Engineering Standard

SAES-T-903 31 March, 2004
Outside Plant Electrical
Protection and Grounding

Saudi Aramco DeskTop Standards

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1 Scope

This standard prescribes mandatory requirements governing systems planning, designing and engineering of electrical protection for telecommunications outside plant. This includes upgrading existing facility when a new cable is being placed.

2 Conflicts and Deviations

Any deviations, providing less than the mandatory requirements of this standard require written waiver approval as per Saudi Aramco Engineering Procedure SAEP-302.

3 References

All referenced Specifications, Standards and Codes, Forms, Drawings and similar material shall be of the latest issue (including all revisions, addenda and supplements) unless stated otherwise. Listed below are applicable standards.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-T-243	*Telecommunications: Protection Equipment in Communication Buildings*
SAES-T-435	*Telecommunications Station Protection*
SAES-T-604	*Communications Plant - Clearances/Separations - Aerial*
SAES-T-624	*Telecommunications Outside Plant - Fiber Optics*
SAES-T-629	*Telecommunications Buried Cable and Wire*
SAES-T-634	*Telecommunications - Cable Testing and Acceptance*
SAES-T-887	*Telecommunications: Electrical Coordination-Protection at Power Plants and Radio Stations*
SAES-T-903	*Telecommunications: Outside Plant Electrical Protection and Grounding*
SAES-T-916	*Communications Building Cable*
SAES-T-928	*Telecommunications - OSP Buried Plant*

3.2 Industry Codes and Standards

GTE	*General Telephone and Electronics*
NEC	*National Electrical Code*
NESC	*National Electrical Safety Code*
UL	*Underwriter's Laboratories*

4 Design

The GTE 903 series on "Protection - Outside Plant" and GTE 605 series on "Protection and Bonding" are hereby recognized as Saudi Aramco Engineering Standard SAES-T-903. Mandatory items and modifications are listed herein.

4.1 Protection General Considerations

4.1.1 Definitions

Approved Ground: A ground is suitable for connection to the building entrance facility protector, the entrance cable shield, or the PBX equipment single point ground. 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, whichever results in the shortest run (maximum allowable distance shall be 6.1 m of grounding conductor. Refer to SAES-T-916.

Exposed Facilities: Any outside plant facilities that are subject to the effects of lightning, power crosses, power induction, or differences in ground potential. All Saudi Aramco cable and facilities are considered to be exposed.

Fuse Cable: A length of protective cable of # 24 AWG or # 26 AWG copper conductors that is inserted in the plant and intended to fuse open on foreign power currents before damage occurs to the cable, customer terminal wiring, or apparatus that it protects. It does not protect against lightning currents and associated voltages.

Protector (Cable): A protector that limits the voltage between the conductors and shields of the cable. Standard cable protectors are equipped with 6-mil (blue) carbon blocks.

Protector (User Terminal or Switching Center): A device that limits voltage between conductors and ground. It is equipped with fail safe solid state arresters.

Single Point Terminal: It is the only acceptable point ground for connection from the equipment to the external protection grounding system. It shall consist of copper bus bar to which the main ground conductor, permanently attached to the power ground or building steel (which has been bonded to power ground), has been securely attached.

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

Common Grounding: Common grounding is the use of the same ground electrode by all services. Underwriter's Laboratories listed (UL-listed) or equivalent ground or bond connectors shall be used.

Common Bonding: Common bonding is the interconnecting of separate ground electrodes and is necessary at locations where common grounding cannot or has not been used. UL-listed or equivalent ground or bond connectors shall be used.

4.1.2 General

4.1.2.1 Protection for telecommunication facilities at crossings and parallels of power lines of over 20 kV phase-to-ground, or serving or passing within a GPR zone of influence of power substations, shall be coordinated as specified by SAES-T-887 and with the Saudi Aramco Communications Standards Committee Chairman (Information Technology Planning Division) representative.

4.1.2.2 All metallic loops in Saudi Aramco are considered exposed to lightning, except any on premises extensions that are:

a) Not exposed to 300 volts or more and

b) Not extended to a separate building located more than 43 m (140 ft.) away.

Commentary Note:

The 43 m (140 ft.) is the zone of protection and it is the physical wall-to-wall distance between buildings.

4.1.2.3 All exposed telecommunication cable conductors that enter buildings shall be protected with UL-listed protectors.

4.1.2.4 Never share a vault, pull box, or manhole with a power system of any voltage.

4.1.2.5 Telecommunication facilities shall not be grounded to a non-grounded power system.

4.1.2.6 Never share a trench with a power cable having a phase-to-ground voltage of more than 20 kV.

4.1.3 Electrical Code Requirements

4.1.3.1 Common grounding shall be provided as required by the National Electrical Code (NEC) Article 800, Section D - Grounding Method.

4.1.3.2 All telecommunications engineering design and construction shall comply with the National Electrical Code (NEC) Article 800, as well as applicable sections in the NESC.

4.1.4 Grounding Electrodes

4.1.4.1 Power ground shall be the preferred ground electrode. If the power service (first choice ground source) is not located within 6 m (20 ft.) of the telephone station protector, relocate the telecommunication protector, or use one of the following electrodes:

a) Ground ring of # 2 AWG (35 mm²) minimum copper conductor, encircling the building at a minimum depth of 0.76 m (2.5 ft.)

b) Grounded metal frame of the building

c) A 25-ohm or less ground electrode bonded to power service ground

Note: All the above grounds present on the premises shall be bonded together, regardless of the distance between electrodes or ground systems.

4.1.4.2 Ground rods are only allowed to be used when no other ground medium is available.

4.1.4.3 If more than one ground rod is required to achieve 25 ohms, they must be greater than 1.8 m (6 ft.) apart, and shall be bonded together with a minimum of # 6 AWG (16 mm²) bare tinned-copper ground wire. Refer to NEC Article 800-40.

4.1.4.4 Chemical treatments of the earth around ground electrodes shall not be used. Marl or concrete could be used to assist in maintaining moisture content around ground electrodes.

4.1.4.5 To provide an electrode that will not readily dry-out, main electrodes shall consist of a minimum of 2.44 m (8 ft.) ground rod(s). If more than one is used, they shall be bonded together with a minimum of # 6 AWG (16 mm²)

bare tinned-copper ground wire. A ground resistance of 25 ohms or less shall be established.

4.1.4.6 Telecommunication ground rods shall be bonded to foreign ground rods when they are located within 2 m (6 ft.) of each other.

4.1.4.7 Locate distribution cable terminals or pedestals so that the drop or service wire can be run to the same side of the premises as the power service or to an adjacent side. The protector shall be located so that the total length of the ground and bond wire from the protector to the power service or building ground does not exceed 6.1 m (20 ft.). In all circumstances, the telecommunications ground shall be bonded to the power ground.

4.1.4.8 All ground conductors placed inside or on buildings shall be insulated according to NEC, Article 800.40 (a)(1).

4.2 Cables Entering Communication Buildings

4.2.1 Termination of Outside plant cables on distribution frames shall be fail safe solid state protectors. Refer to SAES-T-243.

4.2.2 Cables entering communication buildings, either directly or in vaults, shall have fuse cables installed according to Table 1.

Table 1

Gauge of Entrance Cable	Gauge of Fuse Cable	Gauge of Tip Cable
19 or 22	24	22
19 or 22	26	24 or 22
24	None	22
24	26	24
26	None	24 or 22

4.2.3 Bonding and Grounding at Cable Entrances

All cables entering communication buildings and containing a metallic shield, armor and/or strength members shall be grounded and bonded:

a) To each other

b) Not more than 15 m (50 ft.) from the point of entrance

4.3 Cables Entering User Buildings

4.3.1 Station Terminal Equipment

4.3.1.1 Station terminal equipment is represented by such items as telephones, answering sets, PBX's, data and alarm circuits, modems, computers, computer terminals, or other electronic type installations. All of these items shall be served from a protected building entrance terminal.

4.3.1.2 Telephone service, power service, and CATV shall be provided with a common ground system to protect against differences in ground potential between the systems.

4.3.2 Bonding and Grounding at Cable Entrance

4.3.2.1 All cables entering buildings and containing a metallic shield and/or strength member shall be grounded and bonded:

a) To each other

b) Not more than 15 m (50 ft.) from the point of entrance (refer to Figure 1)

4.3.2.2 A metallic splice case must be used at the first splice point inside the building for cables of 400 pairs or less.

4.3.3 Metallic Conduits

All metallic conduits (entrance, riser, tie and station), shall be electrically bonded together and grounded to the main or floor ground bus bar.

4.3.4 Entrance Terminal Grounding

4.3.4.1 The ground lug of protected building terminals shall be connected to an approved and permanent ground (master ground bar) with a minimum of 6 AWG (16 mm^2) insulated solid copper ground wire with no cut, splices or sharp bends. The minimum acceptable bending radius shall be 15 cm (6 in.) for sizes up to # 6 AWG (16 mm^2). The maximum length of ground wire shall not exceed 6.1 m (20 ft.).

4.3.4.2 The design engineer shall illustrate the exact grounding arrangements on the construction drawings, from the ground lug of the protector to the power or building ground.

4.3.4.3 The actual grounding path shall be recorded on the "as-built" drawings.

4.4 Outside Plant Cable Bonding and Grounding

4.4.1 General

4.4.1.1 The design engineer shall review the existing distribution plant where construction activity is to take place (in pedestals and manholes where

splicing, transfers, removal or placement of cable occurs) to ensure that the cable electrical protection devices and the bonding and grounding of cable sheaths meet current Saudi Aramco Standards. This review shall include the physical inspection and testing of made ground electrodes. All non-complying situations must be corrected. This shall include electrical protection devices, grounding, and bonding systems inside existing buildings. The requirements of this paragraph apply to all projects and work orders.

Commentary Note:

The intent of this standard is to insure that the electrical protection system is maintained and safety hazards are highlighted and corrected. When an existing electrical protection device (bond and grounding connection and conductor, station protector) is found to be missing, defective or damaged, a report identifying (manhole, pedestal, terminal no. and location) each item is to be issued promptly. The report is to be forwarded to the responsible maintenance and operations agency so that immediate action can be taken to make repairs of the electrical protection system.

Exception:

The exception to this is when a project job order specifically calls for the repair of the electrical protection system in the scope of work and construction drawing.

4.4.1.2 The metallic shields (including any armors) of all cables through splices (in pedestals, direct buried or in manholes/handholes) splice cases, terminals, apparatus cabinets, etc., shall be continuous throughout the length of the cable, except where it is purposely broken by an insulating joint (within zone of influence of electric power stations). All metallic shields and armors, if present, of all cables shall be made continuous with #6 AWG (16 mm^2) or larger bonding wire. All bonds are to be connected to a common ground to ensure that all cables are at the same potential.

4.4.1.3 At junctions of cable and distribution and service wire, bond the support wire or armor of the service wire to the cable strand or shield.

4.4.1.4 When aerial telecommunication cables and CATV cables are jointly exposed, bond their separate strands:

a) At the beginning and the end of the exposure

b) Four times per 1.6 km (1 mile)

4.4.1.5 Cabinets and repeater housings shall be grounded using a grounding electrode with a resistance of 25 ohms or less according to the National Electrical Safety Code (NESC).

4.4.1.6 In sections that are not jointly used, the cable must be grounded using a grounding electrode with a resistance of 25 ohms or less at 610 m (2000 ft.) intervals.

4.4.2 Aerial Strand

4.4.2.1 Aerial strands shall be continuous and bonded together.

4.4.2.2 When power lines with voltages in excess of 300 volts (but not over 20 kV phase to phase) cross over telecommunication cables on a common pole and a power ground is present, bond the cable strand to the power ground. If separate poles are used, bond the cable strand to the power ground or a 25-ohm maximum man made ground electrode at the first pole on each side of the crossing.

4.4.2.3 If a power ground is not present, bond the cable strand to a ground electrode with a resistance of 25 ohms or less on each side of the crossing.

4.4.2.4 Cable shields and armors, if present, shall be bonded to the vertical power ground conductor within the communication space on joint-use poles.

4.4.2.5 Where two cables from different communication buildings terminate on the same pole at the exchange boundary from different directions, and are not electrically connected any where in their routes, their support strands shall be continuous or bonded together.

4.4.2.6 Separate telecommunication cables on the same supporting structures shall be bonded together at least every 610 m (2000 ft.). Where two cables are supported on the same cable suspension bolt, the bolt does not function as the necessary bond.

4.4.3 Aerial Polyethylene Sheath Cable

4.4.3.1 Where splice cases and splice case-type terminals are used, the metal of the sheath shall be bonded to the strand through the sheath clamps that are fastened to the splice case.

4.4.3.2 Telecommunication cables shall not be placed on power lines carrying voltages of 20 kV phase-to-phase or higher. Joint use shall not be permitted with delta-wired power distribution systems. Refer to SAES-T-604, "Plant - Clearances/ Separations - Aerial", for establishing the minimum acceptable clearances when constructing telecommunications plant on joint pole lines.

4.4.3.3 Bond down guys to support strands and vertical ground conductors. Any existing strain insulators shall be omitted or bonded across with a minimum

of # 6 AWG (16 mm²) copper ground wire unless they have been specifically placed for isolation in places such as at power substations.

4.4.3.4 Aerial cable shields and strands shall be continuous, bonded together and grounded to the power ground at intervals not exceeding 305 m (1000 ft.).

4.4.4 Fuse Cable Protection

Fuse cable shall be placed at the junction of aerial cable with buried or underground cable according to the matrix as shown in Table 2.

Table 2 – Fuse Cable Requirement at Aerial-Buried or Underground Cable Junctions

Aerial Cable Gauge	Buried or Underground Cable Gauge	Fusing Required Yes	Fusing Required No	Fuse Cable Gauge
26	Any		x	
24	26		x	
24	24, 22,19		x (1)	
22	26, 24		x	
22	22, 19	x		24
19	26, 24		x	
19	22, 19	x		24

Note: (1) If 24 or heavier gauge cable extends to the central office, not fusing at this junction will require fusing at the central office unless 22 gauge tip cable is used.

4.4.5 Underground Polyethylene Sheath Cable

4.4.5.1 The manhole/handhole/pullbox ground electrode shall be:

a) Minimum of one 16 mm (5/8 in.) diameter by 2.44 m (8 ft.) long ground rod. If required to obtain required resistance, additional rods must be placed.

b) Tested and measured for resistance to meet requirements as stated in 4.1.4.

4.4.5.2 Bonding and grounding of polyethylene sheath cable at intermediate manholes or pull-throughs where no opening is made in the polyethylene jacket is not required. However, ensure that the distance to a bonded and grounded point is not more than 305 m (1000 ft.).

4.4.5.3 When cables run through metallic conduits, bond the cable metallic shield (and armor if present) to each end of the conduit. Refer to SAES-T-629 for additional details.

4.4.5.4 The steel armor in wire /or tape-armored cables shall be bonded to its underlying metallic shield(s) on each side of all splices (in pedestals, direct

buried or in manholes/handholes, etc.), junctions and terminations. If wire or tape-armored cable is spliced to a standard underground polyethylene-insulated cable (PIC) or to a submarine cable, both ends of the tapes or wires shall be bonded to the cable shields on both sides of the splice. Armor wires shall be bonded to the cable shield(s) at the end of the submarine cable. All bonds shall then be grounded to a common approved ground (refer to paragraph 4.1.4.1) with a minimum of #6 AWG (16 mm²) copper ground wire. This shall apply to all types of cable including standard feeder and distribution outside plant copper conductor cables, fiber optic cables (with or without interstitial copper pairs) and pulse code modulation (PCM) cables.

4.4.6 Buried Polyethylene Sheath Cable

4.4.6.1 Buried cable shields and armors shall be grounded at points not more than 610 m (2000 ft.) from a ground of 25 ohms or less.

4.4.6.2 When a telephone cable is buried beside or beneath aerial grounded power lines, bond the telephone cable shield to the power ground at the beginning of the exposure, at the end of the exposure, and at points not more than 305 m (1000 ft.) from a ground point.

4.4.6.3 When a telephone cable is buried besides or beneath aerial ungrounded (delta) power lines, establish 25-ohm or less man made grounds. Bond the telephone cable shield to the man made grounds at the beginning of the exposure, at the end of the exposure and at points not more than 305 m (1000 ft.) from a ground point.

4.4.6.4 Where a terminal housing/pedestal is located within 3 m (10 ft.) of an electrical supply terminal or transformer housing (grounded system), a # 6 AWG (16 mm²) copper wire shall be used to bond the telecommunication terminal housing to the electrical supply terminal or secondary section of the transformer.

4.4.6.5 When telecommunication cables are buried parallel to buried power facilities (in a joint or separate trench) with fixed separation (one meter or less) and, where there is no requirement for a telecommunications pedestal/terminal, a telecommunication cable may be buried past distribution power transformers/terminals etc., without placing a telecommunications pedestal/terminal solely for the purpose of bonding the cable shield to the power ground. However, ensure that no point on the cable is more than 150 m (500 ft.) from a bond to the power ground. Refer to GTE 887-000-050, Paragraph 8.14.

4.4.6.6 In areas where a terminal housing/pedestal is subject to disturbance/damage from vehicles, etc., it shall be protected with a pedestal guard. These have

typically been constructed of steel pipe. Where pedestal guards are constructed of steel pipe or other metallic materials, they shall be bonded to the pedestal with a # 6 AWG (16 mm^2) copper wire. The copper ground wire shall be attached to a metallic post of the pedestal guard (using cadweld method or an approved mechanical connector) at a point 50-75 mm above the concrete encasement of the metallic post base.

4.4.7 Joint Burial of Power and Telecommunications Cables

Separations between buried power facilities (power cable, power pedestals, etc.) and telecommunication cables (when crossing) shall not be less than 300 mm (12 in.) of well-tamped earth. In areas where this is not possible, 75 mm (3 in.) of concrete or 100 mm (4 in.) of masonry is permitted. Where the power exposure is greater than 15 kV phase to phase, buried telecommunication cables shall be placed inside PVC or similar characteristic conduit at the crossing. Refer to SAES-T-928.

4.4.8 Fiber Optic Cable

4.4.8.1 All metallic members of a fiber optic cable, shall be bonded together and grounded at all splice locations. The ground shall meet these requirements:

1. Be of 25 ohms or less resistance.
2. Be bonded to the power ground, when available within 3 m (10 ft.). Where there is no requirement for a pedestal/terminal, a fiber optic cable may be buried past distribution power transformers/terminals, etc., without placing a pedestal/terminal solely for the purpose of bonding the cable metallic members to the power ground. However, ensure that, no point on the cable is more than 150 m (500 ft.) from a bond to the power ground. Refer to GTE-887-000-050, Paragraph 8.14.

4.4.8.2 When a fiber optic cable containing metallic members is placed on a pole line (and the inductive effects of nearby power lines are not calculated), bond the metallic members to the support strand at all splice points and at intervals not to exceed 2 km (1.25 miles). Where it is not practical to place bonds every 2 km, or where there are complicated power exposures, the bonding and grounding design must be reviewed and approved in writing by the Saudi Aramco Communications Standards Committee Chairman (Information Technology Planning Division). In any case, the separation between bonds will not be permitted to exceed 4.8 km (3 miles). Each bond point shall be grounded to the power ground, where available. In other areas, a ground electrode of 25 ohms resistance or less shall be provided. Joint use with delta power systems is not permitted. Refer to SAES-T-624.

4.4.8.3 Bond the support strand to the power ground at intervals of 610 m (2000 ft.) or less.

5 Installation

Electrical protection of all types of communication facilities including, but not limited to, copper conductor cables used for feed and distribution, pulse code modulation (PCM) cables used for carrier and local distribution, and metallic fiber optic cables (with or without interstitial copper pairs) is mandatory and shall be according to SAES-T-435, SAES-T-887, SAES-T-903, SAES-T-916, and other applicable standards as referenced in this standard.

6 Testing and Inspection

Electrical protection equipment shall be tested with the cable according to SAES-T-634. Inspection of installations shall be carried out by the Saudi Aramco Inspection Department during all phases of construction.

Revision Summary

31 March, 2004	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with no other changes.

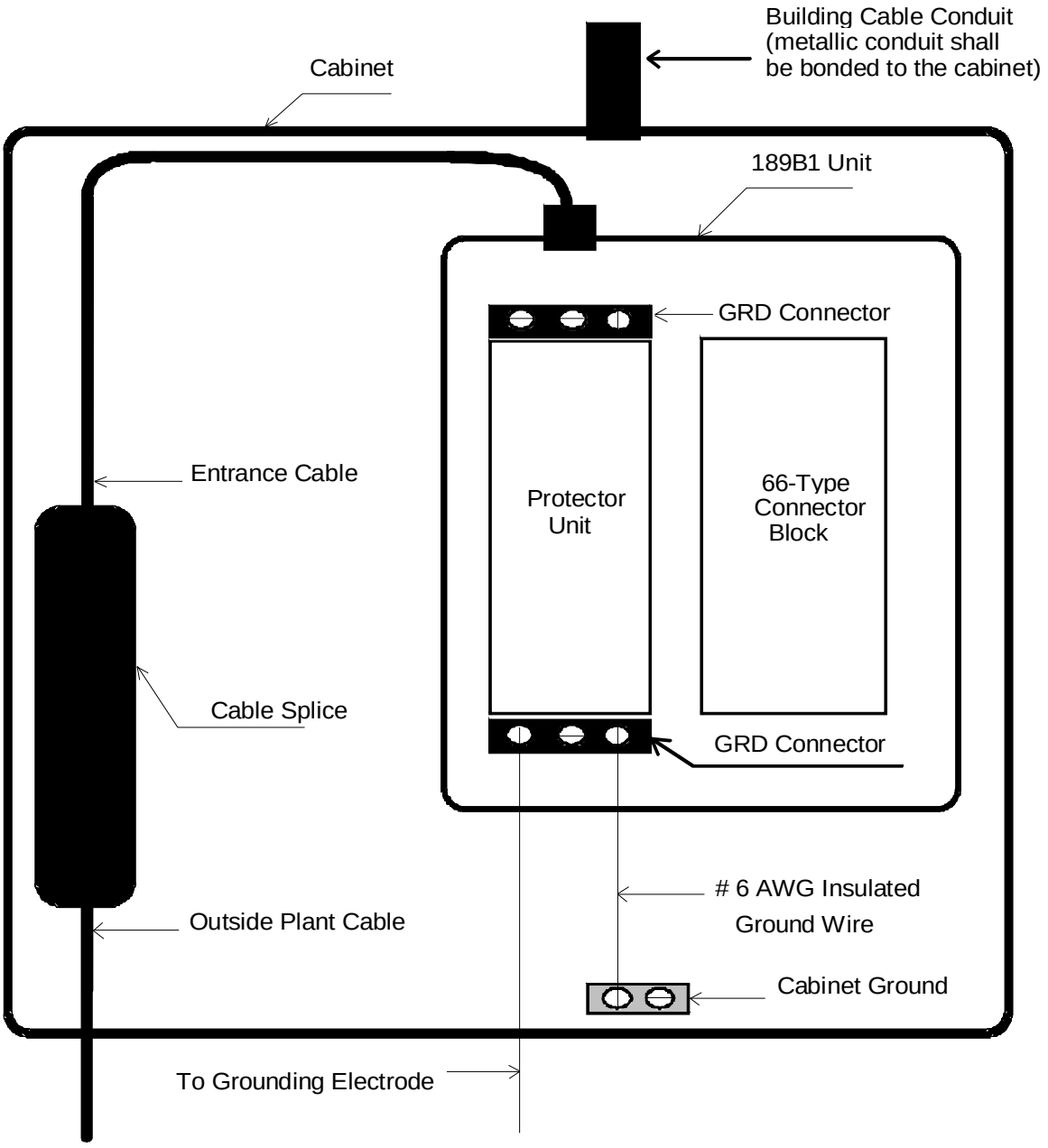

Figure 1 - Bonding and Grounding at Cable Entrance