2016 (£m)	
	NG consolidated reported equity - US GAAP	18,512	a
Less	NG Gas consolidated reported equity - US GAAP	(10,221)	b
Add back	NGG intercompany	5,609	c
Add back	NGG net debt excluding derivatives	(9,147)	d
Add back	NGG Derivatives	514	e
Less	**NG Gas equity pre intercompany and net debt**	**(13,245)**	f
Less	NGET consolidated reported equity - IFRS	(2,774)	g
Less	NGET US GAAP adjustments	27	h
Add back	NGET intercompany	(46)	i
Add back	NGET net det excluding derivatives	(6,766)	j
Add back	NGET derivatives	(253)	k
Less	**NGET equity pre intercompany and net debt**	**(9,812)**	l
Add	**NGG Transmission RV**	5,594	m
Add	**NGG Distribution RV**	8,676	n
Add	**NGG Metering and Xoserve book value**	212	o
Add	**NGET RV**	11,830	p
Add	**NGUK pension scheme liability**	0	
Add	**NG Hybrid bond (equity portion)**	995	q
	NG adjusted equity	**22,762**	r
	NG reported net debt - US GAAP	24,820	s
	NG derivatives related to debt (incl cross currency swaps)	106	t
Less	[NG Hybrid bond (remove non-debt portion)]	(995)	q
Less	Current portion of US GAAP short term debt	(519)	u
	Total net debt (excluding gross short term debt)	**23,412**	v
	Equity plus debt (excluding gross short term debt)	**46,174**	w
	Equity/equity plus debt (excluding gross short term debt)	**49.3%**	x

Notes:

a. The net equity (i.e. amounts attributable to equity shareholders of the parent company) presented in accordance with US GAAP for the National Grid plc consolidated group. This is calculated taking the consolidated equity calculated in accordance with IFRS (per the audited Annual Report & Accounts). The calculated US GAAP 'adjustments' (see note (s)) to net equity are added to the IFRS net equity to obtain the US GAAP net equity.

b. The net equity (i.e. amounts attributable to equity shareholders) presented in accordance with US GAAP for the National Grid Gas plc consolidated group ('NG Gas plc sub-group'). This is calculated taking the consolidated equity calculated in accordance with IFRS (per the audited accounts of NG Gas plc). The calculated US GAAP 'adjustments' (see note (t)) to net equity are added to the IFRS net equity to obtain the US GAAP net equity.

c. NGG intercompany – refers to amounts owed to the NG Gas plc sub-group by other companies within the NG plc group (but outside the NG Gas plc sub-group).

d. NGG net debt excluding derivatives – refers to amounts owed by the NG Gas plc sub-group to external debt holders and to other companies within the NG plc group (but outside the NG Gas plc sub-group), offset by cash and equivalent short-term funds which are deemed to be part of 'net debt'. This includes any accrued debt-related interest and hedge-accounting related fair value adjustments (both of these being calculated on an IFRS basis).

e. NGG derivatives – these are the fair value of derivative instruments used by the NG Gas plc group to hedge its net debt.

f. This is the sub-total of items b + c + d + e. This amount is deducted from the total US GAAP net equity value of the NG plc group. The regulatory asset values ('RAV') of NG Gas plc are added back in as noted in items (m) and (n).

g. The net equity (i.e. amounts attributable to equity shareholders) presented in accordance with IFRS for the National Grid Electricity Transmission plc consolidated group ('NGET plc sub-group'). This is calculated taking the consolidated equity calculated in accordance with IFRS (per the audited accounts of NG Gas plc).

h. The calculated US GAAP 'adjustments' (see note (t)) to NGET plc sub-group's net equity.

i. NGET intercompany – refers to amounts owed to the NGET plc sub-group by other companies within the NG plc group (but outside the NGET plc sub-group).

j. NGET net debt excluding derivatives – refers to amounts owed by the NGET plc sub-group to external debt holders and to other companies within the NG plc group (but outside the NGET plc sub-group), offset by cash and equivalent short-term funds which are deemed to

be part of 'net debt'. This includes any accrued debt-related interest and hedge-accounting related fair value adjustments (both of these being calculated on an IFRS basis).

k. NGET derivatives – these are the fair value of derivative instruments used by the NGET plc group to hedge its net debt.

l. This is the sub-total of items g + h + i + k + j. This amount is deducted from the total US GAAP net equity value of the NG plc group. The regulatory asset value ('RAV') of NGET plc is added back in as noted in item (p).

m. NGG Transmission RV – refers to the regulatory asset value ('RAV') of the gas transmission business owned by NG Gas plc. This is calculated in accordance with the rules set by UK regulator (Ofgem) and is a pool of historical investment and incurred costs upon which an allowed return may be earned. This is effectively a UK equivalent of "rate-base" in the US.

n. NGG Distribution RV – refers to the regulatory asset value ('RAV') of the gas distribution business owned by NG Gas plc. The basis of calculation is as described in item (m).

o. NGG Metering / Xoserve (book values) – the accounting book values of the other businesses that form part of the NG Gas plc sub-group (i.e. excluding the gas distribution and transmission operations, being the regulatory businesses that contribute towards the RAVs). NGG Metering is a gas metering business and Xoserve is a shared services business for the UK's gas distribution networks.

p. NGET RV – refers to the regulatory asset value ('RAV') of the electricity transmission business owned by NGET plc. The basis of calculation is as described in item (m).

q. NGG Hybrid bond (50% equity portion) – refers to the 'equity portion' of the £2 billion of debt issued by NGG (treated as 50% debt 50% equity for credit rating purposes).

r. This is the sub-total of items a + f + l.

s. NG reported net debt – refers to amounts owed by the NG plc group to external debt holders, offset by cash and equivalent short-term funds which are deemed to be part of 'net debt'. This is calculated on a US GAAP basis (i.e. excluding derivatives), less the equity portion of the Hybrid debt as described in item (q).

t. NG derivatives related to debt (incl cross currency swaps) – refers to derivatives used to hedge NG plc group 'net debt'.

u. US GAAP adjustments due to differences between IFRS accounting and US GAAP accounting for the same transactions. There are a number of reasons that these differences

exist. For detailed explanations and examples of the significant GAAP adjustments see pages 153-164 of the NG plc Annual Report & Accounts for 2006/07.

v. This is the sub-total of items s + t + q + u.

w. This is the sub-total of items r + v.

x. This is the ratio of r to w.

PUC 4-14

Request:

For each year since the decision in Docket No. 4323, where either Narragansett Electric or Narragansett Gas did not achieve its allowed ROE, please provide the primary reason with supporting schedules or analysis.

Response:

In the ratemaking process, the authorized return on equity (ROE) is set by the Public Utilities Commission (PUC) based on various factors, including analytical results of studies identifying the return on capital expected by investors. Once incorporated into rates, the return on equity is not guaranteed. Instead, the Company is only able to earn that return if: (1) operating costs remain at or below the cost level included in rates; (2) revenues remain at or above the level anticipated in setting base distribution rates (and are retained by the Company); or (3) some combination of these two circumstances occurs.

With the implementation of the revenue-decoupling mechanism (RDM), there is no opportunity for the Company to retain revenues that might be collected in excess of the revenue level incorporated into rates (except to a limited extent on the gas side). Any excess revenues that might be generated as a result of increased customer load, weather, or good economic conditions is credited to customers through the RDM such that the Company only ever collects exactly the amount of revenues contemplated in setting the approved revenue requirement.

Therefore, when the Company's actual, earned return falls below the authorized return, it is a signal that the Company has expenses that are not being recovered through rates, *i.e.*, the Company's actual cost of service is greater than the level of revenues allowed through the RDM. The Company has not prepared an analysis of the differential between its actual costs and the costs allowed through rates in each year since new rates were set in Docket No. 4323. Rates were set in Docket No. 4323 on the basis of a settlement agreement between the Company and the Division of Public Utilities and Carriers, and the US Navy..

However, in Docket No. 4323, the Company's application to the PUC requested a change in base distribution rates to address a total revenue deficiency of $31,448,278 for Narragansett Electric and a total revenue deficiency of $19,952,203 for Narragansett Gas. The Company settled for an increase of $18,508,229 for Narraganset Electric representing only 59 percent of the Company's calculated deficiency. For Narragansett Gas, the Company settled for an increase of $11,292,567, representing only approximately 57 percent of the Company's calculated deficiency. Thus, the settlement agreement likely did not provide sufficient revenues to allow the Company to earn its ROE even from the outset of new rates.

Prepared by or under the supervision of: Joshua Nowak

More specifically, the settlement rates became effective February 1, 2013, with an authorized ROE of 9.5 percent. Narragansett Electric did not earn its allowed return of 9.5 percent in any year following the settlement. The highest ROE obtained by Narragansett Electric was 8.28 percent in 2015. However, in all other years, the return was well under these results (*i.e.*, 6.98 percent in 2013; 7.52 percent in 2014 and falling to 5.84 percent in 2016).

Narragansett Gas earned its authorized ROE in the 12-month period ending March 2014 (*i.e.*, in the year immediately following the setting of new rates). However, its earned return has fallen each year from that point to 7.78 percent in 2015 and 6.73 percent in 2016.

Therefore, it is clear that the allowed rate increases in the settlement were essentially borderline revenue levels that did not sufficiently address ongoing cost increases arising from day-to-day operations.

Examples of expenses that would be the primary drivers of the differential between the cost of service captured in settlement rates and the actual cost of service include (but are not limited to) the following:

- Labor Costs. The Company's union and non-union labor costs constitute approximately 37 percent of total operation and maintenance (O&M) expenses, or 16 percent of the overall cost of service. The Company's proposed revenue requirement in Docket No. 4323 included labor costs for the employee headcount as of the test year ending December 31, 2011, escalated through the rate year ending January 31, 2014. Payroll costs associated with any increased headcount after December 31, 2011, and raises and salaries and wages after January 31, 2014 for all employees would have had a direct, negative impact on the Company's ability to earn its authorized ROE. As discussed in the Joint Pre-Filed Direct Testimony of Raymond J. Rosario, Jr., Alfred Amaral III, and Ryan M. Constable, there are several drivers for increasing workload in operations that include, for example, increased compliance actions associated with Pipeline and Hazardous Materials Safety Administration (PHMSA) regulatory requirements, and a sustained increase in distributed generation interconnection service applications. The Company has included the increases in labor costs associated with these specific programs in its proposed rates; however, the drivers for these increased workload required arose subsequent to the Company's settlement in Docket No. 4323, and are, therefore, unrecovered unless and until base distribution rates are changed.

- Labor-Related Benefits Costs: The costs of employee healthcare plans and other labor-related costs are constantly escalating. Increases in these costs after the Test Year would have had a direct, negative impact on the Company's ROE, particularly if staffing levels are increasing at the same time to address new workload requirements.

- Incentive Compensation: Under Rhode Island precedent, only a portion of the Company's actual incentive compensation expense is allowed in rates. However, the Company does not have the discretion to eliminate the portion of incentive compensation that is not allowed in rates. Incentive compensation is a normal, expected element of total compensation, which the Company must offer to employees to stay competitive in the marketplace. Therefore, the unrecovered portion of incentive compensation (and any increases in the allowed portion) would have had a direct, negative impact on the Company's ROE.

- Investments Associated with O&M Expense: There are other costs associated with critical programs, processes, or systems that the Company has implemented since the decision in Docket No. 4323 that were not included in rates. For example, as discussed in the Joint Pre-Filed Direct Testimony of Anuraag Bhargava, Daniel J. DeMauro, and Mukund Ravipaty, when National Grid USA Service Company, Inc. implements a new Information Services (IS) system to upgrade or modernize gas and electric service, the Company incurs the associated O&M rent expense. Proposed rent expense for IS projects escalate from $4,266,032 in the Rate Year to $17,859,814 two years later, which would have had a substantial impact on the Company's ability to earn its authorized return. However, the IS projects are necessary to achieve safe, reliable, efficient, and secure operations for customers. Therefore, absent adjustments to rates to recognize post-Rate Year increases in rent expenses, the Company's ability to earn its authorized rate of return on a going forward basis is fundamentally impaired, although the Company plans to make investments that directly benefit utility operations for customers.

The Company works constantly to identify and implement performance enhancements and process efficiencies to mitigate rising operating costs so that it can earn the best return possible under the circumstances and given the rates in effect. Over the longer term, these initiatives help to keep the cost of service lower than it otherwise would be for customers.

However, two challenges exist. First, the level of productivity efficiencies required to offset earnings attrition of the magnitude of 300 to 400 basis points lower than the authorized ROE is not generally attainable through normal operations. Efficiency gains with any level of scale require investment to achieve, such as investment in new systems, but incremental investments in systems infrastructure or automation are not consistently funded in rates. To avoid the earnings attrition that drives more frequent rate cases, it is critical that the Company have a reasonable opportunity to recover these types of investment costs through customer rates on a timely basis. It is these investments that will help to reduce operating costs and assist in slowing the frequency of base-rate changes over time.

Second, the largest part of the Company's cost of service is labor and labor-related costs that are persistently increasing due to inflationary pressures. In fact, these costs often increase at a rate *greater than the rate of inflation*. Increases in staffing and the associated compensation elements

have almost a punishing effect on the Company's ability to earn its authorized return, or even a reasonable return within range of the authorized ROE. Given that the PUC's ratemaking procedures do not allow for any type of inflation adjustment after the Rate Year, it becomes imperative to capture known and measurable changes in staffing levels and associated compensation in base distribution rates when those rates are set.

Lastly, other O&M expenses will vary from the Rate Year based on a combination of financial conditions and the Company's day-to-day operations. With the Company's anticipated capital investment plan, related O&M expenses are likely to vary from those estimated in the Rate Year. In the Company's Power Sector Transformation Plan, the Company would include an annual revenue requirement that would allow for reconciliation of both capital investment, and O&M expenses. Absent a multi-year rate plan that includes reconciliation for O&M expenses, in conjunction with capital investment, the Company is unlikely to earn its authorized return as long as there is a differential between the Company's actual costs and the costs allowed through rates.

Prepared by or under the supervision of: Joshua Nowak

PUC 4-15

Request:

How will Narragansett Electric apply the proposed 15% discount to customers taking from competitive supply?

Response:

The response to this information request applies to electric service only because residential gas customers cannot receive their gas supply from a competitive supplier.

The Company is proposing to apply the 15% discount to both delivery charges and supply charges on the bill of an eligible low income customer, regardless of whether the customer is receiving Standard Offer Service from the Company or receiving electric supply from a non-regulated power producer (NPP) and the Company bills electric supply charges on behalf of the NPP. The Company is proposing that the amount of the discount be based on the total amount billed by the Company. If an NPP has chosen the Complete Billing Service pursuant to the Company's Terms and Conditions for Nonregulated Power Producers, R.I.P.U.C. No. 1191, and, consequently, the customer's bill from the Company includes the NPP charge, then the NPP charge will be included in the amount upon which the low income discount percentage is applied. To the extent that the NPP has not chosen the Complete Billing Service and bills its charges separately, then the low income discount would not be based on an amount that includes the NPP charges.

To clarify the Company's proposal, the Company will add the following clarification to the proposed provision on the low income discount included in the Company's proposed Low Income Rate (A-60) Retail Delivery Service tariff, R.I.P.U.C. No. 2184:

LOW INCOME DISCOUNT

The Customer's total bill for service as determined based upon the provisions above, in addition to charges for generation service billed under the Complete Billing Service option pursuant to §2.1.1 of the Company's Terms and Conditions for Nonregulated Power Producers in effect from time to time, will be discounted by fifteen (15) percent.

Prepared by or under the supervision of: Scott M. McCabe

PUC 4-16

Request:

If low income customers taking from competitive supply will be given the 15% discount, please provide the following, for the most recent 12-month period for which actual data is available, assuming that the current proposal were in place:

(a) The amount of the discount that would have been provided for the A-60 customer class, regardless of the source of energy supply.

(b) The amount of the discount that would have been provided, assuming all A-60 customers had been on standard offer service.

Response:

(a) Please see Attachment PUC 4-16, Page 1, which estimates the total annual discount applicable to Rate A-60 customers regardless of the source of their electric supply to be $5,925,739.

(b) Please see Attachment PUC 4-16, Page 2, which estimates the total annual discount applicable to Rate A-60 customers assuming all were receiving Standard Offer Service to be $5,784,992.

Please note that, for the purposes of this analysis, the Company: (1) has not shown the change in Gross Earnings Tax between the two scenarios as a result of using a different electric supply charges in the two scenarios; (2) has reflected a customer charge of $2.75 per month to align with the Company's proposal for the Rate A-60 customer charge in this rate case; (3) has used the rates in effect during the test year to calculate the estimated low income discounts, with the exception of the aforementioned customer charge and the Competitive Supplier Charges presented on Attachment PUC 4-16, Page 1, Line (21); (4) has not prorated usage between the two months over which a rate change had taken place; and (5) has used the Rate A-60 test year billing determinants (July 2016 through June 2017) because this information was readily available for the analysis.

Prepared by or under the supervision of: Scott M. McCabe

The Narragansett Electric Company
Estimated Low Income Discount Under Current Proposal Based on Test Year Information
Based on Rate A-60 Customers on Standard Offer Service and Rate A-60 Customers on Complete Billing Competitive Supply
(Excludes Rate A-60 Customers on Passthrough Billing Competitive Supply)

		Jul-16 (a)	Aug-16 (b)	Sep-16 (c)	Oct-16 (d)	Nov-16 (e)	Dec-16 (f)	Jan-17 (g)	Feb-17 (h)	Mar-17 (i)	Apr-17 (j)	May-17 (k)	Jun-17 (l)	Total (m)
	kWh Deliveries													
(1)(a)	Rate A-60 (SOS Only)	16,910,045	20,114,312	17,561,740	12,842,700	12,125,905	14,024,365	16,390,016	14,883,949	13,685,715	13,768,105	11,955,269	13,163,850	177,425,971
(1)(b)	Total Rate A-60 (SOS & Comp Supp)	21,035,433	25,257,610	22,359,260	16,270,586	15,217,176	17,635,481	20,779,372	18,795,178	17,159,044	17,236,272	15,059,950	16,491,327	223,296,689
	Number of Bills													
(2)	Rate A-60	35,080	34,946	34,517	34,783	34,504	32,416	33,909	33,542	31,591	32,580	35,339	35,515	408,722
	Rate A-16 Rates in Effect													
(3)	Proxy Customer Charge	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	
(4)	LIHEAP Enhancement Charge	$0.73	$0.73	$0.73	$0.73	$0.73	$0.73	$0.81	$0.81	$0.81	$0.81	$0.81	$0.81	
(5)	RE Growth Charge	$0.17	$0.17	$0.17	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	
(6)	Distribution Energy Charge	$0.04283	$0.04283	$0.04283	$0.04278	$0.04278	$0.04278	$0.04278	$0.04278	$0.04278	$0.04268	$0.04268	$0.04268	
(7)	Renewable Energy Dist Charge	$0.00344	$0.00344	$0.00344	$0.00344	$0.00344	$0.00344	$0.00674	$0.00674	$0.00674	$0.00677	$0.00677	$0.00677	
(8)	Transmission Charge	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.03179	$0.03179	$0.03179	
(9)	Nonbypassable Transition Charge	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	$0.00057	$0.00057	$0.00057	
(10)	Energy Efficiency Program Charge	$0.01107	$0.01107	$0.01107	$0.01107	$0.01107	$0.01107	$0.01154	$0.01154	$0.01154	$0.01154	$0.01154	$0.01154	
(11)	Standard Offer Service Charge	$0.08679	$0.08679	$0.08679	$0.08179	$0.08179	$0.08179	$0.08179	$0.08179	$0.08179	$0.06228	$0.06228	$0.06228	
	Rate A-60 Units Billed on Rate A-16 Rates													
(12)	Proxy Customer Charge	$96,470	$96,102	$94,922	$95,653	$94,886	$89,144	$93,250	$92,241	$86,875	$89,595	$97,182	$97,666	
(13)	LIHEAP Enhancement Charge	$25,608	$25,511	$25,197	$25,392	$25,188	$23,664	$27,466	$27,169	$25,589	$26,390	$28,625	$28,767	
(14)	RE Growth Charge	$5,964	$5,941	$5,868	$7,652	$7,591	$7,132	$7,460	$7,379	$6,950	$7,168	$7,775	$7,813	
(15)	Distribution Energy Charge	$900,948	$1,081,783	$957,647	$696,056	$650,991	$754,446	$888,942	$804,058	$734,064	$735,644	$642,759	$703,850	
(16)	Renewable Energy Dist Charge	$72,362	$86,886	$76,916	$55,971	$52,347	$60,666	$140,053	$126,679	$115,652	$116,690	$101,956	$111,646	
(17)	Transmission Charge	$569,008	$683,218	$604,818	$440,119	$411,625	$477,040	$562,082	$508,410	$464,152	$547,941	$478,756	$524,259	
(18)	Nonbypassable Transition Charge	($12,201)	($14,649)	($12,968)	($9,437)	($8,826)	($10,229)	($12,052)	($10,901)	($9,952)	$9,825	$8,584	$9,400	
(19)	Energy Efficiency Program Charge	$232,862	$279,602	$247,517	$180,115	$168,454	$195,225	$239,794	$216,896	$198,015	$198,907	$173,792	$190,310	
(20)	Standard Offer Service Charge	$1,467,623	$1,745,721	$1,524,183	$1,050,404	$991,778	$1,147,053	$1,340,539	$1,217,358	$1,119,355	$857,478	$744,574	$819,845	
(21)	Competitive Supplier Charges	$426,584	$524,741	$478,770	$339,668	$304,203	$352,424	$427,577	$389,316	$350,226	$342,208	$303,266	$328,256	
(22)	Total	$3,785,228	$4,514,856	$4,002,870	$2,881,593	$2,698,237	$3,096,565	$3,715,111	$3,378,605	$3,090,926	$2,931,846	$2,587,269	$2,821,812	
(23)	Proposed Low Income Discount %	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
(24)	Estimated Low Income Discount	$567,784	$677,228	$600,431	$432,239	$404,736	$464,485	$557,267	$506,791	$463,639	$439,777	$388,090	$423,272	$5,925,739

(1) per Customer Billing System
(2) per Customer Billing System
(3) Per Company Proposal
(4) - (10) Per Summary of Retail Delivery Rates, R.I.P.U.C. No 2095
(11) Per Summary of Rates - Standard Offer Service, R.I.P.U.C. No 2096
(12) Line (2) x Line (3)
(13) Line (2) x Line (4)
(14) Line (2) x Line (5)
(15) Line (1) (b) x Line (6)
(16) Line (1) (b) x Line (7)
(17) Line (1) (b) x Line (8)
(18) Line (1) (b) x Line (9)
(19) Line (1) (b) x Line (10)
(20) Line (1) (a) x Line (11)
(21) per State of Rhode Island Quarterly Open Access Customer Data by Supplier Reports
(22) sum of Lines (12) through (21)
(23) Per Company Proposal
(24) Line (22) x Line (23)

The Narragansett Electric Company
Estimated Low Income Discount Under Current Proposal Based on Test Year Information
Based on all Rate A-60 Customers, Including Those on Competitive Supply, Receiving Standard Offer Service

		Jul-16 (a)	Aug-16 (b)	Sep-16 (c)	Oct-16 (d)	Nov-16 (e)	Dec-16 (f)	Jan-17 (g)	Feb-17 (h)	Mar-17 (i)	Apr-17 (j)	May-17 (k)	Jun-17 (l)	Total (m)
	kWh Deliveries													
(1)	Total Rate A-60 (SOS & Comp Supp)	21,035,433	25,257,610	22,359,260	16,270,586	15,217,176	17,635,481	20,779,372	18,795,178	17,159,044	17,236,272	15,059,950	16,491,327	223,296,689
	Number of Bills													
(2)	Rate A-60	35,080	34,946	34,517	34,783	34,504	32,416	33,909	33,542	31,591	32,580	35,339	35,515	408,722
	Rate A-16 Rates in Effect													
(3)	Proxy Customer Charge	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	$2.75	
(4)	LIHEAP Enhancement Charge	$0.73	$0.73	$0.73	$0.73	$0.73	$0.73	$0.81	$0.81	$0.81	$0.81	$0.81	$0.81	
(5)	RE Growth Charge	$0.17	$0.17	$0.17	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	$0.22	
(6)	Distribution Energy Charge	$0.04283	$0.04283	$0.04283	$0.04278	$0.04278	$0.04278	$0.04278	$0.04278	$0.04278	$0.04268	$0.04268	$0.04268	
(7)	Renewable Energy Dist Charge	$0.00344	$0.00344	$0.00344	$0.00344	$0.00344	$0.00344	$0.00674	$0.00674	$0.00674	$0.00677	$0.00677	$0.00677	
(8)	Transmission Charge	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.02705	$0.03179	$0.03179	$0.03179	
(9)	Nonbypassable Transition Charge	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	($0.00058)	$0.00057	$0.00057	$0.00057	
(10)	Energy Efficiency Program Charge	$0.01107	$0.01107	$0.01107	$0.01107	$0.01107	$0.01107	$0.01154	$0.01154	$0.01154	$0.01154	$0.01154	$0.01154	
(11)	Standard Offer Service Charge	$0.08679	$0.08679	$0.08679	$0.08179	$0.08179	$0.08179	$0.08179	$0.08179	$0.08179	$0.06228	$0.06228	$0.06228	
	Rate A-60 Units Billed on Rate A-16 Rates													
(12)	Proxy Customer Charge	$96,470	$96,102	$94,922	$95,653	$94,886	$89,144	$93,250	$92,241	$86,875	$89,595	$97,182	$97,666	
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(14)	RE Growth Charge	$5,964	$5,941	$5,868	$7,652	$7,591	$7,132	$7,460	$7,379	$6,950	$7,168	$7,775	$7,813	
(15)	Distribution Energy Charge	$900,948	$1,081,783	$957,647	$696,056	$650,991	$754,446	$888,942	$804,058	$734,064	$735,644	$642,759	$703,850	
(16)	Renewable Energy Dist Charge	$72,362	$86,886	$76,916	$55,971	$52,347	$60,666	$140,053	$126,679	$115,652	$116,690	$101,956	$111,646	
(17)	Transmission Charge	$569,008	$683,218	$604,818	$440,119	$411,625	$477,040	$562,082	$508,410	$464,152	$547,941	$478,756	$524,259	
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(19)	Energy Efficiency Program Charge	$232,862	$279,602	$247,517	$180,115	$168,454	$195,225	$239,794	$216,896	$198,015	$198,907	$173,792	$190,310	
(20)	Standard Offer Service Charge	$1,825,665	$2,192,108	$1,940,560	$1,330,771	$1,244,613	$1,442,406	$1,699,545	$1,537,258	$1,403,438	$1,073,475	$937,934	$1,027,080	
(21)	Total	$3,716,686	$4,436,502	$3,940,477	$2,822,292	$2,646,869	$3,039,494	$3,646,540	$3,309,189	$3,024,783	$2,805,635	$2,477,363	$2,700,791	
(22)	Proposed Low Income Discount %	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	15%	
(23)	Estimated Low Income Discount	$557,503	$665,475	$591,072	$423,344	$397,030	$455,924	$546,981	$496,378	$453,717	$420,845	$371,604	$405,119	$5,784,992

(1) per Customer Billing System
(2) per Customer Billing System
(3) Per Company Proposal
(4) - (10) Per Summary of Retail Delivery Rates, R.I.P.U.C. No 2095
(11) Per Summary of Rates - Standard Offer Service, R.I.P.U.C. No 2096
(12) Line (2) x Line (3)
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(16) Line (1) x Line (7)
(17) Line (1) x Line (8)
(18) Line (1) x Line (9)
(19) Line (1) x Line (10)
(20) Line (1) x Line (11)
(21) sum of Lines (12) through (20)
(22) Per Company Proposal
(23) Line (21) x Line (22)

PUC 4-17

Request:

Are there any performance metrics proposed for the non-rate related low income proposals in this docket? If so, please explain.

Response:

There are no performance metrics proposed for the non-rate related low income proposals in the Company's filing in this docket.

Prepared by or under the supervision of: John Isberg

PUC 4-18

Request:

Please provide the results of any FERC audit completed in the last five years.

Response:

FERC did not issue an audit report regarding The Narragansett Electric Company in the last five years.

Prepared by or under the supervision of: Melissa Little

PUC 4-19

Request:

Please provide a listing of any software/data systems that are no longer used and useful, but which are still being amortized in rates currently. What additional software/data systems will become obsolete and no longer used and useful in the Rate Year, but which will still be amortized in rates?

Response:

In the Company's last general distribution rate case in Docket No. 4323, the Public Utilities Commission approved the Advantage billing system for ongoing recovery after it was replaced by the CSS system. The Advantage billing system was transferred to a regulatory asset account from plant-in-service when CSS was placed in service. The Advantage system regulatory asset was fully amortized as of August 2017. As shown on Schedule MAL-4-GAS, Page 1, there was $706,000 of Advantage system amortization in the Test Year, and the Company made an adjustment to remove that amount from the cost of service given that recovery of systems costs is complete.

Also, as shown on Schedule MAL-5-GAS, Page 1, the Company has requested the ongoing amortization of the Rhode Island AM/FM GIS system of $426,184 in the current rate case. The existing system will be replaced with the implementation of IS Project 4630 - US GIS Gas Consolidation to ESRI and ArcFM to consolidate all of the disparate National Grid US gas GIS systems to a common ESRI GIS platform. The consolidation of GIS systems to the ESRI and ArcFM platform implements the latest GIS technology at National Grid. This will also set the foundation for future integration of the U.S. gas GIS systems with other U.S. Gas Business Enablement applications for work management, scheduling, dispatch, and mobility.

Prepared by or under the supervision of: John Gilbert, Daniel DeMauro, and Mukund Ravipaty

PUC 4-20

Request:

Has National Grid considered the use of cloud computing in lieu of Company operated data centers?

Response:

Yes. National Grid is adopting a hybrid cloud strategy, which will enable National Grid to locate information technology workloads in the most optimal environment. This will result in workloads being distributed across a mixture of public and private cloud environments. Traditional data center hosting services will continue to be used for workloads that do not lend themselves to either public or private cloud architecture.

This strategy and approach will provide National Grid with greater flexibility and speed in how services are provisioned while utilizing cost optimization opportunities that modern cloud architectures provide, such as advanced metering services functionality.

The cloud architectures also provides increased agility by connecting National Grid to modern, highly scalable, and elastic infrastructure, which will enable National Grid to adapt rapidly to changes in demand. The service providers maintain the underlying infrastructure, so the infrastructure will always be secure and current from a supportability perspective.

National Grid has already developed public cloud framework designs for a number of cloud vendors (*e.g.*, Azure, AWS). Some initial workloads have already been established as cloud services, and National Grid is applying a structured, methodical approach for the migration of additional workloads across National Grid's hybrid cloud architecture.

National Grid believes that there is an opportunity to eliminate any bias towards capitalization and encourage greater use of software, platform, and infrastructure as a service arrangement through the granting of rate base treatment to prepaid lease contracts associated with the above. For example, as part of the Reforming the Energy Vision Track 2 proceeding, the New York Public Service Commission ruled that utilities may rate-base the expense for leased software paid for upfront. "As utilities evaluate whether to purchase or lease these applications, their ability to earn a return on a portion of the lease investment should help to eliminate any capital bias that could affect that decision," the New York Public Service Commission ruled in its "Order Adopting a Ratemaking and Utility Revenue Model Policy Framework" (Matter 14-00581).

Prepared by or under the supervision of: John Gilbert, Daniel DeMauro, and Mukund Ravipaty