STATIONS AND CUSTOMER PREMISES EQUIPMENT
ELECTRICAL PROTECTION

CONTENTS PAGE

CONTENTS PAGE

1. GENERAL

1.01 This section describes the requirements for protection of telephone stations at customer premises. The purpose of station protection is to ensure the safety of telephone users and telephone employees. Station protection also reduces the possibility of damage to the customer premises and to the telephone plant. The proper application of protective devices will help considerably in maintaining reliability of telephone service.

1.02 The reasons for reissuing this section are listed below. Revision arrows are used to emphasize the more significant changes.

(1) To further identify the purpose of this section in Part 1.

(2) To delete description of supplemental protection from Part 1.

(3) To delete paragraph in Part 2B which describes grounding and fusing applications as depending on the presence or absence of a multigrounded-neutral power system. This condition no longer applies to station protection.

(4) To delete from Part 3 protection description for plant serving customer electronic equipment which is covered in Part 4F.

(5) To further identify exposed cable in Part 3E.

(6) To delete grounding conditions set forth for fuseless protectors in paragraph 4.07. The grounding conditions are no longer a factor per 1981 National Electric Code (NEC).

(7) To add condition for fuseless protection in paragraph 4.07(c) concerning C-service wire.

(8) To add sneak current protection description to paragraphs 4.13 and 4.14.

(9) To delete detailed information in Part 4 concerning electronic PBX protection and key telephone system protection.

(10) To revise Fig. 4 and Fig. 5 to agree with text changes.

(11) To delete figure showing non-multigrounded neutral (MGN) power service grounded to ground rod (acceptable water system or building ground not available). This method is no longer an option.

(12) To delete note from paragraph 4.05 which is in conflict with 4.05(c).

(13) To add note on National Electric Code (NEC) changes for station protectors to paragraph 4.15.

(14) To revise Fig. 7 and 15 to agree with text changes and to delete term "MGN" from Fig. 11.

(15) To delete paragraphs in Part 6D dealing with protection for commercial radio and television and receiving stations. This information is discussed in Section 876-210-100.

(16) To add Part 6F concerning electrical protection for telephones located on boats and docks.

(17) To add to paragraph 7.09 revised provisions by NEC on intersystem bonding and grounding.

(18) To delete special application considerations in Part 9 of sensitive electronic equipment.

(19) To delete Appendix 1—Glossary of Terms and add the Glossary of Terms with revisions as Part 11 of this section.

1.03 ➧The purpose of this document is to provide the protection engineer with an overall understanding of station protection and does not attempt to restrict the discussion solely to the protection responsibilities that may be assumed in the future by a telephone company.➧

1.04 An essential part of any protective system is the adherence to good construction and maintenance practices. The possibility of damage resulting from contact with electric wires or from exposure to lightning can be significantly reduced where standard clearances are observed and protectors are properly installed and maintained.

1.05 In determining the protection requirements for a particular design of telephone plant, the exposure status with regard to power contacts, induction, ground potential rise and lightning must be considered. Lightning and power exposure status is related to the environment of the telephone plant, eg, whether the environment is metropolitan, suburban, or rural as defined in Section 876-100-100. For example, aerial cable in metropolitan and in some suburban areas will generally be exposed to accidental contact with power wires, but may be minimally exposed to lightning because of the shielding afforded by overhead power wires and tall structures. In rural areas, however, aerial cable will most likely be exposed to both power and lightning. In rural areas and in some suburban areas, buried cable will usually be exposed to lightning, and all stations served by the cable will require protection even though there may be no exposure to power wires. Requirements for station protection are sometimes based on administrative considerations and on possible future rearrangements of outside plant construction, particularly with regard to changes in power distribution voltages that might affect the exposure status of telephone plant.

1.06 In general, block and house cable facilities are not exposed to power circuits carrying voltage high enough to require station protection. If exposure to lightning is a factor, however, station protection may be necessary. For example, telephone facilities serving extension stations of a farm interphone system or a PBX may not be subject to contact with power wires, but could be exposed to lightning. Such stations would require protection.

1.07 In the following discussion, the term "fuse cable" generally refers to 26- or 24-gauge copper conductors. The term "fine gauge" or "fuse link" is also used with the same meaning. If the plant consists of aluminum conductors, then 24- or 22-gauge would be considered as "fuse cable". These sizes of aluminum conductors have fusing characteristics comparable to 26- and 24-gauge copper conductors, respectively.

2. STATIONS REQUIRING PROTECTION

A. *National Electrical Code (NEC)* Requirement

2.01 The requirement to protect communication circuits is set forth in Article 800-2 of the ♦1981♦ *NEC** as follows:

> ***"Protective Devices:*** ♦A listed protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block. Also, a listed protector shall be provided on each circuit, aerial or underground, so located within the block containing the building served as to be exposed to accidental contact with light or power conductors operating at over 300 volts to ground.♦ The word 'block' as used in this article means a square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed but not any street. The word 'exposed' as used in this article means that the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.
>
> ***Location:*** The protector shall be located in, on, or immediately adjacent to the structure or building served and as close as practicable to the point at which the exposed conductors enter or attach." (This means that a building may not be served from a protector that is located in a different building.)

2.02 The *NEC* requirements are primarily based on power exposure and only incidently on lightning exposure. Bell System requirements, however, take into consideration all sources of electrical disturbances or exposure, including lightning, power contact or induction, and ground potential rise, and assure that adequate protection is provided.

B. Bell System Requirements

2.03 Telephone circuits (cable, wire, strand, etc) that are subject to disturbances from ***lightning, ground potential rises (GPR),*** or possible ***contact*** or ***induction*** from electrical power circuits

*Partial listing of requirements set forth in Artical 800-2 is reprinted from the 1981 National Electrical Code, Copyright National Fire Protection Association, Boston, MA 02210.

in excess of 300 volts [rms] to ground are called ***exposed circuits.*** A station served by such exposed circuits including an exposed line, drop, or terminal is ▶classified as◀ an ***exposed station*** requiring protection.

> ***Note: All references to electric power wires will apply to circuits operating in excess of 300 volts rms to ground.***

2.04 Protection against lightning surges is obtained by using spark gap station protectors. Protection against power exposure is obtained by using fusible links between the station and the exposure in addition to spark gaps. ▶Additional protection of building wiring which serves station equipment with low impedance paths to ground, is obtained by using sneak current protection (heat coils or fuses). These protection applications are discussed subsequently in this practice. ***It should be noted that all exposed conductors terminated at a station must be equipped with protector units whether they are working or non-working pairs. Exposed unterminated pairs that enter a building may be grounded or isolated from ground. The objective is to avoid arcing caused by foreign voltages. Pairs that are connected to exposed plant are considered exposed, while those that are not connected at exterior closures are unexposed.***

2.05 Changes in the 1981 NEC no longer make it necessary to distinguish between MGN and non-MGN power systems with regard to the grounding of protectors or with regard to the choice of fused vs fuseless protectors.◀

3. CLASSIFICATION OF PLANT AND AREAS

A. General

3.01 From an administrative standpoint, it is not practical to consider each line or circuit individually to determine whether or not it is exposed to lightning, accidental contact with power wires, or hazardous induction. The usual practice, therefore, is to establish areas in which all stations are considered as exposed and requiring protection, or as unexposed and not requiring protection. With the exception of a building or a group of buildings having a feeder cable used exclusively to serve stations within the buildings, the entire area of a block should be classified as either exposed or unexposed.

3.02 ▶Station protection as discussed in paragraph 2.04 should be provided initially in areas that appear to be unexposed if the possibility exists that future plant rearrangements or changes to the power system could result in exposure.◀ In addition, sneak current protection may also be required initially in plant serving station equipment having low impedance paths to ground, if future plant rearrangements could result in exposure to power.

B. Plant Exposed to Power

3.03 All aerial plant (cable shield, supporting strand, or wire plant including distribution wire) is considered exposed, whether power is present or not, since there is no assurance that power will not be built at some later date. The only exception is when the aerial plant is located within a block.

3.04 Underground or buried plant subject to possible power faults resulting in a rise in ground potential or 60-Hz induction exceeding 300 volts (rms) must be considered as exposed. Buried and underground plant must be considered as exposed if connected to exposed aerial plant. Buried plant must be considered as exposed when placed at random separation in a common trench (joint random) with primary power distribution circuits (over 300 volts rms to ground). ▶Power exposure considerations for buried plant are contained in Section 876-102-100.◀

C. Plant Exposed to Lightning

3.05 In general, it must be assumed that all telephone stations served by aerial plant are exposed to lightning, with the exception of stations in metropolitan areas where buildings are close together and sufficiently high (relative to the telephone plant) to provide "cone-of-protection" shielding. Two cones overlapping the telephone cable, one from each side, are preferable. (The cone-of-protection principle is explained in Section 876-210-100.) In such situations, lightning strokes are generally diverted from the telephone plant, and surge current is harmlessly dispersed over public water systems and/or other extensive buried metallic structures.

3.06 ***Underground or buried plant*** must be considered as exposed to lightning ***except:***

(a) Plant located in a metropolitan area under the conditions discussed in paragraph 3.05.

(b) Plant located in an area where the soil resistivity is approximately 100 meter-ohms or less and the incidence of thunderstorm days does not exceed an average of five per year. However, plant and stations located above the average altitude of the surrounding terrain or associated with structures such as fire towers, radio stations, etc, must be considered as exposed to lightning regardless of soil resistivity and thunderstorm incidence.

(c) Plant located where significant data is available to indicate that lightning damage is negligible.

D. Unexposed Plant

3.07 Plant is considered ***unexposed*** when it is ***not*** subject to possible contact with power wires operating in excess of 300V (rms) to ground, rise in ground potential, induction in excess of 300V to ground, or exposed to the effects of lightning. Underground or buried cable is not considered exposed to power contact when placed in the same trench with primary distribution circuits, if standard separations (not random separation) are maintained, and the underground or buried plant is not fed by exposed plant (see paragraphs 3.09 to 3.12).

> ***WARNING: When telephone plant is considered unexposed in an urban environment because it is underground all the way back to the central office, and cone-of-protection shielding is adequate, caution is advised if the associated power facilities are aerial without cone-of-protection shielding. Under such conditions, ac-powered telephone equipment may be damaged by lightning surges on the power facilities. Even though the telephone plant is considered unexposed in this particular case, protectors should still be used, thus providing a method of common bonding and grounding (see paragraph 7.06).***

E. Exposed Cable Shield and Pairs

3.08 In reviewing a particular cable to determine its exposure status or the requirement for protection, it will be helpful to consider the cable in terms of ***exposed cable shield*** and ***exposed pairs.*** ▶***An exposed cable is one which has one or both of the following:***

(a) ***An exposed cable shield***

(b) ***Exposed pairs.***◀

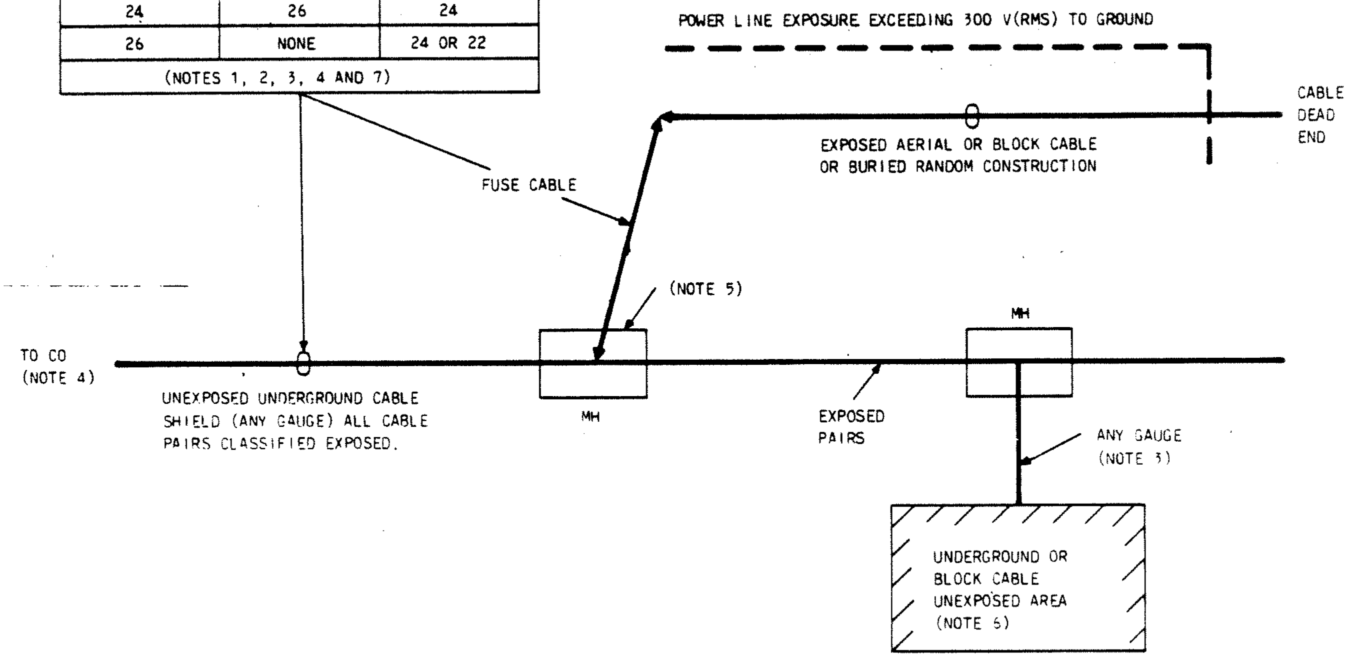
> ***Note:*** Protection applications must consider all sources of exposure; not only power contact but ground potential rise, power induction and lightning. Protection against lightning surges is ▶provided◀ by using spark gap station protectors. Protection against power exposure is provided by using fusible links between the station and the exposure in addition to spark gaps.

Exposed Cable Shield

3.09 Exposed cable shield is defined as any cable shield that has a possibility of coming in physical contact with power. The standard practice is to place fuse (fine gauge) cable at the aerial-underground junction (Fig. 1) to ▶separate◀ aerial cable exposed to power from otherwise unexposed underground cable. With fuse cable in all aerial branches ▶of stations directly connected to UG cable,◀ the requirements for fusing are satisfied. However, this does not eliminate the need for carbon blocks and sneak current protection (heat coils or sneak fuses) ▶at these stations.◀ If fuse cable is omitted at an aerial-underground junction the entire underground cable must be considered as ***exposed.***

3.10 The purpose of fuse cable is to prevent the overheating of protectors in the central office and at the station (resulting from power contact, induction, or ground potential rise of sufficiently high value and duration to operate the protectors). A fuse cable will usually fuse open before the time-current rating of coarser gauge underground cable pairs is exceeded, and it permits maintaining complements of exposed and unexposed pairs in the same cable (Fig. 2). Fuse cable may not always prevent damage ▶either to the cable pairs to which it is connected or to other pairs in the same UG cable.◀ ***Fuse cable does not protect a connecting cable from lightning exposure because the operating (time-current) characteristics of fuse cable or a fuse link of any type are such that lightning surges will usually pass through the fuse without operating it.*** Section 876-101-100 should be used for comparisons of time-current characteristics of ▶some of the commonly used conductors◀, station fuses, and operated protectors. The graphical data presented in Section 876-101-100 shows that

GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
(NOTES 1, 2, 3, 4 AND 7)		



NOTES:

1. THE FUSE CABLE IN THIS CASE MAY SERVE 3 PURPOSES:
   (1) PROVIDES THE REQUIRED FUSE LINK FOR THE MAIN FRAME TERMINATING (TIP) CABLE.
   (2) ISOLATES EXPOSED AERIAL COMPLEMENT FROM UNEXPOSED UNDERGROUND COMPLEMENT.
   (3) PROVIDES REQUIRED FUSE LINK BETWEEN THE POWER EXPOSURE AND STATIONS SERVED FROM UNDERGROUND COMPLEMENT WHICH ARE MULTIPLED WITH EXPOSED PAIRS.
2. WHEN A CABLE CONTAINING BOTH VOICE PAIRS AND VIDEO PAIRS OR COAXIALS IS EXTENDED AERIALLY, ONLY THE VOICE PAIRS MUST HAVE FUSE CABLE. FOR THE PRESENT, THIS REQUIREMENT CAN BE MET BY USING SEPARATE CABLES IN THE LATERAL TO THE POLE OR STUBS IN THE MANHOLE.
3. IN ADDITION TO THE FUSE CABLE LOCATED AT AERIAL-UNDERGROUND CABLE JUNCTIONS, BUILDING OR BLOCK CABLE MAY ALSO REQUIRE A SPECIFIC COMBINATION OF CONDUCTOR GAUGES TO ELIMINATE A POSSIBLE FIRE HAZARD WHERE READY-ACCESS TERMINALS ARE USED (SEE SECTION 638-205-015).
4. ALL PAIRS REQUIRE PROTECTION AT THE CO. THE GAUGE OF THE CO TIP CABLE MUST BE AT LEAST TWO GAUGE SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS FUSE CABLE.
5. FOR LIGHTNING PROTECTION CONSIDERATION REFER TO SECTION 876-400-100.
6. STATION PROTECTION IS REQUIRED BECAUSE PAIRS ARE MULTIPLED WITH EXPOSED CABLE CONDUCTORS.
7. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

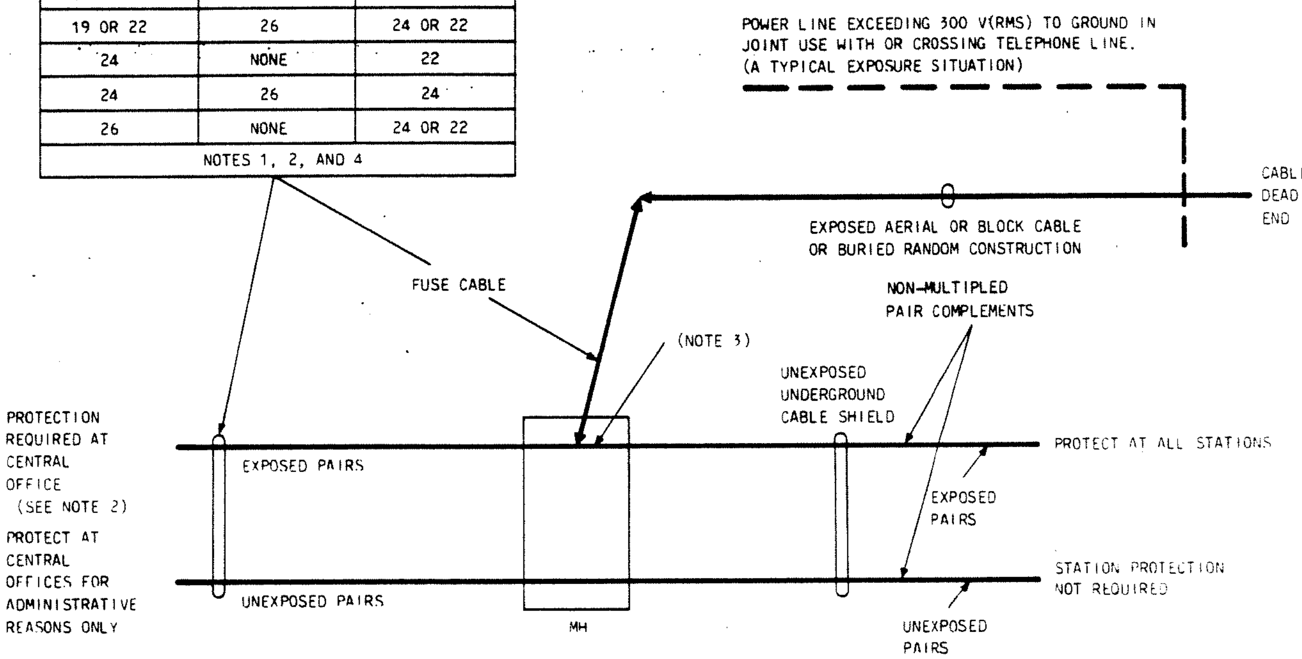
Fig. 1—Underground Cable Containing Only Exposed Pairs

cable and wire pairs, ordinarily used, will fuse open ***before*** the time-current limit of an operated protector is exceeded, thereby eliminating a possible fire hazard at the customer premises as well as at the office main frame. Accordingly, the location of fusible links and the placement of station protectors must be such that, if a pair is fused open, any hazardous potential remaining on the energized section of the telephone circuit will not endanger the customer or customer premises.

Exposed Cable Pairs

3.11 All pairs in aerial or block cable exposed to power or lightning are classified as exposed, regardless of whether or not they appear at terminals. These exposed pairs must be protected, however, only when they are terminated on the customers premises. Pairs in underground unexposed cable that connect to pairs in exposed cable are considered exposed (Fig. 1 and 2).

GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
NOTES 1, 2, AND 4		



NOTES:

1. THE FUSE CABLE IN THIS CASE MAY SERVE 3 PURPOSES.
   (1) PROVIDES THE REQUIRED FUSE LINK FOR THE MAIN FRAME TERMINATING (TIP) CABLE.
   (2) ISOLATES EXPOSED AERIAL COMPLEMENT FROM UNEXPOSED UNDERGROUND COMPLEMENT.
   (3) PROVIDES REQUIRED FUSE LINK BETWEEN THE POWER EXPOSURE AND STATIONS SERVED FROM UNDERGROUND COMPLEMENT WHICH ARE MULTIPLED WITH EXPOSED PAIRS.
2. THE GAUGE OF THE CO TIP OR TERMINATING CABLE MUST BE AT LEAST TWO GAUGE SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS FUSE CABLE.
3. FOR LIGHTNING PROTECTION CONSIDERATION REFER TO SECTION 876-400-100.
4. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

Fig. 2—Underground Cable Containing Exposed and Unexposed Pairs

F. Examples of Exposed Pairs

3.12 The following examples of cable pair exposures are typical of situations frequently encountered in the field or in the design of subscriber plant. The examples may be used as a guide in determining the exposure status of cable pairs or the requirements for station protection.

(a) Where underground cables contain both exposed and unexposed pairs (Fig. 2), two approaches are available for determining protection requirements.

(1) If most of the cable pairs are exposed, all pairs should be classified as exposed to simplify administration. Protection at the station will then be required on all pairs, and either 26- or 24-gauge conductors will be used to coordinate with fuseless station protectors and the central office tip cable (Fig. 1).

(2) If both an exposed and an unexposed status are maintained for cable pairs, the fuse cable at the aerial-underground junction must conform to the requirements specified in Fig. 2. When these requirements are met, the status of the unexposed pairs remains unchanged and station protection will not be required on these pairs. The combination of conductor gauges prescribed in Fig. 2 provides the best protection for exposed and unexposed pairs that can be ob-

tained with cables now available. These requirements should be applied in all new work and, where practical, to rearrangements and changes in existing plant. Twenty-eight gauge conductors would provide better protection for 26-gauge underground facilities than would 26-gauge fuse cable; however, the use of 28-gauge conductors is not feasible at present.

(b) Where an underground primary power circuit is brought to a distribution transformer mounted on a pole in an unexposed block area, the exposure status of the area is not changed, providing that the following conditions are met:

(1) The primary power wires are arranged so that contact with telephone plant is unlikely.

(2) The primary power wires are not extended aerially from the transformer.

(c) Unexposed cable pairs terminating in unexposed areas become indirectly exposed by extending (multipling) these same pairs into an exposed area, even though fuse cable is used at the aerial-underground junction, as shown in Fig. 3.

(d) The multipling of unexposed (underground) cable pairs with exposed (aerial) cable pairs through cross-connecting facilities at the junction of underground and exposed aerial cable should be avoided. Administrative measures should prohibit the bridging of underground cable pairs that feed exposed stations with pairs serving unexposed stations; these measures should also ensure prompt removal of ▶bridge◀ wires on nonworking circuits at the cross connection terminal.

(e) Where both exposed and unexposed pairs appear at a ▶building ◀terminal in an unexposed area, an indirect exposure is created. ***All pairs*** appearing in such terminals are regarded as exposed and require station protection as indicated in building B of Fig. 4. (The otherwise unexposed pairs require protection for administrative reasons only.) With this arrangement, adequate protection is ensured for all stations without establishing complicated rules to avoid the transfer of an unprotected station to an exposed cable pair.

(f) ▶Where only unexposed pairs enter a building (as shown in Building A of Fig. 4), protection is not required at the building terminal.

(g) If any exposed cable pairs enter a building, whether or not under the same sheath, all pairs must be protected (see Fig. 5). However, if most cable pairs entering a building are unexposed, and there are exposed drops which enter the building also, it is not necessary to apply protection to the unexposed cables, provided that the circuits from the drops are protected before appearing in any terminal equipment containing the exposed pairs.◀

G. Exposed Drops from Unexposed Cable

3.13 When drop wire is run from an unexposed terminal into an exposed area (Fig. 6), the cable pairs need not be considered as exposed if (a) a protector is installed at the distribution terminal, and (b) if the cable shield is effectively grounded.

3.14 With the protection arrangement shown in Fig. 6, all pairs in the cable (including those serving the exposed drop wire) can be classified as unexposed. ***The effectiveness of the protection depends on having the cable shield electrically continuous to ground.*** Before protection is installed, a check should be made for insulating joints and cross-connecting terminals to ensure that there are no shield interruptions. If insulating joints are required for corrosion reasons, they must be bridged with a KS-14595, List 1 or 2 capacitor, or equivalent, to provide a path to ground in the event of a lightning or power surge.

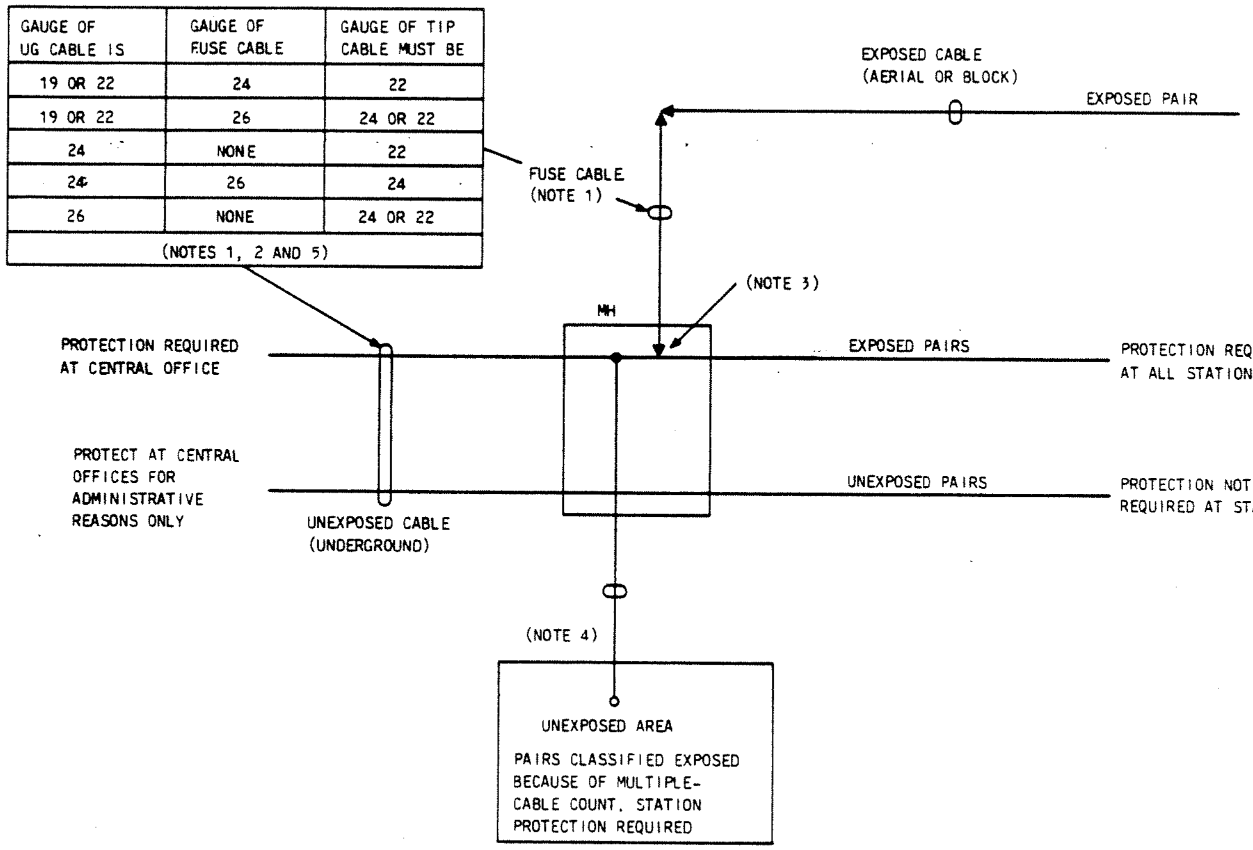
3.15 Where exposed ▶drop wires◀ are served from unexposed cable, protection as shown in Fig. 6 should be installed at the location where the exposed drop enters the building.

4. PROTECTORS FOR EXPOSED STATIONS

A. General

4.01 Information pertaining to the electrical characteristics of station protectors is contained in Section 876-101-100.

4.02 There are two general types of station protectors: "fused" (equipped with two 7-ampere fuses) and "fuseless." Fuseless protectors are available in single-pair and multiple-pair units for use at indoor and outdoor locations. ▶Fused protectors are available only in single pair configurations.◀ All station protectors are equipped with voltage limiting



GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
(NOTES 1, 2 AND 5)		

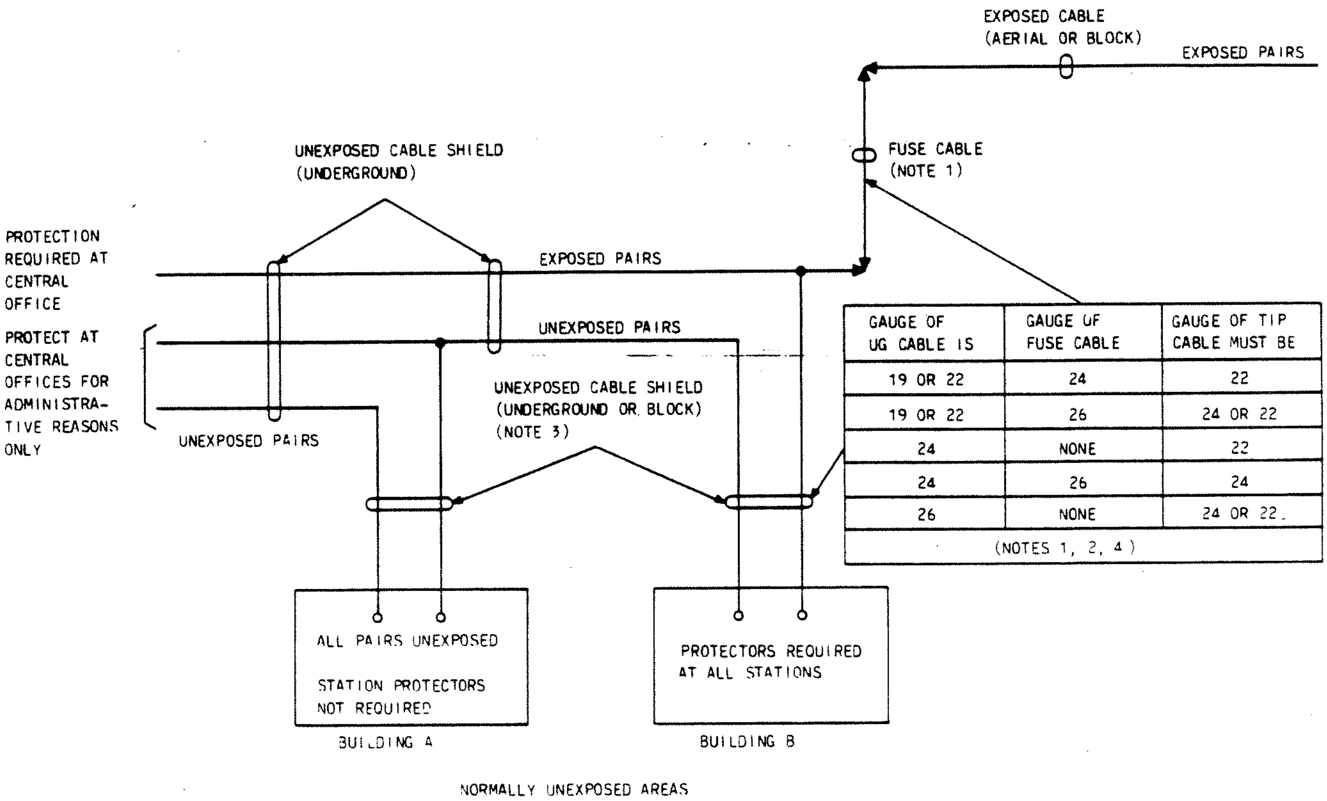
NOTES:
1. THE FUSE CABLE IN THIS CASE MAY SERVE 3 PURPOSES:
   (1) PROVIDES THE REQUIRED FUSE LINK FOR THE MAIN FRAME TERMINATING (TIP) CABLE.
   (2) ISOLATES EXPOSED AERIAL COMPLEMENT FROM UNEXPOSED UNDERGROUND COMPLEMENT.
   (3) PROVIDES REQUIRED FUSE LINK BETWEEN THE POWER EXPOSURE AND STATIONS SERVED FROM UNDERGROUND COMPLEMENT WHICH ARE MULTIPLED WITH EXPOSED PAIRS.
2. THE GAUGE OF THE CENTRAL OFFICE TIP OR TERMINATING CABLE MUST BE AT LEAST TWO SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS FUSE CABLE.
3. FOR LIGHTNING PROTECTION CONSIDERATION REFER TO 876-400-100.
4. UNEXPOSED UNDERGROUND OR BLOCK CABLE, ANY GAUGE, EXCEPT WHERE READY-ACCESS TERMINALS ARE USED. SEE SECTION 638-205-015 FOR SPECIFIC COMBINATION OF GAUGES.
5. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

Fig. 3—Indirectly Exposed Cable Pairs

devices such as carbon block assemblies having 3-mil gaps or gas tubes. ➧Where exposed to power, circuits serving PBXs (except battery feed PBX) also should be equipped with sneak current protection. Circuits which become exposed to power in the future should be protected in the same way. Sneak current protection is also used on certain special services and leased lines when required by local company practices. Certain customer provided equipment may have secondary protective devices which create low impedance paths to ground. These circuits also require sneak current protection.➧

B. Fuseless Protectors

4.03 The fuseless protector has a much higher current-carrying capacity than a fused protector.



GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
(NOTES 1, 2, 4)		

NOTES:

1. THE FUSE CABLE IN THIS CASE MAY SERVE 3 PURPOSES:
   (a) PROVIDES THE REQUIRED FUSE LINK FOR THE MAIN FRAME TERMINATING (TIP) CABLE.
   (b) ISOLATES EXPOSED AERIAL COMPLEMENT FROM UNEXPOSED UNDERGROUND COMPLEMENT.
   (c) PROVIDES REQUIRED FUSE LINK BETWEEN THE POWER EXPOSURE AND STATIONS SERVED FROM UNDERGROUND COMPLEMENT WHICH ARE MULTIPLED WITH EXPOSED PAIRS.
2. THE GAUGE OF THE CO TIP OR TERMINATING CABLE MUST BE AT LEAST TWO SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS A FUSE CABLE.
3. AREA B: WHERE READY ACCESS TERMINALS ARE USED, SEE SECTION 638-205-015 FOR SPECIFIC COMBINATION OF GAUGES.
4. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

♦Fig. 4—Effect of Indirect Exposure on Unexposed Pairs♦

In conjunction with the use of fuseless protectors where power exposure exists, a fusible link is required between exposed plant and the protector in order to minimize any fire or shock hazard at the station in the event of a sustained power contact. The fusible link may be ♦one of the following:

(a) A 24- or 26-gauge cable having a minimum length of two feet under the shield

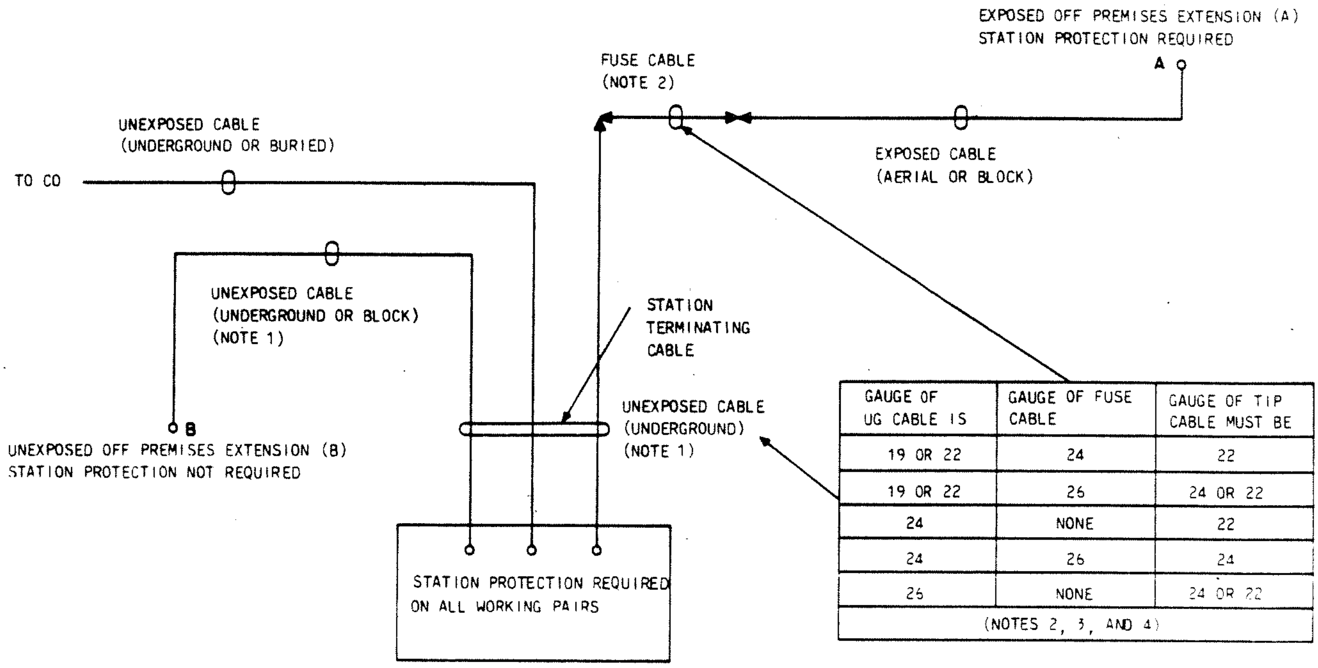
(b) The 24-gauge conductors in a cable terminal stub

(c) The 24- or 26-gauge conductors in the input cable stub of a multiple pair station protector

(d) The 24-gauge conductors of urban wire

(e) E block wire (or equivalent) bridling between drop wire and open wire or rural wire.

4.04 Because of the savings in investment and maintenance expense, fuseless protectors should be used at all stations where the fusible element or link described in paragraph 4.03 can be provided.♦



GAUGE OF UG CABLE IS	GAUGE OF FUSE CABLE	GAUGE OF TIP CABLE MUST BE
19 OR 22	24	22
19 OR 22	26	24 OR 22
24	NONE	22
24	26	24
26	NONE	24 OR 22
(NOTES 2, 3, AND 4)		

NOTES:

1. WHERE READY ACCESS TERMINALS OR MAIN FRAME TIP CABLES ARE USED, SEE SECTION 638-205-015 FOR SPECIFIC COMBINATION OF GAUGES.
2. THE FUSE CABLE IN THIS CASE PROTECTS STATION TERMINATING CABLE OR MAIN FRAME CABLE AND OFF PREMISES EXTENSION (B), BUT DOES NOT PROTECT OFF PREMISES EXTENSION (A) STATION PROTECTORS SERVED BY THE EXPOSED COMPLEMENTS SINCE THE FUSE CABLE IS NOT BETWEEN THE STATION AND THE EXPOSURE. THEREFORE AN ADDITIONAL FUSE LINK IS REQUIRED BETWEEN POWER EXPOSURE AND STATION (A).
3. THE GAUGE OF THE TIP OR TERMINATING CABLE MUST BE AT LEAST TWO SIZES LARGER THAN ANY FINE-GAUGE CONDUCTORS USED AS FUSE CABLE.
4. FUSE CABLE DOES NOT PROVIDE LIGHTNING PROTECTION.

▶Fig. 5—Indirect Exposure at Stations◀

4.05 Fuseless protectors ▶should◀ be used at stations served from buried distribution cable directly connected to exposed aerial cable, provided either cable has 24- or 26-gauge conductors so located that they will serve as a fusible link. This requirement is met if the fine-gauge conductors are located at one of the following points:

(a) In the aerial or buried cable at the junction pole (see note)

(b) In the buried cable section between the first pedestal terminal and the aerial junction (see note)

(c) In the connecting block wiring at the pedestal terminal.

Note: A minimum of 2 feet (not including connections) of fine-gauge (24- or 26-gauge) cable is satisfactory for protection reasons.

4.06 Only 24- or 26-gauge copper distribution cable (or equivalent) should be used in random separation construction with buried distribution closures. This permits the use of fuseless station protectors. (Fuse links cannot be constructed in a buried splice). The recommendation to use 24- or 26-gauge distribution cable is made with the view of simplifying administrative procedures and ensuring proper coordination of fusing requirements. ▶Where 19- or 22-gauge distribution cable is used in all buried construction, it is necessary to install fused protectors at the station. However, fuse-type protectors have a higher first cost and cost more to maintain than the fuseless station protector.◀

4.07 Fuseless protectors may also be used at all stations served by open wire. multiple line wire (19 through 24 AWG), or C rural wire (single pair, 14 AWG) subject to the following conditions.

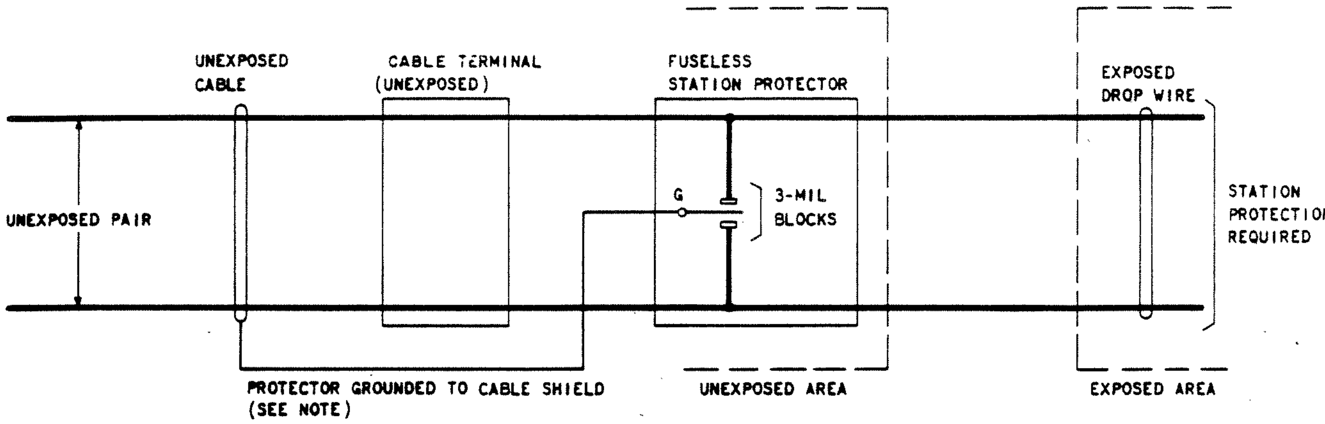


Fig. 6—Exposed Drop From Unexposed Cable

(a) The bridling between ▶aerial◀ drop wire and open wire or multiple rural wire or C rural wire must consist of at least 2 feet of E block wire (0.027-inch diameter) fusible link (or equivalent), installed as described in Section 462-240-200. (See Table A for acceptable combinations.)

(b) The ▶aerial drop wire◀ must consist of either a single-pair drop wire or F multiple drop 22-gauge. ***Older types of multiple drop wire (0.027-inch diameter) or block wire must not be used because this wire cannot be protected against fusing on the premises (available fuse-link E block wire has approximately the same fusing characteristics as the multiple drop wire and will not provide proper fusing coordination).***

▶(c) Buried C Service Wire or E-Armored Service Wire must not be used because a fuse-link of E block wire will not protect the buried wire.◀

C. Fuse-Type Protectors

4.08 If the bridling requirements in paragraph 4.07 cannot be met, a protector with fuses must be used.

4.09 A fuse-type protector may be required when it is necessary to run more than one drop or block wire for battery supply. ▶Detailed arrangements using fused protectors for this purpose are described in BSP 460-100-400.◀

▶TABLE A◀

PLANT	DROP	E BLOCK BRIDLE FUSE REQUIRED
Open Wire	1 pr. or F mult.	Yes
19 AWG Rural	1 pr. or F mult.	Yes
22 AWG Rural	1 pr.	No
22 AWG Rural	F mult.	Yes
24 AWG Urban	1 pr. or F mult.	No.
C Rural	1 pr. or F mult.	Yes

D. Protected Terminals

4.10 With fuseless protected building terminals, it is necessary to have a short length of 24- or 26-gauge protective cable between exposed plant and the terminal to prevent dangerous overheating of protectors and possible fire hazard within the terminal enclosure as a result of a power contact with exposed cable. ▶Most multipair protectors or protected terminals are equipped with either 24- or 26-gauge stub cables which serve as a fusible link.◀ Conductor fusing is, therefore, confined within the sheath and reduces the potential fire hazard. Ready-access terminals, however, present a special problem because the PIC cable conductors, terminated on connecting blocks, cannot serve as fusible links without creating the danger of fire within the enclosure. For example, if an exposed cable is 24-gauge and if 24-gauge PIC cable is extended to a ready-access terminal in the building, it is likely that conductor fusing will occur at or near the terminal posts of the protector. This tendency to fuse where the conductors are separated, rather than under the sheath, is because conductors within a cable sheath are closely packed and pairs adjacent to the wires carrying current help to dissipate the heat. To eliminate a possible fire hazard, the PIC cable terminating on the protectors must be at least two gauges (AWG) larger than the fuse cable. Where a ready-access terminal is installed on the exterior of a noncombustible wall or in a fire-resistant enclosure on the exterior of a combustible wall, 24- or 26-gauge PIC cable in the terminal may serve as the fusible link. Specific applications of fine-gauge protective cable to provide safe fusing arrangements for ready-access terminal installations are described in Section 638-205-015.

E. PBX Protection—General

4.11 Protection requirements for exposed lines serving PBX equipment, and for some off-premises lines, may be different from those of a station served from a central office. (Off-premises lines originate at the PBX and may be exposed, ie, PBX lines serving stations remotely located from the PBX.)

4.12 Where only a few exposed Central Office trunks serve a PBX, fuseless station protectors can be used in accordance with the provisions of paragraphs 4.04 through 4.07. Where two or more drop wires are used for battery-feed purposes, fuse-type protectors are recommended (instead of fuseless protectors) to simplify the special wiring methods necessary for limiting current drain through one protector mounting.

4.13 Where exposed cable pairs are extended into buildings, protectors with 26- or 24-gauge conductors in the input stub cable are often used for PBX protection. ▶Where exposed to power, circuits serving PBXs should be equipped with sneak current protection installed on each line conductor. Circuits which may become exposed in the future should be protected in the same way.◀ It should be recognized that stub fuse links or station fuses are ***not*** substitutes for sneak current protection. Sneak current protective devices operate on low magnitude currents that will not affect stub fuse links or station fuses. ***Sneak current protective devices do not provide lightning protection.***

4.14 ▶Sneak current protection may be provided at the building entrance facility (BEF) or at the network interface (NI), whichever is most economical. In the case of new installations, providing sneak current protection in the BEF by means of heat coils will generally cost less than using fuses. In existing installations which contain protectors that cannot accommodate 4-type protector units, providing sneak current protection by fuses located either at the BEF or NI will generally be more economical, unless some other factor compels replacing the existing protector.◀

4.15 When main frame type equipment that is not listed by Underwriters Laboratories (such as the 302- or 303-type connectors) is used in subscriber buildings, it must be mounted in a dedicated, enclosed space exclusively for telephone communications equipment (main frame room) and under control of the telephone company (see note). The application of main frame type connectors equipped with ▶4-type protector units with heat coils is described in the appropriate section in the 636-3YY-ZZZ layer.

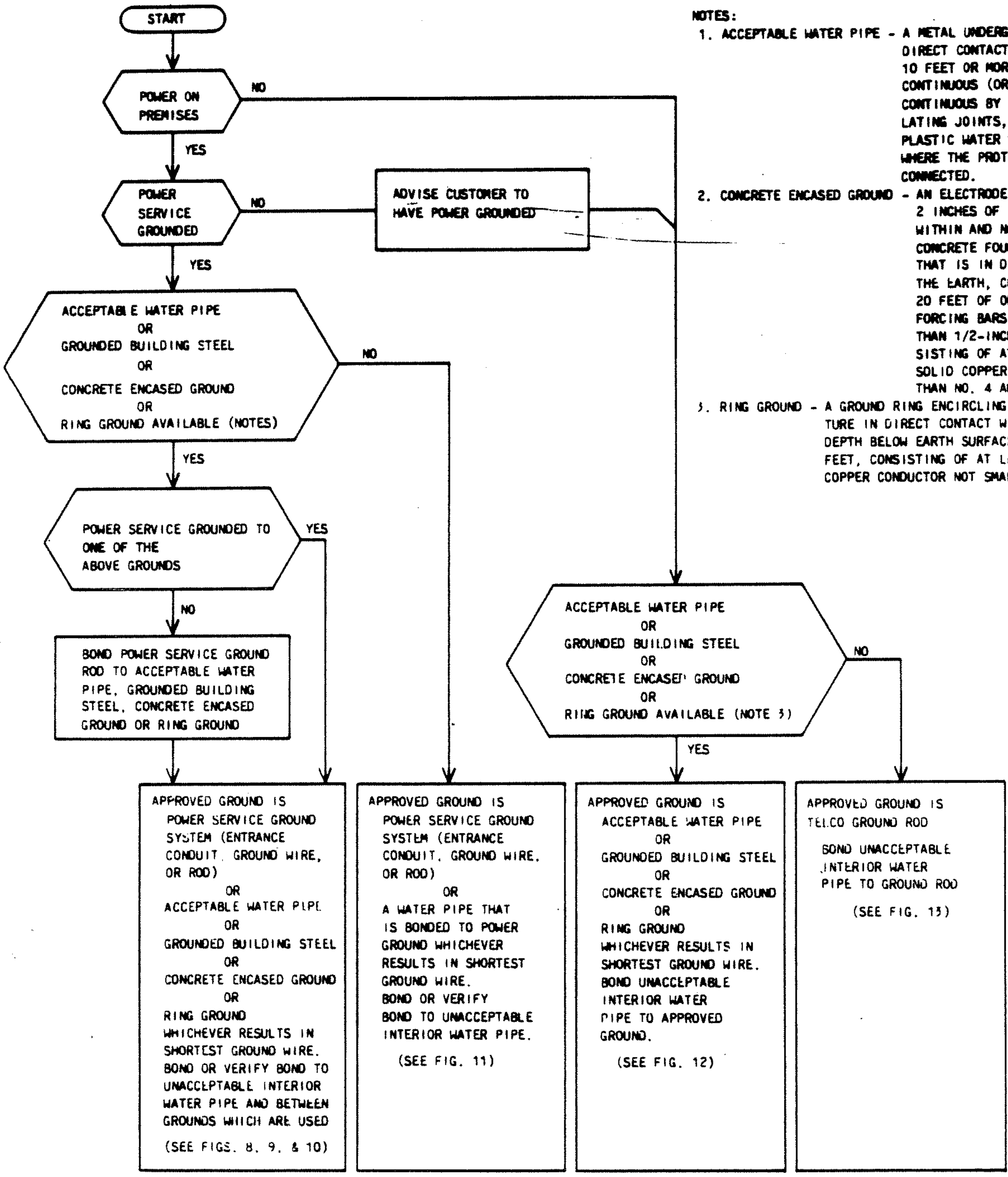
> ***Note:*** Changes in the 1981 NEC require all station protectors not located in dedicated equipment rooms to be "listed" by a nationally recognized testing laboratory such as Underwriters Laboratories.

F. Customer Premises Electronic Equipment

4.16 Electronic-type station equipment installations, especially those utilizing local ac power, may require special protection and grounding considerations. It is recommended that protection and grounding requirements be reviewed with the customer or the equipment vendor prior to the installation of the network service.◀

4.17 Typically, a single point ground (SPG) terminal is provided on electronic station equipment. It is the only acceptable point for connection from the equipment to the external protection grounding system. ▶When such a connection is required, access to the SPG must be provided at the NI. The building entrance protector ground may then be brought to the NI and extended to the customer's SPG.◀

4.18 ***The building entrance facility protector must always be connected to an approved ground via the shortest and straightest practical route (see Section 631-400-102).*** Figures 7 through 13 illustrate methods for selecting an approved protector ground.



NOTES:

1. ACCEPTABLE WATER PIPE - A METAL UNDERGROUND WATER PIPE IN DIRECT CONTACT WITH THE EARTH FOR 10 FEET OR MORE AND ELECTRICALLY CONTINUOUS (OR MADE ELECTRICALLY CONTINUOUS BY BONDING AROUND INSULATING JOINTS, PLASTIC PIPE OR PLASTIC WATER METERS) TO THE POINT WHERE THE PROTECTOR GROUND WIRE IS CONNECTED.
2. CONCRETE ENCASED GROUND - AN ELECTRODE ENCASED BY AT LEAST 2 INCHES OF CONCRETE, LOCATED WITHIN AND NEAR THE BOTTOM OF A CONCRETE FOUNDATION OR FOOTING THAT IS IN DIRECT CONTACT WITH THE EARTH, CONSISTING OF AT LEAST 20 FEET OF ONE OR MORE STEEL REINFORCING BARS OR RODS OF NOT LESS THAN 1/2-INCH DIAMETER, OR CONSISTING OF AT LEAST 20 FEET OF BARE SOLID COPPER CONDUCTOR NOT SMALLER THAN NO. 4 AWG.
3. RING GROUND - A GROUND RING ENCIRCLING A BUILDING OR STRUCTURE IN DIRECT CONTACT WITH THE EARTH AT A DEPTH BELOW EARTH SURFACE NOT LESS THAN 2 1/2 FEET, CONSISTING OF AT LEAST 20 FEET OF BARE COPPER CONDUCTOR NOT SMALLER THAN NO. 2 AWG.

Fig. 7—Selecting an Approved Ground

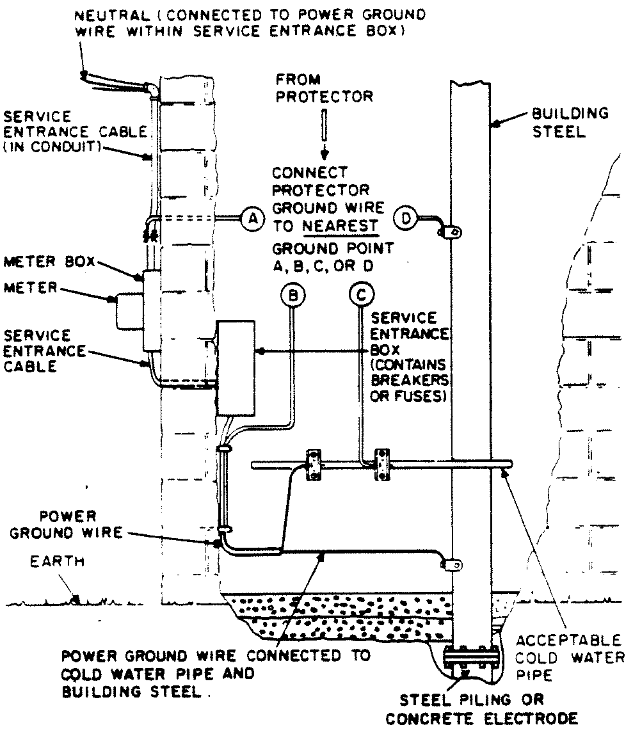


Fig. 8—Acceptable Water System or Building Ground—Power Service Grounded to Cold Water Pipe and Grounded Building Steel

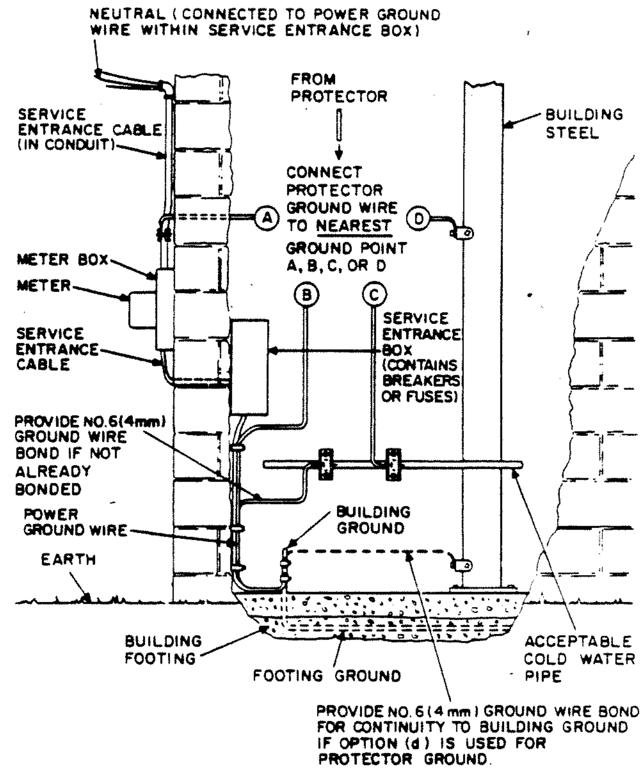


Fig. 9—Acceptable Water System or Building Ground—Power Service Grounded to Building Footing Ground

4.19 ➧Where a single-point ground terminal is employed, the installer of ac powered electronic station equipment must ensure that it is connected to an approved local ground.

4.20 All talking and signaling pairs associated with electronic PBX and KTS systems that leave the building housing the equipment in exposed facilities must be protected at both ends. If the facilities are exposed to only lightning, then station protectors are required at both ends. If the facilities are exposed to lightning and/or power, then station protectors, and fuse links (cable fuse) are required at both ends.

4.21 A coupled bonding conductor (CBC) is used to connect the SPG to the protector or entrance cable ground at the building entrance facility. It is a conductor that is closely coupled to the pairs feeding the station equipment. Mutual coupling or transformer action between the CBC and the cable pairs minimizes lightning surge voltages between the station equipment and local ground.

4.22 The telephone company portion of the CBC may consist of a continuous cable shield or a No. 10 copper conductor that is tie-wrapped to the house cable and run between the protector or entrance cable ground and the NI. A termination is provided at the NI for the customer to extend the CBC to the electronic station equipment. A combination of methods may be used in a single installation, eg, a cable shield from the BEF to the riser closet ground and a No. 10 conductor tie-wrapped between the closet and the NI.

4.23 Where a cable shield is used for a CBC, it is imperative to maintain shield continuity. It should be verified that bonds have been constructed using acceptable permanent hardware and not temporary hardware such as two B-bond clips with a single 14 AWG appliance wire.➧

4.24 All station protectors ***located in the same building*** including those for trunks and off-premises extensions should have the ground termi-

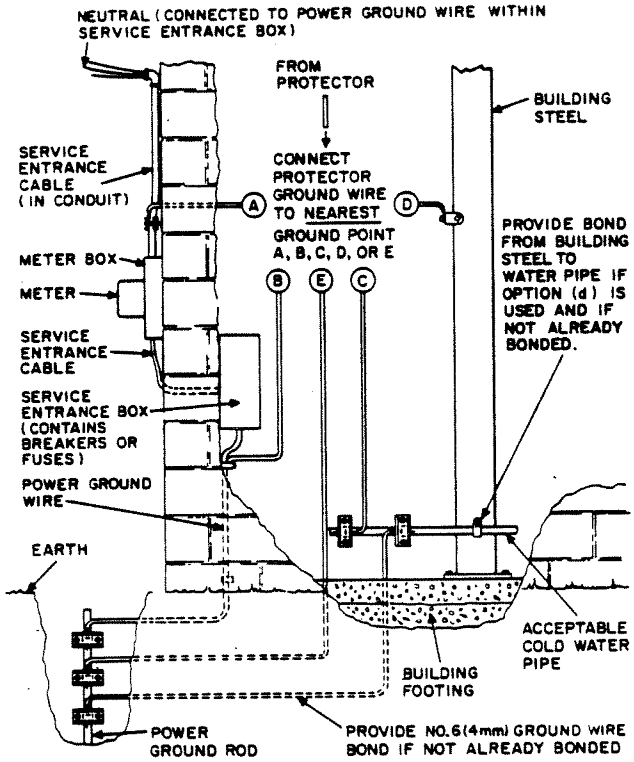
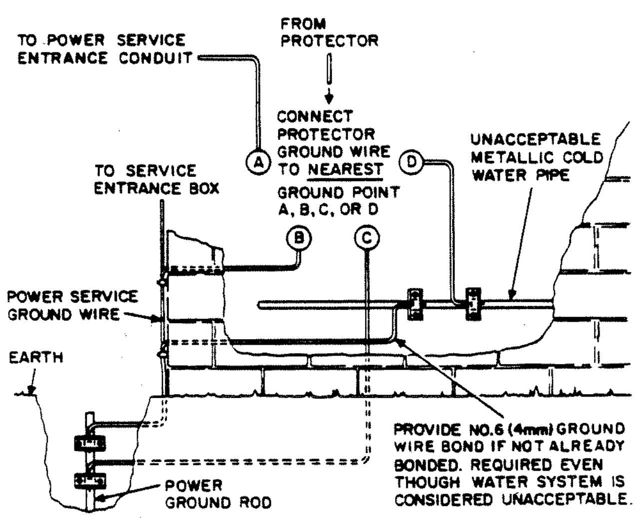


Fig. 10—Acceptable Water System—Power Service Grounded to Ground Rod



◆Fig. 11—Acceptable Water System or Building Ground not Available—Power Service Grounded to Ground Rod◆

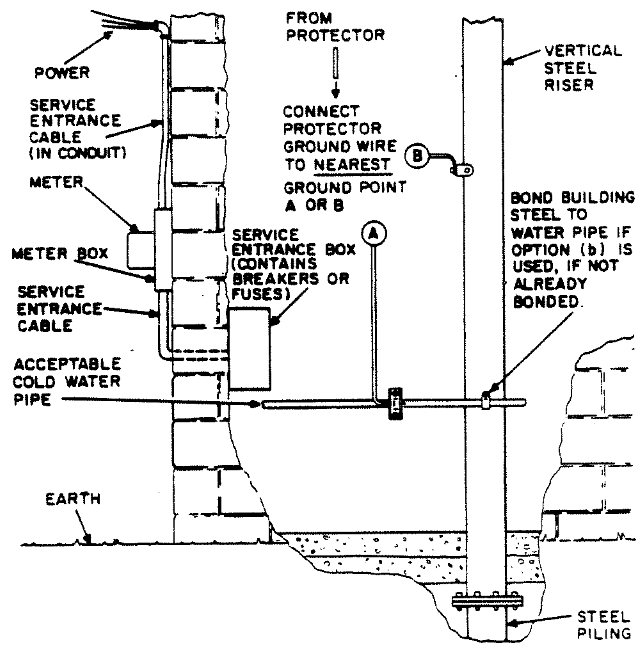


Fig. 12—Acceptable Water System or Building Ground—Power Service not Grounded or No Power on Premises

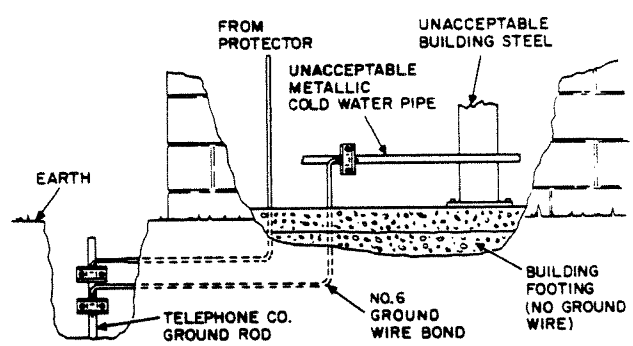


Fig. 13—Acceptable Water System or Building Ground not Available—Power Service not Grounded or No Power on Premises

nals bonded to the PBX equipment Single Point Ground terminal and to the approved ground in accordance with the external wiring and spacing criteria shown in Fig. 14A or Fig. 14B as applicable.

5. LOCATION OF PROTECTORS

A. General

5.01 Detailed instructions relating to the installation of protectors at both indoor and outdoor locations are contained in Division 460. Some general considerations involved in selecting protector locations are outlined in the following paragraphs.

B. Indoor Stations

5.02 Where protectors are placed inside a building, it is desirable to select a location accessible for maintenance as near as possible to the point where the power service enters the building. Also, protectors should be located with the idea of limiting the length of line conductor and ground wire within the premises. With fuseless protectors, the line conductors remain grounded for the duration of a power contact. To ensure that the voltage on the ground wire cannot rise sufficiently to create a hazard, the length of ground wire from the protector to the grounding electrode should be as short as possible in order to provide a low-impedance path. Minimizing the length of separate bond wires from the protector to the power ground is also important. Protectors should be installed in a location which will minimize the length of ground wires and bonds to the power grounds.

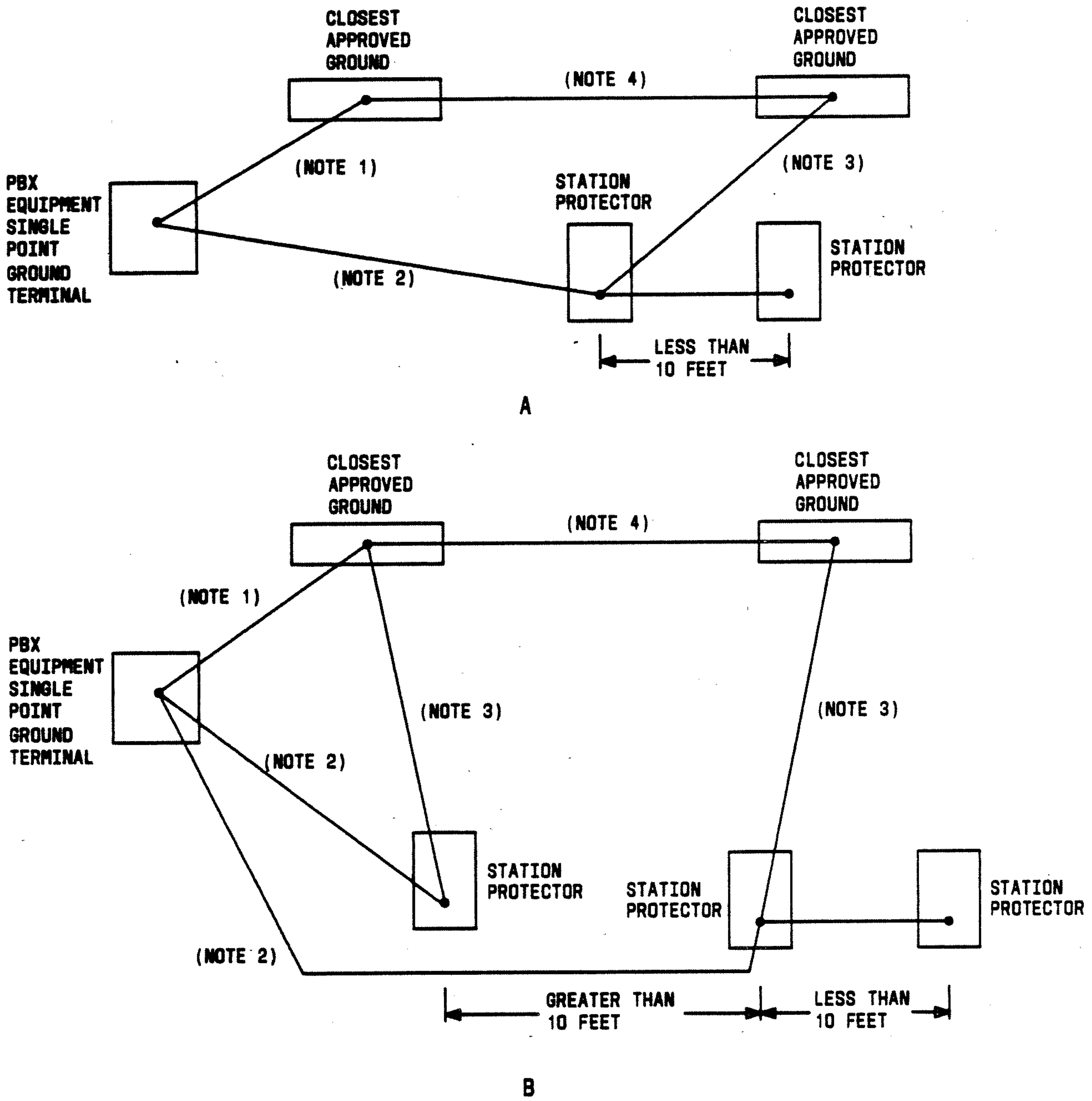
5.03 In selecting a location for fused protectors, a compromise between length of ground wire and length of drop conductors may be necessary. In such cases, it is preferable to have the conductors on the line side of the protector as short as possible. This is recommended because the line conductors are likely to remain energized for some time after the fuses operate.

C. Outdoor Stations

5.04 In general, outdoor stations served by exposed conductors require standard station protection with the ground connected as specified in Section 460-100-400. Figure 15 shows that carbon block protectors should be used for many stations (particularly coin telephones) that have in the past been treated as unexposed. For example, protectors are necessary because of lightning exposure of aerial power facilities serving the station or booth, or because of lightning exposure of the serving underground plant which has been erroneously assumed to be unexposed to lightning. The warning in paragraph 3.07 describes the latter situation. (Refer to Section 506-410-400 for treatment of single-slot coin telephones under exposure conditions.) However, some outdoor stations require special grounding arrangements to prevent a possible shock hazard to persons using the telephone. These stations are as follows:

(a) ***Public Telephones:*** Metallic outdoor station assemblies, such as booths and drive-up or walk-up telephones that have a power supply for lighting, should be grounded as instructed in Section 508-100-100. At these stations, the telephone set housing and booth structure must be connected to the electric service ground to prevent exposed metal parts from becoming accidentally energized by a short circuit in the internal power wiring. Grounding the station assembly to the power ground ensures operation of the branch circuit fuse, thereby preventing a possible shock hazard. Common grounding of power and telephone protection is automatically provided when the station protector ground is connected to the housing assembly of the subscriber set or to the booth structure.

(b) ***Stations on Wood Poles:*** Where a station served by exposed conductors is to be installed on a wood pole, a location having the best available ground for the protector should be selected. The most desirable location is a pole that has an existing vertical ground wire connected to a multigrounded neutral conductor and a ground electrode. The vertical ground wire should be used for grounding the station protector. Where a vertical run of ground wire is to be established, telephone company personnel may drive a ground rod and run the wire to the top of the telephone space. At this point, the wire should be bonded to the cable strand and left in a coil of sufficient length for the power company to extend to the neutral conductor. ***A station should not be placed on a pole having a power vertical ground wire for lightning protection unless the ground wire is connected to a multigrounded neutral conductor.*** The reason for this precaution is to avoid the effects of a rise in voltage-to-ground resulting from the operation of lightning protec-



NOTES:
1. SEE PARAGRAPH 4.19
2. SEE PARAGRAPH 4.18
3. SEE PARAGRAPH 4.17
4. ALL APPROVED BUILDING GROUNDS ARE OR MUST BE COMMON BONDED

Fig. 14—PBX External Wiring for Protection Grounding and Bonding

tion devices on the power system. This condition might present a shock hazard or interrupt telephone service by grounding the station protector. If an acceptable grounding medium (such as a multigrounded neutral) is not available, the protector should be grounded to a station ground rod placed about 2 feet from the base of the pole, provided that the station is served from cable. Where the station is served from wire plant (open, rural, urban), the ground rod should be supplemented by a ring of B ground wire placed approximately 6 inches deep and enclosing the ground area on which a telephone user would stand.

(c) ***Stations on Metal Poles:*** The use of metal poles for telephone stations should be avoided, wherever possible, because special installation and maintenance measures may be necessary, which can increase the cost of the job. More important, however, is the possibility of electric shock and damage to station equipment, which may be difficult to eliminate. To guard against such hazards, the following precautions must be observed:

(1) Where telephone conductors are unexposed and the power circuits on the metal pole are not in excess of 300 volts (rms) to ground, station protection or special precautions are not required. [In some cases the presence of power circuits on a single pole may not affect the exposure status of the telephone plant, as explained in paragraph 3.12(b).] Where exposed telephone conductors are involved, however, the station protector ground should be connected to the metal pole. This precaution must be observed in all cases, even though other means of grounding the station protector are employed. If the metal pole is bonded to a low-impedance ground such as a multigrounded neutral or equivalent, no additional grounding of the station protector is required. If the metal pole is not effectively grounded, the protector ground should be connected to a station ground rod placed about 2 feet from the pole. The ground rod should be bonded to the pole near the ground line.

(2) ▶Where a metal pole supports power circuits (open-wire or in conduit) of more than 300 volts (rms) to ground, the telephone station should not be installed unless the pole can be grounded to a multigrounded neutral. Where telephone circuits are exposed, the protector ground need only be connected to the pole, which must be bonded to a multiground neutral.◀

6. STATIONS REQUIRING SPECIAL PROTECTIVE MEASURES

A. General

6.01 Special protective measures are generally required for stations located in areas where abnormal electrical disturbances outside the telephone system can create a shock hazard or cause damage to telephone facilities. Station installations requiring special protection considerations are as follows:

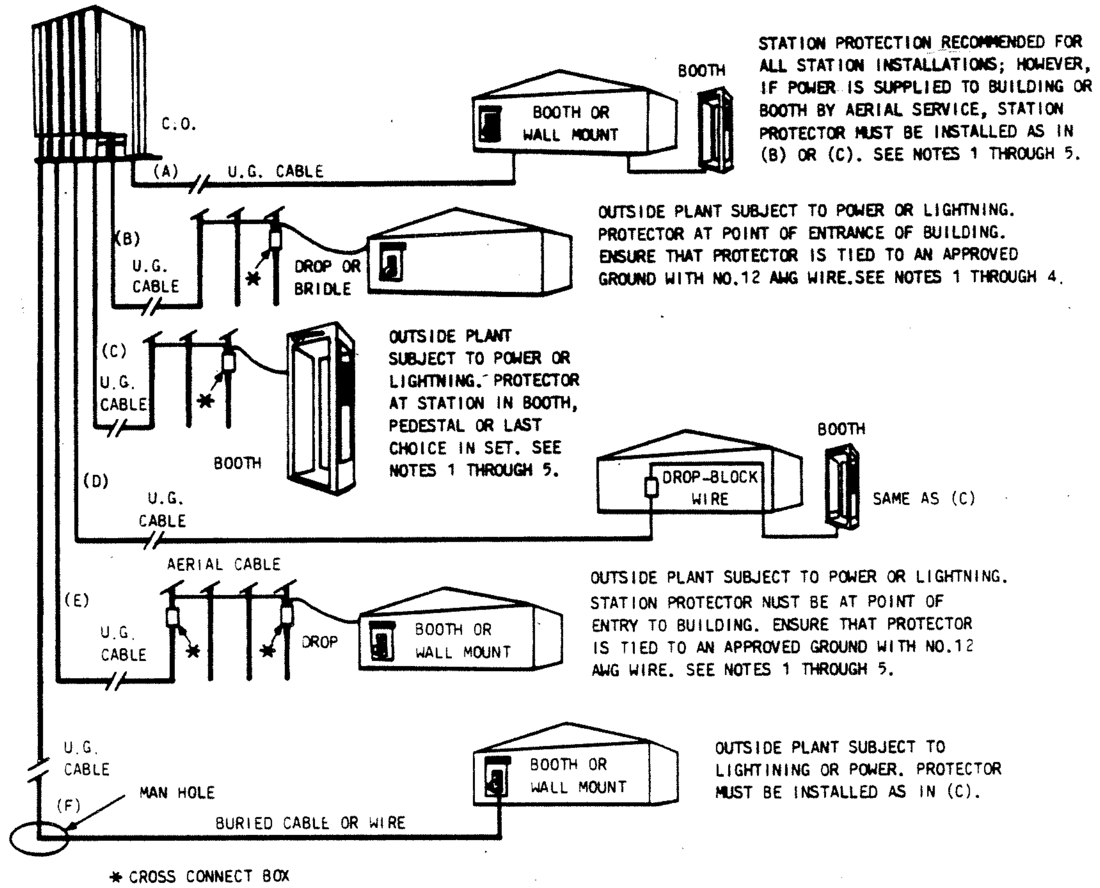
(a) At power substations or generating stations where excessive ground potential rise may be experienced.

(b) Where privately owned communication circuits are connected to ▶telephone company circuits, and the privately owned facilities◀ are in structural conflict or in joint use with power circuits not suitable for general joint use.

6.02 The application of special environmental protective measures at power substations to protect wire-line communications facilities serving the power substation is described in Section 876-310-100. Measures applicable to the situations in paragraph 6.01(b) are described in Division 876, Layer 6. Described in paragraphs 6.03 through 6.08 are other installations where it is desirable to employ special or auxiliary protection so that maintenance of station protectors may be reduced.

B. Power Substation Vicinity

6.03 Careful consideration should be given to the problems and consequences of serving subscriber premises located within the influence of a power station ground grid. For example, if a residential development or an industrial or business complex is affected, ▶and there is extensive grounding of carbon blocks, the station protectors in the area should be equipped with gas tubes.◀ When ground potential rise exposure magnitudes are large and when the dielectric strength of the serving facilities could be exceeded (affecting service reliability), isolating or neutralizing transformers may be required (ie, a large business with a PBX may require neutralizing transformers). Telephone cable serving a power station should be dedicated to that purpose. Other subscribers within the influence of the same power station should be served, if possible, by a separate cable; or, as an alternative, the splice point from a



NOTES:
1. FOR ADDITIONAL INFORMATION ON STATION PROTECTOR AND SIGNALING GROUNDS, REFER TO SECTION 460-100-400.
2. HOUSINGS OF ALL OUTSIDE STATIONS MUST BE GROUNDED. IF SET IS NOT MOUNTED IN A GROUNDED ENCLOSURE, RUN A NO. 12 AWG WIRE FROM STATION TO NEAREST APPROVED GROUND.
3. CARBON BLOCKS THAT BREAK DOWN PREMATURELY CAN CAUSE FAILURES OF COIN COLLECT OR REFUND. CARBON BLOCKS SHOULD BE REPLACED BY GAS TUBE PROTECTORS (123E1A) OR 11B1A PROTECTOR UNITS IN 123-TYPE PROTECTOR BASE. SEE SECTION 506-100-100.
4. WHEN THE PROTECTOR IS MOUNTED IN AN ENCLOSURE SUCH AS A BOOTH OR SHELF, BOND THE ENCLOSURE AND PROTECTOR GROUND TOGETHER WITH NO LESS THAN NO. 12 AWG WIRE. SEE SECTION 508-100-100.
5. WHEN PROTECTOR IS MOUNTED INSIDE SET, CONNECT WIRING PER THIS SKETCH.

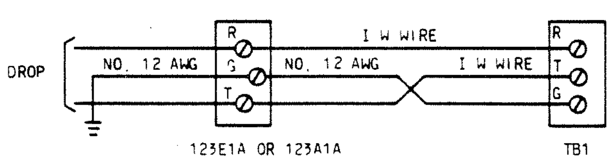


Fig. 15—Coin Telephone Protection Requirements

common cable serving the power station and other subscribers should be made at a sufficient distance from the power station so that ground potential rise limits will coordinate with requirements of the power station communication services. Section 876-310-100 should be consulted for protective transformers, cable splicing, and grounding requirements if these exposure conditions are encountered.

C. Remote Locations

6.04 Telephone stations are sometimes bridged on circuits of trunk open-wire lines and are called "toll stations." These stations and remote rural subscriber stations may serve fire warden towers, airports, etc, where continuity of service is very important. At such stations, lightning exposure may be severe, and prompt maintenance of service is often difficult because of the remoteness of the location. To improve the maintenance at these highly exposed stations, the regular carbon block station protectors may be supplemented ▶or replaced with gas tubes.

D. Radio Transmitting and Receiving Stations

6.05 Protection considerations for telephone facilities at radio stations are described in Section 876-210-100.

E. Mobile Homes and Recreational Vehicles

6.06 The metallic structure of mobile homes, as well as the environment of their location (often in trailer parks having non-standard power wiring and where acceptable water pipes do not exist) requires some special protection measures. The preferred location for the station protector is adjacent to the power service that feeds the mobile home. This will limit the length of the protector ground wire, or the bond wire between the protector and the power where they are grounded to separate electrodes. This is based on the assumption that the power ground is usually the best available ground. In addition, a separate bond wire should be run between the protector ground and the chassis of the mobile home. Protection and grounding requirements for mobile homes is covered in Section 461-220-100. Telephone service, protection and grounding requirements for recreational vehicles, such as camp trailers, camper trucks and motor homes differ from that of mobile homes and are covered in Section 461-220-101.

F. Docks and Boats

6.07 Electrical protection of telephones located on boats or on docks requires some special treatment because of the environment at these locations. Good grounds normally are not available on docks, because acceptable metallic pipes or power conduits do not exist. Water pipes and conduit are either wholly or partially of plastic. This also makes bonding to other utilities impossible on the dock.

6.08 Because of these factors, it is recommended that protectors for all of the stations served from the dock be located on land near the end of the dock and adjacent to the power service equipment that feeds the dock. In some cases this could be within a nearby building. This will permit the protector to be grounded to the power service ground as a first choice. If the protector cannot be located near the power service, or the power ground is not accessible or not present, the protector should be grounded to a telephone ground rod. This is not intended to prohibit grounding or bonding to a water pipe, or any other electrode, that can be verified as acceptable. For instance, metal pipes or bulkheads that extend into the water are suitable grounding electrodes. However, it is recommended that these be used to supplement the telephone ground rod and not as the only source of ground.

6.09 Where signal ground is required at the station, it should be provided via the shield of the service wire or cable. Shield continuity should be maintained between the remote cable termination by the station and the protector ground. Bonding or grounding should not be attempted either on the dock or in a boat. Connecting the ground (yellow wire) to boat ground would defeat the isolation between boat ground and shore power ground which is deliberately maintained in some boats as a corrosion protection measure.◀

7. STATION PROTECTOR GROUNDING AND BONDING

A. General

7.01 If telephone equipment and wiring are isolated from ground (earth) and from metallic or grounded structures such as gas and water pipes, heating systems, power conduit and wiring, and "foreign" communication facilities, abnormal voltages may develop on these systems as a result of power or lightning disturbances. The voltage differences that may exist between the various structures must be equalized or limited by common bonding and grounding to reduce shock hazard and to prevent arcing and damage to equipment or property.

B. Effective Station Grounding Systems

7.02 Effective voltage equalization between conducting surfaces is a basic consideration in achieving effective grounding. Equalization between a station ground and power ground is accomplished by providing low-impedance connections or bonds between the station protector ground and the power ground system. ▶The effectiveness of any telephone station power neutral ground system is a function of the surge impedance (rather than resistance) of the entire grounding system. The potential difference between telephone equipment and other objects bonded to the power system depends primarily upon the surge impedance of bonding conductors through which surge currents pass and which are not common to the two systems. Since the resistance of the bonding conductors is small, it can usually be neglected when calculating surge voltages in bonding systems.◀ The potential difference between the two systems (V_F) is defined in the following expression:

$$V_F = L_G \ell \,(di/dt)$$

where

L_G = Self-inductance of the ground connection in *Henrys per foot*

ℓ = Distance from end to end of the grounding conductor in feet

di/dt = Rate of change of current in amperes per unit of time in seconds

The subsequent discussion is concerned with practical application of the above expression. (Refer to Section 876-101-130 for a list of references and extensive discussion of grounding theory, impulse characteristics of grounds, effective grounding systems, self-inductance, surge impedance, etc.)

7.03 Figure 16 illustrates the transient voltage relationships that exist when a telephone protector is discharging lightning current. Assume that lightning either strikes the drop or the associated plant in the vicinity of a subscriber station. Some portion of the total stroke current will discharge through the protector gaps and flow on the grounding conductor to the cold water pipe at point *b*. Ultimately this stroke current reaches earth via the buried section of water pipe. Voltage V_3, produced by current I_S flowing on the non-common portion of the bonding system between points a and *d*, will appear between the telephone set and the power equipment enclosure. Potential V_1, appearing between the telephone set and plumbing, is somewhat less than V_3 since it is only that voltage drop developed between points *a* and *b*. Another source of extraneous longitudinal potential that can appear in the vicinity of a telephone set is from lightning surges entering the premises over the power service conductors and producing a potential drop in the neutral grounding conductor between points *c* and *d*. The magnitude of such voltage is a function of the length of the power neutral grounding conductor over which we have little control.

7.04 To obtain some quantitative feel for the magnitude of inductive voltage likely to develop when stroke current enters a station conductively, two of the voltages shown in Fig. 16 should be considered: (a) V_1, which develops in the protection ground lead between points *a* and *b*; and (b) V_3, consisting of the voltage appearing between points *a* and *b* ***plus*** V_2 developed in the section of pipe from point *b* to point *d*. In each case the discharge voltage developed in the protector and mounting will supplement the potential drop appearing in the ground path. Under heavy current discharges, the drop across the protector may equal that of its initial sparkover. Referring back to the formula in paragraph 7.02, assume the following conditions:

(a) The simplified waveshape of lightning stroke current from Fig. 17 (di/dt) at the station is 1000 amperes/microsecond.

(b) ℓ = length of conductor from *a* to *b* = 10 feet; from *b* to *d* = 5 feet.

(c) $L_G = 0.4 \times 10^{-6}$ Henrys/foot self-inductance (an approximate figure for telephone work due to mutual impedance effects of nearby conducting objects).

V_1 voltage

$$V_F = (0.4 \times 10^{-6}) \times 10 \left(\frac{1.0 \times 10^3}{10^{-6}}\right)$$

$$= 4{,}000 \text{ volts}$$

V_2 voltage

$$V_F = (0.4 \times 10^{-6}) \times 5 \left(\frac{1.0 \times 10^3}{10^{-6}}\right)$$

$$= 2{,}000 \text{ volts}$$

$$V_3 = V_1 + V_2$$

$$= 6{,}000 \text{ volts}$$

7.05 The calculations in paragraph 7.04 show that the voltage that might appear between components of the subscriber set and a grounded power enclosure (V_3, Fig. 16) would be about 6000 volts on the front of the surge. Although this magnitude of voltage is rather high, it exists for a very short interval of time (approximately 10 microseconds). This example should demonstrate clearly why effort should be made to avoid long ground leads in the planning of a subscriber installation. Ideally, all three utilities (power, telephone, and water) should enter the premises at approximately the same point to minimize the length of the grounding conductors. A helpful step in reducing the length of ground leads is the practice of mounting the station protector directly on a water pipe with a grounding strap. This minimizes voltages between station apparatus and conducting objects associated with the plumbing. Even with this improvement, a significant length of water pipe ground

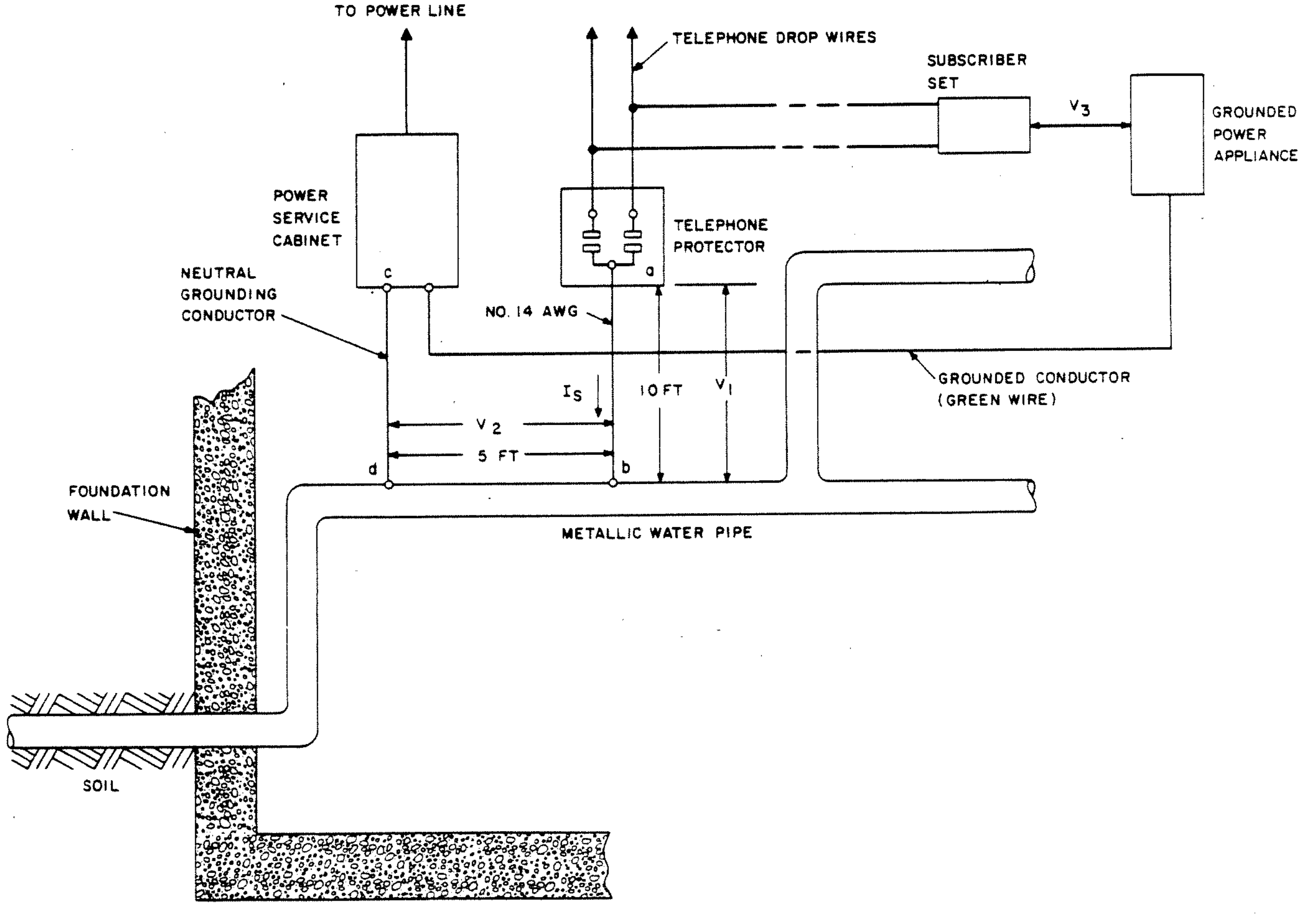


Fig. 16—Subscriber Station Protection Problem

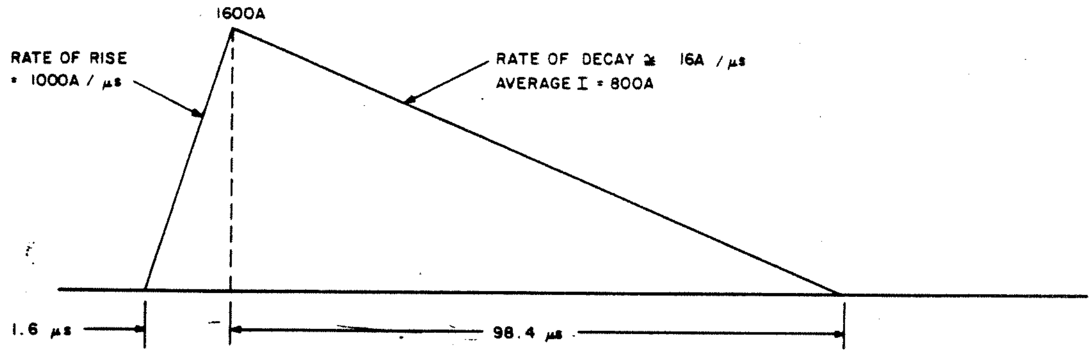


Fig. 17—Simplified Waveshape of Stroke Current in Station Ground Lead

conductor may remain between the point where the station protector is mounted on the pipe and the point where the power neutral grounding conductor is connected to the pipe. The remedy in this case is to mount the station protector on the pipe as close as is practical to the point where the power neutral conductor is connected to minimize potential differences.

C. Hazard of Separate Grounds

7.06 ♦If unbonded separate grounds were to be used for telephone and power, a difference of potential could develop between the two systems which may exceed the dielectric strength of the station equipment. This situation could expose the user to electrical shock and the equipment to damage.♦ For example, in telephones employing 60-Hz power for the dial light, the transformer is exposed continuously to voltage differences between the primary winding associated with the power source and the secondary winding connected to telephone wiring. The prevention of electric shock and station damage points up the need for common grounding to equalize or limit hazardous voltage differences.

D. Selection of Grounds

7.07 The increasing use of a nonmetallic underground piping (such as those made of concrete or plastic) have made both public and private water systems substantially less reliable as grounds than previously when water systems were constructed of metal piping. New construction very often uses plastic underground piping and existing metal systems are often repaired, replaced or altered using plastic piping. The ♦*1981* NEC♦ now recognizes this fact in both Articles 250 covering grounding of power services and Article 800 covering grounding of communication protectors. ♦Water pipes are no longer the first and only choice as a grounding electrode.♦ The ***NEC*** now stresses the bonding together of all available electrodes into a system and the preferential choice for grounding the power is to any point on that system. The first choice for grounding of protectors is to the nearest available location on the system ***or*** to the power service conduit or grounding electrode conductor which is connected to the system, ***whichever results in the shortest run of grounding conductor.*** The system consists of a bonded-together assembly of all of the following electrodes which are available at the premises or structure:

(1) A metal underground public or private water pipe with at least 10 feet of metal pipe in direct contact with the earth

(2) The metal frame of a building where effectively grounded

(3) A concrete encased electrode described in the ***NEC*** as follows: "An electrode encased by at least 2 inches of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth, consisting of at least 20 feet of one or more steel reinforcing bars or rods of not less than 1/2 inch diameter, or consisting of at least 20 feet of bare copper conductor not smaller than No. 4 AWG."

(4) A buried ground ring described in the ***NEC*** as follows: "A ground ring encircling the building or structure, in direct contact with the earth at a

depth below earth surface not less than 2-1/2 feet, consisting of at least 20 feet of bare copper conductor not smaller than No. 2 AWG."

7.08 Article 250-81 of the ♦1981♦ ***NEC*** states: "Continuity of the grounding or the bonding connector to interior piping shall not rely on water meters." Connections to water pipe electrodes should be made at a point where normal maintenance of meters and pumps or the installation of ♦plastic water meters or insulating pipe sections for reducing vibration will not interrupt the grounding circuit.♦ Insulated sections of pipe should be bypassed with a No. 6 bond wire (after consultation with the property owner) to maintain common grounding of the interior piping section.

7.09 In addition, the NEC requires that the protector ground, power ground and interior metal water piping ***always*** be bonded together ♦even though the underground portion is plastic or metal less than ten feet.♦ Do not use a gas pipe as the grounding electrode for a protector. ♦Article 250-71(b) of the 1981 NEC has been revised to require an accessible means to be provided at the power service for intersystem bonding and grounding. This may consist of one of the following:

(1) Exposed metallic service conduit

(2) An exposed power grounding conductor

(3) An external connection provided on the service equipment or raceway.♦

7.10 Where the elements of the grounding system exist at the premises, the selection of protector ground and the required bonding, covered in Fig. 7 to 13, will result in the best choice of ground and all of the necessary bonding.

7.11 Where the elements of the grounding system do not exist, it is still essential that power and telephone grounds be common and bonded to interior water piping even though unacceptable as an electrode.

7.12 Grounded metallic structures (such as buried tanks, pipes, conduits and building steel) may be used for protector grounds when such structures will provide a better ground than a driven electrode. If the electric service is grounded to a buried metallic structure, the telephone protector ground should also be connected to the same structure. Also make sure there is a bond to the interior water pipe.

7.13 Where none of the previously described grounding electrodes is available, standard ground rods must be used for grounding station protectors.

8. BONDING OF POWER AND TELEPHONE GROUNDS

8.01 The procedures outlined in paragraphs 7.06 through 7.13 are intended to accomplish common bonding of power and telephone grounds at the subscriber station. Wherever the situation results in separate grounds, the following arrangements must be followed:

(a) If an acceptable public or private water system is available and the power service is grounded to a driven electrode, the telephone protector ground must be connected in accordance with Fig. 10.

(b) ♦Where power and telephone grounds are connected to separate rods, they must be bonded together.♦ If structural conditions make it impractical to run wire for the entire distance between rods, a metallic pipe of a cold water system (which is not likely to be disconnected or rearranged) may be used as part of the bonding run, although the pipe may not be acceptable for grounding station protectors. Building steel may also be used as part of the bonding run. In such cases, both the power and telephone ground rods must be bonded to the water pipe with a No. 6 wire.

(c) Where a power ground is not provided, the telephone protector must be grounded to an acceptable ground. A follow-up procedure must be established where the customer has the power grounded in accordance with the ***National Electrical Code*** and then informs the telephone company when the ground is installed. The bond must then be placed by the telephone company.

8.02 To conform with recommendations of the ***National Electrical Code,*** ♦***1981,***♦ a No. 6 copper wire should be used for bonding the telephone and power grounds. This is the minimum size wire having sufficient current-carrying capacity for practically all power fault conditions at subscriber stations.

8.03 Any grounding or bonding conductor which is run through a metallic conduit should be bonded to the conduit at both ends. ▶Splices in bonding or grounding conductors reduce reliability and must be avoided.◀

9. BONDING AND GROUNDING IN HIGH-RISE AND LOW-WIDE COMMERCIAL AND INDUSTRIAL BUILDINGS

A. General

9.01 Current telephone company experience reveals low lightning trouble rates for telephone equipment in all types of tall buildings. However, in high-rise and low wide-area industrial or commercial buildings, ▶there is a possibility of differences of potential being developed between telephone conductors and grounded conductors and steel structural members due to lightning strikes to the building, or to the telephone or power conductors that serve the building. As discussed in paragraph 4.16, some electronic station equipment may be sensitive to such surges and special grounding and bonding procedures may be required to minimize them, even when the telephone cable serving the building is classified as unexposed.◀

9.02 A high-rise building is considered to be any multi-story building, over three stories, of structural steel or reinforced concrete construction. A reinforced concrete building is equivalent, electrically, to a structural steel building. This equivalency results from the use of steel reinforcing bars that are wire-tied so that they will remain in place while concrete is poured. The low wide-area building is typified by the large shopping mall, factory, or warehouse.

B. Recommendations

9.03 Recommendations are made in the following paragraphs to improve the bonding and grounding methods used in high-rise industrial and commercial buildings, and to minimize longitudinal potential differences at the interface between local equipment ground and the talking pairs. A typical high-rise building is shown in Fig. 18 to illustrate application of these recommendations. A typical low-wide building is shown in Fig. 19.

9.04 ***Shielded Riser Cables:*** Cables of this type, which are now used in most buildings, should be used if possible. If unshielded riser cables are used or if shield continuity cannot be assured, see paragraph 9.10.

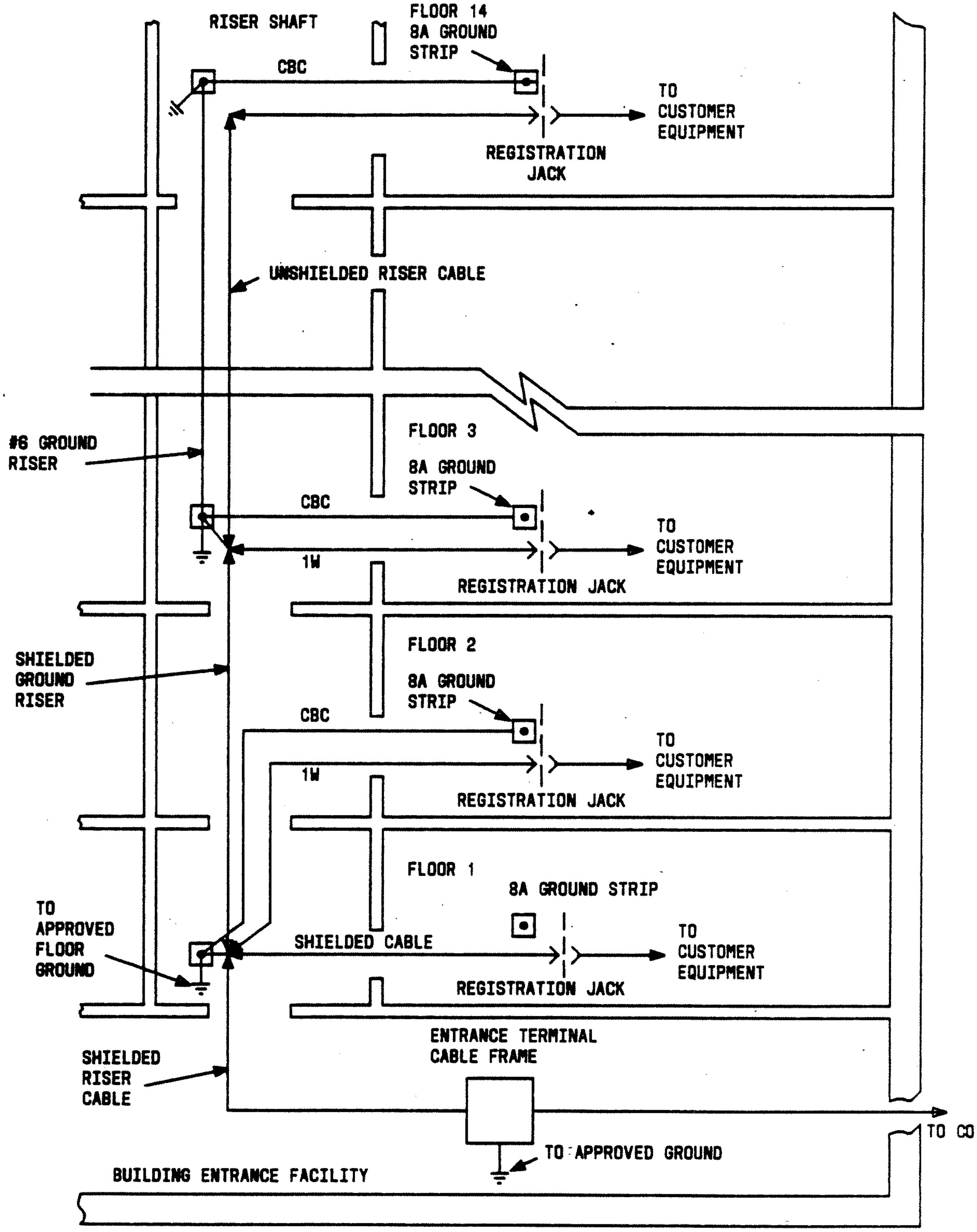
9.05 ***Shield Ground at Entrance:*** The cable shield should be bonded to an approved ground at ▶or near◀ the point of entrance as now required in Section 631-400-102.

9.06 ***Shield Continuity:*** Shield continuity should be maintained over the entire cable length as required in Section 631-400-102. If shielded house cables are used, continuity should be maintained between the house cable shield and the riser cable shield.

9.07 ***Grounding Terminal:*** A suitable grounding terminal must be provided at the building entrance facility (BEF) and in each ▶riser closet in a high-rise building and in each satellite closet in a low-wide building where cable pairs are broken out to serve the station equipment.◀ The grounding terminal in the BEF must be on or as close to the protector as possible (if entrance is protected) and bonded to the entrance cable shield and protector grounding lug with a No. 6-gauge copper wire.

9.08 ***Shield Ground on Floors:*** The ***riser cable shield*** should be bonded to an approved floor ground, using a No. 6-gauge copper bond wire, at every point where the conductors enter or leave the shielded riser cable. Where pairs enter or leave the cable to feed more than one floor above or below the floor where the riser cable shield is grounded, an additional shield ground is required on the floor that is fed. If conductors do not enter or leave the cable on a floor, the cable shield does not require grounding on that floor. The connections from the shield to the approved floor ground must be done in the riser closet. The shield must be connected to the grounding terminal in the riser ▶or satellite◀ closet (paragraph 9.07) and the grounding terminal connected directly to one of the following approved floor grounds:

- Building steel
- Metallic water pipes
- Power feed metallic conduit supplying panel board(s) on the floor
- The grounding conductor for the secondary side of the power transformer feeding the floor. (If this option is selected, the connection to the grounding conductor should be made by a licensed electrician.)
- A grounding point specifically provided in the building for the purpose.



♦Fig. 18—Electrical Protection in a High-Rise Building♦

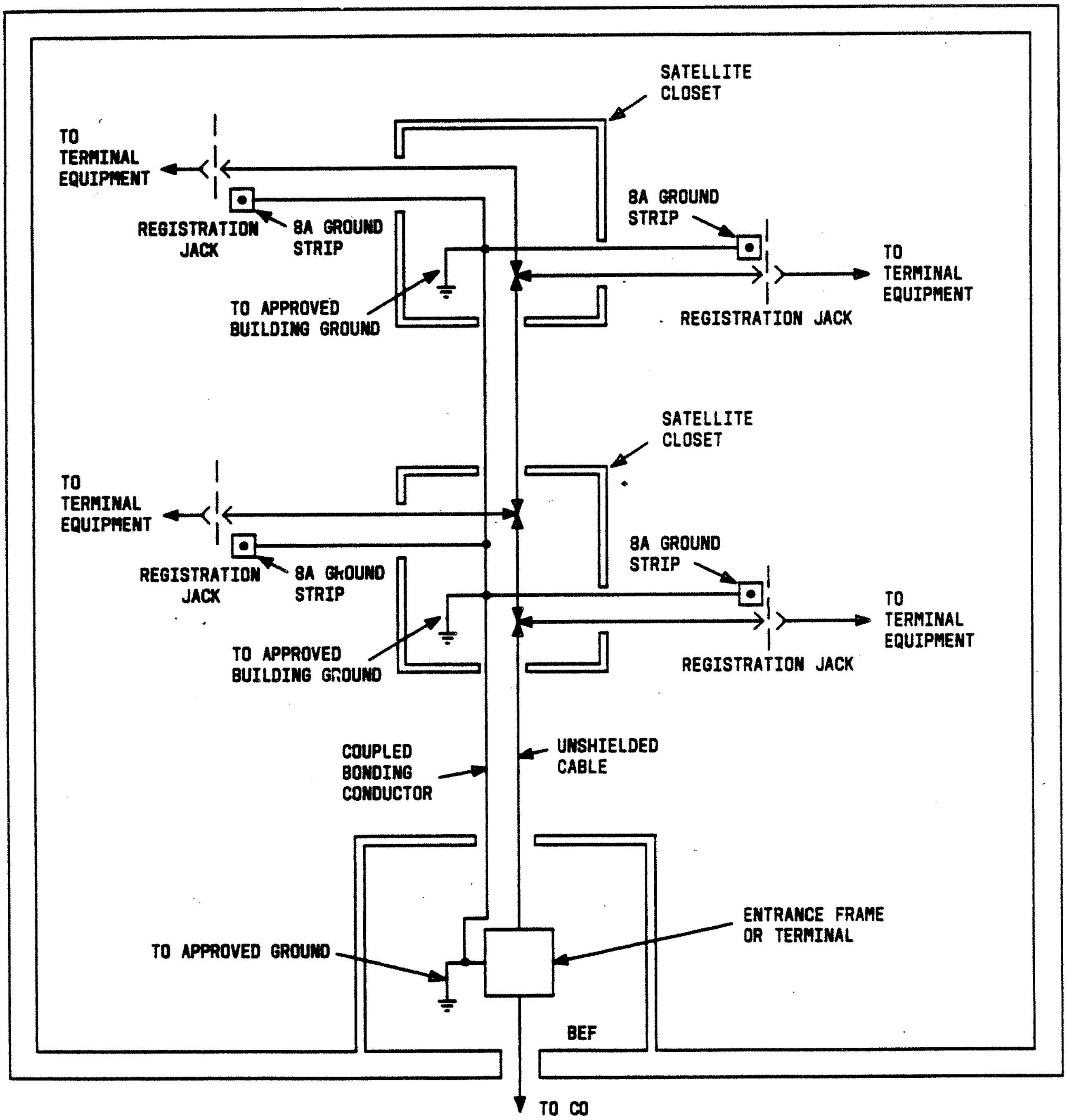


Fig. 19—Electrical Protection in a Low-Wide Building

DANGER: If the approved ground (or approved floor ground) can only be accessed inside a dedicated power equipment room, then connections to this ground should be made by a licensed electrician.

9.09 ***Unshielded Riser Cables:*** If it is not economically feasible to use shielded riser cable, or if shield continuity cannot be assured, a No. 6-gauge copper ground riser should be run ➧in close proximity with the cable or cables in each unshielded riser cable route. The ground riser serves the same purpose as the cable shield although it is not as efficient as the cable shield.➦ The ground riser should be grounded as if it were the cable shield in accordance with recommendations in paragraphs 9.05, 9.06, 9.07 and 9.08.

9.10 ***Riser Location:*** Riser cables should be run as close as possible to vertical grounded conductors such as building steel and in the central portion of the building. Lightning currents are minimal near the central portion of the building, and the mutual induction of the riser cable and vertical grounded conductors minimizes induced potentials on the talking pairs. ➧Locations in the outside walls, particularly corners, should be avoided. Lightning currents are greatest at these places.➦ Although the riser shaft locations are not under telephone company control, a choice may exist and the Building Industry Consulting Service (BICS) should request a favorable riser cable route.

9.11 ➧***Coupled Bonding Conductor (CBC):*** Where a CBC is required, the continuous cable shield discussed in paragraphs 9.04 to 9.07 serves as the CBC from the BEF to the approved floor ground in the riser closet or satellite closet. That portion of the CBC between the riser or satellite closet and the NI is furnished by the telephone company as described in paragraph 4.22. The CBC is bonded both to the approved floor ground in the closet and to the termination at the NI.➦

10. REFERENCES

10.01 The following practices pertain to station and PBX protection:

SECTION	TITLE
201-202-101	Main Distributing Frames—Type of Protection
201-207-801	300-Type Connectors and Associated Protection Units Including 121-Type Protectors
460-100-400	Station Protection and Grounds
461-220-100	Mobile Home Wiring Permanent Type
461-220-101	Recreational Vehicle Wiring Nonpermanent Type
518-010-105	Key Telephone System—Grounding and Special Protection Requirements
553-100-210	Switching Cabinets and Consoles— J58849 (A, B) (MD) and (D, E)—Installation, Connections, and Installation Tests—Nonpackaged 800A PBX
553-100-211	Switching Cabinets and Consoles— Installations, Connections, Service Options, and Installation Tests— Packaged 800A PBX
553-201-200	Installation, Connection, Service Options and Installation Test—801A PBX
553-205-200	Switching Cabinet and Console—Identification, Installation, Connection, Service Option and Tests 805A PBX
553-212-200	Installation, Connectors, Service Options and Installation Tests 812A PBX
554-101-101	Dimension® 400 PBX System Preinstallation and Planning Information
➧554-101-103	Dimension 100 PBX Preinstallation and Planning Information➦
554-105-101	Dimension 400E PBX Preinstallation and Planning Information

SECTION	TITLE
631-400-102	Cable and Terminal Grounding in Subscriber's Buildings—General
636-300-100	300-Type Connectors—Description, Installation
636-320-100	Description, Installation, and Marking—302-Type Connectors
➧636-330-105	305-Type Connectors—Description
636-330-108	308-Type Connectors—Description, Installation and Marking➧
636-330-100	303-Type Connectors—Description
638-205-015	Fuse Cable Requirements
802-001-ZZZ	Protective Grounding Systems (see key-numbered sections for specific types of ground systems)
876-101-100	Electrical Protection Devices
876-101-130	Electrical Protection Grounding
876-210-100	Electrical Protection of Radio Stations
876-310-100	Electrical Protection of Wire Plant Communication Facilities Serving Power Stations
876-400-100	Electrical Protection—Cable
916-559-770	Cable Termination Facilities—Central Office Type—General

10.02 The following additional references apply to PBX protection.

DOCUMENT	TITLE
CPCN-135KY	(Customer Product Change Notice) PBX Systems, 801A PBX Class A Change, November 27, 1973
EL 876	800A PBX Protection and Grounding
EL 2047	800A Lightning Protection (Supplements EL 876)
EL 5393	PBX Systems—DIMENSION 100 and 400 PBX's Revision in AC Power and Grounding Requirements
SBM 5301	Engineering Complaint Final Report 801A PBX Internal Grounding (available from BTL field representative)

➧11. GLOSSARY OF TERMS

11.01 For convenience and additional information, the following glossary of terms is supplied.➧

Approved Floor Ground—A ground on a floor of a building suitable for connection to the grounding terminal in ➧a satellite or➧ riser closet and to the PBX equipment ground. Such ground may be any one of the following: building steel, metallic water pipes, power feed metallic conduit supplying panel boards on the floor, the grounding conductor for the secondary side of the power transformer feeding the floor, or a grounding point specifically provided in the building for the purpose.

Approved Ground—A ground suitable for connection to the BEF protector, the entrance cable shield, or the PBX equipment single point ground. With the 1981 National Electric Code, water pipe electrodes are no longer the first and only choice as a grounding electrode. The ➧NEC➧ stresses the importance of bonding together all available electrodes into a system. The first choice for grounding of protectors is to the nearest available location on the system, or to the power service entrance conduit or grounding electrode conductor which is connected to the system, ***WHICHEVER RESULTS IN THE SHORTEST RUN OF GROUNDING CONDUCTOR.***

Arrester—A protection device used on power lines to limit the line-to-ground surge voltage due to lightning while simultaneously interrupting "power follow", ie, the discharge of normal power.

Bond(ing)—The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct any current likely to be imposed. Bonding provides equalization of potential between separate connections to ground.

Building Entrance Facility—A space provided on the customer premises for termination of distrubution cable.

Carbon Blocks—A pair of electrodes made of carbon that provide an air discharge gap of a specified dimension.

Carbon Block Protector—A protector that uses carbon blocks for voltage limiting.

Coupled Bonding Conductor—➧A conductor used to extend approved ground in the BEF (building entrance facility) to certain types of ac powered terminal equipment. It is closely coupled to the pairs feeding the equipment so that mutual coupling or transformer action between the CBC (common bonding conductor) and the cable pairs minimizes surge voltages between the equipment and its local ground. The CBC consists of a continuous cable shield, a tie-wrapped conductor, or a combination of both.➧

Customer Premises Equipment—Any equipment such as PBX systems, key systems, data sets, etc. This term is often used interchangeably with the term station equipment ➧or terminal equipment➧ in protection practices.

Exposed Facilities—Any ➧outside plant➧ facilities subject to the effects of lightning, power crosses, power induction, or differences in ground potential. Exposure to lightning necessitates the use of protectors. Exposure to power (above 300V rms to ground) necessitates the use of cable fuses, fusible links, or station fuses, as well as protectors. Exposure to power also necessitates the use of sneak current fuses on circuits ➧serving terminal equipment➧ which have a low impedance path to ground.

Foreign Voltage (current)—Any voltage (current) imposed on the telephone plant that is not supplied from the central office or from telephone equipment.

Fuse—An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it.

Fuse Cable—A length of protective cable having 24- or 26-gauge copper conductors that is inserted in the plant and intended to fuse open on foreign power currents before the cable station wiring or apparatus which it protects. It does not protect against lightning currents.

Fuse Link—A conductor, usually block wire, that serves the same purpose on wire plant as fuse cable on cable plant.

Gas Tube Protector—A protector that has spark gaps which discharge in a gas atmosphere within a ➧sealed➧ envelope.

Ground—A conducting connection, intentional, or accidental, between a circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

Ground (Earth) Resistivity—The measured DC resistance of a volume of earth usually expressed in meter-ohms.

Ground Potential Rise—A voltage difference between grounding electrodes due to the conduction of earth return currents. Ground Potential Rise (GPR) on cable pairs can exist when lightning currents are conducted to ground at the station protector. The GPR is most widely recognized as voltages generated due to power fault current conducted to ground.

Ground Riser—A No. 6-gauge copper wire run as a coupled wire with a riser cable when a continuous shield cannot be assured. This wire must be grounded at locations where the riser cable shield would have required a ground.

Grounding Terminal—➧A suitable bar, bus, terminal strip or binding post terminal where grounding and bonding conductors can be connected. Connections to the grounding terminals are considered to be terminations of grounding conductors and do not qualify as splices, and thus are permitted. The grounding terminal in the BEF may be located on or adajacent to the station protector.➧

Heat Coil—A device which grounds a conductor when overheated by current.

High Rise Building—Any multi-story building over three stories of structural steel or reinforced concrete construction.

Induction:

(a) ➧***Electrostatic Induction***—Voltage-controlled currents in a conductor, such as telephone lines, as a result of capacitive coupling from the electric field of a nearby power line.

(b) ***Electromagnetic Induction***—Currents in a conductor, such as telephone lines, produced by coupling from the magnetic field of a nearby power line.◀

Insulating Joint—A splice in a cable sheath where the continuity of the metal sheath, shield, ▶or armor◀ is deliberately interrupted to prevent the flow of electrolytic currents that may cause corrosion.

Joint Random Spacing (Separation)—Where telephone cable is buried in the same trench with power conductors and no deliberate attempt is made to maintain a separation between the two systems.

Low-Wide Building—A building typified by the large shopping mall, factory or warehouse. ▶The terminal equipment may be located remotely from the entrance facility protector, possibly requiring special grounding and bonding procedures.◀

▶***Network Interface***—The location on all Connecting Entities' premises at which any Network Channel, service, or tariff offering is properly terminated in terms of design, installation, and maintenance parameters and a physical interface is provided for connection to the Network.◀

Multiground Neutral (MGN) System—A power system where the neutral conductor is continuously present along with the phase conductors and is grounded at least four times per mile.

Primary Power—Power operating at more than 300 volts rms to ground.

Protector (Station or Central Office)—A device which limits voltage between telephone conductors and ground. Equipped with 3-mil (white) blocks or gas tubes.

Protector Ground Conductor—A wire run from the ground lug on the protector to an approved ground via the shortest and straightest route.

Protector Unit—A device containing carbon blocks, or a gas tube, in combination with shorting devices and/or heat coils, that screws or plugs into a protector, protected terminal, connecting block or central office connector.

Riser Cable—A cable run vertically in a high-rise bulding for providing pairs to each floor. It is preferable that this cable be shielded. To minimize voltages due to lightning strokes to the building, the riser cables should run along the central axis of the building.

Riser Closet—A space provided on a floor of a high-rise building for terminating pairs which leave the riser cable to feed that floor.

▶***Satellite Closet***—The last space within a building that is under control of the telephone co. where pairs are brought out to feed customer premises equipment.◀

Secondary Power—Power operating at less than 300 volts to ground. Typically 120/240 or 277/480 volts rms.

Single Point Ground Terminal—▶A connecting point provided with some PBX and key systems. It is the only acceptable point for connection from the equipment to the external protection grounding system.◀

Sneak Current—A foreign current flowing to ground through terminal wiring and equipment that is driven by a voltage that is too low to cause a protector to arc over to ground.

Sneak Current Protection—▶Use of devices to protect against sneak currents either by interrupting the current (sneak current fuses), or grounding the conductor (heat coils).◀

Splice (Ground Wire)—A method whereby ground wire is extended by joining two or more separate sections together by mechanical connectors. Every attempt must be made to keep ground or bond conductors free of splices between authorized terminations. ▶Authorized terminations for ground and bond wire include approved ground, approved floor ground, protector ground lug, grounding terminal, cable shield, and ground riser.◀

Station Equipment—See customer premises equipment.

Station Fuse—A device such as an 11-type fuse which is used in place of a cable fuse link, stub fuse link, or fine gauge cable. The station fuse ***does not*** satisfy requirements for protectors or sneak current fuses. ◀

Surge Impedance—The impedance of a ground ▶wire or◀ electrode at the frequency of the current wave applied. At low frequency, the surge impedance is close to the dc resistance. When a surge is applied, the instantaneous impedance varies with time and is dependent on the waveform of the surge and the physical characteristics of the particular grounding electrode.

Thunderstorm Day—Any day during which thunder is heard at a specific observation point. Such observations confirm the presence of lightning but do not provide information on the number of strokes to earth.

Water Pipe Area—An area, usually urban or surburban, having an extensive metallic underground water system and where the power services at buildings are normally grounded to the water pipe system.