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Rural Utilities Service

BULLETIN 1751F-805

SUBJECT: Electrical Protection at Customer Locations

TO: All Telecommunications Borrowers
RUS Telecommunications Staff

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OFFICE OF PRIMARY INTEREST: Engineering Standards Branch,
Telecommunications Standards Division

PREVIOUS INSTRUCTIONS: This bulletin replaces
Telecommunications Engineering and Construction Manual (TE&CM)
Section 805, Number 8, issued August 1980.

FILING INSTRUCTIONS: Discard TE&CM 805 and replace it with this
Bulletin. File this bulletin with 7 CFR 1751 and REANET.

PURPOSE: To provide technical information for use in the
design, construction and operation of RUS Borrowers'
telecommunications systems. This bulletin includes an outline
of protection principles that should be employed on
telecommunications circuits at customer service access
locations, including the application and installation of
subscriber primary protectors and applicable grounding
techniques. Supplemental information with respect to
installations at customer locations is included in RUS
Bulletins 345-52 and 345-154.

Administrator

Date

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Protection
Protection, Electrical
Protection, Subscriber Stations
Subscriber Stations

ABBREVIATIONS

A	Unit of electrical current, amperes
ac	Alternating current
AHJ	Authority Having Jurisdiction
AWG	American Wire Gauge
ANSI	American National Standards Institute
CATV	Community Antenna Television
CPE	Customer Premises Equipment (customer owned)
cm	Unit of length, centimeter (1/100 of a meter)
FCC	Federal Communications Commission
Hz	Unit of Frequency, hertz (cycles per second)
km	Unit of length, kilometer (1000 meters)
m	Unit of length, meter (equivalent to 3.28 feet)
mm	Unit of length, millimeter (1/1000 of a meter)
MGN	Multigrounded Neutral
NEC	National Electrical Code
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
PABX	Private Automatic Branch Exchange
TE&CM	Telecommunications Engineering and Construction Manual
Ω	Greek letter Omega, symbol for resistance unit, ohms

DEFINITIONS

Authority Having Jurisdiction: The state, county, or local agency that regulates the requirements to be observed for installing electrical wiring and equipment in, on, or near premises and buildings. (Note: By RUS loan contract and mortgage provisions, RUS requires borrowers to observe the National Electrical Code provisions when using RUS loan funds and, thus, in areas where there is no local Authority Having Jurisdiction, RUS is effectively the Authority Having Jurisdiction.)

Common grounding: The intentional interconnection of all separate grounding systems and grounded facilities existing at a premises. This includes such entities as the power system ground, metallic water systems, telecommunications primary protector grounds, community antenna television grounds, etc.

Fuse Link: A length of finer gauge wire in series with a coarser gauge wire, for the purpose of "fusing" open during an abnormally high current condition. A fuse link normally provides protection from currents which could otherwise heat conductors and start fires.

Listed: Equipment or materials included in a list published by an organization which is acceptable to the Authority Having Jurisdiction (AHJ). The organization has to be concerned with product evaluation and maintain periodic inspection of the manufacturers' production of listed equipment or materials. The listing has to state either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner. (This includes organizations such as Underwriters Laboratories, ETL Testing Laboratories, etc., but not RUS and RUS' List of Materials.)

Multigrounded Neutral: A power system neutral conductor which is connected to purposefully installed (made) electrodes or existing electrodes at least four times per mile (1.6 km) in addition to the grounding connections at individual services and each transformer location.

1. GENERAL

1.1 Scope: This bulletin considers telecommunications subscriber primary protector installations at private residences, small businesses, and mobile homes. The information presented is general in nature and is intended to apply to the typical installations that most RUS borrowers will encounter. Details on other specific protection installations may be found in the 800 series of the Telecommunications Engineering and Construction Manuals (TE&CM) (proposed conversion to REA Bulletins 1751F-801 through 1751F-825). It should be noted that protection of telecommunications customer premises equipment at power generating stations and power substations involves special concerns. Because of their special considerations, RUS recommends that borrowers consider retaining the services of a consulting engineer that specializes in such protection designs.

1.2 Primary Protector Use: To limit hazards resulting from power circuit and lightning surges, rural area telephone companies install suitable primary protectors at virtually all customer access locations. This practice applies whether the customer is served by aerial, buried or underground plant. All primary protector installations have to comply with applicable requirements of the National Electrical Code¹ (NEC) [formally identified as ANSI/NFPA 70] and any applicable local codes which are more stringent. The NEC requires that primary protectors be installed on all telecommunications circuits unless the circuits are served entirely within a city "block" and the circuits serving the customer are not exposed to possible contact with power circuits operating at 300 volts or higher. Because RUS borrowers rarely encounter such (unexposed) circuits, RUS expects all customer circuits to be protected.

2. PROTECTION PRINCIPLES

2.1 Problem Sources: Subscriber circuits and the customer equipment connected to them may be subjected to abnormal voltage and current transients caused by: (1) lightning surges, (2) contacts between telecommunications outside plant conductors and power distribution conductors, (3) induction from the

¹ All references to the National Electrical Code in this document pertain to the 1993 edition. Readers are urged to refer to the edition of the NEC and any, more stringent, local codes adopted by their AHJ.

magnetic fields associated with power circuits or lightning, and (4) conduction of power fault or lightning currents in the earth or other electrical conductors nearby the telecommunications plant. A detailed discussion of these sources is provided in RUS Bulletin 1751F-801.

2.2 Protection Objectives: Telecommunications protection measures are necessary to help prevent: (1) electric shock to telecommunications users and the general public that may come into contact with plant facilities, (2) damage to the subscribers' premises or equipment; and (3) damage to telephone company equipment.

2.2.1 Customer Equipment Attachments: Rulings by the Federal Communications Commission (FCC) have made it acceptable for subscribers to attach their own equipment directly to the switched network where it may be exposed to the transients discussed in 2.1. Today's customers are taking advantage of this freedom and are connecting several telephones to their lines. In addition, customers are also connecting sophisticated electronic devices such as facsimile machines, telephone answering devices, burglar and fire alarms, computers (via modems) and many other types of devices. To help avoid possible equipment operational upset or damage, RUS recommends that primary protectors be installed on all telecommunications circuits financed with RUS loan funds.

2.3 Protection Methods: The basic principles which help to prevent harmful potentials at telecommunications subscribers' locations are twofold: (1) common grounding (bonding) of all metallic utilities at the premises, and (2) use of appropriate primary protectors on telecommunications conductors to divert lightning and abnormal power currents to earth.

2.3.1 Common Grounding (Bonding) of Utilities: Utilities requiring common grounding are: (1) the telecommunications system, (2) the power system, (3) metallic water pipe systems and (4) Community Antenna Television (CATV). Metallic hardware associated with all of these systems may be handled by customers and the development of excessive voltages between them, which could present a serious shock hazard, can be minimized by common grounding (bonding). The grounding electrodes of all these systems have to be bonded together at all installations. Bonding has to be done whether or not the water system is considered to be a low resistance ground or not.

2.3.2 Bonding Purpose: The purpose for bonding separate grounding electrodes is depicted graphically in Figures 1 and 2.

2.3.2.1 Without Bonding: Figure 1 illustrates how the voltage difference between two electrodes rises to hazardous levels when a lightning surge on the power grounding system flows to earth via the power grounding electrode. In the example, a 500 A surge flows through the 25 Ω power electrode resistance and causes 12,500 volts to appear across the power grounding electrode. Since the telecommunications electrode is remotely located (and for illustration purposes here not affected by the rise in potential at the power grounding electrode) the 12,500 volts appears between the two system electrodes. If the current surge entered via the telecommunications grounding system, results would be about the same with (500 A x 37.5 Ω) or 18,750 volts appearing across the telecommunications grounding electrode and between the two system grounding electrodes.

2.3.2.2 With Bonding: Figure 2 illustrates how the voltage differences between the two electrodes are minimized when the electrodes are bonded to one another as required by the NEC. (In the example a 100 foot (30.5 m) length of #6 AWG copper conductor is assumed to bond the two electrodes together). Figure 2 shows that the surge current divides between the two bonded electrodes. In our example, a 500 A surge arriving on the power system splits with about 300 A flowing to earth via the power grounding electrode and 200 A flowing to earth via the bonding conductor and the telecommunications grounding electrode. The voltage drop between the two electrodes calculates to be (200 A x 0.04 Ω) or 8 volts. If the 500 A surge entered via the telecommunications system, results would be similar with (300 A x 0.04 Ω) or 12 volts appearing between the two electrodes. In both situations the voltage difference is drastically reduced from values expected without bonding of the two electrodes. Shorter bonding conductors or use of the power grounding system for grounding primary protectors will help to reduce voltage differences between utilities even more.

2.4 Additional Information: Supplementary information on grounding is covered in RUS Bulletin 1751F-802.

3. TELECOMMUNICATIONS PRIMARY PROTECTOR TYPES

3.1 Preferred Protectors: There are two types of primary protectors: fused type and fuseless type. Fuseless type

protectors are preferred because they provide more effective protection than fused types and because the maintenance associated with these units is normally lower than that for fused type protectors. Fused type primary protectors should be avoided except where the requirements for fuseless primary protectors cannot be met. The following paragraphs describe the two types of protector in more detail.

3.2 Fuseless Primary Protectors

3.2.1 Design: A fuseless primary protector employs white coded (350 to 600 Volts) carbon air-gap, orange coded gas tubes, or equivalent surge arresters connected between each line conductor and ground. These arresters have a breakdown value adequate for the protection of personnel and well below the dielectric strength of equipment and wiring furnished by a telephone company. Manufacturers produce fuseless primary protectors with various current-carrying capacities which "Listing" agencies recognize by noting the maximum fuse link with which fuseless primary protectors can be used. Common maximum fuse link ratings for fuseless primary protectors include 22, 24, and 26 AWG copper conductors with thermoplastic insulation and 20 AWG, 40 percent, copper-clad steel wire (bridle wire). Telephone companies have to be certain to coordinate the fuse link rating for a particular fuseless primary protector with the installation circuitry. This means making certain that the protector used has a current-carrying capacity appropriate for the wire or cable pair and/or the fuse link to which the fuseless protector will be connected. On RUS financed projects, the maximum fuse link should be 24 AWG because RUS requires all service drops to have 22 AWG conductors.

3.2.1.1 Advantages: Fuseless primary protectors are advantageous because, unlike fused primary protectors, their grounding connection is maintained during a telecommunications line contact with a power line. The uninterrupted grounding helps in de-energizing a power circuit by offering additional paths to ground which promotes higher magnitude power line fault current to facilitate sensing and speedier operation of power line fuses and circuit breakers. Elimination of fuses also prevents the excessive potential on drop wire and protector terminals as would be the case with a fused type primary protector after fuse operation resulting from a power contact. Use of fuseless primary protectors results in a reduction in customer maintenance visits for fuse replacement.

3.2.1.2 Disadvantages: Fuseless primary protectors can not be used at every installation site and their use requires judgements on the part of the installer with respect to the maximum fuse wire with which the protector can be used. Fuseless primary protectors can only be installed when the installation will be compliant with NEC Sections 800-30(a)(1)a through 800-30(a)(1)e. Otherwise a fused primary protector has to be used. As noted in 3.1.1, fuseless primary protectors require coordination with the installation circuitry's current-carrying capacity and the maximum fuse link design of the protector.

3.3 Fused Type

3.3.1 Fused Primary Protectors: Fused type primary protectors employ white coded (350 to 600 Volts) air-gap, orange coded gas tube, or equivalent surge arresters for the limitation of excessive potentials, and fuses to limit sustained currents to a value less than which the protector can safely carry. (Fuses in fused type primary protectors are rated for 7 amps and the wiring inside a fused primary protector is rated for 15 amperes per conductor continuously). The fuses are required to open the circuit on currents resulting from power contacts which would otherwise result in a fire hazard because of protector overheating. One fuse is connected in each side of the line on the line side of the arrester.

3.3.1.1 Advantages: Fused primary protectors provide effective safety from fire hazards related to power contact problems for installations where fuseless primary protectors are not allowed by the NEC.

3.3.1.2 Disadvantages: With fused type primary protectors, the grounding connection for the drop wire is lost when the fuses operate and the drop wire and protector line terminals may remain energized at an excessive potential. Because the line terminals of a fused-type primary protector may remain energized after the fuses have operated, craftspersons should exercise caution in touching terminals until it has been verified that the terminals are safe.

3.4 Solid-State Arresters

3.4.1 Solid-State Primary Protectors: At the present time, because of their lower peak current-carrying capability, RUS

does not recommend the use of solid-state arresters in primary protectors used at customer premises.

4. PRIMARY PROTECTOR INSTALLATIONS

4.1 Protector Locations: When planning and staking customer installations the selection of primary protector locations should be made with major emphasis on achieving common grounding of the telephone company's primary protector ground with the power system ground. The NEC requires primary protectors to be located as close as practical to the point at which exposed telecommunications conductors enter or attach to the building. The NEC also requires that the metallic shield of a telecommunications cable be grounded (or insulated) as close as practicable to the point where the cable enters the building. RUS recommends that wherever possible grounding of a cable shield and a primary protector be accomplished at the same location and that the power service grounding established at the building served be used as the telecommunications primary protector grounding electrode. See REA Bulletin 345-52, "REA Standard for Service Entrance and Station Protector Installations". (Proposed codification to 7 CFR 1755.500 through 7 CFR 1755.510)

4.2 Primary Protector Selection: Protector types and indoor versus outdoor mountings are covered in REA Bulletin 345-52. In addition to utility needs, primary protectors should be "Listed" by Underwriters Laboratories, ETL Testing Laboratories, or other similar organization acceptable to the Authority Having Jurisdiction (AHJ). Primary protectors should also be RUS accepted or technically accepted.

4.3 Listed Drop Wire: The NEC requires communications wires and cables without a metallic shield (usually aerial drop wire and cable) between the last outdoor support and the primary protector to be "Listed."

4.4 Telecommunications Service Drop Designs

4.4.1 Shieldless Drops: When shieldless cable or drop wire is used between the last outdoor support and a fuseless primary protector, the NEC relies on conductor fusing coordination to help prevent fire hazards caused by a possible power conductor contact to telecommunications plant. The NEC requires the primary protector grounding conductor and drop wire conductor to

be sized and the primary protector to be sized (see Paragraph 3.1.1) such that none of these circuit elements fuse open before conductors ahead of them (towards the central office). These sacrificial conductors have to be located between the possible point of power conductor exposure and the service drop and may be in the form of a cable stub or a supplementary fusible link between the wire or cable plant and the customer drop, or they may be the outside plant wire or cable conductors themselves.

4.4.2 Shielded Drops: When shielded cable is used between the last outdoor support and a fuseless primary protector, the NEC relies on the effectively grounded metal shield to help prevent fire hazards caused by a possible power conductor contact to telecommunications plant. The grounded cable shield helps to draw power line current of sufficient magnitude to cause power line fuses, circuit breakers, etc., to quickly open the power circuit and remove the hazard. Additionally, the NEC requires the sizing of the conductors within shielded telecommunications drop cable to be purposefully chosen (coordinated) such that conductors within the drop cable safely fuse open before the protector grounding conductor or conductors within the protector (see Paragraph 3.1.1).

5. GROUNDING AND BONDING - PERMANENT INSTALLATIONS

5.1 Copper Grounding and Bonding Materials: Copper is the most commonly used material for bonding and grounding conductors and its exclusive use has been assumed throughout this bulletin. Article 800-40(a)(2) of the NEC states: "...the grounding conductor shall be copper or other corrosion-resistant conductive material, stranded or solid."

5.2 Bonding Power and Telecommunications Systems: As indicated in Paragraph 2.3, it is essential that power and telecommunications grounding systems at a subscriber's access location be connected (bonded) to each other and to any metallic water piping system in order to avoid dangerous voltage differences within the subscriber's premises. Common grounding (bonding) is essential whether or not such piping systems meet the minimum requirements as preferred grounding electrodes or whether the telecommunications facilities are buried. A low resistance ground is desirable in that it aids in assuring de-energization of the power system in the event of a contact. A low resistance ground is also beneficial in minimizing the

development of excessive potential differences between systems, but low resistance grounds are not a substitute for potential equalization by common grounding.

5.3 Grounding Primary Protectors at Premises: Part D of Article 800 of the NEC provides detailed information on the proper method for grounding primary protectors and cable shields at customer premises.

5.4 Grounding Electrode Choices

5.4.1 NEC Provisions: In Part D of Article 800, the NEC has established three selection groupings or orders of preference for the choice of a grounding electrode for a primary protector. These preferences are contained in Section 800-40(b)(1), 800-40(b)(2) and 800-40(b)(3). In the first selection grouping, Section 800-40(b)(1), the NEC requires that the primary protector grounding conductor be connected to the nearest of any of some seven (7) cited "acceptable" electrodes. It is important to note that the numbering within this selection grouping is not an order of selection but simply a means to separate and conveniently list choices. The intent of the NEC is that the primary protector grounding conductor be connected to the "acceptable" electrode which is nearest to where the primary protector is installed.

5.4.2 NEC Grounding Selection Order: If none of the electrodes cited in Section 800-40(b)(1) are available at the premises, the installer defers then to Section 800-40(b)(2) and then to Section 800-40(b)(3) should there be no electrodes of the type cited in Section 800-40(b)(2).

5.5 Recommended Primary Protector Installations

5.5.1 General: Primary protectors and cable drop shields should always be installed as near as is practicable to the selected grounding electrode with the desired installation involving as short and as straight a primary protector grounding conductor as possible. The location should also be coincidentally designed to be as close to where the conductors will enter the building. As can be seen from Paragraph 5.4, the choices of electrode can be confusing because of their numbers and the specifics involved to assure NEC compliance. To reduce the confusion some, the following presents the RUS recommended order of preference for installing primary protectors:

5.5.1.1 Power Service Grounding System (Preferred): Install primary protectors as close as practicable to where the telecommunications wire or cable is to enter the building served choosing a point which is coincidentally planned to be as close as practicable to where some accessible part of the premises' power service grounding system exists. The desired installation will involve as short and as straight a primary protector grounding conductor as possible attached directly to the nearest accessible point on the premises power service grounding system. The power service grounding system includes any of the following: (1) the power service accessible means external to enclosures as covered in NEC Section 250-71(b), (2) the metallic power service raceway, (3) the power service equipment enclosure, (4) the power service grounding electrode conductor or grounding electrode conductor metal enclosure, or (5) the grounding conductor or the grounding electrode of a building or structure power disconnecting means, that is grounded to an electrode as covered in NEC Section 250-24. Telephone companies can ask customers to have an electrician provide the means for bonding as prescribed in NEC Section 250-71(b) when there is no other accessible portion of the power service grounding system available at the premises;

5.5.1.2 Premises Grounding Electrode System: If there are no electric power facilities at the premises, install primary protectors as close as practicable to an accessible point on the building or structure grounding electrode system as covered in NEC Section 250-81. This grounding electrode choice introduces some confusion because NEC Section 250-81 requires that if two or more of the four possible electrode sources cited are present at the premises that they be bonded together. Included are (1) any metal underground water piping in direct contact with the earth for 10 feet (3.05 meters) or more, (2) the metal frame of a building if the frame is effectively grounded, (3) concrete-encased electrodes meeting the provisions of NEC Section 250-81(c), and (4) a ground ring of the type cited in Section 250-81(d). Some of these electrodes may be quite simple to find while others may not be so easy to spot. However, all will have to be bonded together to form a grounding system before they can be used as the protection grounding electrode;

5.5.1.3 Grounded Interior Metal Water Piping System: If there are no electric power facilities at the premises and no premises grounding system as described in Paragraph 5.5.1.2, install primary protectors as close as practicable to a grounded metal underground water pipe which is in direct contact with the earth

for 10 feet (3.05 meters) or more as discussed in NEC Section 250-80(a). Please note that there are two provisos with respect to this electrode choice: (1) The buried piping cannot be relied upon alone as the NEC requires water piping to be attached to another, supplemental, acceptable grounding electrode, and (2) attachment to the water piping has to be made within 5 feet (1.52 m) of where the pipe enters the building. (RUS recommends installing a supplemental ground rod as a standard practice to dispel any doubt about the existence of required supplemental grounding. The concern for attaching to the water pipe within 5 feet (1.52 m) of the pipe's entry into the building is with future piping repairs using non-metallic piping and the resultant loss of electrical continuity);

5.5.1.4 Individual Electrodes: If there are no grounding electrodes of the types discussed in Paragraphs 5.5.1.1 through 5.5.1.3, install primary protectors as close as practicable to any of the individual electrodes cited in Paragraph 5.5.1.2; or

5.5.1.5 Ground Rods or Pipe Electrodes: If there are no grounding electrodes of the types discussed in Paragraphs 5.5.1.1 through 5.5.1.4, install primary protectors to: (1) an effectively grounded metal structure, or (2) a ground rod or pipe not less than 5 feet (1.52 m) in length and 1/2 inch (12.7 mm) in diameter, driven, where practicable, into permanently damp earth and separated from lightning conductors as covered in NEC Section 800-13 and at least 6 feet (1.83 m) from electrodes of other systems. Telephone companies should always make ground rods their absolute last choice at a building where power is also installed. In addition, in areas of the country where the frost line exceeds 18 inches (46 cm) use of longer 8 foot (2.4 m) rods should be used in lieu of 5 foot (1.52 m) ground rods.

5.6 Ground Rod(s) Without Bonds: Use of a ground rod as the only primary protector grounding electrode is acceptable only when the customer premises location has no internal metallic water pipe and no electric service. In all other cases, it is essential that all of the grounding electrodes be interconnected whether or not any or all of these are "low resistance" grounds. As noted in Paragraph 2.3.2, bonding is necessary to avoid the development of hazardous voltages between grounded systems during surge events. These voltages constitute a possible shock hazard to telecommunications users.

5.7 Grounding Conductors and Connections: Grounding conductors from primary protectors to the various grounding electrodes listed in Paragraphs 5.4 and 5.5 should be sized as shown in Table 1, using insulated copper wire "Listed" by Underwriters Laboratories, ETL Testing Laboratories, or some other similar organization acceptable to the AHJ. Grounding attachments (grounding connectors) used to connect primary protector grounding conductors to NEC acceptable grounding electrodes should also be "Listed" by Underwriters Laboratories, ETL Testing Laboratories, or some other similar organization acceptable to the AHJ.

5.8 Where Separate Ground Rods are Used: Whenever separate ground rods are used for electric and telecommunications facilities at a premises, the telecommunications ground rod should be bonded with at least a #6 AWG copper wire to some easy access point on the power grounding system, i.e., power grounding conductor, grounding electrode, metallic conduit covering the power grounding conductor, etc., (see Paragraph 5.5.1.1). If the rods are of dissimilar metals, corrosion may be a problem, as discussed in Bulletin 1751F-802.

5.9 Protectors Not Near Electric Service Ground: Where conditions are such that the only location the primary protector can be installed is away from the power service grounding system, installation of the primary protector may be accomplished by: (1) attaching the primary protector grounding conductor to a ground rod driven as close as is practicable to the primary protector installation site as described in Paragraph 5.5.1.5, and (2) bonding the telecommunications ground rod to the electric system grounding system (i.e., power grounding conductor, grounding electrode, metallic conduit covering the power grounding conductor, etc., [see Paragraph 5.5.1.1]) using at least a #6 AWG conductor. A water pipe may be utilized in the bonding but the #6 AWG bonding conductor has to be attached to the water pipe within 5 feet (1.52 meters) of where the pipe enters the building. Oftentimes, it is more practical to attach the #6 AWG bonding conductor all the way to the electrical grounding system grounding conductor, grounding electrode, etc.

5.10 Section 250 of the NEC: NEC Section 250, on grounding, includes information concerning bonding and grounding of the power system at the subscriber's premises. It stresses the interconnection of available grounds at the premises to form a grounding electrode system in order to prevent hazardous

differences in potential between the various systems. It is primarily the subscriber's responsibility to see that bonding between the electric service driven electrode and the water system is provided by an electrician. If this bond is not installed, the subscriber should be notified and requested to have it installed. If the subscriber is unwilling to have this bond installed by an electrician, the telecommunications grounding electrode should be bonded to somewhere on the power grounding system and bonding of the water pipe should be included as part of the telecommunications installation. RUS recommends that in such circumstances that the installer be a certified electrician acceptable to the AHJ. In most areas of the country, the electric service grounding electrode and grounding conductor are part of the house wiring installation and are the property of the subscriber. It is, therefore, not normally necessary to obtain permission of the power distribution company before bonding to it.

5.10.1 Power Grounds Away From Buildings: A note of caution is necessary for access to power system grounding at other than what is available inside or just outside the external wall of a building or home. Except in the case of mobile home installations (see Section 6 of this bulletin), Article 800 of the NEC intends that primary protector grounding conductors be attached to the nearest accessible point on the power grounding system (see Paragraph 5.5.1.1) that is related to the power service means or main disconnecting means for the building or home. Power grounding means at poles and other sources away from the building or home, such as at curb side locations, are not acceptable sources for telecommunications primary protector grounding. These grounding sources are remote sources with respect to the grounding source established (and required by the NEC) at the building being served. Because they are remote grounding sources, they could expose telecommunications customers to hazardous potential differences that may appear across the power grounding means established at the building power service or disconnecting means and the remote telecommunications grounding electrode source chosen away from the building or home. Because of this possible hazard, RUS recommends that such grounding sources not be used for primary protector grounding. If the AHJ mandates that the telephone company serve a customer and establish the demarcation point at such a remote location, RUS recommends that the telephone company install a primary protector at the remote location. RUS also recommends that final connection to the customer owned drop and telecommunications facilities not be completed until the

customer presents the telephone company with evidence of the AHJ's certification that the customer's facilities comply with the NEC or local code requirements.

5.11 Multipair Fuseless Primary Protectors: Multipair primary protectors include a common grounding bar as an integral part of their mounting. Where such a bar is furnished, two or more fuseless primary protectors should be grounded by connecting an insulated copper wire (gauge shown in Table 1) from the grounding electrode to the grounding terminal on the protector assembly.

Table 1 Grounding Wire Gauge for Fuseless Protectors

(Number of Pairs)		Grounding Conductor
FUSELESS	FUSED	Gauge (AWG)
1 to 2	1 to 3	12
3 to 5	4 to 7	10
6 OR MORE	8 or more	6

6. GROUNDING AND BONDING - MOBILE HOMES AND TRAILERS

6.1 Protection of Mobile Homes: Mobile home and trailer installations present certain problems not encountered in permanent buildings. As in other installations, it is desirable for access that the primary protector be installed outdoors. However, mounting of a primary protector on the trailer body is usually objectionable to the owner, and other methods have to be employed. (See RUS Bulletin 345-52).

6.2 Primary Protectors: Protection for mobile homes involves the use of standard primary protectors preferably of the fuseless type where the provisions of the NEC can be observed.

6.3 Preferred Primary Protector Installation: The RUS preferred method for installing a primary protector at a trailer (or mobile) home involves extending buried plant from the main distribution cable to a pedestal-mounted terminal housing within 1 foot (30.5 cm) from the outside wall of the trailer to be served. The primary protector is grounded to an 8 foot (2.5 m) driven ground rod using a "Listed" grounding conductor of at least 12 AWG. The frame of the trailer is also bonded to the driven ground rod using at least a 6 AWG, insulated, copper,

conductor. If the power service disconnecting means is within 35 feet (10.7 m) of the trailer, the telecommunications ground rod is to be bonded to the power service grounding system using at least a 6 AWG, copper, conductor. (The 6 AWG conductor [bond] from the telecommunications company driven ground rod to the grounding electrode at the power service disconnecting means should be insulated unless it is buried and not exposed to possible human contact throughout its entire length.) If the power service disconnecting means is more than 35 feet (10.7 m) away from the trailer, the telecommunications ground rod does not have to be bonded to the power service grounding system. For additional details see Figures 3 and 4.

6.4 Another Installation Method: The NEC allows utilities to install telecommunications primary protectors at mobile homes in a manner which differs from RUS' preferred method. The code allows the primary protector to be installed adjacent to the power disconnecting means or power service equipment means serving a mobile home. However, this code allowance includes a number of provisos which require significant site and power installation evaluation on the part of the telecommunications installer; some of this evaluation may be impossible to determine because facilities are buried or out of sight. Even if all factors favor installing a primary protector at the power equipment location, there is still the problem of how and what type cable/wire to use beyond the protector and how to make the transition to station wire to serve the customer. Each installation would present problems. RUS prefers the installation method described in Paragraph 6.3 because it involves minimal assessment of the power facility and all installations are the same (standardized) except for the bonding to the power grounding means (i.e., there is either a bond or there is not a bond).

7. AC POWER SERVICE PROTECTION

7.1 Equipment Damage: With the ever increasing customer use of data equipment, key systems, PABX's, telephone answering devices, computers (via modems), burglar and fire alarm systems with telecommunications data connections, and other subscriber telecommunications equipment powered by 60 Hz ac power, telephone companies have a greater need to be in a position to offer customers guidance in preventing equipment damage caused by surges.

7.1.1 Common Bonding of Electrodes: The first line of defense for protecting this type of customer premises equipment is to provide common grounding and bonding as described in Paragraph 2.3.

7.1.2 Severe Exposure Situations: In severe exposure situations, such as high lightning damage probability areas shown in RUS Bulletin 1751F-801 or locations with a history of power system faults, common grounding and bonding alone may not provide adequate protection. In such circumstances, protection should be supplemented by providing additional surge protection to both the ac power and the telecommunications facilities.

7.2 Protection of AC Power Service: A two step approach of implementation should be employed when protection of the telecommunications and power facilities is warranted at a premises:

7.2.1 Step One: If experience proves special measures are warranted, telephone companies should advise their customer to install a secondary power arrester. The secondary arrester should be installed as close as practicable to where the ac power conductors enter the premises, usually at the power overcurrent protection device (main circuit breaker box, etc.,) or alternatively at the service weatherhead on the subscriber's premises. (Examples of acceptable secondary arresters may be found under the Item "gi" listing of RUS Informational Publication 344-2, "List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers.") Harmful surges in the power supply are first intercepted by the secondary arrester and only remnant parts of the incoming surge travel on through to connected electrical equipment inside the premises. With certain types of secondary arresters, a minimum of 20 feet (6 meters) of steel conduit between the secondary arrester and the branch circuit panel is required so that there is sufficient inductance for the proper operation of the arrester. The installation of a secondary arrester should help to protect all electrically powered equipment on the subscriber's premises. The secondary arrester should be installed by a qualified electrician. In no case should telephone company personnel or the subscriber be expected to install the secondary arrester; and

7.2.2 Step Two: In addition to the secondary power arrester, telephone companies should recommend to their customers that customers install, at a minimum, a listed telecommunications

secondary protector on the customer equipment and a listed power service protector at the electrical outlet from which the customer equipment is to be energized. The power service protector should be installed as close to the ac powered telecommunications equipment as practicable, see Figure 5, "Typical Power Service Protector Installation." (Examples of acceptable power service protectors may be found under the Item "gg" listing in RUS Informational Publication 344-2, "List of Materials Acceptable for Use on Telecommunications Systems of RUS Borrowers." Telecommunications secondary protectors should comply with Section 800-32 of the NEC and should be "Listed" by an organization which is acceptable to the AHJ). It is extremely important that the telecommunications secondary protector grounding terminal and the power service protector grounding terminal be connected to the same grounded source, with the power receptacle ground at the installation site being the best choice. Telephone companies should additionally recommend to customers that if the protection method to be employed by the customer includes other than plug-in types of equipment that the customer have the installation made by a qualified electrician.

7.2.2.1 Recommended Alternative: A recommended, preferred, alternative would be that the telephone company advise the customer to connect the telecommunications equipment to a "Listed" device that is designed specifically for this type of protection and which incorporates both the power service protector and the telecommunications secondary protector within the same device enclosure and which commonly bonds the grounding of both types of protectors within the device enclosure.

7.3 Protector Coordination:

7.3.1 Telecommunications Protector Coordination: Customers should be advised to consult with the telecommunications secondary protector manufacturer regarding proper coordination of the telecommunications secondary protector with the telecommunications primary protector. The clamping voltage of the telecommunications secondary protector should be chosen to properly coordinate with the clamping voltage of the telephone company's primary protector. In usual telecommunications wiring there is sufficient wiring impedance at the effective frequency of surge related events for the telecommunications secondary protector to have a lower clamping voltage than the primary protector; however, extremely low values may be detrimental to service because excessively frequent operation may effectively

cause objectionable disruption of communications. Consultation with the protector manufacturer should help in making effective choices.

7.3.2 Power Protector Coordination: Customers should be advised to consult with the power service protector manufacturer regarding proper coordination of the power service protector with the power secondary arrester. The clamping voltage of the power service protector should be chosen to properly coordinate with the clamping voltage of the power secondary arrester. In usual power mains wiring there is insufficient wiring impedance at the effective frequency of surge related events and it is better for the power service protector to have a lower clamping voltage than the power secondary arrester. Coordination will help to prevent the protectors installed deep within the premises from always clamping first when reacting to surges and drawing current into the premises wiring when the first line of defense could react and clamp the surges to ground and prevent unnecessary current flow in the inside wiring. Consultation with the protector manufacturer should help in making effective choices.

7.4 Power Company Practices: Power company practices regarding secondary arresters vary considerably. In most cases, installation of a secondary arrester at the weatherhead of the subscriber's service would require temporary de-energization of the secondary circuit serving the service. It is, therefore, essential that all installations of secondary arresters be coordinated with the power company involved. In some instances the power company may recommend that the secondary arrester be installed at the customer's load center instead of at the weatherhead. In other instances the power company may recommend the use of aluminum or plastic conduit, or possibly no conduit instead of the steel conduit. These alternatives should be approached with caution as many secondary arresters rely on the reactance of the steel conduit to develop sufficient voltage drop to cause the arrester to operate. If the steel conduit is not employed coordination between the secondary arrester and protected equipment becomes more important and should be addressed.

Figure 1 Example Without Common Grounding

Figure 1: Example without Common Grounding

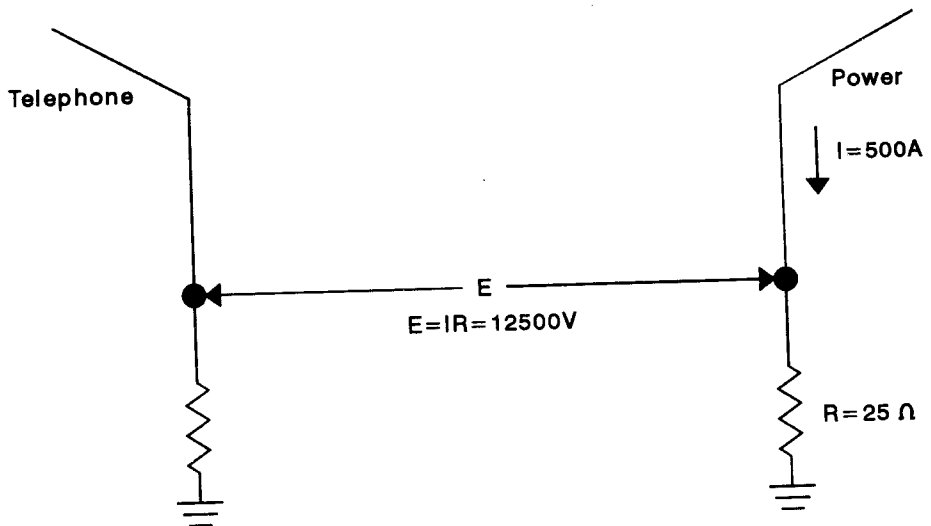
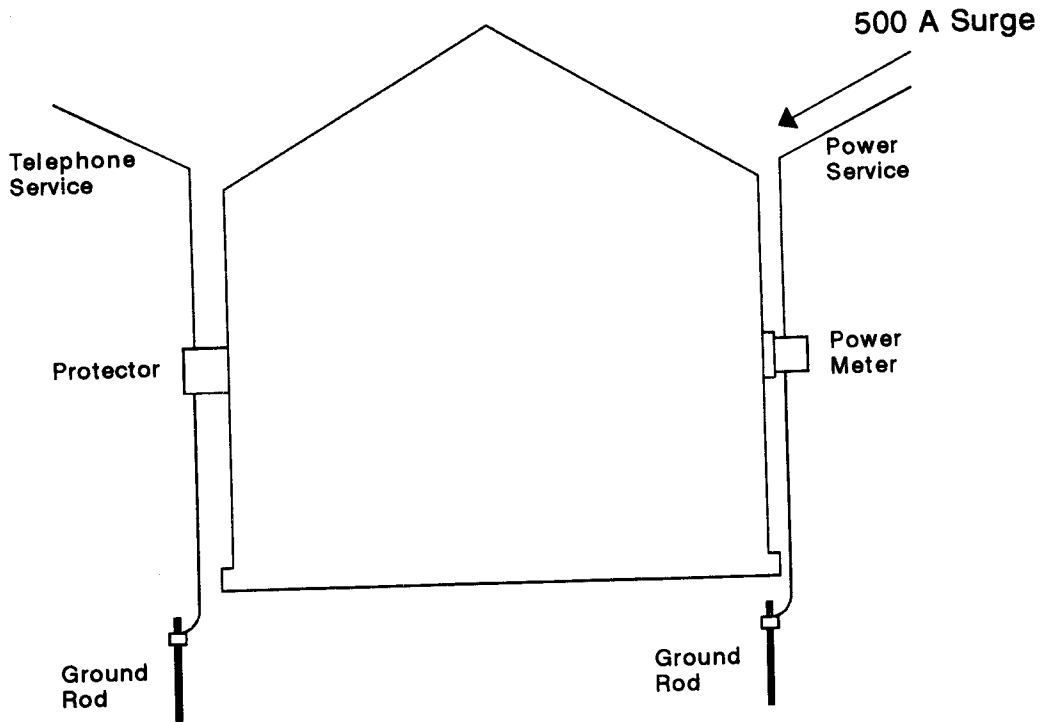


Figure 2 Example With Common Grounding

Figure 2: Example with Common Grounding

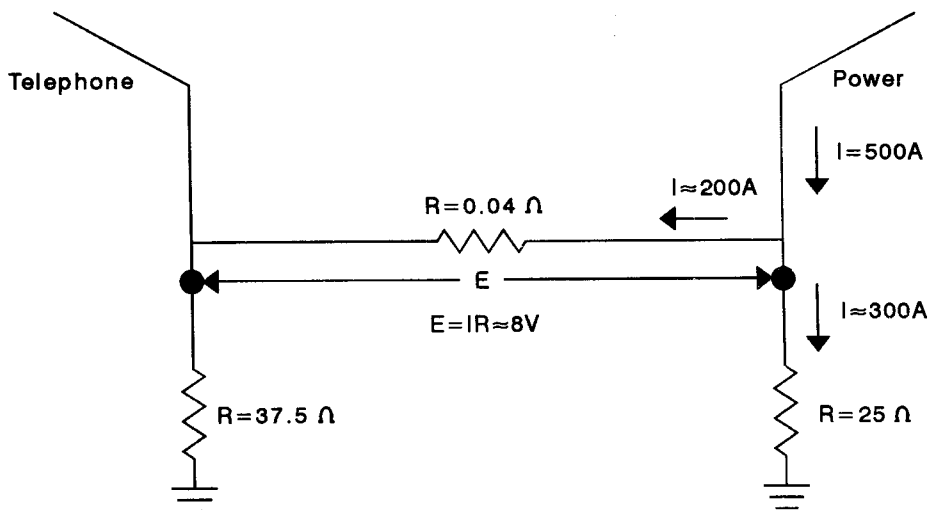
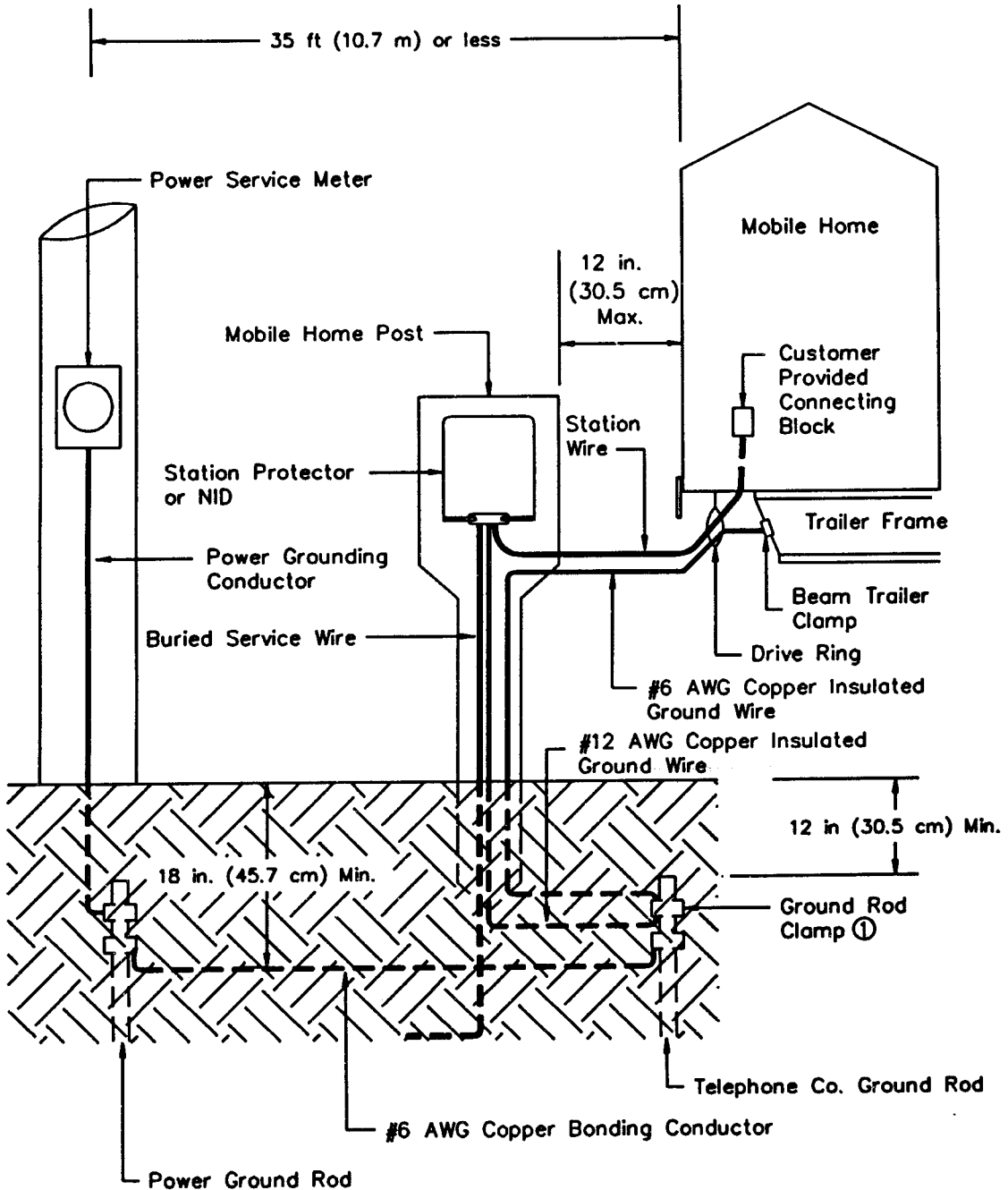


Figure 3 Mobile Home with Bond to Power

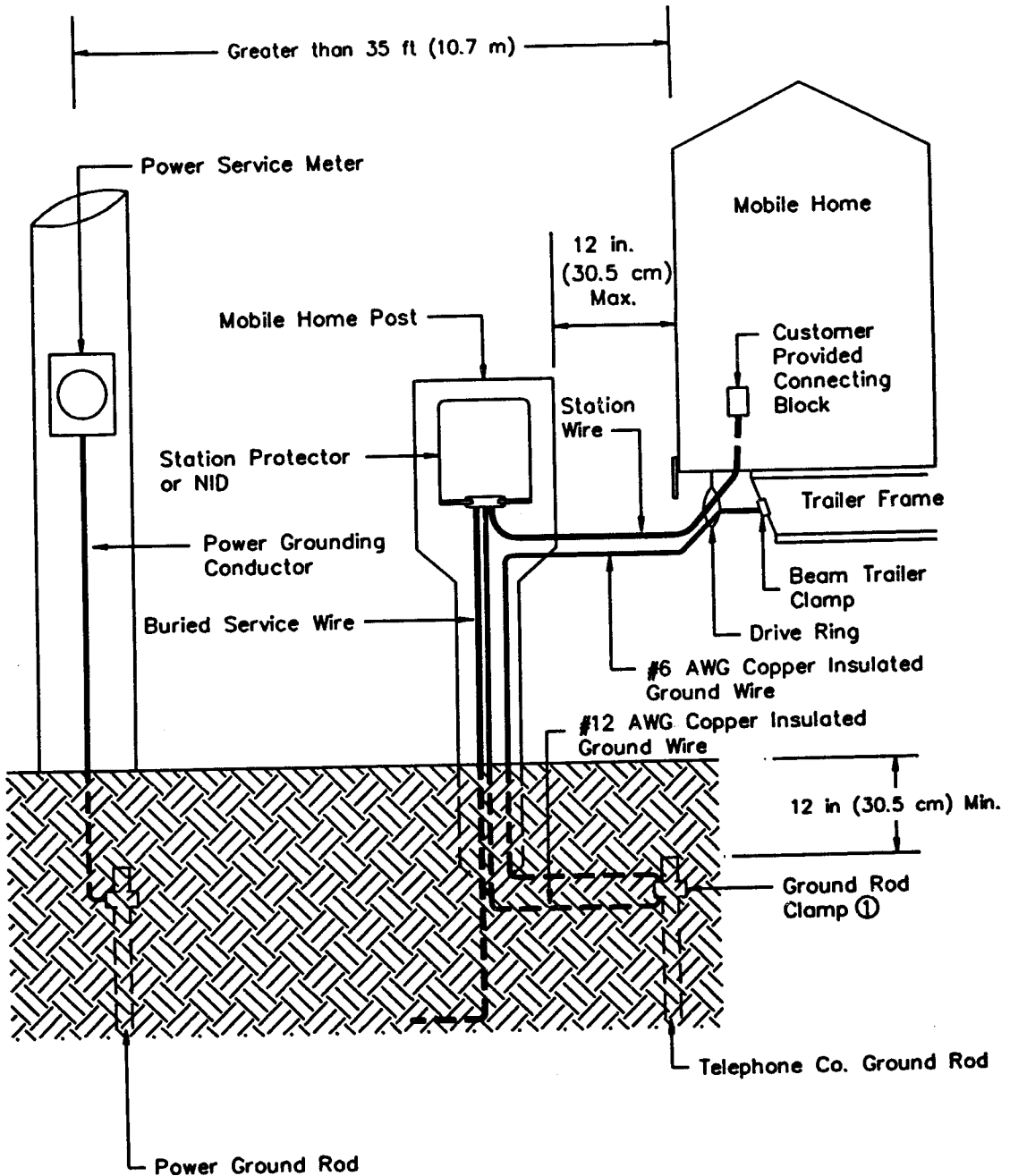
Figure 3 Mobile Home with Bond to Power



Notes: ① Clamp has to be accepted by Listing Agency (UL, etc.) for two conductors, otherwise two clamps have to be used.

Figure 4 Mobile Home Without Bond to Power

Figure 4 Mobile Home without Bond to Power



Notes: ① Clamp has to be accepted by Listing Agency (UL, etc.) for two conductors, otherwise two clamps have to be used.

Figure 5 Typical Power Service Protector Installation

Figure 5: Typical Power Service Protector Installation

