

Pipeline Construction Near Powerlines

STD.8710

Scope

- (1) This standard provides Enterprise Products Company (Company) requirements for pipeline construction near powerlines. These requirements shall apply to pipeline construction that parallels overhead high voltage electric transmission lines in the same right-of-way or in close proximity thereto by Company forces or by other parties constructing to Company standards. Construction and installation shall comply with all applicable federal, state, and local rules, regulations, and codes.
 - (2) This standard is not intended to be all-inclusive, but to represent *minimum requirements only*.
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1.0 REFERENCES

1.1. Pipeline and Hazardous Materials Safety Administration (PHMSA)

49 CFR 192	Transportation of Natural and Other Gas by Pipeline
49 CFR 195	Transportation of Hazardous Liquids by Pipeline

1.2. Occupational Safety and Health Administration (OSHA)

29 CFR 1926	Safety and Health Regulations for Construction
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2.0 OVERVIEW

2.1. Guidelines

- (1) Piping parallel to, crossing, or in proximity of electric power transmission lines are subject to electrostatic and electromagnetic induced voltages and currents. The Contractor is required to provide trained electrical safety inspectors to supervise the necessary mitigating procedures associated with electrical safety on the pipeline when specifically required to work near powerlines as defined in the scope of work. The Contractor and his/her personnel should be aware of safety requirements when construction crosses or parallels electrical power lines.
- (2) PHMSA Pipeline Safety regulation 49 CFR §192.467 and §195.575 states:
Where a pipeline is located in close proximity to electrical transmission tower footings, ground cables or counterpoise, or in other areas where fault currents or unusual risk of lightning may be anticipated, it must be provided with protection against damage due to fault currents or lightning, and protective measures must also be taken at insulating devices.
- (3) The principal limiting factors of construction are the minimum sag of the wires and the distance from the conductors that must be maintained by equipment operators to ensure against electrical shock resulting from induced voltage. In the latter case, the Occupational Safety and Health Administration (29 CFR §1926.600) dictates:
 - (a) Except where electrical distribution and transmission lines have been deenergized and visibly grounded at point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines shall be operated proximate to power lines only in accordance with the following:
 - For lines rated 50 kV or below, minimum clearance between the lines and any part of the crane or load shall be 10 ft.
 - For lines rated over 50 kV, minimum clearance between the lines and any part of the crane or load shall be 10 ft plus 0.4 in. for each 1 kV over 50 kV, or twice the length of the line insulator, but never less than 10 ft.
 - In transit with no load and boom lowered, the equipment clearance shall be a minimum of 4 ft for voltages less than 50 kV, and 10 ft for voltages over 50 kV, up to and including 345 kV, and 16 ft for voltages up to and including 750 kV.
- (4) The Contractor shall adhere to these regulations at all times. In addition, the minimum clearance for lines 750 to 1,000 kV shall be 20 ft. These guidelines are for ideal weather conditions, and the clearances shall be greater under more adverse weather conditions.

3.0 ELECTRICAL SAFETY INSPECTOR

3.1. Guidelines

- (1) The Electrical Safety Inspector is the responsible person in charge of electrical safety during construction of the pipeline.
- (2) The Contractor with approval of the Company shall supply this inspector.

3.2. Requirements

- (1) The Electrical Safety Inspector shall:
 - (a) Have extensive knowledge of National and State codes for electrical safety;
 - (b) Be fully aware of proper grounding procedures and the dangers associated with inductive and conductive coupling, lightning, fault current, power arc, etc., on above and below ground structures; and
 - (c) Know the intrinsic hazards of the construction equipment being used and the safe distances from overhead conductors required.
- (2) The Electrical Safety Inspector shall:
 - (a) Furnish the instrumentation required to monitor voltage levels, and ascertain vehicle instrumentation, equipment, and authority required to ensure safe working conditions;
 - (b) Communicate at least daily with the power company dispatcher controlling the involved electric lines;
 - (c) Have stop task authority;
 - (d) Obtain weather information daily from the local weather office;
 - (e) Have the authority to inspect all pipeline and construction equipment grounding procedures; and
 - (f) Have a strong background in electrical distribution and grounding so that these duties can be fully understood.

4.0 GROUNDING PERSONNEL

- (1) Grounding crews shall be staffed by personnel who, by training and experience, are familiar with and can carry out mitigative procedures specified in applicable codes and standards, and as specified in later sections of this Standard. All personnel working in an area of high-voltage power lines shall be instructed to minimize contact with metallic equipment. The Company may provide Inspectors (that report to the Company Representative) to inspect grounding procedures.
- (2) Each member of each grounding crew shall be equipped with rubber insulating gloves and mitts in conformance with applicable codes and standards. Gloves shall be inspected daily. Torn or otherwise defective gloves shall be discarded. Each grounding crew shall be equipped with Contractor-supplied instrumentation for measuring induced voltages and currents.

5.0 WORK STOPPAGES

5.1. Introduction

Further reduction of the possibility of electrical hazards can be achieved if work on the pipeline is suspended during periods of severe weather, or when adjacent power lines are being energized or de-energized.

5.2. Guidelines

- (1) Since temporary grounding is not intended to safely mitigate voltages arising from lightning or power line faults, it may be necessary to halt all pipeline construction during inclement weather conditions.
- (2) The Electrical Safety Inspector, after discussions with the Contractor and Company Representative, shall decide when work is to be stopped.

5.3. Conditions

Work may be stopped if one or more of the following conditions prevail:

- Any thunderstorm activity within 3 miles of the area of overhead high voltage power lines.
- Local electrical storms denoted by visible lightning or sound of thunder.
- High winds, wet snow and rain.
- Scheduled switching on the electric power transmission system.
- Repeated contravention by Contractor of any grounding procedure.

6.0 POTENTIAL MEASUREMENTS OF METALLIC FOREIGN STRUCTURES

6.1. Introduction

A foreign structure is any metallic structure in the right-of-way of the pipeline construction. Exposure of any metallic structure during trenching operations can represent a potential hazard.

6.2. Guideline

- (1) Measure voltage between the pipe and the exposed metallic foreign structure.
- (2) Record the voltage measurement on a data sheet (Appendix A).

6.3. Equipment Required

- AC Voltmeter (Comparable to the Fluke 87 Series II Analog/Digital Multimeter)
- Insulated Rubber Sheet

6.4. Procedure

If any metallic structures are exposed, check to see if they are coated. In the event that the structure is coated, the coating should prevent contact with any voltages that exist between the pipe and the foreign structure, although (if deemed necessary by the Electrical Safety Inspector) the structure should regardless be tested for high voltages. If the structure is not coated, then follow these steps:

- (1) Measure AC voltage(s) on the foreign structure
- (2) Record value(s) on a data sheet (Appendix A)
- (3) Pipe to foreign structure voltage > 15 volts?
 - (a) YES – Wrap the structure with an insulated rubber sheet, similar to what electrical linesmen use when working on live conductors. If this does not prevent the voltage hazard, Grounding or Bonding procedures may be required. See 11 for Grounding procedures, or Figure B-1: Procedure – Potential Measurements of Pipe for Bonding procedures.
 - (b) NO – No special procedures are required. The pipe shall not be grounded or bonded to a foreign structure without permission of the owner of the foreign structure. If the owner will not allow direct bonding or grounding, other provisions shall be made.

7.0 POTENTIAL MEASUREMENTS OF PIPE

7.1. Introduction

The pipeline to ground voltage of any string of pipe, exposed to contact by personnel, shall be measured periodically using a calibrated voltmeter of suitable range and high impedance (approved by Electrical Safety Inspector).

7.2. Equipment Required

- AC Voltmeter (Comparable to the Fluke 87 Series II Analog/Digital Multimeter)
- Pipe End Clamp

7.3. Guidelines

- (1) The pipe to ground voltage must be measured on all welded pipe strings each day or after returning to work from a weather shutdown.
- (2) Determine voltage between the pipe and a steel pin at least 10 in. in the ground and 3 ft from the string of pipe.
- (3) Record each voltage measurement on a data sheet.

7.4. Procedure (Figure B-1)

- (1) Connect a pipe end clamp to the uncoated edge of the pipe joint.
- (2) Install a ground rod at least 10 in. in the ground and at least 3 ft from the pipe.
- (3) In the event ground rods cannot be driven to this depth due to solid rock in the area, a large metal plate or mesh with bonding cables attached shall be used. The plate should be around 20 ft. x 6 ft. in size, and should be dragged onto the site and covered with soil to make a ground connection.

NOTE: This step may be omitted if a ground rod or adequate ground system, meeting this criteria, is already in place.

- (1) Connect voltmeter to both pipe clamp and ground cable.
- (2) Set meter for AC volts.
- (3) Read AC volts from meter.
- (4) Record value on a data sheet at pipe - ground voltage.
- (5) Remove meter connections.
- (6) Measure pipe string length. Record value on data sheet.
- (7) Pipe to ground voltage \geq 15 volts?
 - (a) YES – Grounding procedures required. See 11 for grounding procedures.
 - (b) NO – Grounding not required.
- (8) In the event that measured AC voltage above ground exceeds 30 volts, the electrical safety inspector shall issue appropriate warnings, and all work on the pipe string shall be suspended until potential is reduced to less than 15 volts with the driven ground rods.
- (9) Once the work on the pipe is complete and potential measurements are no longer required, remove the clamp.

8.0 GROUNDING OF PIPE TO CONSTRUCTION EQUIPMENT

8.1. Introduction

Each piece of equipment used to handle pipe in any way, such as for unloading, picking up, transporting, bending, or bonding, in the event current measurements show it is necessary, shall be equipped with a cable assembly capable of grounding the individual joints of pipe to the equipment handling that piece before the piece is moved. "Setting-in" booms shall be equipped with a ground cable, and the ground must be maintained at least until the stringer bead is completed. Rubber tired equipment should be grounded prior to grounding pipe to equipment.

8.2. Equipment Required

- Grounding Cable Assembly

8.3. Procedure

- (1) Connect grounding cable assembly from construction equipment to the pipe joint.
- (2) Install supporting straps or slings as required.
- (3) Move pipe with construction equipment to desired location.
- (4) When pipe is set in place, remove all supporting straps.
- (5) Remove grounding cable assembly from the pipe joint.

9.0 GROUNDING OF PIPE DURING STACKING AND STRINGING

9.1. Introduction

When handling pipe near, or parallel to, power lines, the following procedure as stated herein shall be followed.

9.2. Equipment Required

- Ground Rod(s)
- Grounding Cable Assembly

9.3. Procedure

- (1) Stack pipe joints per applicable stacking specs, or stack in a 10 (or less) joint stack.
- (2) Install a 1/2 in. (minimum size) ground rod at least 10 in. in the ground and at least 4 ft from the stack.
- (3) Install a grounding cable between the ground rod and the stack.
- (4) Using grounding cables, daisy-chain each pipe joint in the stack to assure the entire stack of pipe is grounded.
- (5) Maintain the ground connection until each individual joint is removed from the stack.
- (6) Stringing of pipe is permitted as long as each joint is connected to a ground.
- (7) A single ground rod can be used for multiple joints of pipe connected together up to 400 ft in total length.

10.0 OPERATION OF CONSTRUCTION EQUIPMENT

10.1. Introduction

Rubber tired vehicles operating on the right-of-way are also subjected to induced voltages from the proximity to power lines.

10.2. Equipment Required

- Grounding Chain
- Grounding Cable Assembly
- Ground Rod

10.3. Procedure

- (1) Upon entering and operating on an electric power transmission right-of-way or near electrical power lines, attach a chain to the vehicle's frame of suitable length to maintain contact with the ground.
- (2) Park vehicles no closer than 200 ft from the right-of-way unless the vehicle is grounded.
- (3) Each fuel truck shall be equipped with a cable assembly capable of completing an electrical bond between the truck and any piece of equipment to be fueled. Fuel trucks and equipment must be grounded with a ground rod prior to grounding between them. It is required that this bond be made each time, prior to completing any part of refueling operations. Care shall be taken where the cable attachments are made so that good electrical continuity is established.
- (4) Rubber tired vehicles shall not be refueled on the electric power right-of-way or near electrical power lines unless the vehicle is electrically bonded to the fueling facility/vehicle prior to commencement of the refueling operation, and the refueling vehicle is grounded to earth.
- (5) Rubber tired equipment parked for any appreciable time on a power line right-of-way may collect a considerable charge of static electricity. Efforts should be made to park such vehicles away from overhead lines. Vehicles should be parked no closer than 100 ft from the base of electric line towers. All tired vehicles, if parked on the right-of-way for over five hours, must be grounded with at least a 1/2 in. diameter ground rod that is driven or screwed to a depth of at least 4 ft. All vehicles that might be parked on the right-of-way for five hours or more at a time shall be equipped with a 1/2 in. copper ground rod and connecting cable assembly. Cable shall be at least No. 8 AWG and have insulated clips capable of completing an electrical bond between the ground rod and the automobile. Each time an automobile is parked on the power line right-of-way, the ground rod shall be pushed as far as possible into the ground, and an electrical connection made between the rod and the automobile. This bond shall remain as long as the car is parked on the power line right-of-way. Signs shall be posted for "authorized vehicles only." If rubber tired equipment is required to move about, then a short chain can be dragged behind the equipment for grounding in lieu of using a ground rod as stated above. The chain shall be heavy duty with at least 1 1/2 in. links. The Contractor is to provide the Company's vehicles with the equipment for grounding.
- (6) At all times during construction, care must be exercised to assure that booms and cables are no closer than 10 ft from overhead power lines. Minimum midspan height between power line towers can range anywhere between 20 and 25 ft. Usually this height is greater, but in some cases the power lines may sag this low, or even lower. Height should never be taken for granted, but should be investigated in each case. Check with the local power company for vehicle clearance. Consideration must also be given to the possibilities of broken cables whiplashing close to power lines. Each piece of equipment shall be positioned so that should this occur, the cable would not come closer than 25 ft from a power line.

- (7) Proper signage shall be utilized along all vehicle / equipment paths crossing within powerline easements or below powerlines.
- (8) Designated equipment spotters shall be utilized when equipment has the capability of encroaching within 10-ft of a powerline.

11.0 CONNECTING AND DISCONNECTING GROUNDING FACILITIES

11.1. Introduction

Pipeline grounding is accomplished using ground rods and clamps as shown below. To avoid personal injury or arc damage on the pipe, the following steps are required.

11.2. Guidelines

Ground pipe using single No. 2 AWG welding cable or equivalent.

11.3. Equipment Required

- Ground Rod
- Grounding Cable Assembly
- Pipe End Grounding Clamp

11.4. Procedure (Figure B-2)

- (1) A ground rod at least 10 in. in the ground and at least 3 ft from the pipe.
- (2) Connect pipe end grounding clamp to the pipe.

WARNING: There is a possibility that a voltage will occur on the pipe that may be a safety problem even while the operator is connecting the pipe end grounding clamp to the pipe. Due to this risk, the operator shall use insulating tools and gloves, and shall avoid standing on wet ground. Any other special precautions deemed necessary should also be followed.

- (3) Connect grounding cable to the grounding facility/rod.
- (4) Connect grounding cable to the pipe end grounding clamp.
- (5) Cables used for temporary grounding attachments shall have good mechanical strength as well as high conductivity. The cable shall be single conductor AWG No. 3, 1715-strand welding cable or equivalent. Cable attachments to temporary grounding systems shall be made using a method that assures good electrical contact with the pipe metal, and which applies firm pressure. The method of attachment should have a current carrying capacity of at least 200 amperes. Connections may also be made by the Thermite weld process, but under no circumstances should there ever be any arc welding of temporary clamps.
- (6) When grounding joints or strings of pipe, the ground rod shall be driven, and the connection between the rod and the ground cable made first. The connection between pipe and ground cable may then be made. Removal of all cables shall be in reverse order, that is, the cable should be disconnected from the pipe first. All grounding attachments or removals will be made by or under the direct supervision of the electrical safety inspector.
- (7) Each string of welded pipe that is between loose ends shall temporarily be grounded to a ground rod at least 1/2 in. in diameter, and which is driven to a depth of at least 4 ft. Any string of continuously welded pipe in excess of 2,000 ft shall be grounded at least twice, and strings of pipe should be limited to 3,000 ft long. These temporary grounds shall be maintained until the sections are tied into portions of line that have permanently been grounded with zinc wire or magnesium anodes and backfilled.

- (8) It is acceptable to use bare road casing for additional grounding during construction. This may be done by attaching a bond cable between any exposed metallic surface of the pipeline and the bare casing. Any bonds made for this purpose must be removed before the backfilling operation.
- (9) It is acceptable to use straight polarity welding for stringer bead should the electromagnetic field produced by the power lines cause magnetization of the pipe.
- (10) When the pipeline no longer requires grounding, the grounding system may be disconnected.
- (11) Disconnect the grounding cable from the pipe end grounding clamp.
- (12) Disconnect the pipe end grounding clamp to the pipe joint.
- (13) Disconnect the grounding cable from the ground rod.
- (14) Remove the ground rod.
- (15) To avoid injury, follow the connecting and disconnecting procedures in the order shown.

12.0 BONDING OF PIPING AND TIE-INS AND CUT-OUTS

12.1. Introduction

- (1) Coordination is essential when conducting tie-ins and bonding across these pipes.
- (2) Bonding of a tie-in can transmit a voltage hazard remote from this tie-in.

12.2. Guidelines

- (1) Bond all piping at tie-ins and cut-outs regardless of pipe-ground voltage, prior to piping work (tie-in, cut-out).
- (2) Bond piping with single No. 2 AWG welding cable or equivalent.

12.3. Equipment Required

- Grounding Cable Assembly
- Grounding Clamps

12.4. Procedure (Figure B-3)

- (1) Connect pipe grounding clamps to each side of the tie-in. Removal of coating may be necessary to get metal to metal contact.
- (2) Connect the grounding cable between the pipe grounding clamps.
- (3) When bond is installed, a pipe-ground voltage measurement should be taken and recorded. (See figure B-5 below). If the pipe-ground potential exceeds 15 volts, the Electrical Safety Inspector shall mandate special precautions.
- (4) Coordinate and schedule all tie-in bonding with the Electrical Safety Inspector and the Contractor.
- (5) Begin piping work (tie-in or cut-out).
- (6) Maintain all temporary grounds until section is tied-in to the line and permanent grounding is installed.
- (7) Final Coating of all tie-in welds and Thermite weld points must be performed using insulated gloves and boots, and under the supervision of the Electrical Safety Inspector.

13.0 TEMPORARY GRADIENT CONTROL MATS

13.1. Introduction

Temporary Gradient Control Mats are required during construction for personnel safety when working on exposed portions of the pipeline. The mats are also used after construction on aboveground portions of

the pipe, in areas where a permanent gradient control mat is not present and there is a possibility of touch and step voltages greater than 15 volts.

13.2. Guidelines

- (1) All attachments for temporary grounding systems shall be made by a method that assures good electrical contact and applies firm pressure. Cable for temporary pipeline grounding shall have good mechanical strength as well as high conductivity.
- (2) The grounding cable shall be single conductor No.6 AWG welding cable or equivalent.
- (3) The method of attachment must have a current carrying capacity of at least 200A.
- (4) Connections may also be made by Thermite weld process, but absolutely no arc welding of temporary clamps will be permitted.
- (5) Construct temporary mats of 50mm chain linked galvanized steel fencing.

13.3. Equipment Required

- Gradient Control Mat (chain linked galvanized steel fencing).
- Grounding Cables.

13.4. Procedure (Figure B-4)

- (1) Stretch fencing in the "Y" direction.
- (2) Tighten tension bars.
- (3) Extend ground mat a minimum of 3 ft outside work area in all directions.
- (4) Connect grounding mat to the pipeline at two separate connections with grounding cables.

14.0 GRADIENT CONTROL MATS

14.1. Introduction

A part of the permanent pipeline mitigation system is the gradient control mats at above ground structures. These mats should be constructed and installed following pipeline installation, but prior to making a tie-in.

14.2. Guidelines (Figure B-5)

- (1) A gradient control mat consisting of zinc ribbon (or an approved six gauge zinc coated steel mesh) covered with a washed crushed stone shall be installed at valve sites or appurtenances, where required.
- (2) Permanent zinc ribbon grounding facilities shall be installed by grounding personnel in accordance with the specifications of the pipeline project.
- (3) These facilities shall be installed at each grounding location following pipeline installation.
- (4) Grounding cable between zinc ribbon and the pipe shall be No.6 AWG.
- (5) Crushed stone shall extend a minimum of one foot beyond zinc ribbon and at least 3 ft beyond the fencing.

Appendix A Potential Measurements of Metallic Foreign Structures Voltage Measurement Data Sheet



STD.8710-Appendix
A.xls

Appendix B Figures

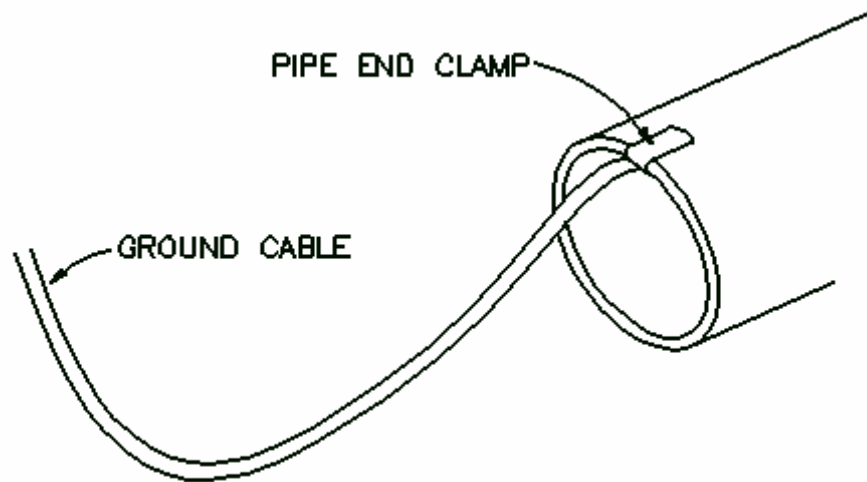


Figure B-1: Procedure – Potential Measurements of Pipe

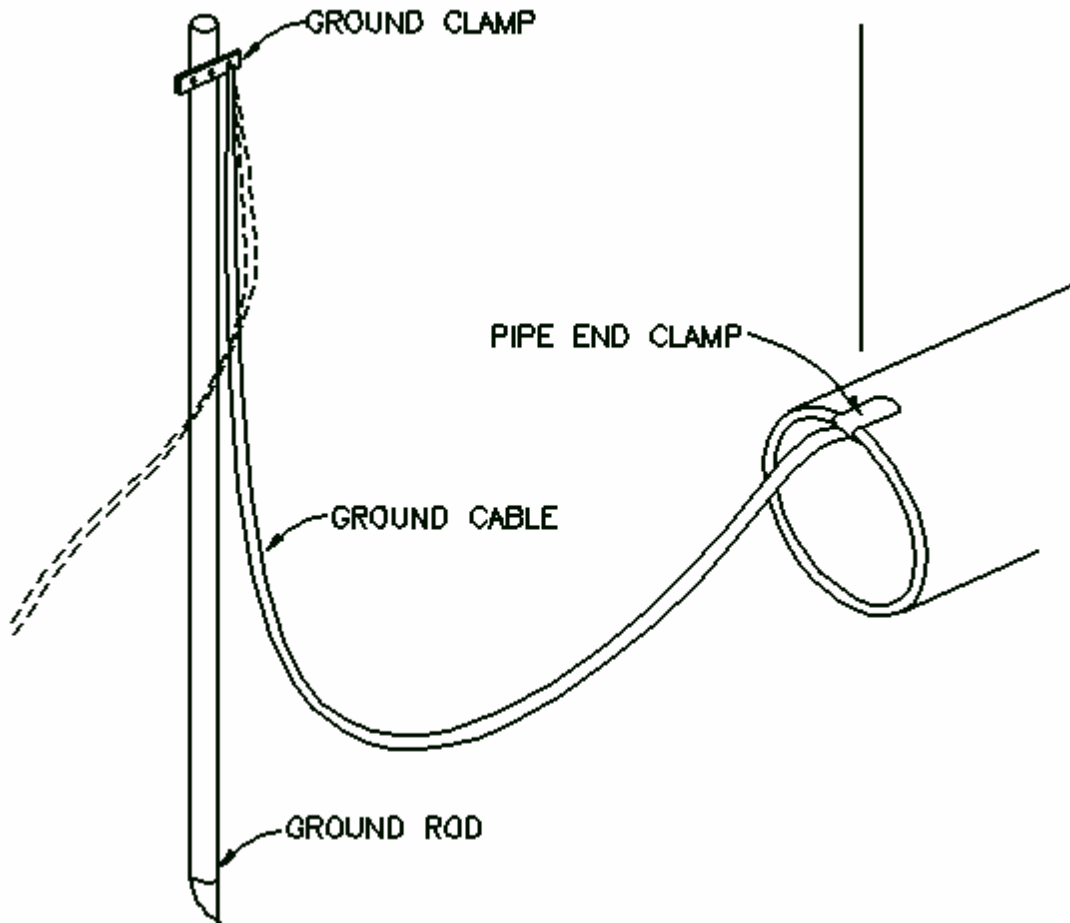


Figure B-2: Procedure – Bonding and Piping at Tie-Ins and Cutouts

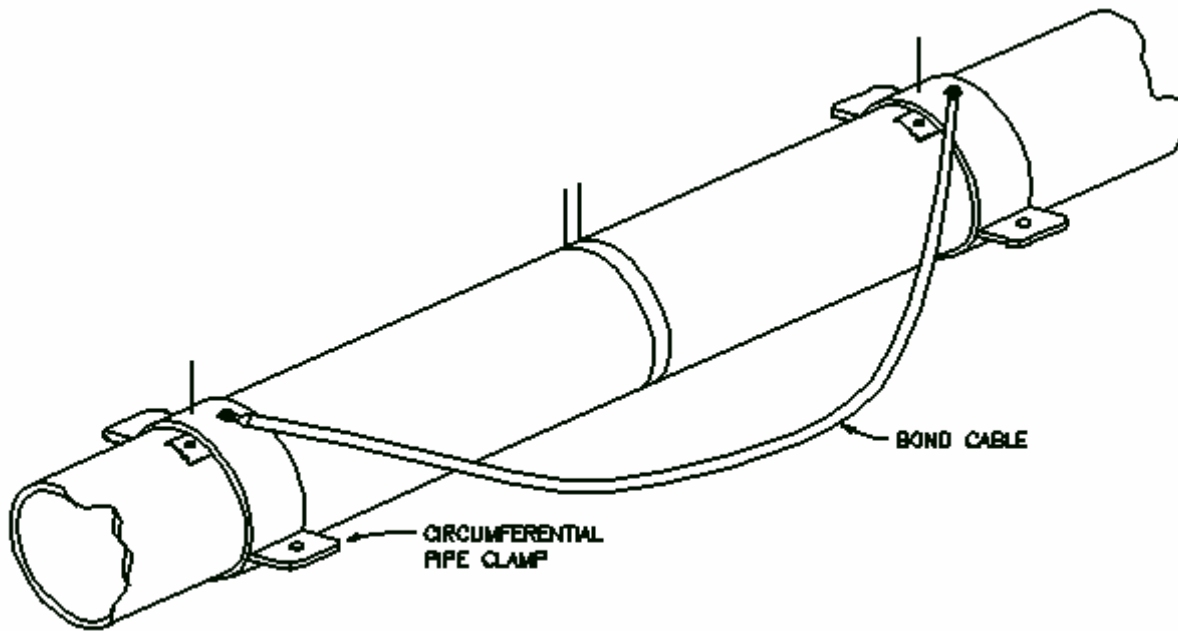


Figure B-3: Procedure – Bonding and Piping at Tie-Ins and Cutouts

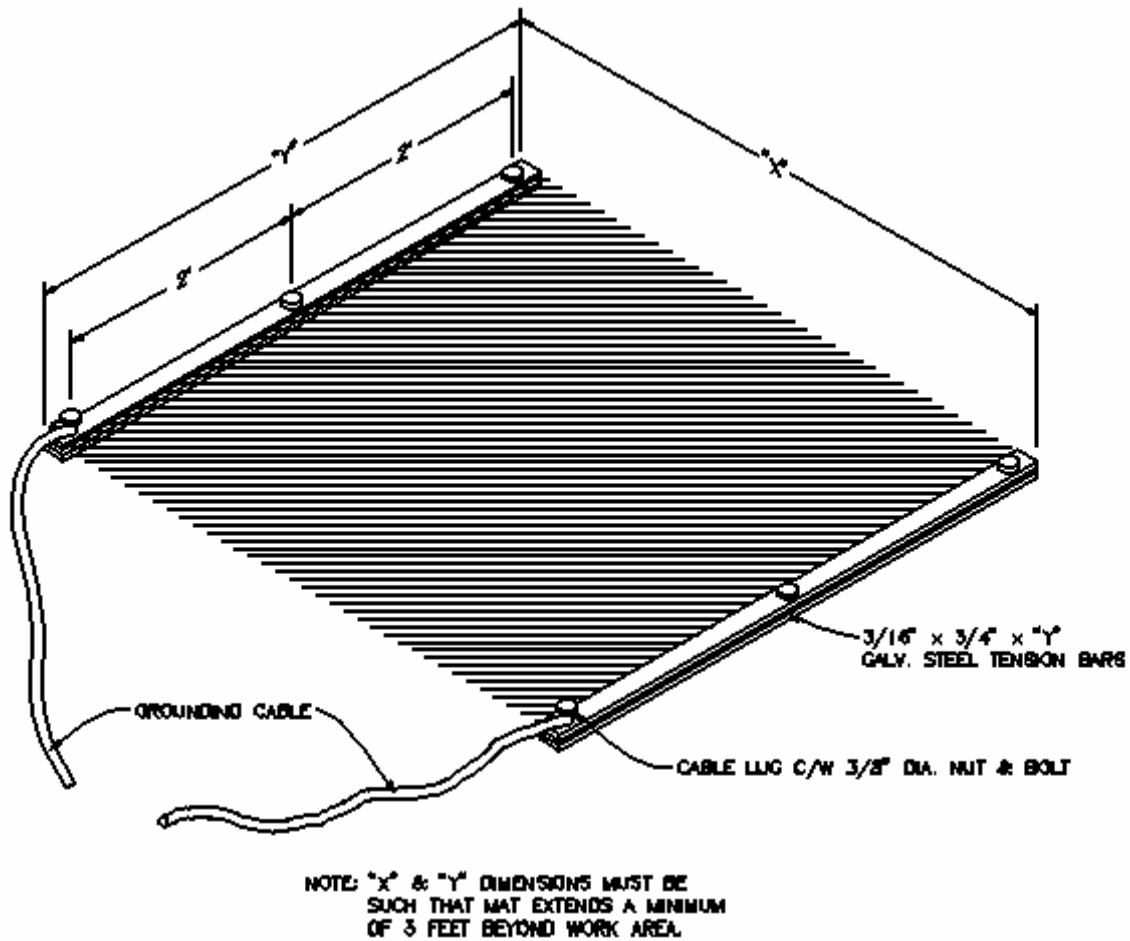


Figure B-4: Procedure – Temporary Gradient Control Mats

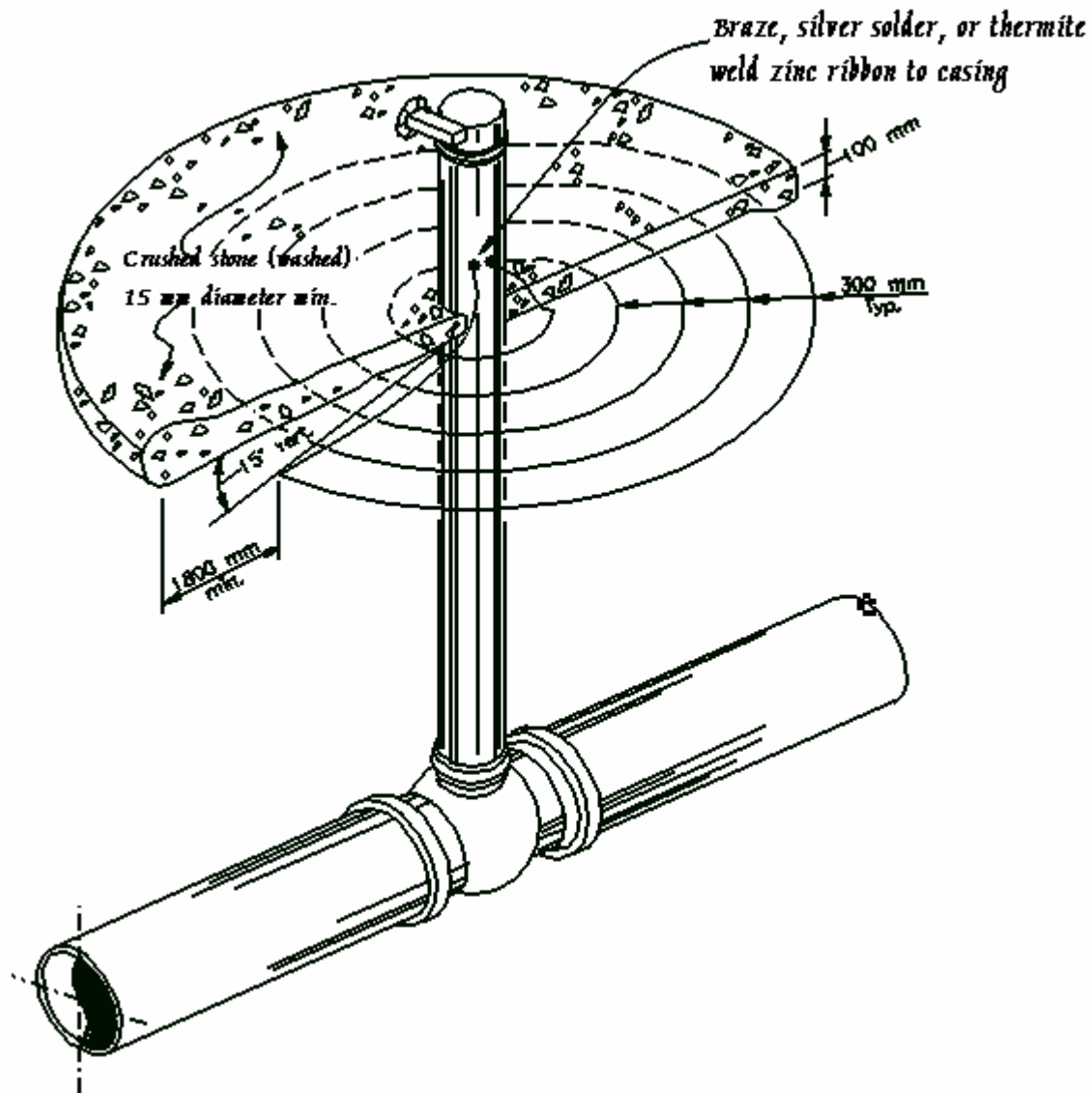


Figure B-5: Procedure – Temporary Gradient Control Mat at Valve

Attachment Revision Log/Record

Revision 0.0		Publish Date: 14 Jul 11
Location of Change	Type of Change	Reason for Change
N/A	N/A	
Revision 1.0		Publish Date: 31 Jan 17
Location of Change	Type of Change	Reason for Change
Section 2.1(1)	Addition	Added "when specifically required to work near powerlines as defined in the scope of work." after "safety on the pipeline"
Section 2.1(3)	Revision	Updated references to OSHA standard
Section 2.1(4)	Revision	Section converted to (3) (a) which renumbered the remaining section
Section 4.0	Revision	Transferred section 4.0 "Work Stoppages" from this standard into "Grounding Personnel", and renumbered the remaining sections in this standard.
Section 5.3	Revision	Reworded for clarity
Section 7.3(1)	Addition	Added "or after returning to work from a weather shutdown." After "each day" to the end of the first sentence.
Section 10.3(1)(4)	Addition	Added "or near electrical power lines" after "right-of-way"
Section 10.3(7)(8)	Addition	Added subsections "(7) Proper signage..." and "(8) Designated equipment spotters..."
Section 12.4(1)	Addition	Added sentence "Removal of coating may be necessary to get metal to metal contact."