Some Safety Considerations for Pipelines Near Overhead Power Lines

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Leaders in Corrosion Control Technology℠







Introduction

This presentation is to accompany the latest revision of NACE SP0177 (formerly RP0177), “Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems,” to illustrate the possible hazards of alternating currents and lightning.







Notice

- This presentation is for information only
- Its purpose is to assist in demonstrating some electrical hazards while working on pipelines that are near overhead electrical transmission power lines
- This presentation does not attempt to cover all possible hazards and situations
- Some safety guidelines are presented, but they should not be considered as complete safety procedures
- Its is strongly recommended that individual companies develop and implement safe work procedures and practices, and ensure employees recognize the potential electrical shock hazards.







Background

- Shared rights-of-way with high-voltage electrical transmission power lines are common
- Resulting alternating current (AC) influence on metallic structures can be hazardous
- There are significant safety concerns



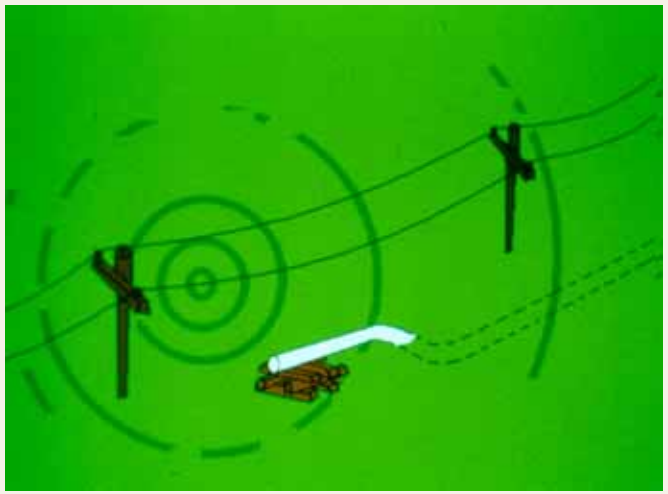






The Source of Alternating Currents

- Energized electrical conductors generate electrostatic and electromagnetic fields
- Metal objects within this field can become electrically energized
- Towers, fences, heavy equipment, trailers, pipelines, etc., are subject to this influence



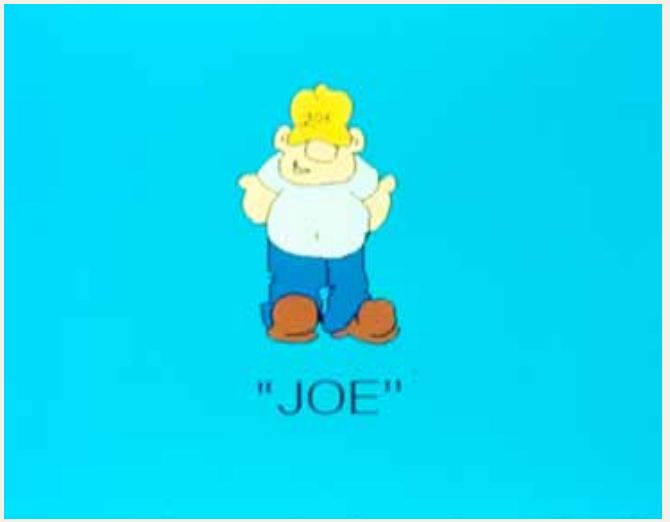






Our Main Character: Joe

- Joe will make mistakes that an experienced pipeliner should never make
- Joe can help personnel remember that special considerations are needed while they work on or near a right-of-way with an electrical transmission line



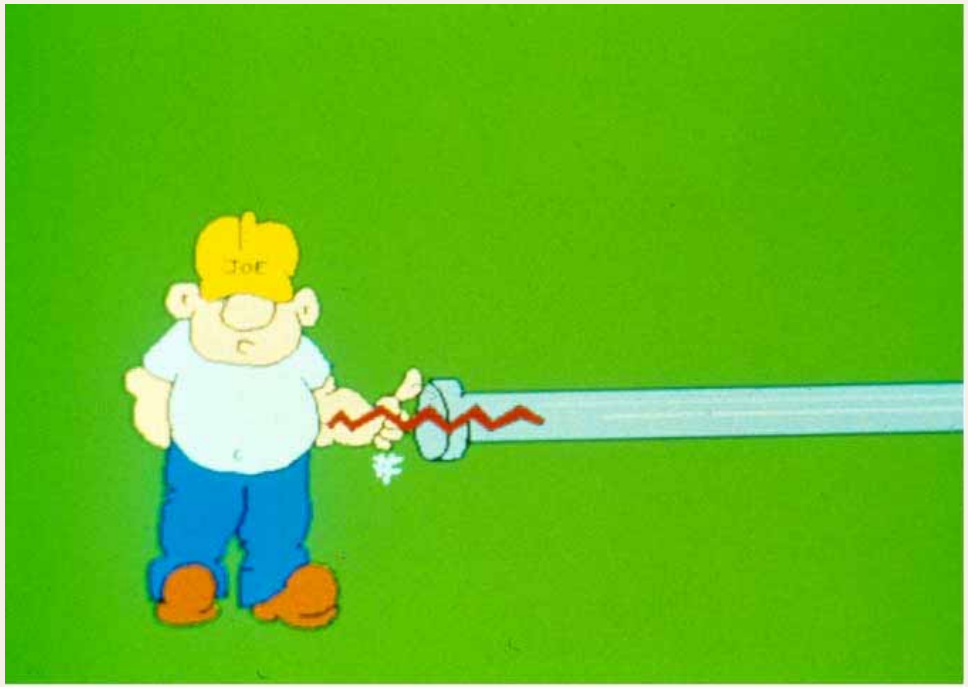






Electrical Current Hazards & Physical Reactions

- When this pipe is under the influence of an electromagnetic field, and Joe touches it, a current can pass through his body to earth.



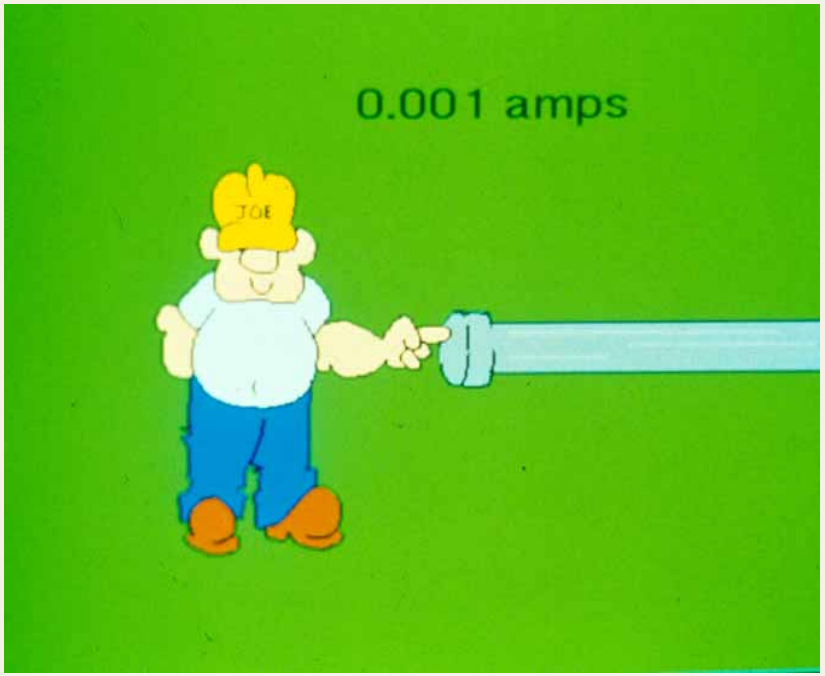






Electrical Current Hazards & Physical Reactions

- At 0.001 amps (1 milliamp) Joe feels no shock and is unaware that the pipe is energized.



- Ampere: a measure of electrical current

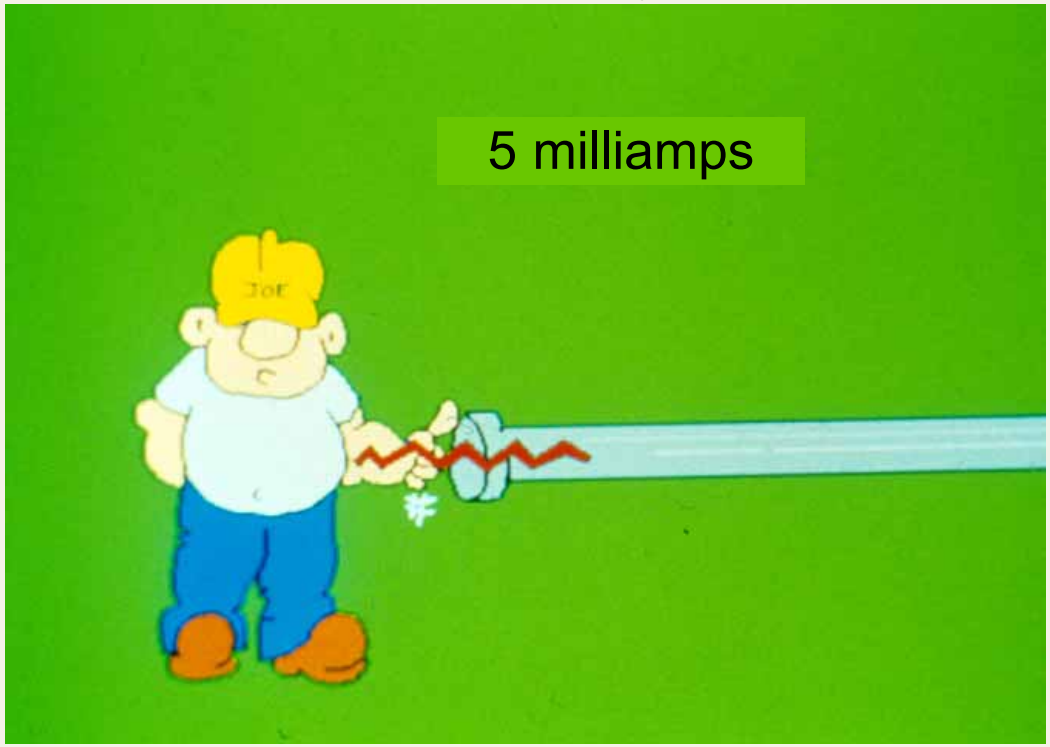






Electrical Current Hazards & Physical Reactions

- At 5 milliamps Joe knows the pipeline is energized. He can feel the shock, but can remove his hand from the pipe without any effort.
  - 5 milliamps (RMS under steady state conditions) is the electrostatic induction limit allowed by NESC Rule 232C 1c.



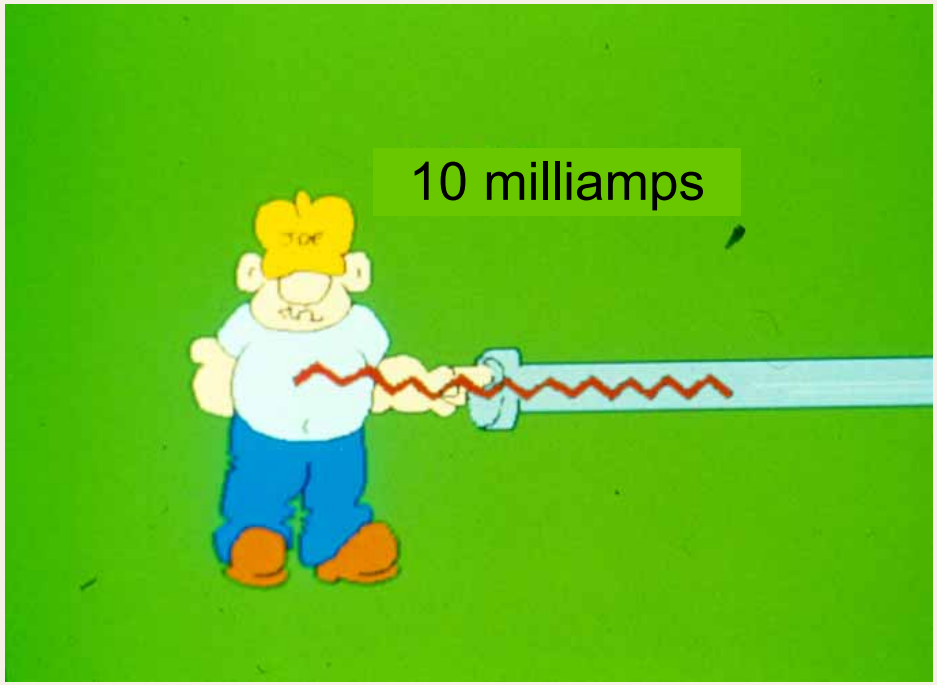






Electrical Current Hazards & Physical Reactions

- At 10 milliamps Joe gets a painful shock, but he can still remove his hand from the pipe in most cases.
- He knows better than to try that again.



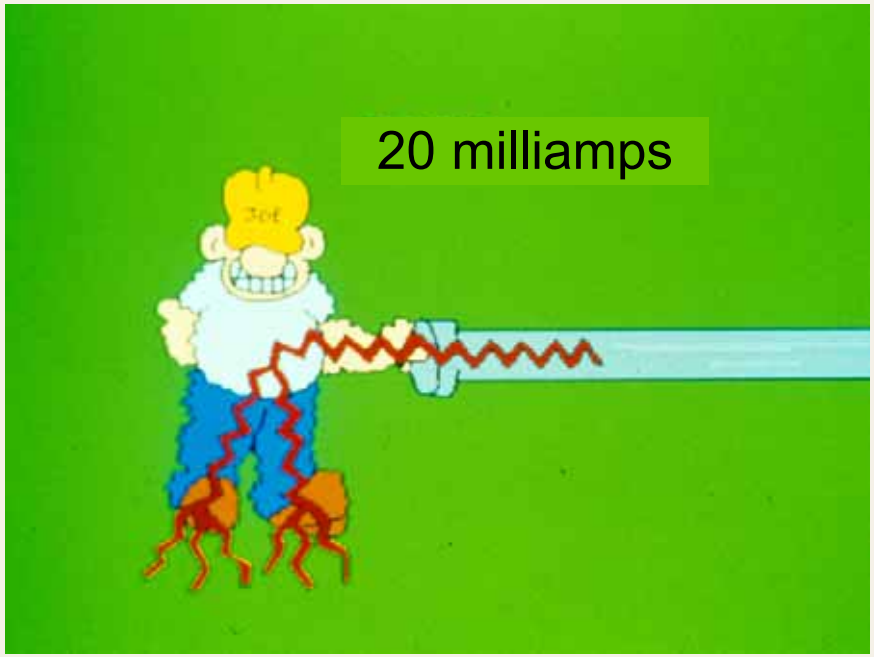






Electrical Current Hazards & Physical Reactions

- At 20 milliamps Joe is in trouble. The shock is painful and muscular control is lost.
- He cannot remove his hand from the pipe.



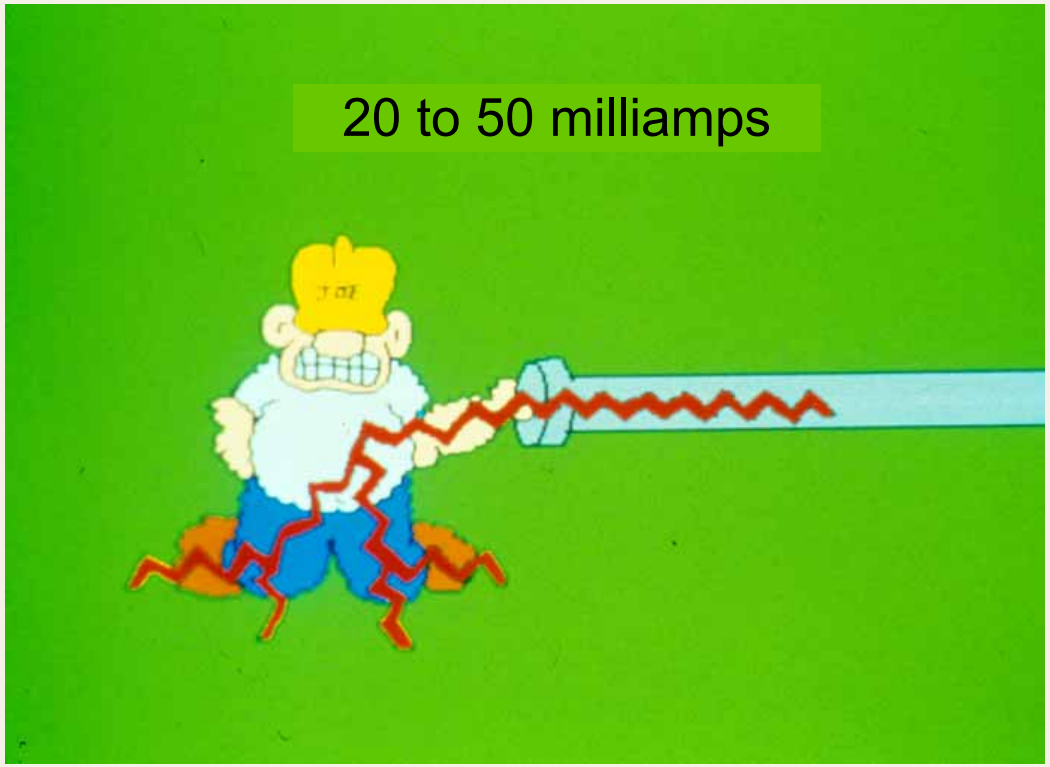






Electrical Current Hazards & Physical Reactions

- At 20 to 50 milliamps Joe is in further trouble.
- Trouble breathing, muscle control, knees buckling



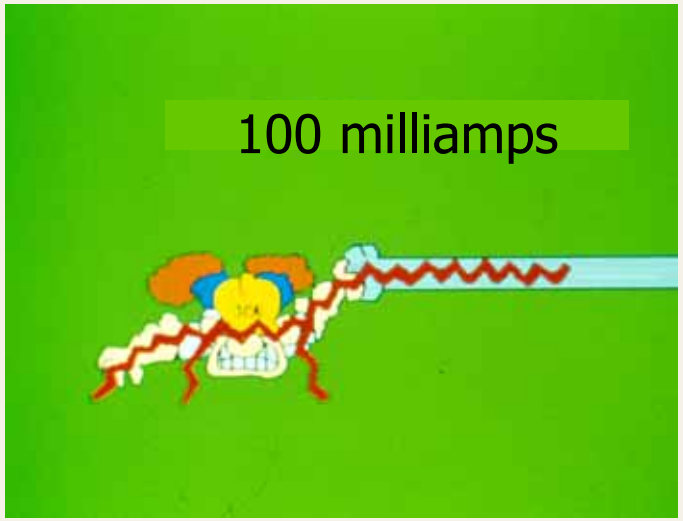






Electrical Current Hazards & Physical Reactions

- At 100 milliamps Joe is down. His heart will probably go into ventricular fibrillation.
- Joe cannot help himself.
- Help is needed to restore heartbeat and breathing.
- At higher currents he may suffer burns and severe muscular contractions. His heart may restart, but his breathing probably won't.
- JOE NEEDS HELP!



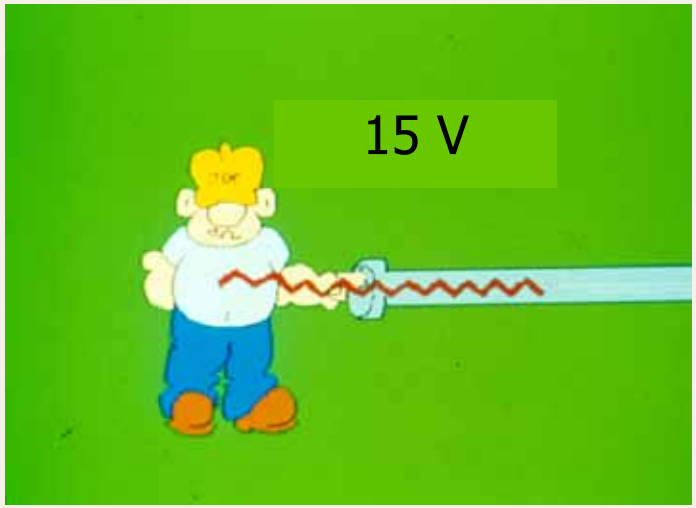






Electrical "Touch" Voltage Hazards – A Means to Evaluate Safety

- A touch voltage of 15 V on a pipeline is considered a shock hazard.
  - Volt: A measurement of electrical potential difference
- Voltage Examples:
  - Dry Cell: 1.5 V_{dc}
  - Car Battery: 12 V_{dc}
  - House Wiring 115-230 V_{ac}



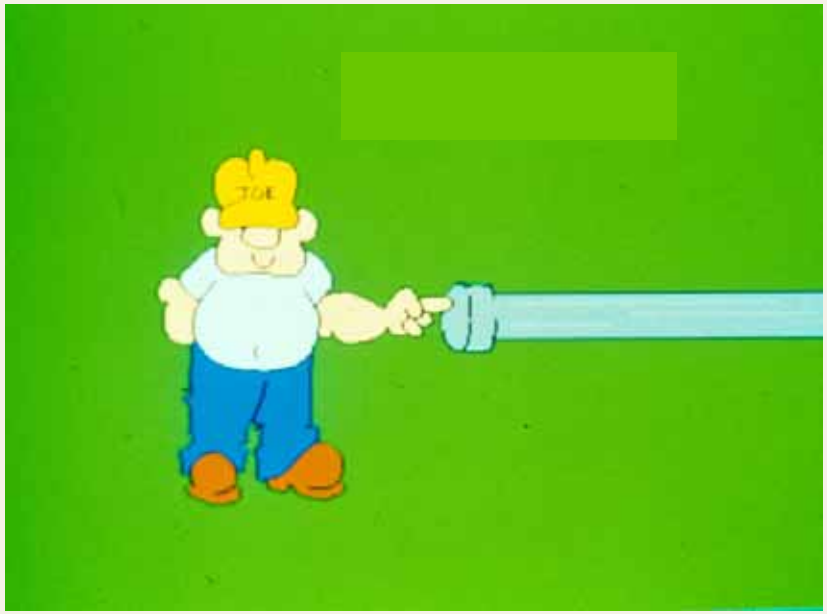






Dry versus Wet Conditions

- Dry soils, dry shoes, and dry gloves can alter tolerable touch voltage levels.
- Voltage that might go undetected under dry conditions may give a nasty shock on a wet day.









Dangerous Exposure to Currents and Ways to Avoid Exposure

- Joe touches pipe that is strung out on skids under some power lines, and gets zapped!
- Joe needs to notify a safety supervisor about the condition.
- If the pipe is long enough the zap can be serious.
- A properly grounded pipe will keep Joe from getting zapped.



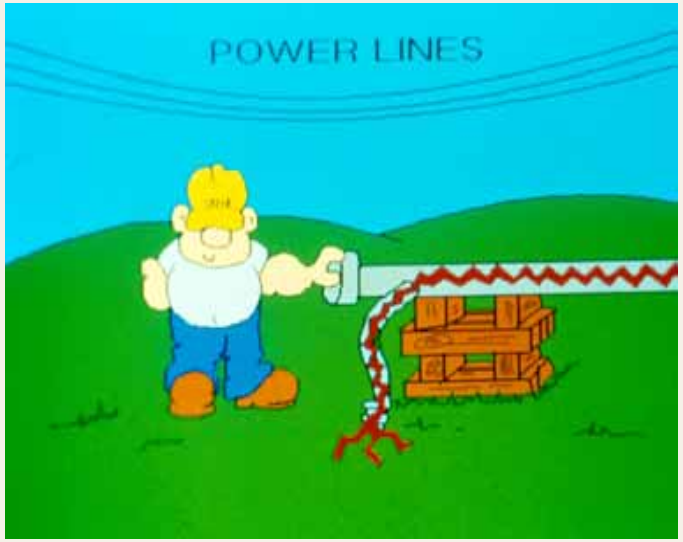






Dangerous Exposure to Currents and Ways to Avoid Exposure

- The picture shows a temporary driven ground rod. Multiple rods may be required to make the pipe safe.
- A properly installed temporary or permanent ground mat might do the same job if Joe were standing on it
- While above grade during construction, the pipe should be grounded at least every 1,000 feet with adequately sized cables.



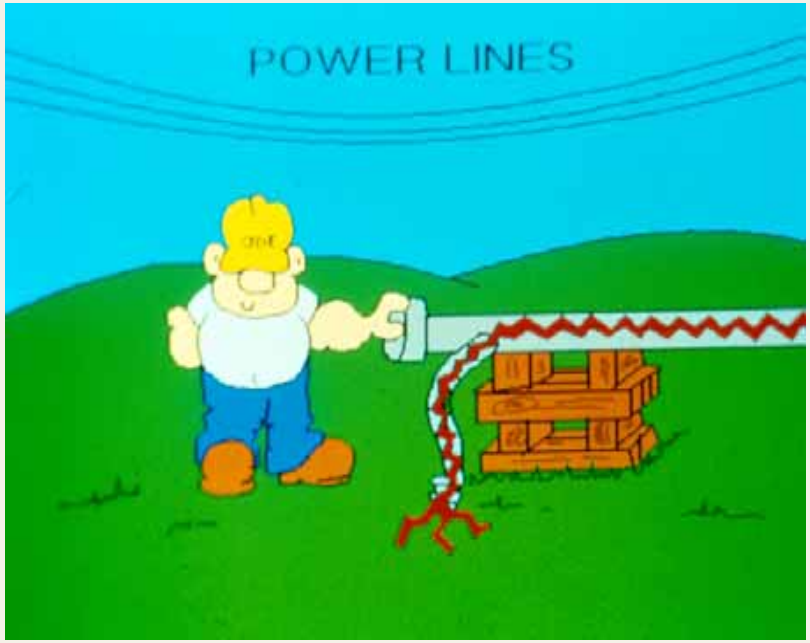






Dangerous Exposure to Currents and Ways to Avoid Exposure

- Even with grounds, the conditions may be unsafe.
- Qualified personnel should inspect the grounding system and measure the pipe voltage to ground to verify that conditions are safe to work.



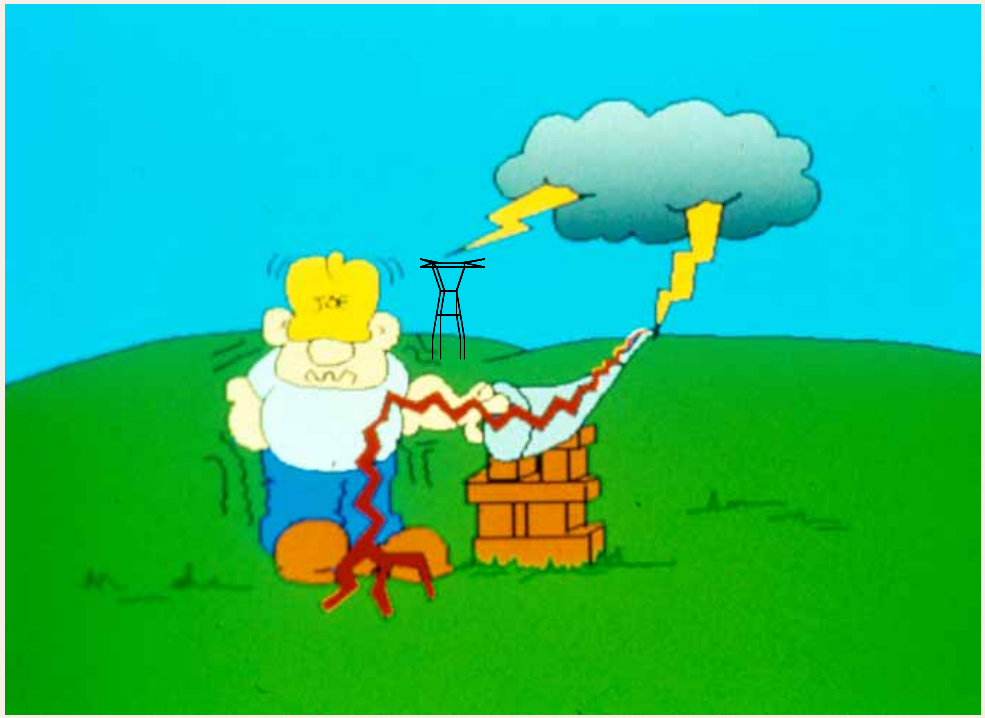






Lightning Hazards and Safety Measures

- Even if lightning strikes far away, Joe can still be zapped.









Lightning Hazards and Safety Measures

- Even with grounding close to Joe's position, he can still be zapped by lightning.



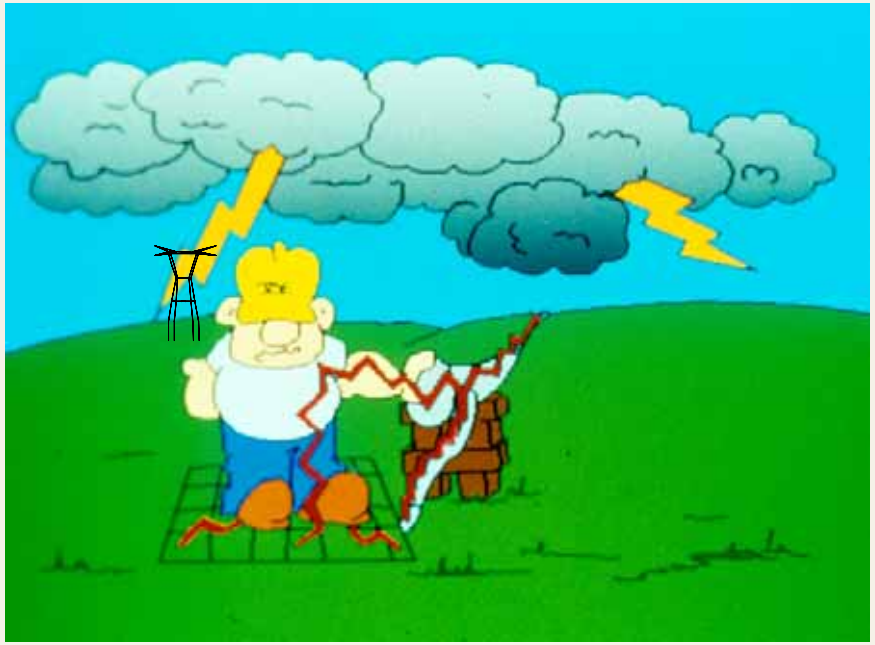






Lightning Hazards and Safety Measures

- Ground rods or mats may not be enough to keep Joe from experiencing a shock.
- WORK SHOULD BE STOPPED WHEN LIGHTNING ACTIVITY IS PRESENT!









More Examples of Electrical Hazards and Personal Protection Measures

- Joe can accidentally contact the pipeline, even after it's in the trench.
- Here, he finds that cathodic protection tests leads can give him a shock. The same applies for other aboveground appurtenances such as valves, casing vents, fences, etc.









More Examples of Electrical Hazards and Personal Protection Measures

- To avoid a shock, Joe should have followed correct procedures before touching the pipe or appurtenance.
- If Joe identifies a shock hazard at the test station or another aboveground appurtenance, he must stop and notify the safety supervisor.



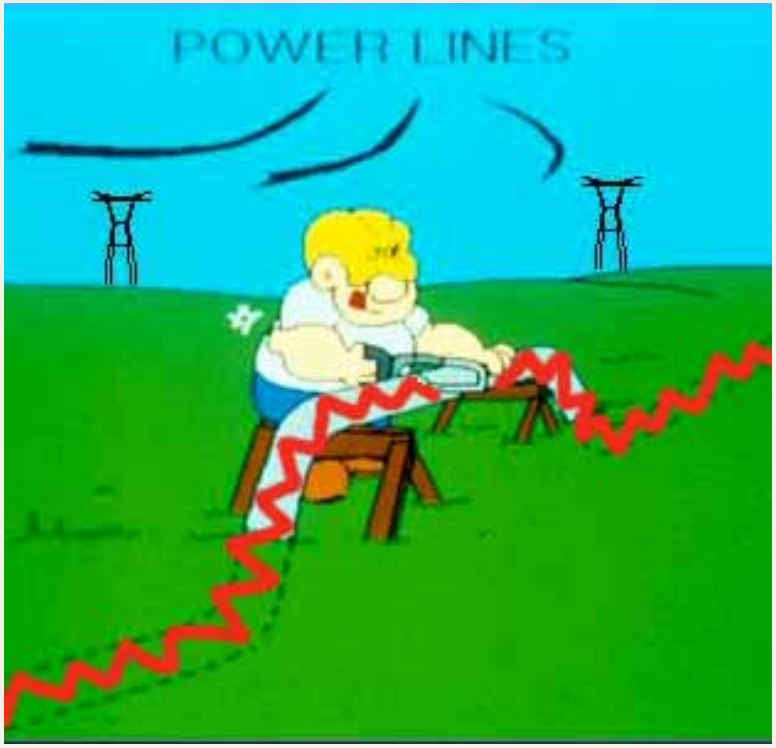






Electrical Hazards Exist Even If You Can't Feel Them

- Joe is starting to cut the pipe. He doesn't feel the current, so he believes he is safe.
- He does not realize that as soon as he separates the pipe the current may run through his body. He may be shocked and seriously injured.
- If he gets zapped now he may bite his tongue!



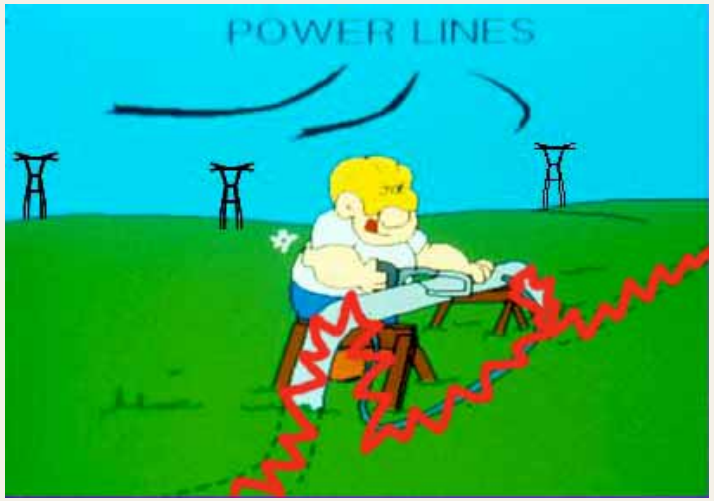






Electrical Hazards Exist Even If You Can't Feel Them

- Adequate bonding across the point to be cut will eliminate the hazard.
- Bond across the site BEFORE beginning the cut.
- A gradient control mat may also be required at this site.
- See CAN/CSA – C22.3 No. 6-M91 Typical Temporary Gradient Control Mat



- Note: Joe checked that the pipe was safe before connecting the bond and touching the pipe.

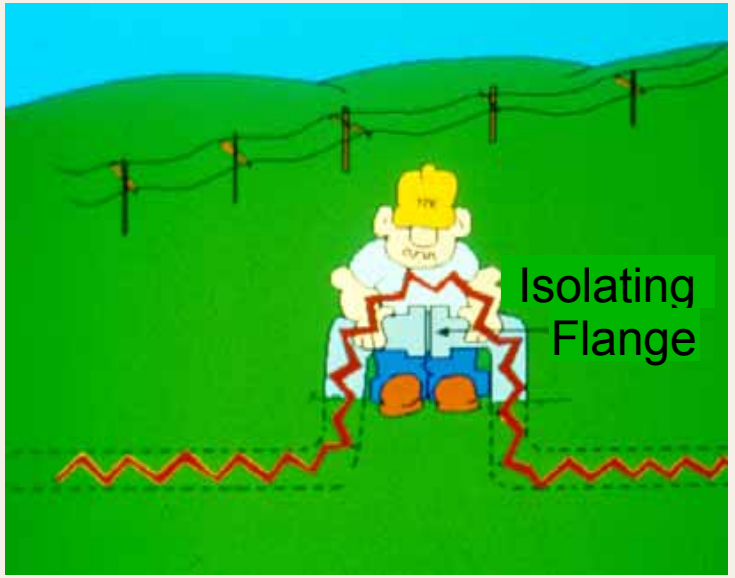






More Examples of Electrical Hazards and Personal Protection Measures

- Occasionally, Joe works on aboveground pipes that are not electrically continuous, such as isolated flanges, joints, unions, or couplings.
- Putting his hands across the isolator could make Joe's body a path for any current present on the pipeline



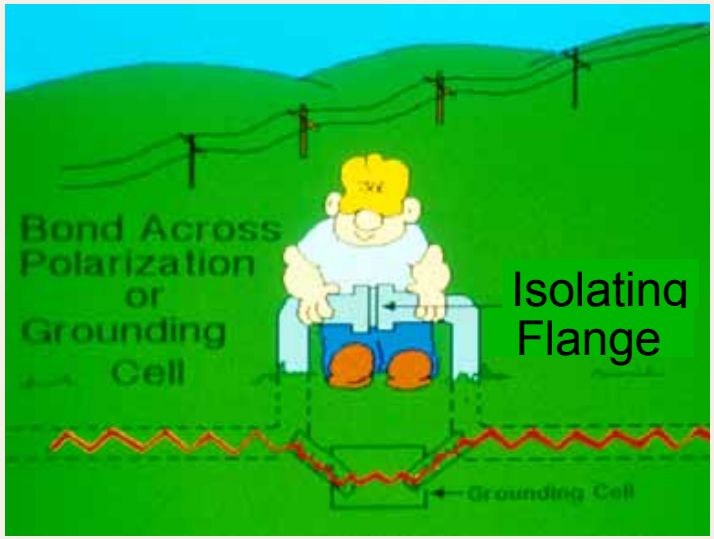






More Examples of Electrical Hazards and Personal Protection Measures

- The isolating flange, joint, union, or coupling and Joe can be protected by a properly sized installed polarization or grounding cell.
- A temporary bond across the isolator can also protect Joe while he works on the pipe.



- Note: Joe checked that the pipe was safe before connecting the bond and touching the pipe.







More Examples of Electrical Hazards and Personal Protection Measures

- Here again Joe is offering his body as a path for the electric current.
- He has the same situation as the flange without the bond and the hacksaw cut where he bit his tongue.



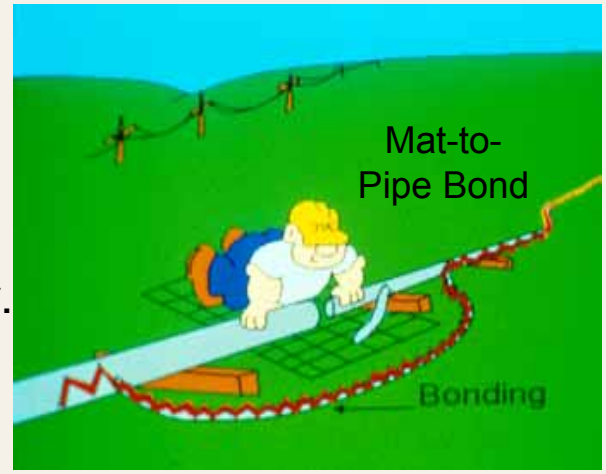






More Examples of Electrical Hazards and Personal Protection Measures

- While Joe may not know it, there is a current on the pipeline.
- He is protected by the ground mat and the cable bonding the pieces together. (See CAN/CSA-C22.3 No. 6-M91, Typical Pipe-Grounding Clamp)
- Joe is working on a mat bonded to the pipe. He knows he is safe. He has personally checked the bonds and the clamps. The conditions have been verified to be safe by qualified safety personnel.



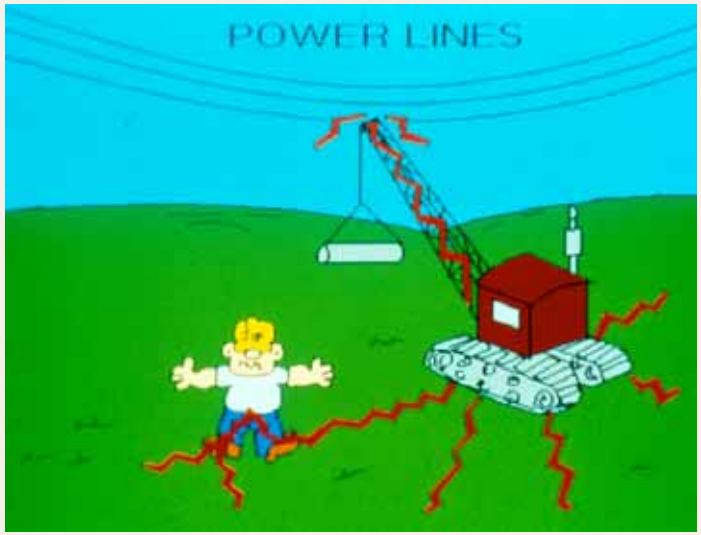






Electrical Hazards Exist Even If You Don't Touch Them

- A crane gets too close to a power line.
- Joe gets zapped by current that travels from one foot, through his body, and out the other foot.
- **Step Voltage**: A hazard when large amounts of fault current are flowing in the earth.



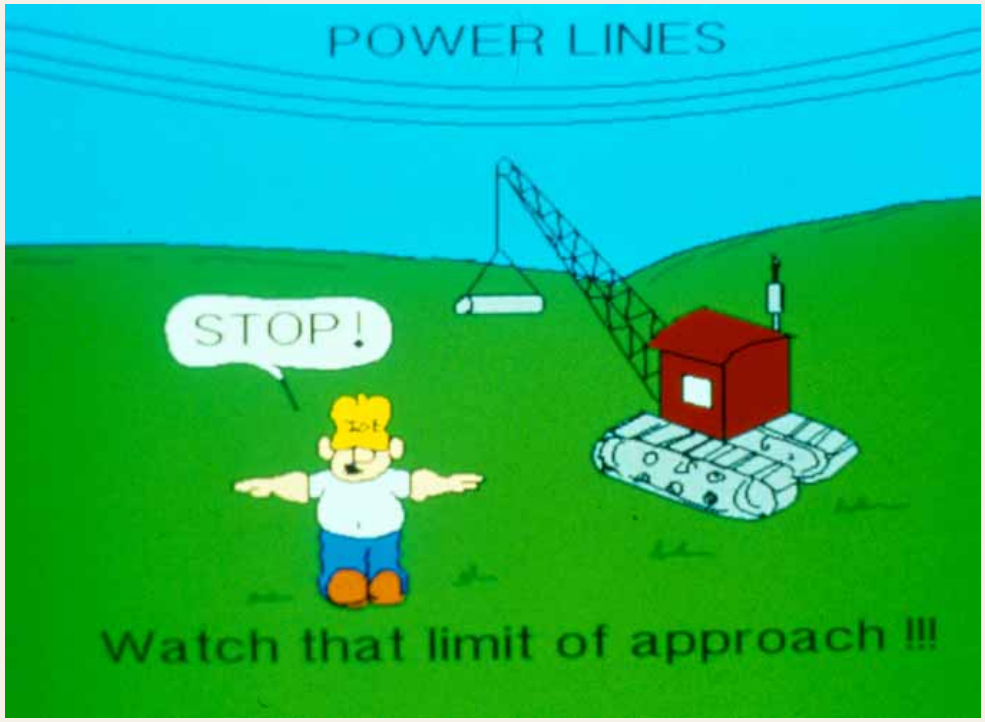






Overhead Electrical Wires Are Dangerous!!!

- Strict adherence to safety regulations is the only way to operate.
- **WATCH THAT LIMIT OF APPROACH!!**



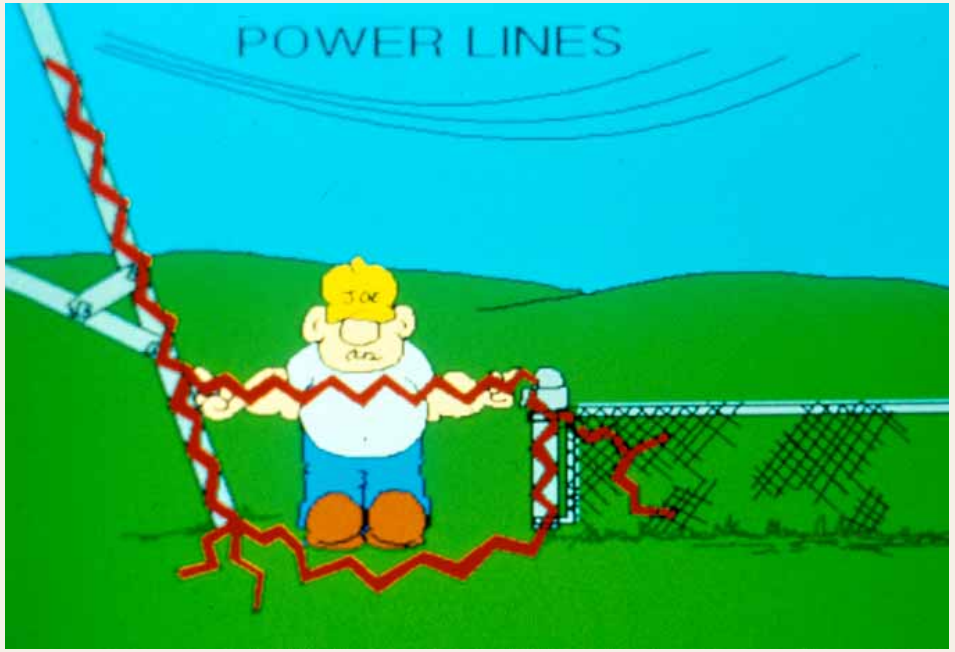






More Examples of Electrical Hazards and Personal Protection Measures

- Joe is between the leg of an electric transmission tower and a metallic fence.
- **CAUTION:** Just being near a tower can be hazardous during a fault.



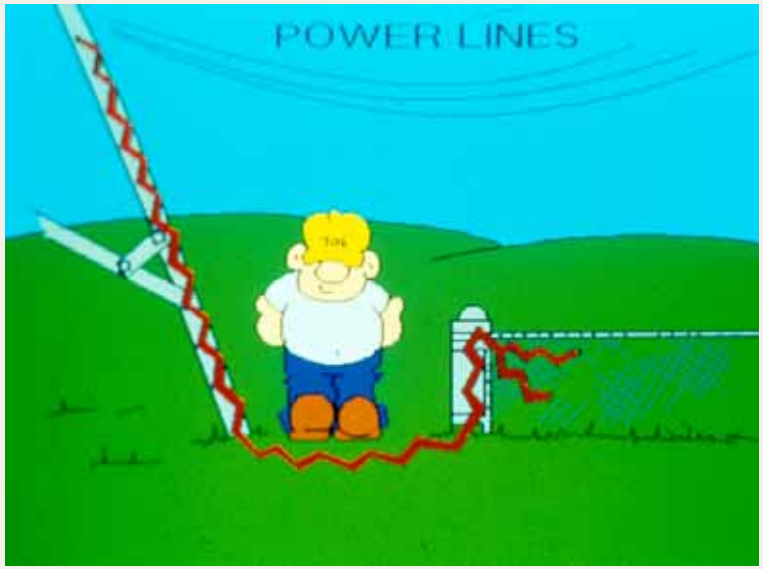






More Examples of Electrical Hazards and Personal Protection Measures

- Using what he has learned today, Joe, his tongue safely tucked into his cheek, and with both hands in his pockets, walks between the tower and fence.



- Note: In a lightning storm, conditions may be unsafe even without touching the structures. Joe should not be near the tower during a storm.

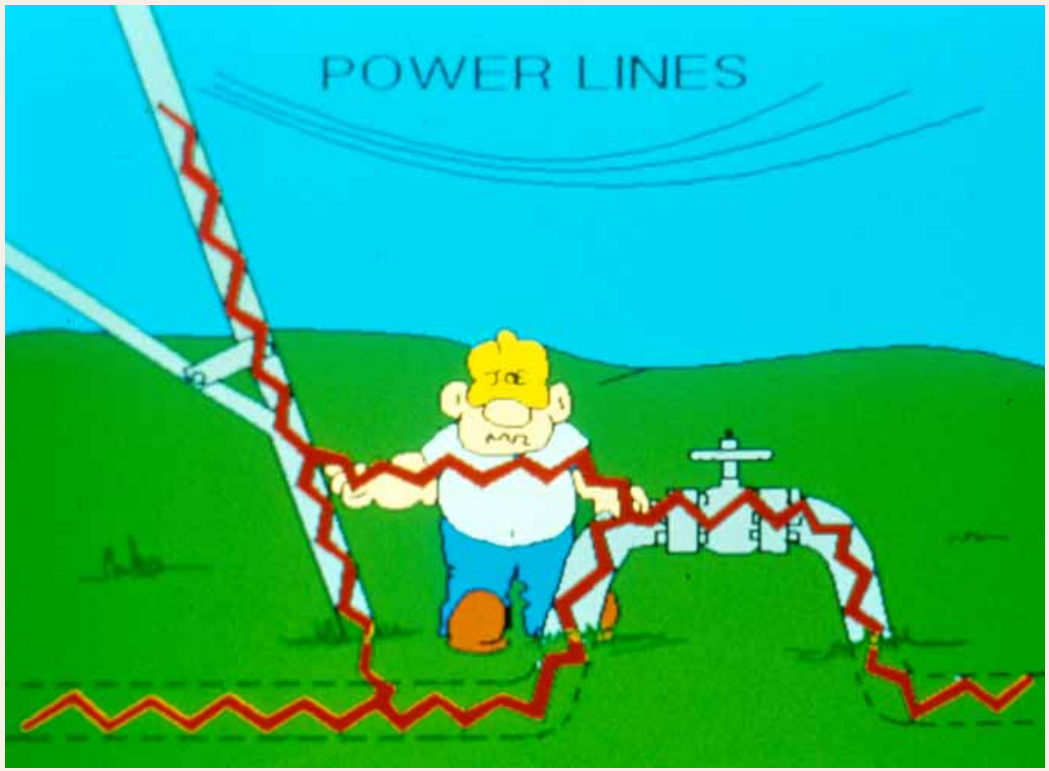






More Examples of Electrical Hazards and Personal Protection Measures

- As Joe contacts the tower leg and the pipeline, he gets zapped by the current.



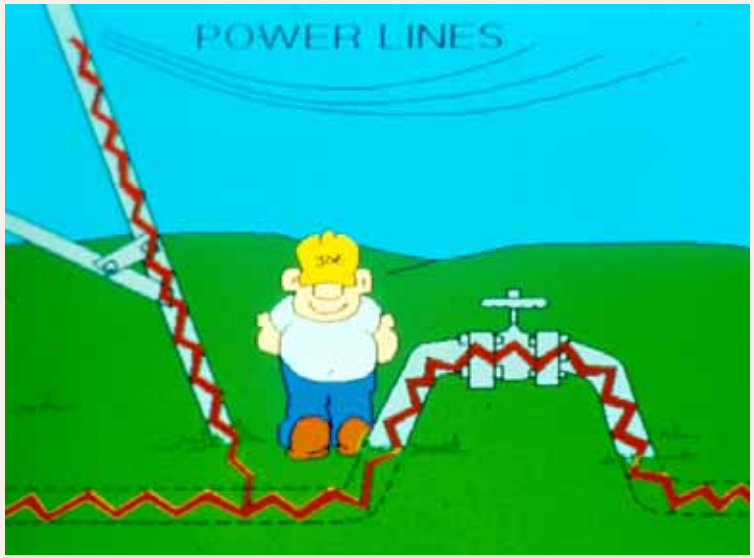






More Examples of Electrical Hazards and Personal Protection Measures

- Joe should keep his hands in his pockets and make sure he does not physically contact these two structures while passing through the space between them.









More Examples of Electrical Hazards and Personal Protection Measures

- The long fence parallels the power line for some distance, and then comes close to an aboveground section of Joe's pipeline.
- Joe may not know of the possible hazard before he contacts both the fence and the pipeline.



- Note: Here, even a small metallic structure in contact with the earth can give Joe a shock if he touches both at the same time.

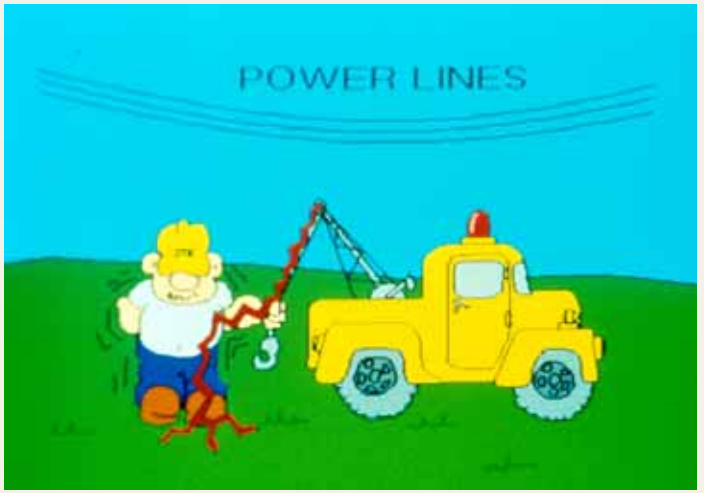






More Examples of Electrical Hazards and Personal Protection Measures

- Joe gets a surprise when he grabs a wire cable from the crane truck.
- Once again, Joe is offering his body as a path for the current to flow to the earth.
- The rubber tires block the current flow from the truck to the ground.









More Examples of Electrical Hazards and Personal Protection Measures

- Drag chains connected to the truck help pass current from the truck to the ground, and Joe is unaware of current flow









Personal Protection and Thought Helps You Avoid Injury

- Joe has had a hard day having survived numerous shocks and falls that have not contributed to his normally good humor.
- Joe's trial in the "School of Hard Shocks" should remind you of a few basic principles and procedures that make work safe.









Summary

- When pipelines are installed in joint corridors with electrical transmission power systems, hazardous conditions may exist during and after construction.
- Follow established safety procedures, both during and after construction.
- All personnel must be aware of and recognize the potential shock hazards and be trained in the approved safety procedures.







Summary

- During construction, aboveground sections can be made safe with a simple temporary grounding and bonding.
- Measurements should be recorded prior to performing any work to ensure everyone's safety.
- Communications and measurements are required along the spread during construction because conditions may change as the installation progresses.







Summary

- Warning signs should be posted and RED ZONES clearly designated, including at electrical power system crossings.
- Both NACE SP0177 and CAN/CSA-C22.3 No.6-M91 recognize 15 V as a potential shock hazard.
- Check the weather forecast prior to beginning work. Work should be stopped when lightning activity is present.







When Working Near Overhead Power Lines

- WORK SAFE!
- ALWAYS TREAT THE PIPELINE AND APPURTENANCES AS A LIVE CONDUCTOR.







Help Is Available

- NACE SP0177 (formerly RP0177), “Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems”

- Contact NACE International
  Tel: (U.S. & Canada) 1-800/797-6223
  Tel: (Worldwide) +1 281/228-6223
  Fax: 281/228-6329
  E-mail: FirstService@nace.org
  Web: **www.nace.org/nacestore**







Help Is Available

- CAN/CSA-C22.3 No. 6-M91, “Principles and Practices of Electrical Coordination Between Pipelines and Electric Supply Lines”

- Contact the Canadian Standards Association (CSA)
  Tel: (U.S. & Canada) 1-800/463-6727
  Fax: 416/747-2473
  E-mail: info@csagroup.org







Help Is Available

- EPRI Report EL-4147-V1, “Utility Corridor Design: Transmission Lines, Railroads, and Pipelines, Vol. 1: Engineering Analyses and Site Study”
- EPRI Report EL-3106, “Power Line-Induced AC Potential on Natural Gas Pipelines for Complex Rights-of-Way Configurations,” Volumes 1 to 4
- Contact EPRI
  Tel: (U.S. & Canada) 1-800/313-3774
  E-mail: askepri@epri.com







Help Is Available

- CIGRE CE/SC:36. Technical Brochure. Ref: No: 95 “Guide to the influence of high voltage AC power systems on metallic pipelines”

- Contact the International Council on Large Electric Systems (CIGRE)
  Tel: +33 1 53 89 12 90
  Fax: +33 1 53 89 12 99







Help Is Available

- ANSI/IEEE Standard C2, “National Electrical Safety Code (NESC)” Rule 232C 1c

- Contact the Institute of Electrical and Electronics Engineers (IEEE), Three Park Ave., 17th Floor, New York, NY 10016-5997. Tel: 212/419-7900

- Web: www.ieee.org







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