

SECTION 3

Service Entrance Requirements

The Utility will, in all cases, designate where the Utility service will terminate on the customer's building or structure. The utility will consult with and consider the customer's preferences before making this determination.

3.1 Service Requirements

Only those individuals who have been properly trained in wiring techniques, code requirements, and electrical safety will be allowed to wire on the MU system. MU will not inspect customer wiring or provide electrical code interpretations. By law, this is allowed to be done only by State-Certified Electrical Inspectors. The City of Marshfield Electrical Inspector is State-Certified and can be contacted at the phone number listed in Section 1.0.

Basic items for completing the service entrance to the customer's main disconnect switch for a single family residential building include:

1. The minimum service and meter socket/pedestal size is 200 amperes for underground service and 100 amperes for overhead service. Service entrance conductors and main disconnects may be 100 amp on underground services if the National Electric Code load calculation allows.
2. Table 3-1 shows the minimum conductor sizes for residential use only for 120/240 single-phase 3-wire service entrances: (Conductor sizing from NEC 310.15 and applies for wire/cable types THW, THWN, THHN and USE).

Service Size <u>Amperes</u>	Service Entrance Conductors	
	<u>Copper</u>	<u>Aluminum</u>
100	#4	#2
150	#1	2/0
200	2/0	4/0
400	400	600 *

Note: * Larger than 500 kcmil will not be accepted for overhead service entrances

3. Conduit sizing for entrances must be:
 - A minimum size of 2 inch HDPE bore duct or 2½ inch Schedule 40 Electrical PVC for underground services. Schedule 80 PVC is required for all risers and above grade installations. Risers should extend approximately 3 inches above ground level.

- On overhead masts that extend above the roof, rigid metal conduit is required to the weatherhead. The mast may not extend over 5 feet above the roofline without permission from MU. For 200 ampere or less services, the minimum rigid metal conduit size is 2 inch. All overhead masts should be back-guyed if the service drop attachment point is more than 36 inches above the roof. MU may also require back guying or bracing on service wire lengths over 100'. No couplings are allowed in the service mast above the roofline. The top section of conduit must be a full section of conduit and be securely anchored to the building just above any coupling. No portion of the mast pipe, except the portion extending through the eave/overhang, shall be covered.
4. The main disconnect must be located within 8 feet of where the service entrance raceways or service entrance cable enters the structure.
 5. All aluminum connections must be made with aluminum rated connectors. The conductor and connector must be properly brushed, treated, and dressed with approved corrosion inhibitors.
 6. Only metering conductors may be installed in pedestals or meter sockets.
 7. In rural areas, meters shall be turned toward the road or driveway whenever practical for ease of reading.
 8. All services of the same class/voltage must be served from a common service entrance mast. This can be a single mast or parallel mast depending on load. If services of different characteristics are utilized and the meter sockets cannot be connected with a common bus due to mechanical limitations, dual mast may be allowed if located close together. For example, with a combination of a 400-amp service and a 200-amp service or a combination of a three phase and a single-phase service, dual masts may be allowed if located close together. Contact MU before installing dual mast. MU must approve all dual mast installations.
 9. The maximum mast wire size is 500 kcmil, regardless of service type.
 10. All overhead service attachments should have a reinforced insulated attachment (screw knob, service clevis, etc.) point provided. Back guying, if required, of overhead mast should be 36" above the roof line measured to the attachment point.
 11. All nuts, bolts, lugs, etc. located within meter sockets and meter pedestals are to be torqued per the manufacturer's specifications.

3.1.1 Grounding

- 1) Two ground rods are to be installed at least 6 feet apart, and if present on the premises the following are to be bonded to the grounding system:
 - Metal underground water pipe system
 - Concrete enclosed electrode
 - Ground rings
 - Metal frame of building
 - Communication grounding electrode
 - Cable TV grounding electrode

If you have an ufer ground (rebar incased in concrete) ground rods are not required. Ground rods are only required when you need to supplement a water service or where no other electrodes are available.

Other grounding configurations are described in NEC Article 250 and Safety and Professional Services SPS 316.250 (1) (2).

- 2) Ground rods and grounding electrode conductors shall not be located in front of the meter pedestal, wire troughs, or within 2 feet of the underground cable route. Good wiring practice is to install the ground rods outside the drip line.
- 3) Grounding electrode conductors shall not be run in or through the overhead meter socket or underground meter pedestal. On current transformer (CT) cabinets, the grounding electrode conductor may be run into the CT cabinet if enclosed in a separate conduit and terminated on the neutral strip or run directly into the main disconnect.
- 4) NEC 250 and the Wisconsin Electrical Code Chapter SPS 316.250 both provide details on specific grounding issues. Specific references include:

NEC 250 Part V	Bonding
NEC 250 Part VI	Equipment Grounding & Equipment Grounding Conductor
NEC 250 Part VII	Methods of Equipment Grounding
NEC 250.102(C)	Size-Supply Side Bonding Jumper
NEC 250.94	Bonding for Other Systems
NEC 820 Part IV	Grounding Methods
NEC 250.104	Bonding of Piping Systems and Exposed Structural Steel
NEC 250.50	Grounding Electrode System
NEC 250.52	Grounding Electrodes
SPS 316.250	Two-Ground Rod Requirement
NEC 250.62; 64	Grounding Electrode Conductor Material; Installation
NEC 250.66, table	Size of Alternating-Current Grounding Electrode Conductor
NEC 810.21	Bonding Conductors and Grounding Electrode

Conductors—

	Receiving Stations
NEC 800 Part IV	Grounding Methods (Communication Circuits)

- 5) In a building with 10 feet or more of metallic water pipe in contact with the earth, the water pipe must be bonded to the neutral bar in the main distribution panel or first disconnecting means. The bond to the water pipe must be within 5 feet of where the water line enters the building, and the bond must be on the supply side of the water meter. Also note that the metallic water piping must be bonded even if there is no earth contact.

The bond to the water pipe shall not be made within 1 foot of either side of the water meter.

6) Service Entrance Ground Conductor Requirements

Table 3-2 shows the required grounding electrode conductor sizes for various service entrance conductor arrangements. The table is based on NEC 250.66. This table should be used in conjunction with table 3-1. The grounding conductor must be a minimum of #4 copper for a 200 ampere service.

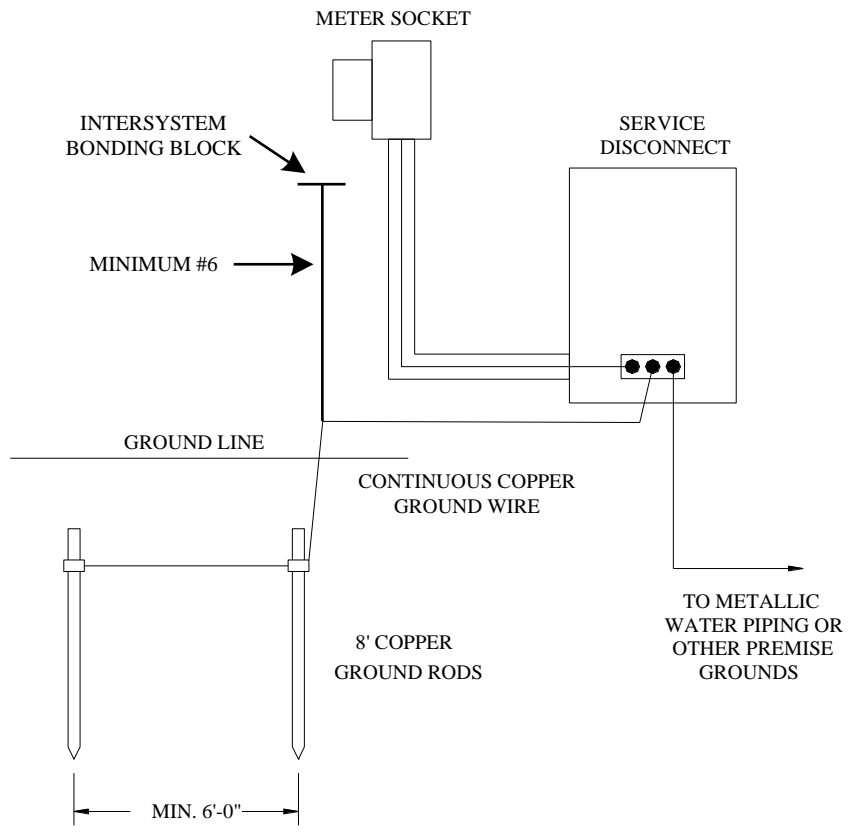
- 7) All grounding conductors, (green and bare conductors) must be bonded to the neutral in the main distribution panel or first disconnecting means. Equipment grounding conductors and grounding electrode conductors are not permitted in the meter socket or other entrance equipment unless the main disconnect is located in the meter socket/pedestal.

**Table 3-2
Grounding Electrode Conductor for Alternating Current Systems
And
Equipment Bonding Jumper on Supply Side of Service**

SIZE OF LARGEST SERVICE-ENTRANCE CONDUCTOR OR EQUIVALENT AREA FOR PARALLEL CONDUCTORS		SIZE OF GROUNDING ELECTRODE CONDUCTOR	
<i>Copper</i>	<i>Aluminum or Copper-Clad Aluminum</i>	<i>Copper</i>	<i>Aluminum or Copper-Clad Aluminum</i>
#2 or smaller	1/0 or smaller	#8	#6
#1 or 1/0	2/0 or 3/0	#6	#4
2/0 or 3/0	4/0 or 250 Kcmil	#4	#2
Over 3/0 through 350 Kcmil	Over 250 Kcmil through 500 Kcmil	#2	1/0
Over 350 Kcmil through 600 Kcmil	Over 500 Kcmil through 900 Kcmil	1/0	3/0
Over 600 Kcmil through 1100 Kcmil	Over 900 Kcmil through 1750 Kcmil	2/0	4/0
Over 1100 Kcmil ¹	Over 1750 Kcmil ¹	3/0	250 Kcmil

¹ Equipment bonding jumper for this category shall be not less than 12-1/2% of the area of the phase conductors of the same materials.

Note: In almost all cases a #4 AWG ground wire is required to all ground rods and for all grounding electrode conductors.



**Figure 3-1
Overhead Service**

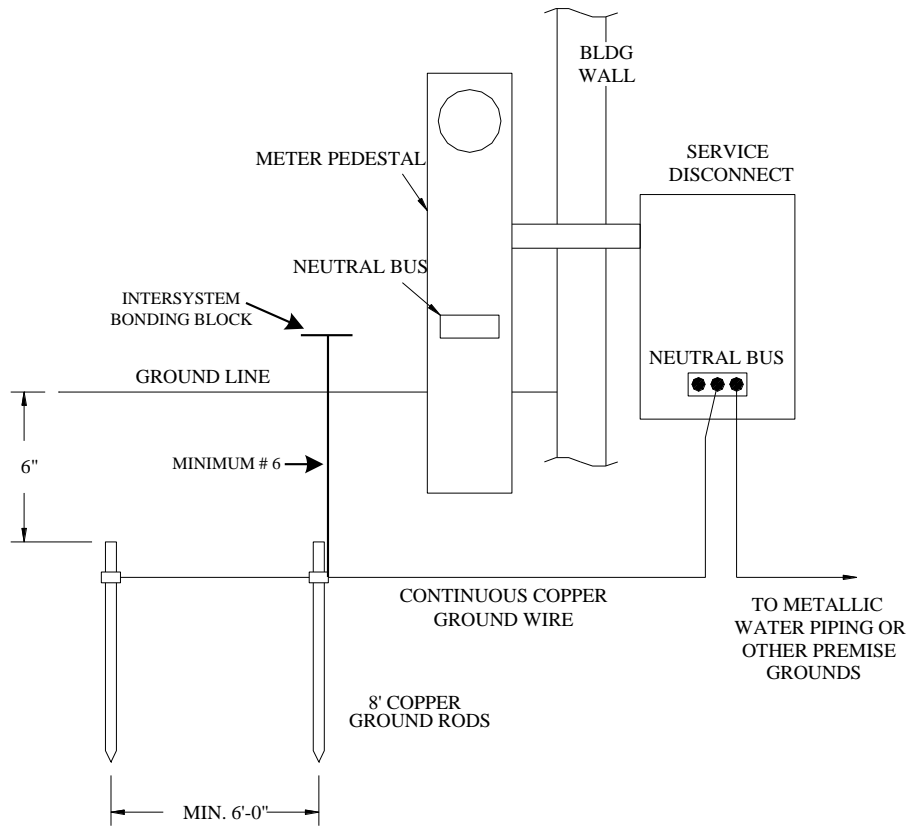


Figure 3-2
Underground Single-Family Without Service Disconnect in Meter Pedestal

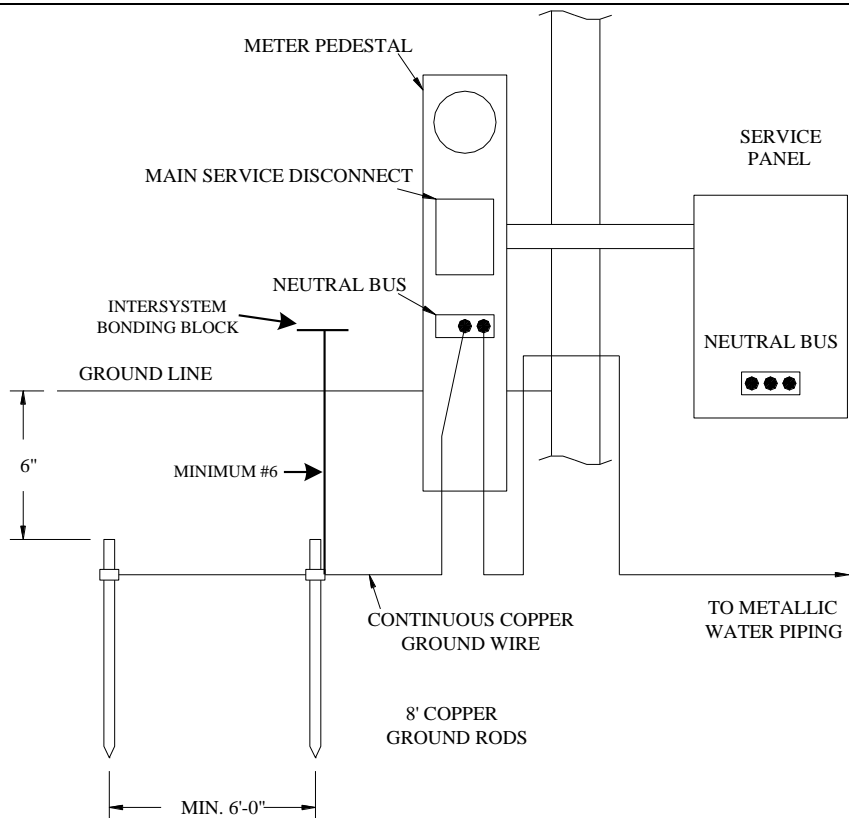
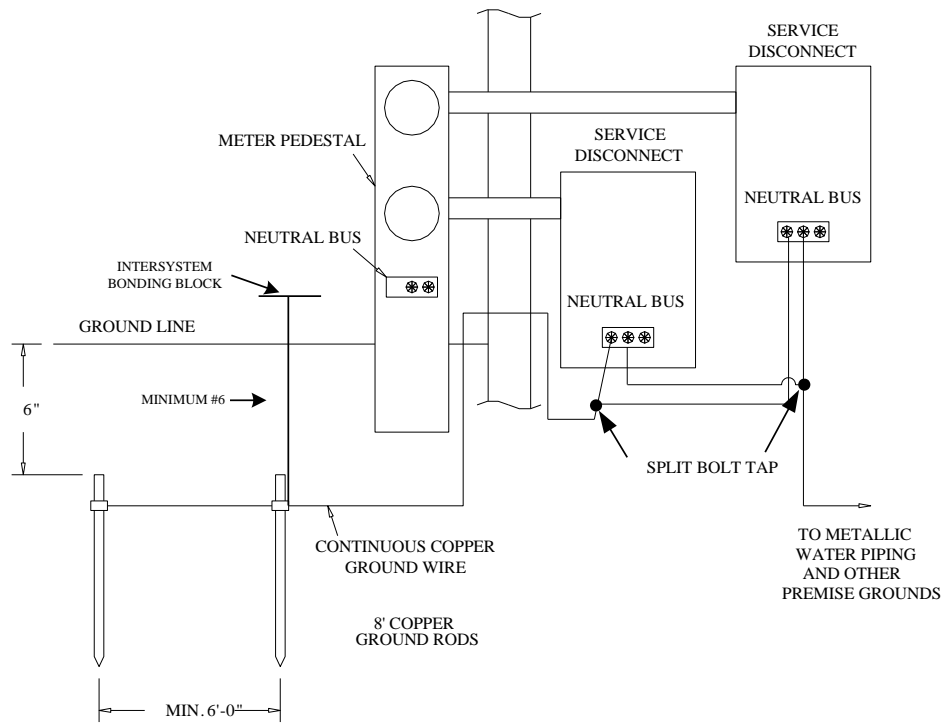


Figure 3-3
Underground Single-Family With Service Disconnect in Meter Pedestal

The service disconnect shall be located in the meter pedestal if the raceways containing service conductors or cables, or service entrance cable not contained within a raceway extends longer than 8 feet into a building to the service disconnect. [SPS 316.230 (3) (b)] A service disconnect with overcurrent protection is required on all self-contained metering installations where the conductors go underground after leaving the meter socket, the over current disconnect maybe eliminated if the conductors are installed in conduit, a red caution tape is installed in the trench 1 foot below grade, and the conduit route is parallel with and within 2 feet of the building wall. Transformer rated installations with multiple services originating from one transformer will be evaluated at time of design to determine if a disconnect is required.



NOTE: Wires to ground rods and to waterline are un-spliced. Both un-spliced wires can originate from one panel. Then, run two wires out of the other panel and "tap" to these un-spliced wires.

Figure 3-4
Underground-Two Family Residential

3.1.2

200 Ampere Single Phase Underground Service

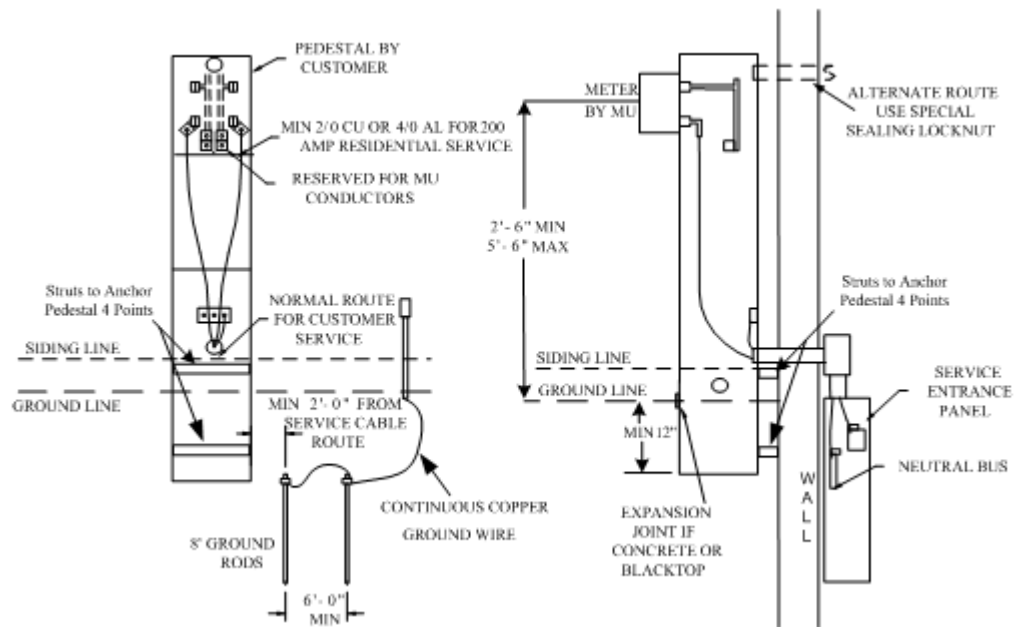


Figure 3-5

200 Ampere Single Phase Underground Service

The main disconnect must be located within 8' of where the services entrance cable or raceway enter the building. Figure 3-5 depicts the main entrance in the traditional location. Also consult the previous sections of this chapter for proper sizing of the grounding conductor. All new and upgraded underground services shall be installed to the existing foundation wall by means of two (2) horizontally or vertically installed pieces of unistrut with four points of contact and secured at the top of the meter pedestal per manufacture requirements. Treated Lumber will not be accepted.

3.1.3 200 Ampere Single Phase Underground Service with Main Breaker

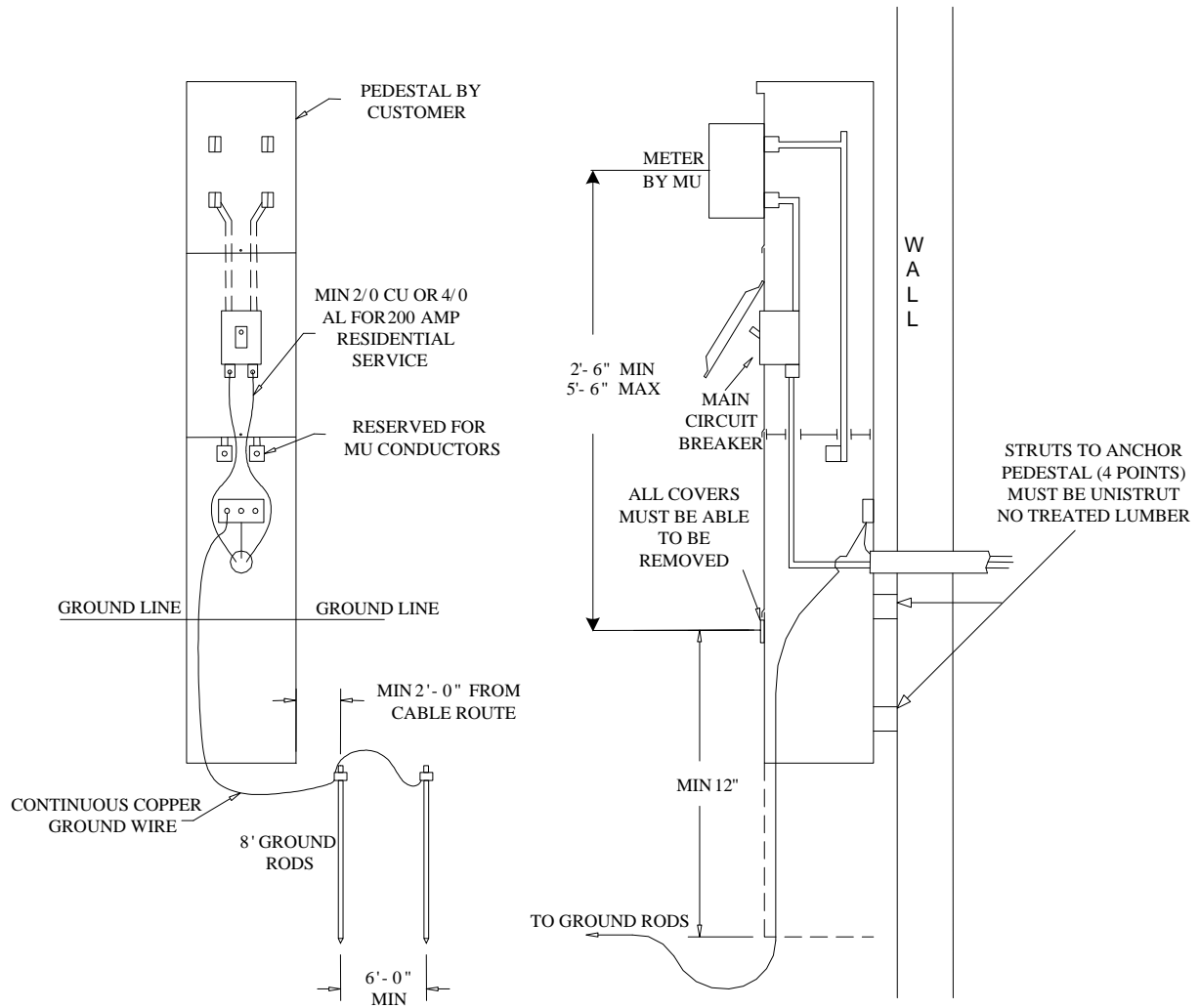
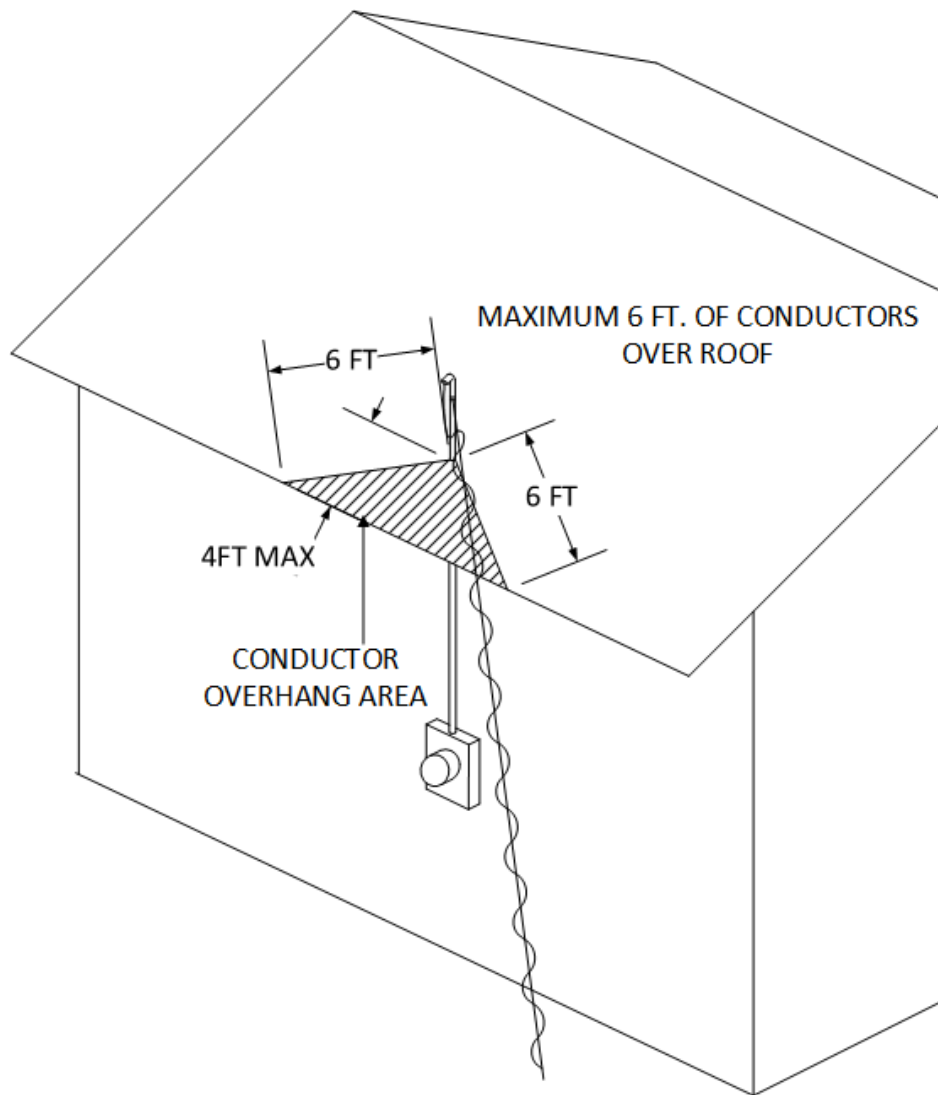


Figure 3-6
200 Ampere Single Phase Underground Service with Main Breaker

Figure 3-6 is applicable for underground service where the main breaker is an integral part of the outdoor underground service pedestal. See also Section 3.1 - Figures 3-2 and 3-4 for the more common underground service with an indoor main breaker(s). If this equipment is freestanding, see figure 3-11.



ROOF MUST HAVE A 4/12 PITCH TO USE CLEARANCES IN
NEC 230.24 (A) EXCEPTION NO. 3

Figure 3-7 (b)

100-200 Ampere Single Phase Overhead Service

Figures 3-7 (a) and 3-7 (b) show a typical overhead single-phase 120/240-volt 3-wire service arrangement. See Table 3-3 for overhead line clearances and separations.

Table 3-3
Service Drop Clearance Requirements
(Minimum Clearance at Maximum Load and Temperature)

1.	In general, service conductors must maintain 8' over roofs. (NEC 230.24 (A))
2.	Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portions of the roof to not less than 450 mm (18 in.) shall be permitted if (1) not more than 1.8 m (6 ft.) of overhead service conductors, 1.2 m (4ft.) horizontally, pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support. (NEC 230.24 (A) Exception #3)
3.	Where the voltage between conductors does not exceed 300 and the roof has a slope of 100 mm in 300 mm (4 in. in 12 in.) or greater, a reduction in clearance to 900 mm (3 ft.) shall be permitted. (NEC 230.24 (A) Exception #2)
4.	The drip loop and service conductor must have at least a 3' separation in any direction from windows, doors, porches or similar structures. An exception is granted for a window that does not open or the top edge of a window.
5.	The drip loop and service conductor shall have a separation of at least 12" to any communication circuits.
6.	Communication, telephone, cable TV, and customer-owned cables shall not be attached to the service mast. (NEC 230.28)
7.	The service entrance conductor shall not extend more than 8' of service entrance cable or raceway into the building.
8.	The customer's neutral conductor shall be identified by white tape, white insulation, white paint, or other techniques permitted by NEC Article 200.
9.	An overhead service may be attached to a customer-owned pole or post provided that the pole or post is treated with a wood preservative, is back-guyed, and the pole/post has a minimum of a 5" diameter top.
10.	The customer is responsible to provide and install an insulated attachment point either located on the service mast or a screw knob that will support the utility's service conductors.
11.	No portion of the service mast pipe, except the portion extending through the roof eave/overhang, shall be covered.

3.1.5 Temporary Service

Temporary Service Requirements Include:

1. The Utility shall specify the location of temporary service pole(s) or meter pedestal to avoid clearance problems. The temporary service pole or meter pedestal will need to be clear of the route for permanent service.
2. Meter sockets shall be rated 100 or 200 ampere, be UL approved, of ringless design, and have bypass horns or a manual lever bypass.

3. The distribution panel must be weatherproof or protected from the elements, have ground fault protection with proper protective covers on all outlets, and be installed so as to comply with the electrical code.
4. For residential temporary services, entrance conductor shall be a minimum of #4 copper or #2 aluminum for 100-ampere service and 2/0 copper or 4/0 aluminum for 200-ampere service. For commercial temporary services, entrance conductors shall be #3 copper or #1 aluminum for 100-amp service and 3/0 copper or 4/0 aluminum for 200-amp service. The customer must provide protection for cable and conductors that is acceptable to the local electrical inspector and/or MU.
5. Two ground rods are required in addition to a bond to metallic water piping, if present, for grounding. The grounding electrode conductor should be terminated in the distribution panel and not run through or terminate in the meter socket.
6. The temporary service pole shall be at least 5" in diameter at the top. Three 2"x 4"s will meet this requirement. Bracing and stakes shall also be of 2"x 4" construction.
7. Only MU will make connections to the Utility system.
8. Junk, unserviceable, or inadequate capacity equipment such as 60-ampere meter sockets and/or indoor 60-ampere fuse panels are not acceptable for temporary service. If MU must make return trips because of clearance problems, or unsafe or otherwise inappropriate equipment, MU will apply additional charges.
9. Temporary services are for short-term use. If a temporary service is expected to be used longer than 90 days, it shall be installed as a permanent service.
10. Temporary service may be allowed on utility poles on a case-by-case basis with Utility permission.
11. Temporary services shall not utilize the permanent meter socket mounted on the house to provide a route into the house. The permanent meter socket must be kept unused until the permanent service conductors are installed.

Note: The NEC requirements are the same for temporary service as for permanent service.

Figures 3-8 (a), (b), (c) and (d) on this and the following pages show temporary overhead and underground service arrangements that MU would except.

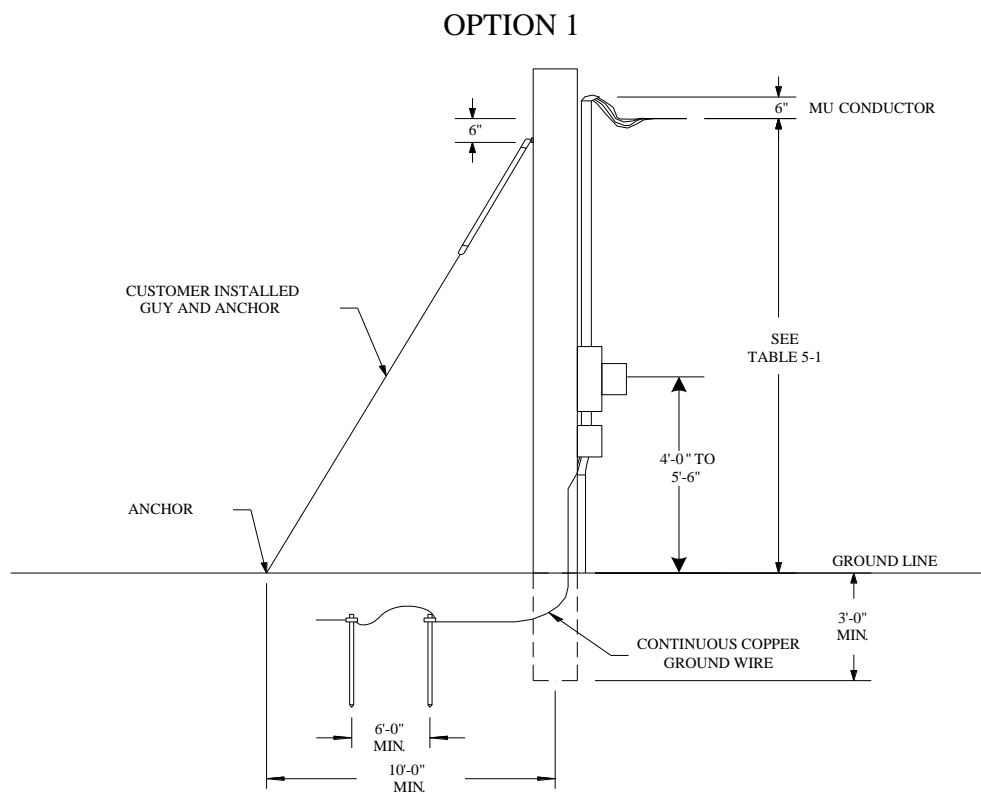


Figure 3-8 (a)
Temporary Overhead Service Options

OPTION 2

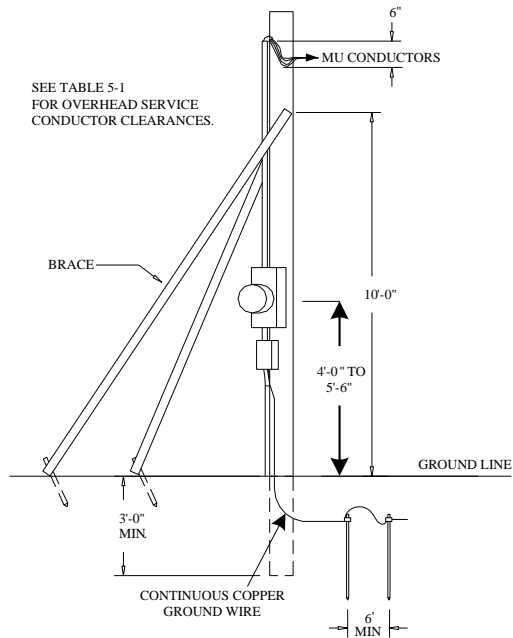


Figure 3-8 (b)
Temporary Overhead Service Options
OPTION 3

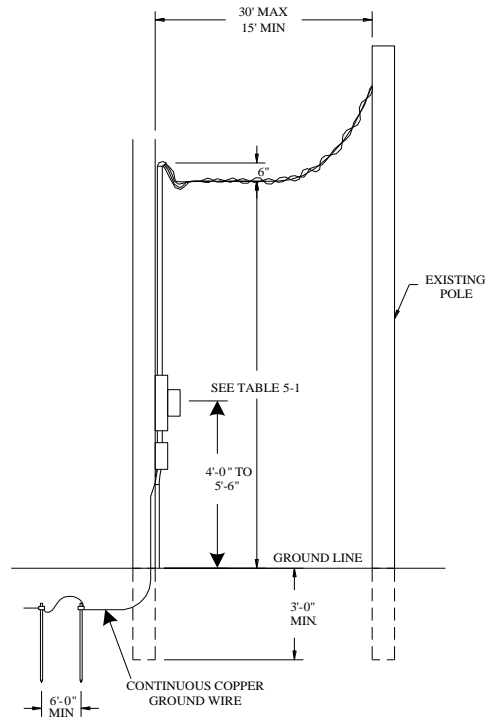


Figure 3-8 (c)
Temporary Overhead Service Options

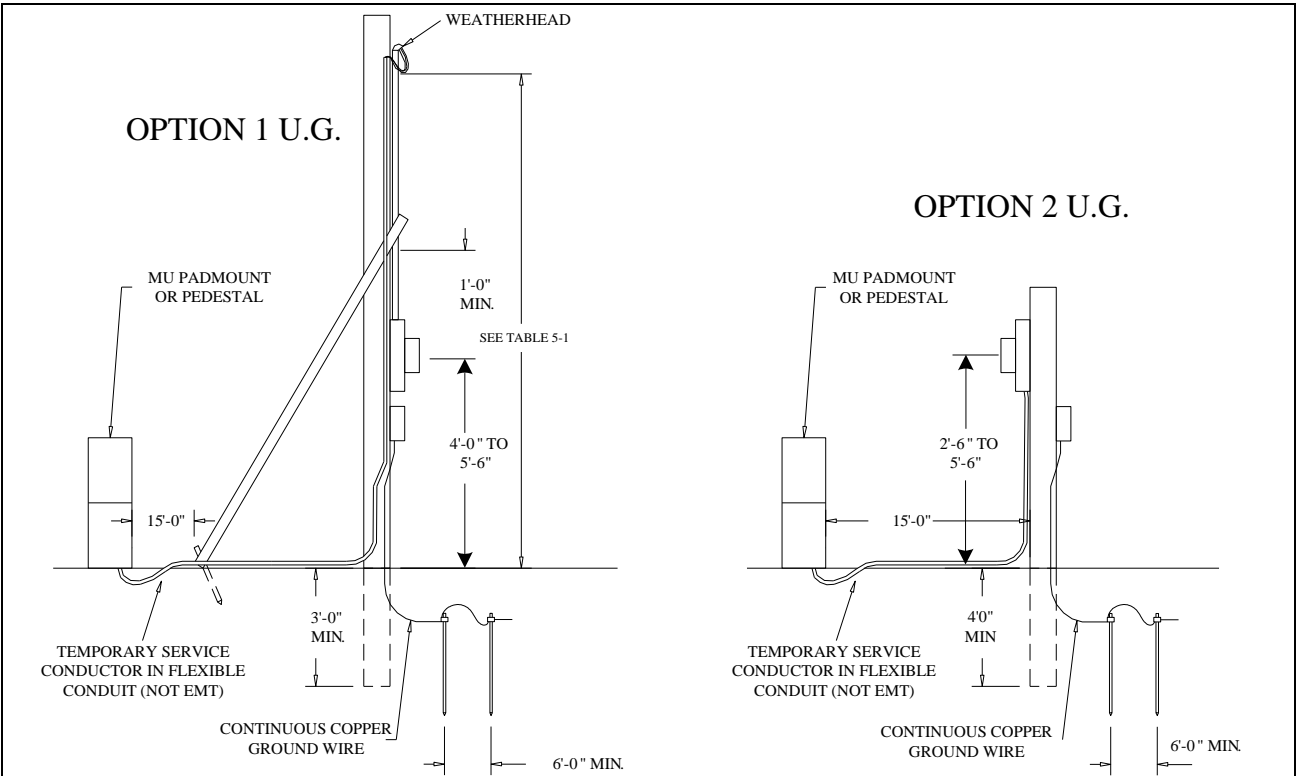


Figure 3-8 (d)
Temporary Underground Service Options

3.1.6 Permanent/Temporary Underground Service

The customer may install a permanent meter pedestal and breaker panel as shown in Figure 3-9 and avoid using a temporary service. The breaker panel must be weatherproof or protected from a wet or damp environment. To utilize this option, the basement walls must be backfilled and tamped for MU to run a permanent underground service. See permanent underground services for additional requirements.

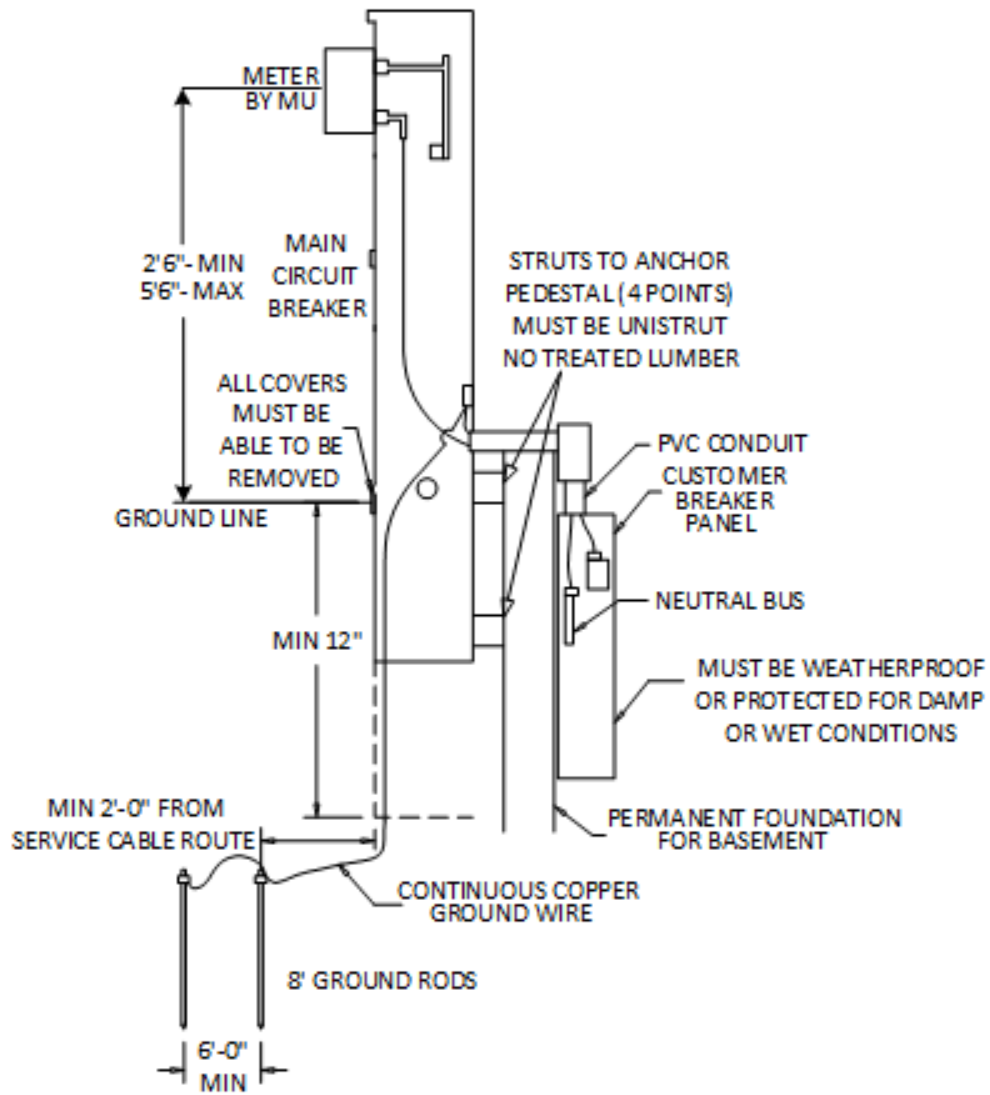


Figure 3-9
Temporary/Permanent Underground Service Option

3.1.7 Mobile Home Services

A mobile home is defined by NEC 550.2 to be: "a factory-assembled structure or structures transportable in one or more sections, that are built on a permanent chassis and designed to be used as a dwelling without a permanent foundation where connected to the required utilities, and includes the plumbing, heating, air-conditioning, and electric systems contained therein. For the purpose of this code and unless otherwise indicated, the term "mobile home" includes manufactured homes".

Mobile homes, if the axles, wheels, and/or tongue are still in place are considered movable. The code authority, local or state inspector should be consulted for the applicable code sections if the mobile home has been rendered immovable. MU will consider all manufactured homes to be mobile homes unless the code authority issues an opinion to the contrary.

Mobile home service extensions shall comply with the following standards:

1. MU will spot the location of the service entrance facilities to comply with all code clearances. The customer will install the mobile home service pedestal(s) with the meter pointed toward the driveway or street. The customer shall also label the pedestal to identify the mobile home being served where it is not obvious.
2. Other NEC 550.32 requirements for mobile home service are:
 - a. Service will be 120/240-volt single phase.
 - b. The service entrance equipment must be rated 100 amperes or greater, be waterproof, and be mounted at least two feet above finished grade level.
 - c. The service entrance equipment cannot be mounted on the mobile home, must be within sight of the mobile home, but not more than 30 feet from the mobile home.
 - d. The entrance panel must have at least a 50 ampere 120/240 volt breaker.
 - e. The electrical panel shall have branch circuit capability for serving an accessory building, structure, or additional electric equipment. The entrance equipment should also have provisions for serving an outdoors 15 or 20 ampere, 120-volt GFI outlet.
 - f. Two 8' ground rods with a minimum 6' separation shall be installed for grounding. The grounding electrode conductor shall be at least #6 copper enclosed in PVC conduit and terminated in the service panel without entry into or connection to the meter socket.
 - g. The customer cable or cord from the entrance panel shall have an equipment ground, neutral conductor, and two hot conductors.
3. Figure 3-11 shows the freestanding meter pedestal support post installation requirement.
4. Adequate clearances and separations must be followed. See Section 5 on clearances.

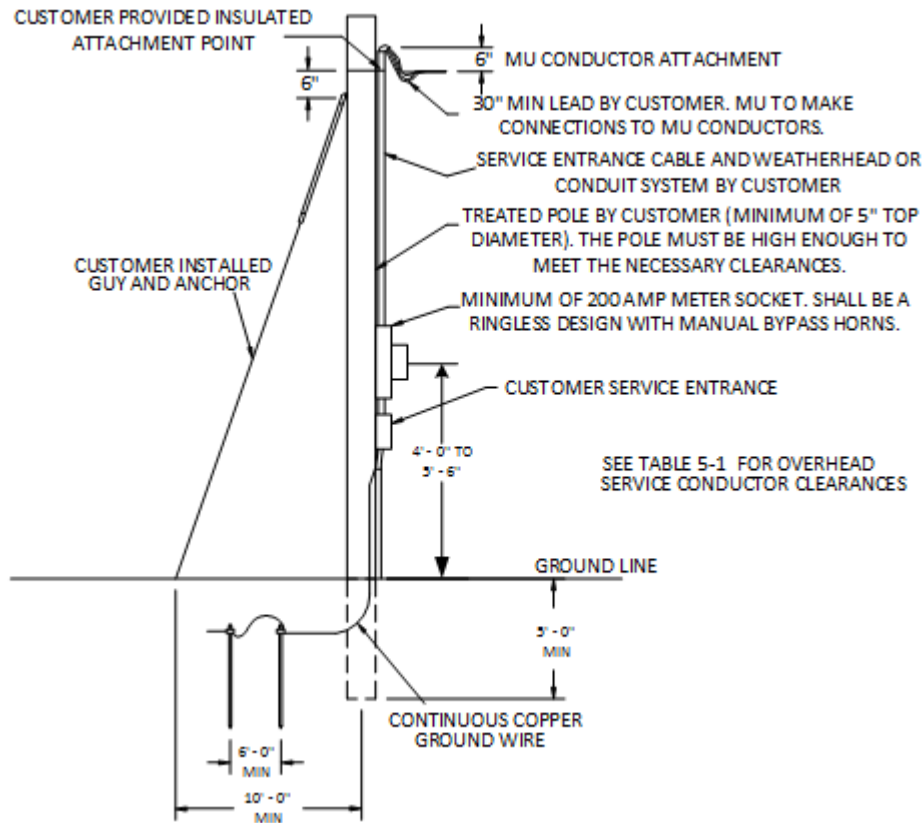
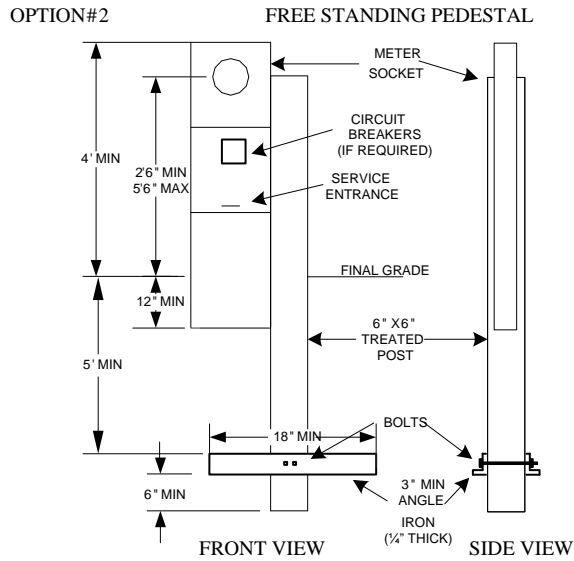
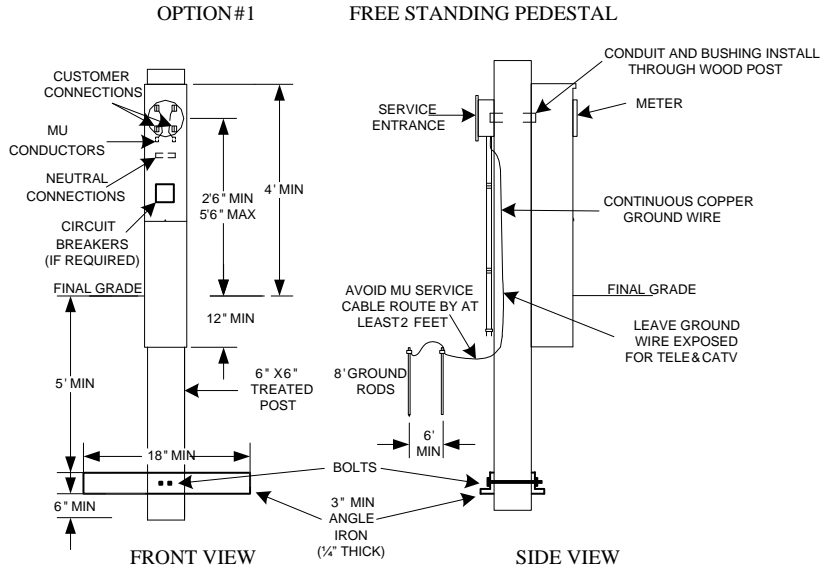


Figure 3-10
Typical Overhead Service Arrangement



NOTE: FOR BOTH OPTIONS POST SHOULD BE WRAPPED A MINIMUM OF TWO TIMES WITH A MINIMUM OF 6 MIL PLASTIC BETWEEN THE GROUNDLINE AND THE ANGLE IRON

**Figure 3-11
Free Standing Pedestal Options**

3.2 Single Phase 120/208 Volt Network Service (0-200 Ampere)

This voltage is common near commercial areas and in multi-unit condominium/apartment developments. Single-phase service is limited to a maximum of 200 amperes. Larger installations shall use a three-phase service to supply single-phase loads and metering with the total load balanced on all three phases.

The fifth jaw shall be added to single-phase 120/240-volt meter sockets for 120/208 single-phase service. The fifth jaw shall be added at the 9 o'clock position, anchored to the meter socket, and secured as shown in Figure 3-12. The customer should purchase the fifth jaw from the supplier of the meter socket.

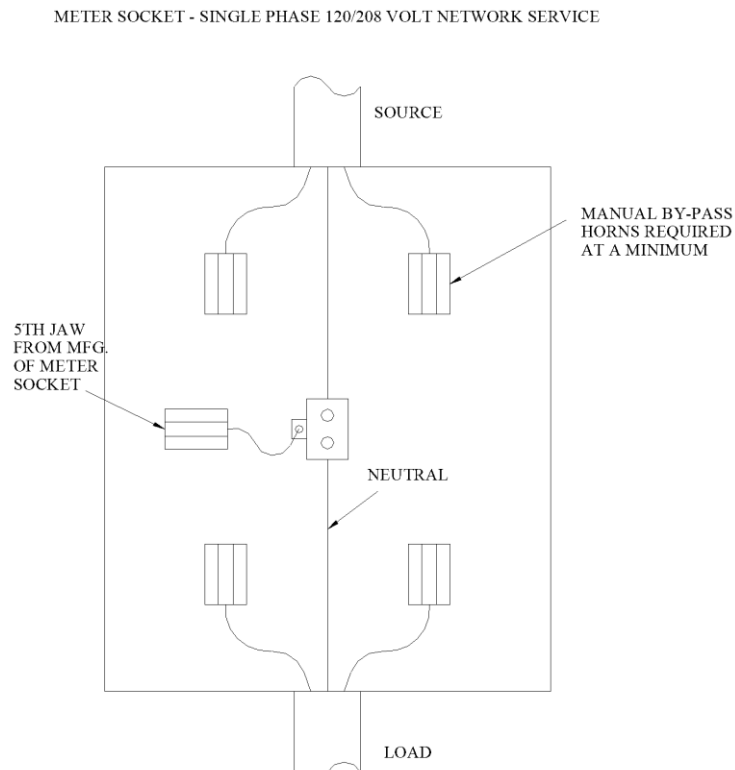


Figure 3-12
Single Phase 120/208 Network Meter Socket

3.3 Single Phase Service Installations for 2-4 Meters

Meter sockets must be ringless style, 200 amp minimum rating (main bus), clamp type jaws, and sealable with wrench-operated connectors. See Section 3.1.4 for underground service requirements and Section 3.1.5 for overhead service requirements.

Figure 3-13 shows a typical two-meter arrangement.

Each meter position must be permanently labeled with the address or apartment number **on the inside and on the exterior** of the meter socket identifying the service panel. If possible, avoid exterior labeling on removable portions of the socket. Meters will not be set until the meter socket has been permanently labeled and the office has a listing of the service addresses. See table 4-1 for additional requirements for multiple meter installations.

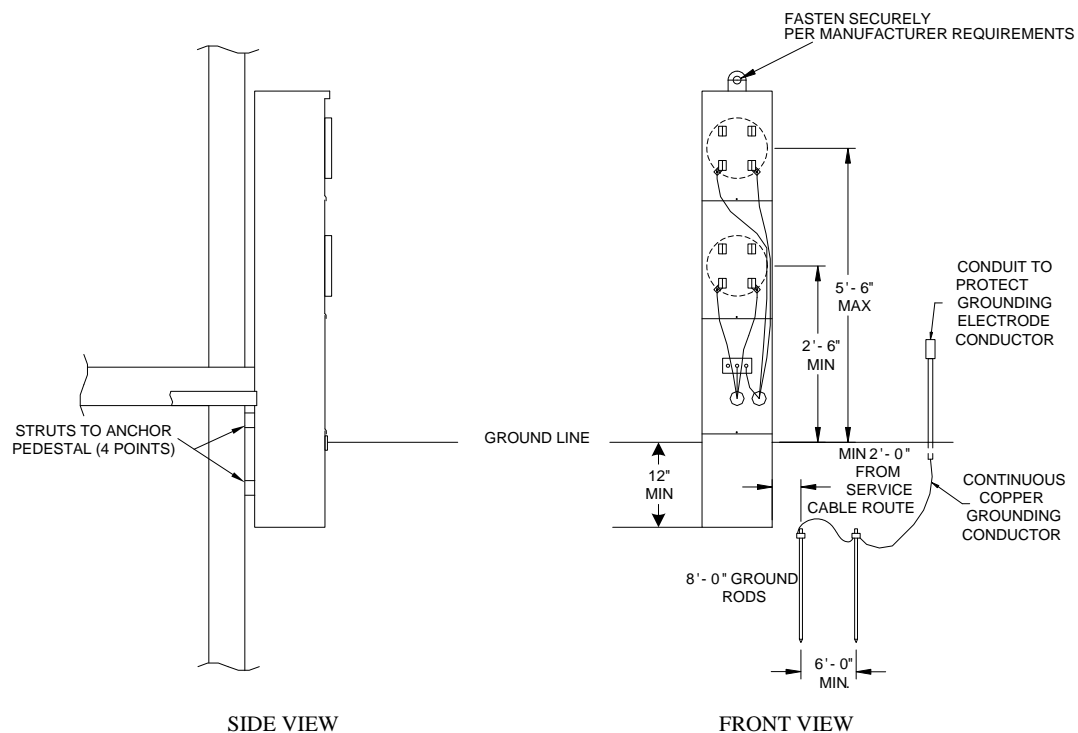


Figure 3-13
Typical Two-Meter Pedestal Installation

3.4 400 Ampere Single-Phase Residential Service

Residential 400-ampere service will be supplied at 120/240 volts with a 320-class meter. Clearance, separation, and grounding requirements are the same as for other 120/240-volt single-phase services.

The meter socket shall meet the following specifications:

1. Socket must be of the ringless type.
2. Socket must be heavy duty with studs and replaceable lugs or crimped on connectors.
3. Socket must include a lever bypass that releases the jaws when in the bypass position.
4. All 400-amp sockets must include an anti-inversion kit installed by the contractor or manufacturer to prevent installation of a 200-amp meter and inversion of a class 320 meter.

All single-phase residential services exceeding 200 amps will use class 320 meters instead of an instrument transformer metering installation. Commercial installations over 200 amperes will be evaluated to determine if the class 320 meter will be adequate. All three-phase services exceeding 200 amperes will be metered with instrument transformers.

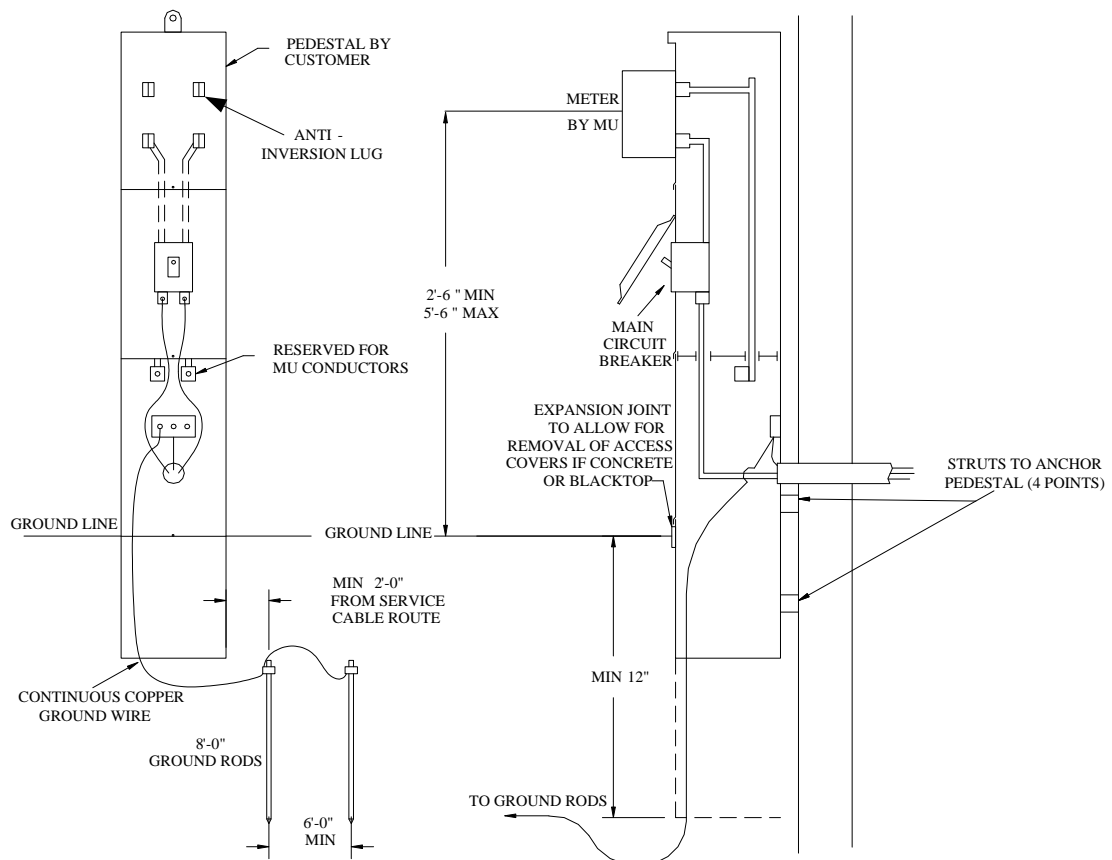


Figure 3-14 (a)
400 Ampere Single Phase Underground Service with Main Breaker

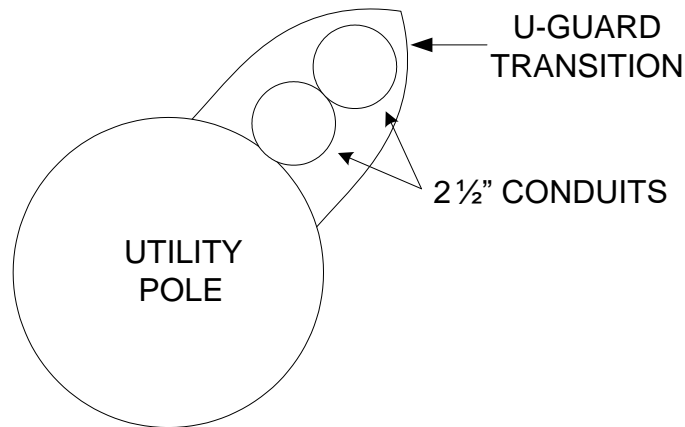


Figure 3-14 (b)
400 Ampere Single Phase Underground Service Conduit Location at Utility Pole

3.5 Underground Electric Service Guidelines

MU's standard service lateral will be single phase, 200 amp consisting of up to 100' (trench length) of 4/0 aluminum triplex installed in 2-1/2" schedule 40 PVC or 2" HDPE conduit from the meter pedestal to our equipment. The route for the standard underground service shall be frost free. All services are to be buried to a minimum depth of 30" regardless of size. Red caution tape must be installed no less than 1 foot below grade and no less than 1 foot above service. Schedule 80 conduit is required if the conduit is exposed. The meter pedestal will be installed in a location approved by the utility to minimize the service route. The utility will calculate the nominal cost of the standard underground service on an annual basis.

All requests for new service connections must be made a minimum of ten (10) workdays prior to the desired connection date. Sufficient notice is required on services larger than 200 amps to ensure that any necessary preparations can be made. Given sufficient notice, the utility will make every reasonable effort to ensure that the service lateral is installed within the allotted time. The services will normally be installed in the order that they are inspected and approved for installation. Request for permanent service must be made at Marshfield Utilities. In general, frost conditions usually are encountered around November 15th. It is possible frost conditions could be encountered before that date. Services installed in frost/frozen ground will result in extra charges to the customer and customer must sign a waiver cost sheet before the service will be installed.

Underground service will be installed in a timely manner as schedule and weather conditions allow. A minimum of three (3) days is required to call in locates.

Customer Requirements

1. The customer shall furnish and install a utility approved meter pedestal (200A min).
2. All work must conform to national, state, and local regulations.

3. The meter shall be located at least three (3) feet from an existing deck, patio, or door. This clearance may be reduced in certain situations. Contact MU for approval before installation. The preferred location for new services will be on the front or sides of the house. Rear house locations are discouraged. Existing services may remain in the rear but should be relocated to the side or front if there are possible encroachment issues such as decks, A/C units, etc.
4. A 12' wide service installation route shall not be under any existing or proposed structure or deck and must be clear of trees, stumps, or any other obstruction. The route must be level, within 3" of finished grade, and frost free.
5. All conductors and connections on the load side of the meter socket are the responsibility of the customer.
6. Final restoration of the service lateral route is the customer's responsibility.
7. After installation, the customer must keep a 12' (6' either side) clear zone along the route of the underground service lateral. All obstructions, including storage sheds, garages, decks, or patios must be kept out of this zone.

Standard Underground Service Installation

The utility will install or arrange for the installation of the standard service lateral. Customers will not be allowed to install these service laterals. Customers will be charged additional fees if the installation cost exceeds the utility's calculated nominal cost for a standard underground service. Additional expenses may result from, but are not limited to, road or sidewalk bores, concrete or asphalt replacement, improper fill, rocky conditions, or extremely wet conditions. Customers will always be responsible for any additional fees due to frost or frozen ground. The metering point designates the point of ownership change between the utility and the customer. Service laterals after the metering point will be owned and maintained by the customer. The utility will terminate both ends of utility installed service laterals.

Non-Standard Underground Services

On single-phase services over 200 amps and all three-phase services, the customer will provide the service lateral installation to include trench, conduit, and conductors installed to Marshfield Utilities' specifications. Conduits and conductors must be proper size and type to meet all applicable codes. Conduits at poles should extend approximately 3" above final grade. Contact MU for location where conduit should come up on pole. The electrical inspector will approve all installations in the City of Marshfield before connection by Marshfield Utilities. The customer is responsible for terminating the service lateral conductors at the customer end and Marshfield Utilities will terminate at the Utility end. Each will provide Utility approved termination lugs for the applicable terminations. Marshfield Utilities will assume ownership of the service once installed and accepted, and will maintain the service lateral. The metering point will be the point of ownership change on all services. Service lateral installations with the meter at the transformer will be owned and maintained by the

customer. The customer will receive an allowance for the cost of a standard service lateral based on the actual length. Table 3-4 shows MU's standard service wire and conduit sizes for service entrance sizes ranging from 200 – 3,000 amps.

Existing Services

Marshfield Utilities will assume ownership and be responsible for any required replacement of existing service laterals. The customer is responsible for the maintenance and replacement of the meter socket and all wiring on the load side of the meter socket. Service laterals that need to be relocated at customer request will need to be replaced at customer expense. "Zero-length" services where the meter is located on one pole ahead of the service will be replaced as needed and considered as new services.

Costs associated with moving meters or service laterals which are infringed upon by decks, storage sheds, etc., or that do not meet other code/MU requirements will be borne by the customer unless a written variance had been granted by MU. The customer is responsible for removing any obstructions along the service lateral route as required in the future for maintenance or replacement. If the utility removes or contracts the removal of obstructions, the customer will be responsible for the cost. If a service fails in an area that is not accessible because of an obstruction the customer will be responsible for the replacement of the service. The service will not be spliced and partially rerouted around the obstruction. Existing installations requiring maintenance will be subject to the same restrictions and guidelines as a new service. This includes replacement of the meter socket with a meter pedestal when the service lateral or the service entrance conductors are replaced.

Overhead to Underground Conversions

The utility will install the standard service laterals per all applicable requirements of the new service lateral installations. The customer will pay the full cost of the underground service lateral, less the cost of an equivalent overhead service drop not to exceed 100'. This cost will be recalculated on a per foot basis each year. The Utility will install the standard underground service lateral where the customer is upgrading their service entrance equipment, which normally includes the main distribution panel and meter equipment from a 100 amp or less service to a 200-amp service.

Underground Service Upgrades

Underground service lateral upgrades to 200 amp required because of increased loads will be installed by the Utility per all applicable requirements of the new service lateral installation, at no cost to the customer. The utility will make the determination as to whether the existing service lateral is adequate or in need of upgrade. Upgrades to services in excess of 200 amps will be handled as a new non-standard service.

Maximum Service Lateral Length

A maximum service lateral length has been established as a guideline for standard residential 4/0 underground service. Service laterals in excess of this length or services with higher than normally anticipated electric loads should be evaluated on a case-by-case basis. This would apply to any air conditioning loads that exceed 3 tons. These service laterals may need to be upgraded to 400 amps or may require an extension of the primary line.

Service laterals extending directly from a transformer should be limited to 250'. Service laterals extending from a pedestal should not exceed 150'. Longer lengths are acceptable if service loading is to be significantly lower than normal.

**Table 3-4
Acceptable Underground Service Lateral Configurations**

<u>Rated Amps</u>	<u>Min. Conduit Size</u>	<u>Aluminum Conductor</u>	<u>Copper Conductor</u>	<u>Compact AL Conductor</u>
200 (1Ø)	2 ½"	1 – 4/0 AWG	1 - 3/0 AWG	1 – 4/0 AWG
200 (3Ø)	2 ½"	1 – 4/0 AWG	1 - 3/0 AWG	1 – 4/0 AWG
400 (1Ø)	(1) 4"	-----	1 - 500 kcmil	-----
	(2) 2 ½"	2 – 4/0 AWG	2 – 3/0 AWG	2 – 4/0 AWG
400 (3Ø)	(1) 4"	-----	1 - 500 kcmil	-----
	(2) 2 ½"	2 – 4/0 AWG	2 – 3/0 AWG	2 – 4/0 AWG
600 (1Ø)	(2) 4"	2 – 400 kcmil *	2 – 300 kcmil	2 – 400 kcmil *
600 (3Ø)	(2) 4"	2 – 400 kcmil *	2 – 300 kcmil	2 – 400 kcmil *
800 (3Ø)	(3) 4"	3 – 400 kcmil	2 – 500 kcmil	3 – 400 kcmil
1200 (3Ø)	(4) 4"	4 – 500 kcmil	3 – 600 kcmil	4 – 500 kcmil
1600 (3Ø)	(5) 4"	5 – 600 kcmil	4 – 600 kcmil	5 – 600 kcmil
2000 (3Ø)	(6) 4"	6 – 600 kcmil	5 – 600 kcmil	6 – 600 kcmil
3000 (3Ø)	(9) 4"	9 – 600 kcmil	8 – 500 kcmil	8 – 750 kcmil
Acceptable Overhead Service Lateral Configuration				
All services	Per NEC	500 kcmil or less	500 kcmil or less	500 kcmil or less

For any other conductor sizes, consult with MU.

Each parallel run of conductors shall have its own conduit.

* Acceptable if load calculation is 540 amps or less

For residential consult Table 3-1

Allowable conductor sizes for underground AL and CU service conductor: 4/0, 250, 300, 350, 400, 450, 500, and 600.

Allowable conductor sizes for underground compact AL service conductor: 4/0, 350, 400, 450, 500, 600, and 750.

3.6 Voltages or Phase Conversion (Load Balance)

All 3 phase customers are required to balance have their loads in accordance with table 3-5. Customers changing from a Delta voltage such as 120/240 to a Wye voltage such as 120/208 or changing from single phase to three-phase service will generally accomplish load balance by replacing any single-phase distribution panels with three phase distribution panels. It is acceptable to distribute existing or planned single phase panels across the three phases to meet the listed requirements if a sufficient number of single-phase distribution panels are involved. The main distribution panel must be three phase.

Actual Load	Maximum Difference Between Phases
Under 100 amps	20%
100-200 amps	15%
Over 200 amps	10%

The percent difference calculation is:

$$\% \text{ Difference} = \left(\frac{\text{Amps High Phase} - \text{Amps Low Phase}}{\text{Amps Low Phase}} \right) * 100$$

3.7 Pad-mounted Transformers

Refer to Section 5.2 for separation and clearance requirements for the location of pad-mounted transformers near buildings, which are taken from Volume 1 of the Wisconsin State Electrical Code. In general, three feet on the sides and back and 12' in front of the transformer pad must remain clear at all times.

Protective posts are required where pad-mounted transformers, poles, and related utility equipment are subject to vehicular traffic. The cost associated with installation of these protective posts is the responsibility of the customer. If MU has to install this protection, the cost will be billed to the customer or included in the service extension contract. Figure 3-16 shows how the posts should be installed.

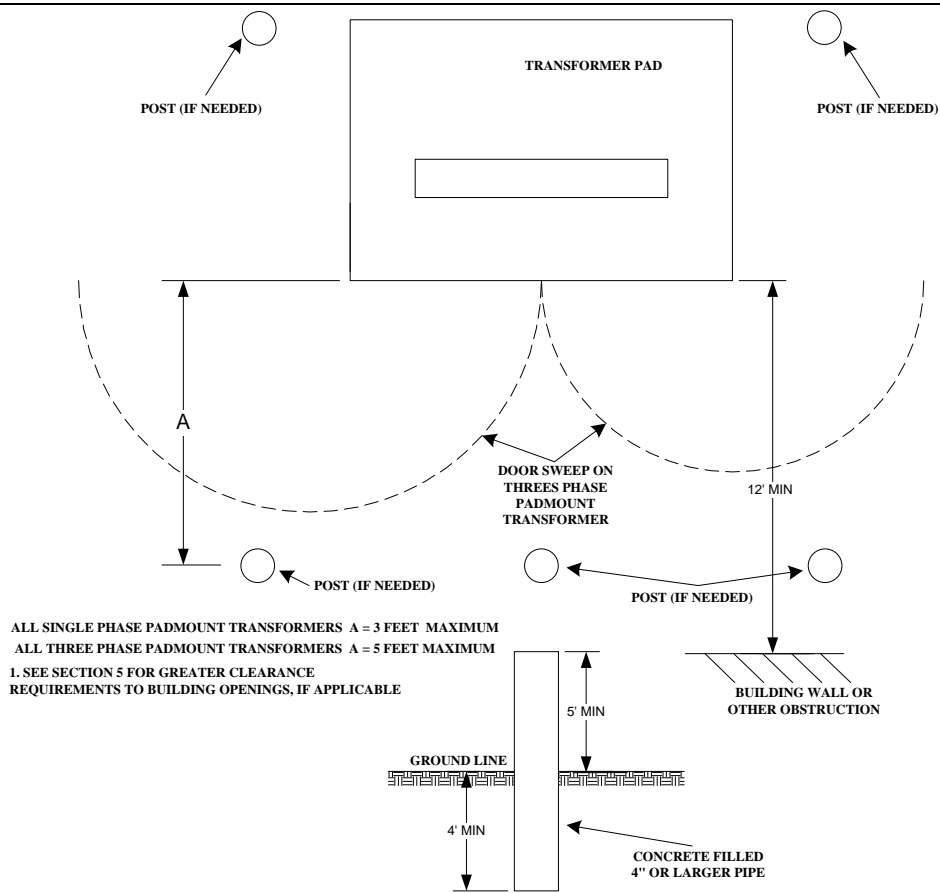


Figure 3-15
Protective Posts for Pad-mounted Transformers

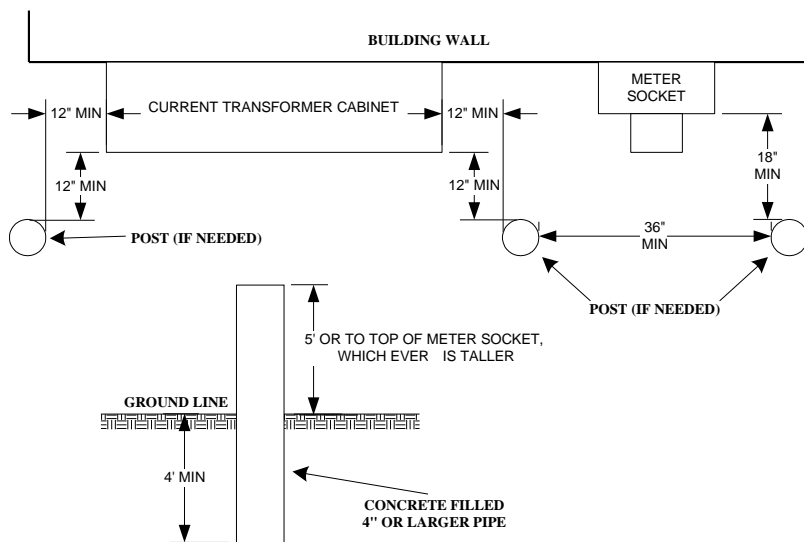
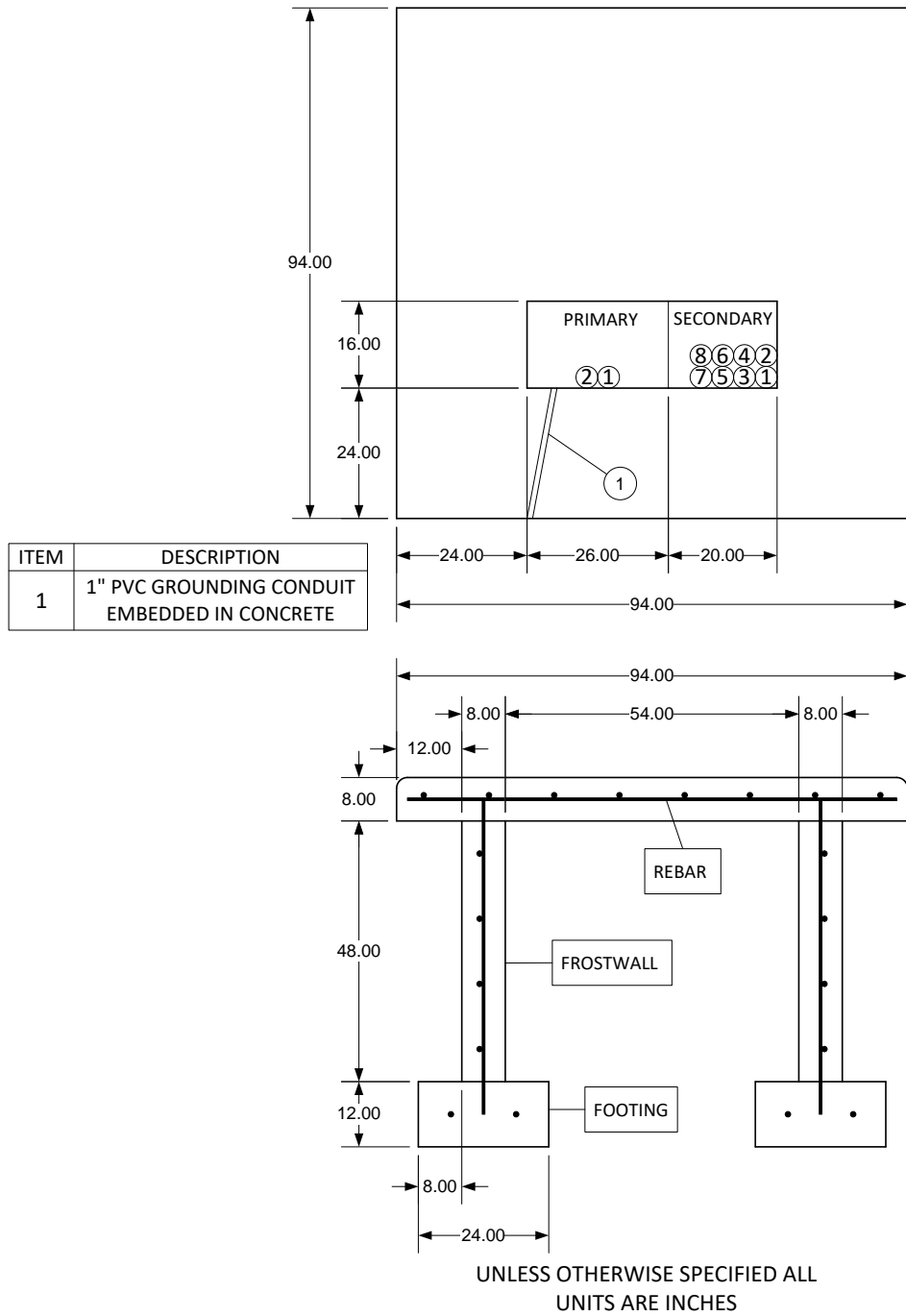


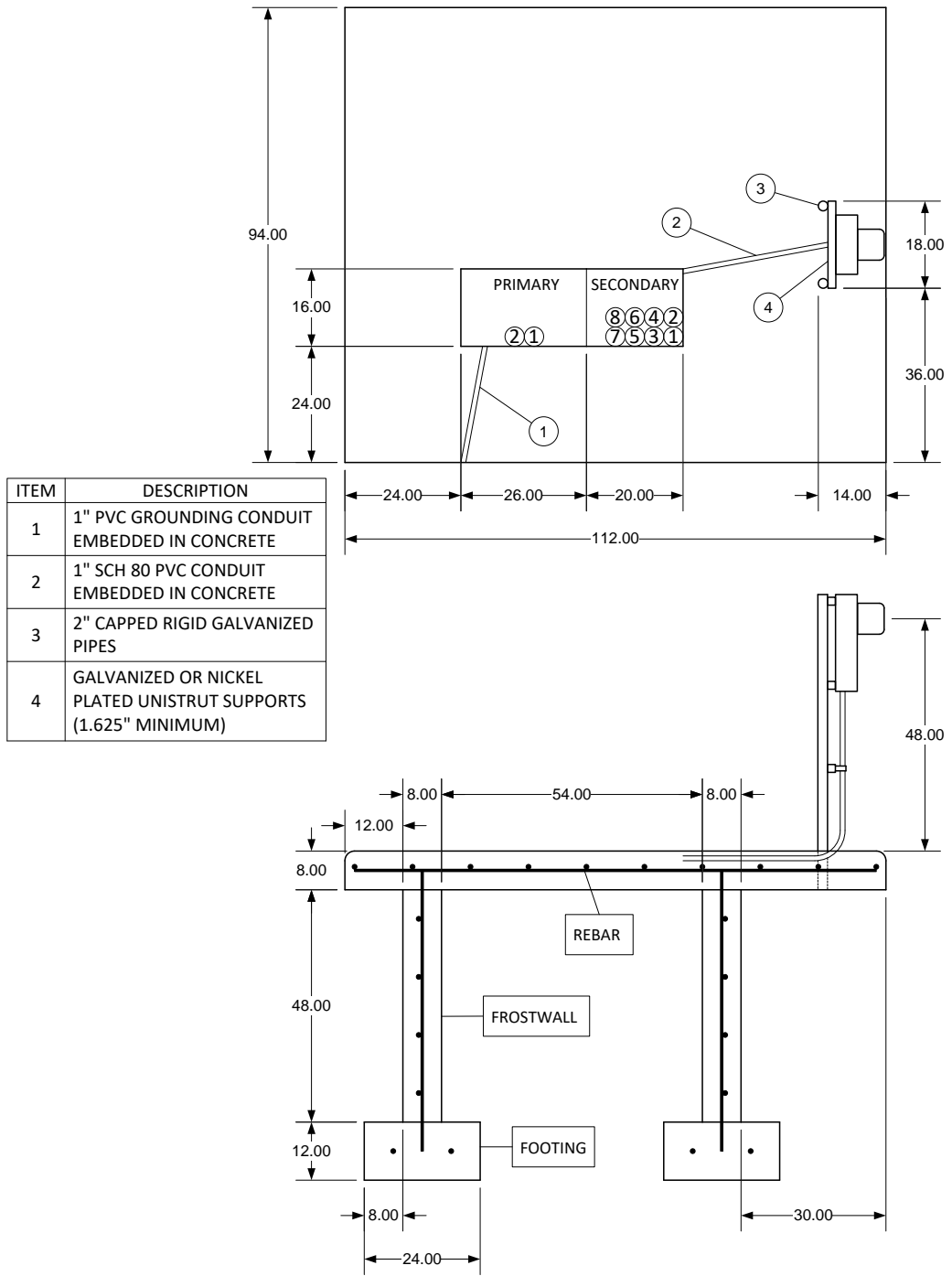
Figure 3 -16
Protective Posts for Current Transformer Cabinets and Meter Sockets

3.8 Concrete Pads for Padmount Transformers



Refer to table 3-6 for construction notes

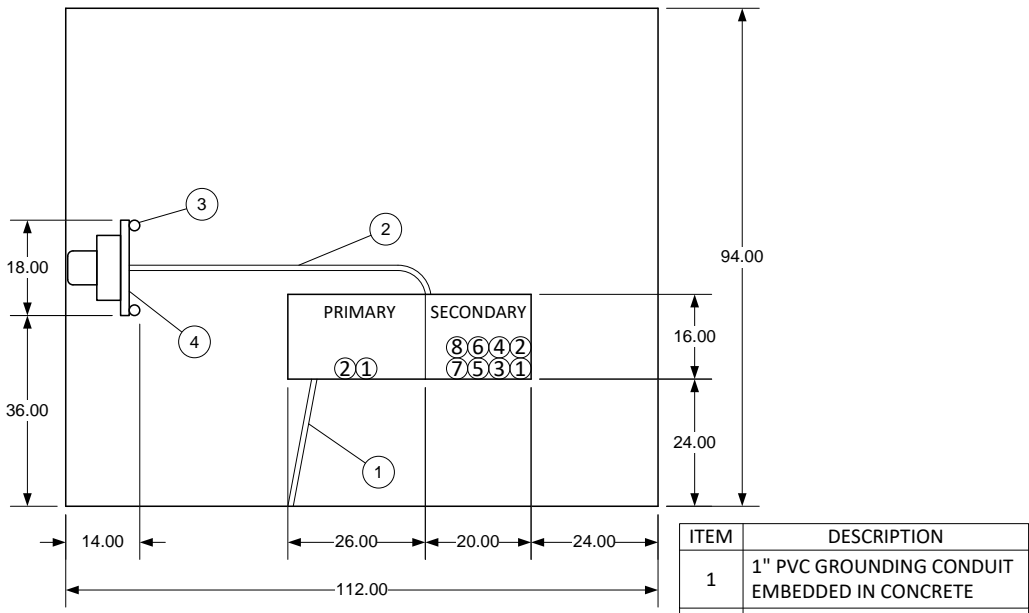
Figure 3-17
Three Phase Transformer Pad (75 – 750 KVA) Without Metering



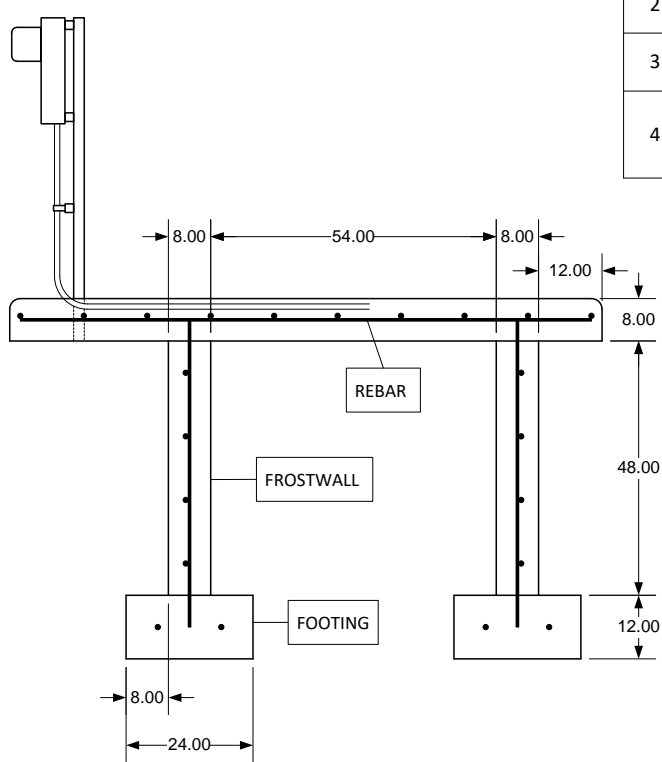
UNLESS OTHERWISE SPECIFIED ALL
UNITS ARE INCHES

Refer to table 3-6 for construction notes

Figure 3-18
Three Phase Transformer Pad (75 – 750 KVA) with Metering on Secondary Side



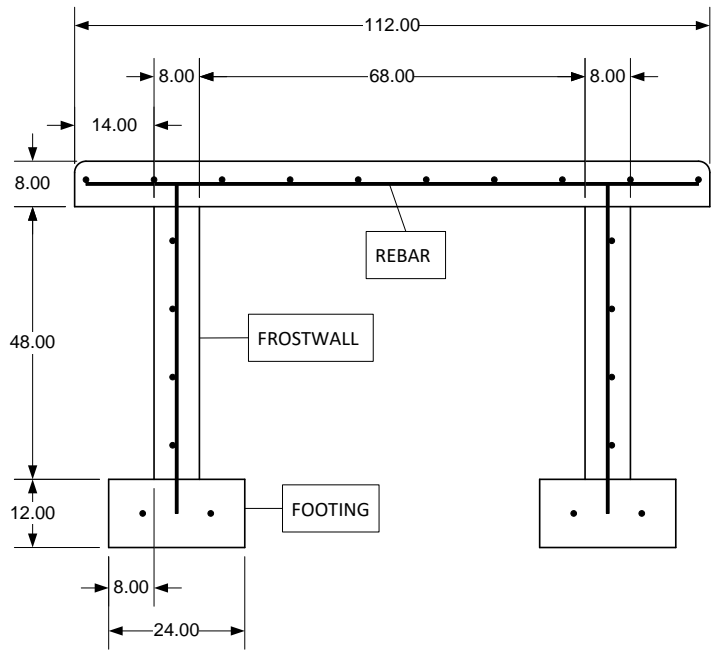
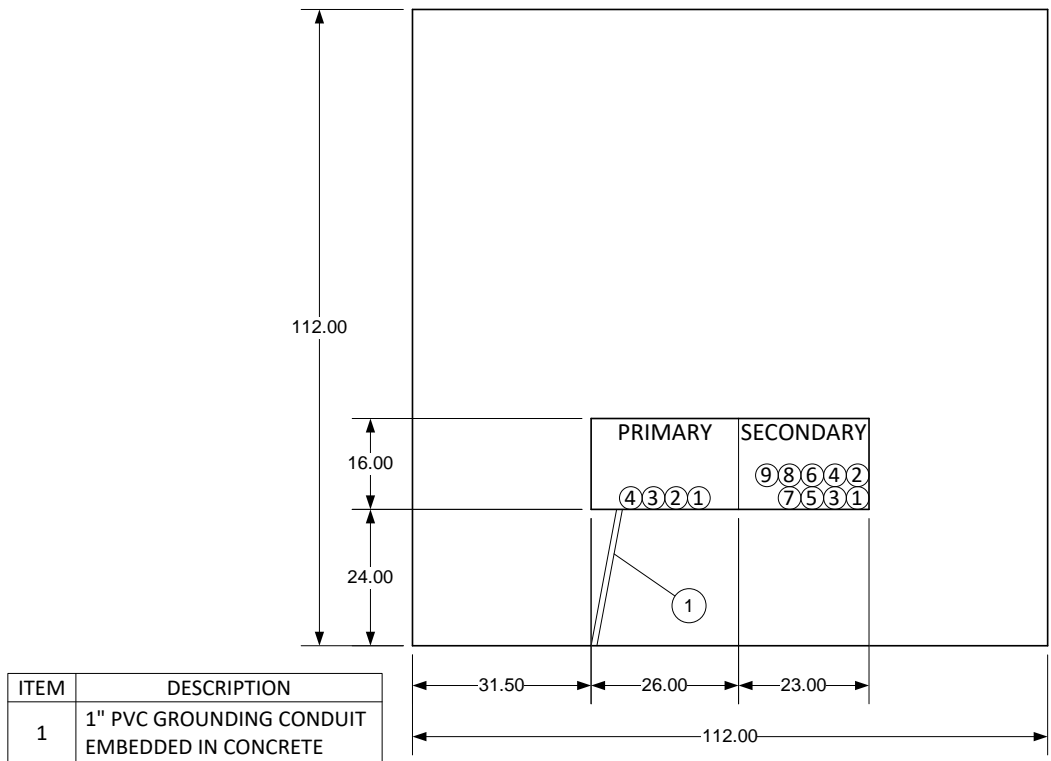
ITEM	DESCRIPTION
1	1" PVC GROUNDING CONDUIT EMBEDDED IN CONCRETE
2	1" SCH 80 PVC CONDUIT EMBEDDED IN CONCRETE
3	2" CAPPED RIGID GALVANIZED PIPES
4	GALVANIZED OR NICKEL PLATED UNISTRUT SUPPORTS (1.625" MINIMUM)



UNLESS OTHERWISE SPECIFIED ALL
UNITS ARE INCHES

Refer to table 3-6 for construction notes

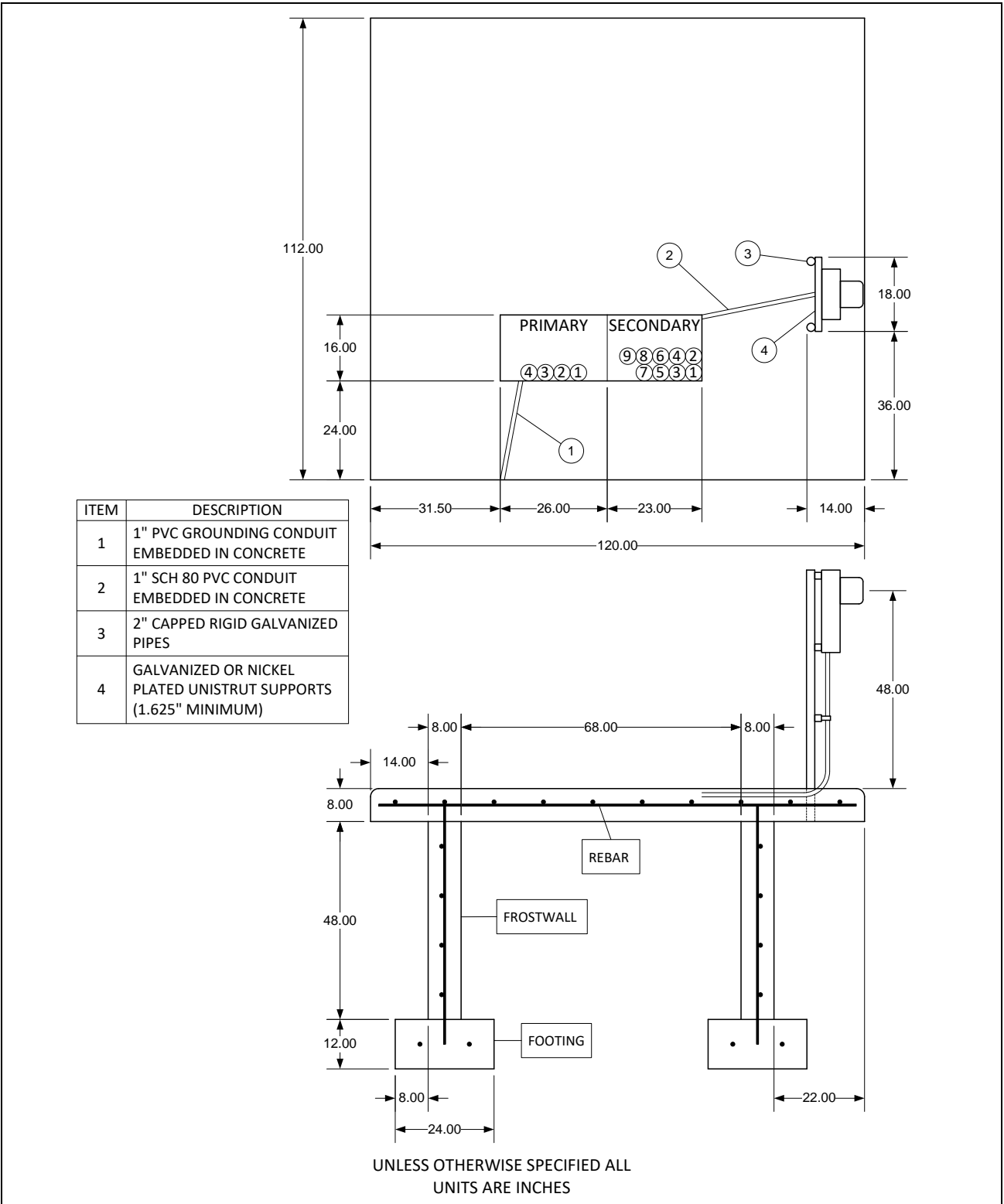
Figure 3-19
Three Phase Transformer Pad (75 – 750 KVA) with Metering on Primary Side



UNLESS OTHERWISE SPECIFIED ALL UNITS ARE INCHES

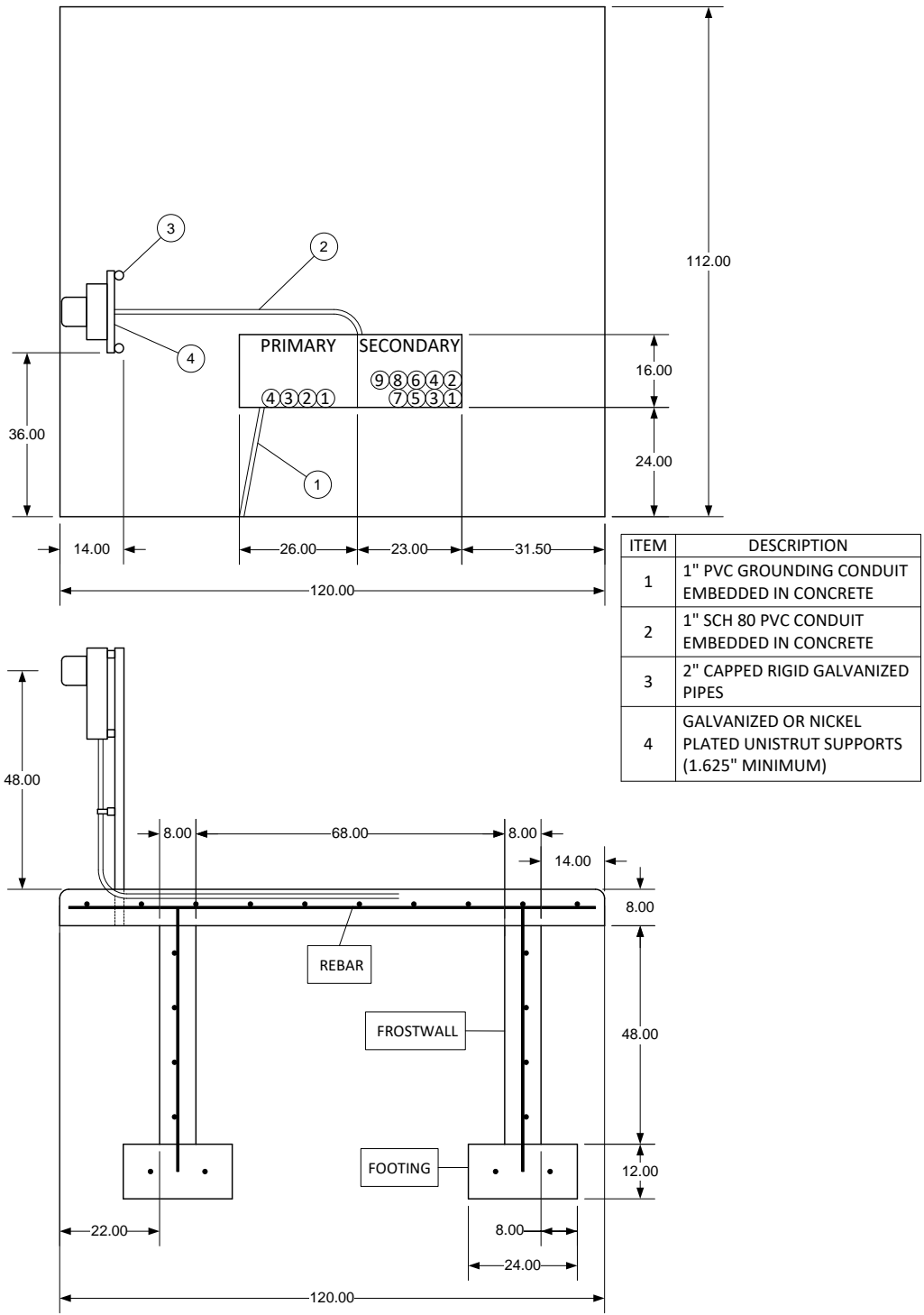
Refer to table 3-6 for construction notes

**Figure 3-20
Three Phase Transformer Pad (1000 - 2500 KVA) Without Metering**



Refer to table 3-6 for construction notes

Figure 3-21
Three Phase Transformer Pad (1000 – 2500 KVA) with Metering on Secondary Side



UNLESS OTHERWISE SPECIFIED ALL
UNITS ARE INCHES

Refer to table 3-6 for construction notes

Figure 3-22
Three Phase Transformer Pad (1000 – 2500 KVA) with Metering on Primary Side

**Table 3-6
Three Phase Transformer Pad Construction Notes**

1. All conduits are to be installed BEFORE PAD is poured. Consult with MU for orientation, size, and length of conduits. All elbows must be long sweep with a minimum of 36" radius on 4" conduit and 48" radius on 6" conduit. Use 4" conduit unless otherwise specified from MU.
2. If metering in transformer, a 1" metering conduit must be embedded in the concrete from the meter socket into the secondary side of the transformer. The metering conduit shall not pass through the primary compartment of the transformer.
3. A 1" grounding conduit must be embedded in the concrete within 2" of the bottom of the pad from the front left side of the primary compartment to the outside edge of pad. Final grade shall sufficiently cover the end of the conduit.
4. Contact MU about pad location and orientation and meter equipment location.
5. Concrete shall have a minimum compressive strength of 3500 psi at the time of stripping or first lift. All concrete shall be air entrained (4% to 6% by volume) with a W/C ratio of 0.45. Minimum cure time before setting a transformer is seven days.
6. Reinforcing steel shall be ASTM A615 Grade 60. Reinforcing steel should be placed at one-foot spacing and tied to prevent displacement during concrete placement. (1/2" minimum size) Reinforcing steel should tie the footing to the frost wall and frost wall to the pad.
7. The finished top surface of the pad shall be flat and level with a wood float finish.
8. All conduits to be in window area and just above top (2" max) of the pad with conduit bushing or bell end connector installed. Service conduits must start from the right front corner of the window and be positioned tightly to the right front corner. (Consult MU for the number and size of conduits). Primary conduits must be in the front of the window and centered in the primary portion of the window.
9. Check pad dimensions against actual transformer dimensions if possible on larger transformers.
10. Backfill around footing, frost wall and pad shall be crushed rock or sand.
11. Upon completion, remove all framing materials from the pad, including those from inside the conduit opening.
12. Soil compaction of 95% or better is required under the pad.
13. Conduit shall not pass through the frost wall or footing.
14. Install a 5/8" x 8' copper plated steel grounding rod a minimum of 8" from grounding conduit external to transformer pad.
15. Top of pad is to be approximately 4" above finished grade.

3.9 Conductor Identification for Three-Phase Wiring

All three-phase conductors are to be properly identified with colored tape in accordance with Table 3-7 to ensure proper connections and phase rotation. MU intends to have a clockwise, ABC, left-to-right rotation on all service conductors in meter sockets and in the main panel. This includes CT/PT metering installations.

Phase:	A	B	C
Position:	Left	Center	Right
Tape Color:			
120/208	Black	Red	Blue
277/480	Brown	Orange	Yellow
Primary	Red	White	Blue

3.10 Vertical Space to Terminate in Switchgear and Entrances

Table 3-8 shows the minimum vertical termination space required in customer owned switchgear for incoming MU service conductors.

SWITCHGEAR (AMPS)	MINIMUM NUMBER OF CONDUCTORS PER PHASE	WIRE SIZE ALUMINUM	MINIMUM NUMBER OF CONDUITS AND SIZE - INCHES	MINIMUM VERTICAL DISTANCE -INCHES
400	2	4/0 AWG	2-2 1/2"	12"
600	2	500 KCMIL	2-4"	18"
800	3	400 KCMIL	3-4"	24"
1000-1200	4	600 KCMIL	4-4"	30"
1600	5	600 KCMIL	5-4"	36"
2000	6	600 KCMIL	6-4"	42"
2500	8	600 KCMIL	8-4"	42"
3000	9	600 KCMIL	9-4"	42"

3.11 Farm Services

Farm services requiring a minimum 400-ampere service capacity shall follow this general standard. The customer will install an electrical distribution center. The electrical distribution center may be built on a yard pole, self-supporting structure, or a building.

1. Customer owned equipment is not allowed on Utility owned poles.
2. The Utility will not install additional service drops to any farm building or structure within 150 feet of the customer's electrical distribution center. Beyond this distance, MU will evaluate the situation to determine if additional service points are warranted. A separate meter may be installed at the distribution center for another building, which is not part of the farm operation. This will normally be at the same location as the first meter to ensure one service to a customer site.
3. The farm customer shall protect the electric distribution center equipment from physical damage by vehicles and farm operations. The customer shall maintain the equipment in good operating order. When a Utility-owned yard pole is replaced, it is the customer's responsibility to move all customer equipment at customer expense. At the Utility's option, the existing pole may be given to the customer and the Utility may install a new transformer pole.
4. All equipment must be installed in accordance with all applicable electrical codes.
5. The Utility will perform all work on Utility equipment and complete the connection to the customer's service conductors. The customer shall not connect conductors to Utility equipment or extend wires or service from the customer's equipment that is un-metered.
6. The customer will furnish, install and maintain an electrical distribution center that includes the following:
 - a. CT cabinet (if 400 amps or larger)
 - b. Main disconnect or up to 6 disconnects with over current protection (A pole top transfer switch does not provide over current protection).
 - c. Meter socket, metering conduit, and metering weatherhead
 - d. Service ground
 - e. Other items that may be required include:
 - 1) Guys for customer overhead branch service circuits.
 - 2) Overhead circuits - 4 wire (single phase) or 5 wire (three phase)
 - 3) Standby generator circuit within conduit and weatherproof junction box.
7. All conductors on the yard pole shall be installed in conduit.

3.12 Termination Enclosures

Termination enclosures may be necessary with certain wiring, spacing, clearance, or equipment choices. The customer should consult with MU before planning or utilizing these enclosures. Typical enclosure arrangements are shown in Figure 3-20.

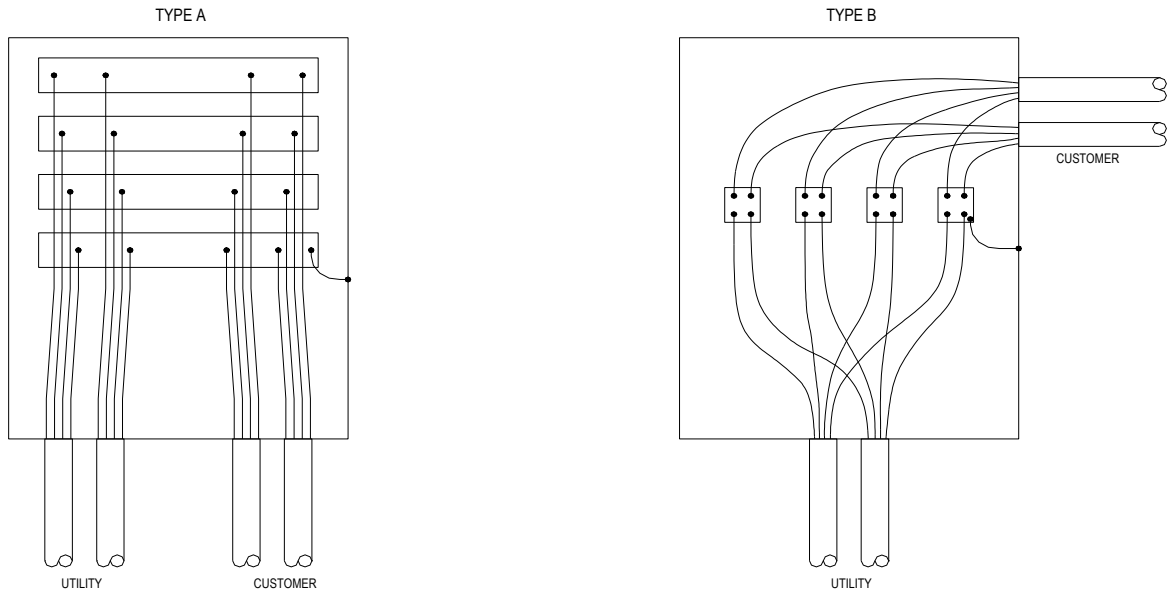


Figure 3-23
Typical Termination Enclosure Arrangements

Table 3-9 Pre-approved Termination Enclosures					
Amperes		Type	Manufacturer	Catalog #	HxWxD (")
400	1Φ 3-wire	B	Erickson	TB-365N	45.5x20x7.25
	1Φ 3-wire	B	GalvaClosure	TB-413-1	42x20x8
	3Φ 4-wire	B	Erickson	TB-465N	45.5x20x7.25
	3Φ 4-wire	B	GalvaClosure	TB-434-1	42x20x8
800	3Φ 4-wire	B	Erickson	TB-467N	48x24x11
	3Φ 4-wire	A	GalvaClosure	TBBX-834-3	48x36x14
	3Φ 4-wire	B	GalvaClosure	TB-834-3	54x36x14
	3Φ 4-wire	B	Erickson	TB-468N	60x36x15
1200	3Φ 4-wire	A	GalvaClosure	TBBX-1234-5	54x46x14
	3Φ 4-wire	B	GalvaClosure	TB-1234-4	54x36x14
1600	3Φ 4-wire	B	Erickson	TB-469N	60x35x15
	3Φ 4-wire	A	GalvaClosure	TBBX-1634-4	54x46x14
	3Φ 4-wire	B	GalvaClosure	TB-1634-5	60x38x16
	3Φ 4-wire	B	Erickson	TB-4610N	64x40x15
2000	3Φ 4-wire	A	GalvaClosure	TBBX-2034-5	66x54x14
	3Φ 4-wire	B	GalvaClosure	TB-2034-6	72x42x20
2500	3Φ 4-wire	B	Erickson	TB-4611N	64x40x15
	3Φ 4-wire	A	GalvaClosure	TBBX-2534-7	72x50x20
	3Φ 4-wire	B	GalvaClosure	TB-2534-7	72x42x20
	3Φ 4-wire	B	Erickson	TB-4612N	78.25x44x20.625
3000	3Φ 4-wire	A	GalvaClosure	TBBX-3034-8	72x50x20
	3Φ 4-wire	B	GalvaClosure	TB-3034-8	72x42x20

3.13 Cable Television Power Supplies

Cable television power supply service is available at 120/240-volt 3-wire single phase. The customer should consult MU to ensure that this voltage is available at the desired location. At times, 120/208-volt 3-wire single phase may be the voltage available. These services will normally be installed on utility owned poles after approval by MU.

1. All installations must conform to all applicable electrical codes and MU's requirements for clearances, climbing space, and working space. Only qualified and authorized cable television representatives shall make this installation. Those representatives shall be trained and knowledgeable of clearance requirements and working rules of the NESC, Volume I of the Wisconsin State Electrical Code, and applicable requirements of OSHA. Furthermore, these representatives shall be trained and competent in:
 - a. Identifying and distinguishing electric utility system components and exposed live parts.
 - b. The techniques necessary to determine the nominal voltage of exposed live parts.
 - c. The minimum safe approach distances corresponding to the voltages to which the qualified representatives will be exposed.
2. The customer will furnish and install all equipment and materials except for the Utility meter.
3. The meter socket shall be a minimum of 100 ampere, ringless, and have manual bypass horns for 120/240-volt 3-wire service. If 120/208-volt service is supplied, a fifth terminal will need to be provided by CATV.
4. The service entrance conductors shall be run in non-metallic conduit. The service entrance conductors shall use 600-volt insulation and shall extend a minimum of 36" beyond the weatherhead. MU will make the service connections and specify the masthead height on the pole.
5. The service disconnect, power supply unit, meter socket, and cable television cable shall be located in the same quadrant on the pole and shall normally face in the direction of the street or road. There shall also be a maximum of 6" between the service entrance conductors and the cable television cable.
6. Service grounding shall comply with the NEC 250. If located on a:
 - a. Steel pole, bond the service to the pole.
 - b. Wood pole (with one ground rod), bond to ground wire and install additional 8' ground rod.
 - c. Wood pole (with no ground rods), install two 8' ground rods and ground wire.
7. The service conductor may be sized for the actual disconnect size utilized.

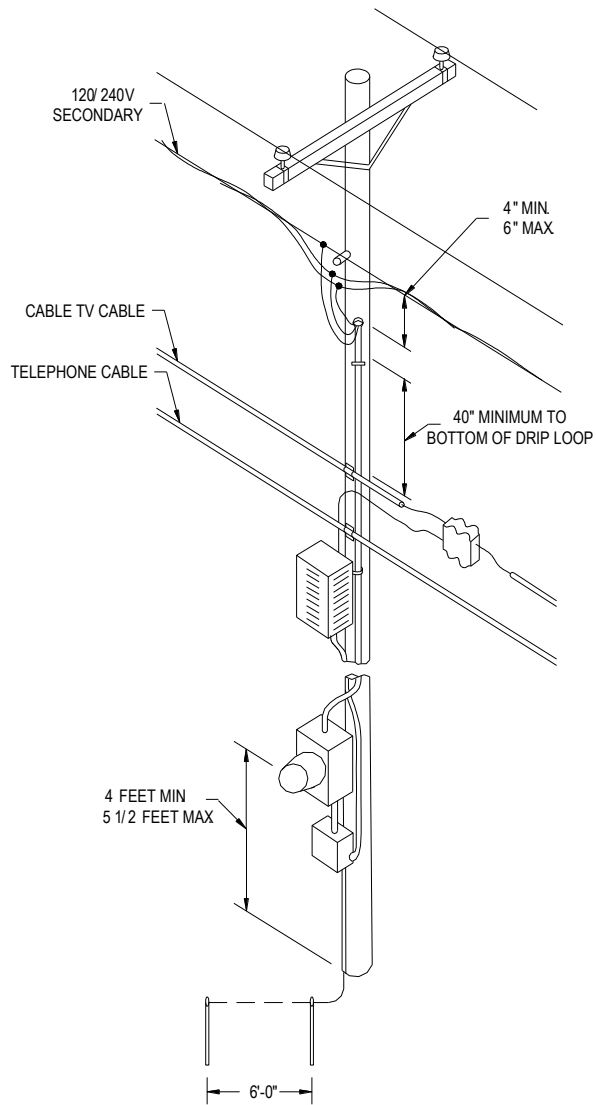


Figure 3-24
Typical Cable Television Power Supply Arrangement