Static electricity in plastic natural gas pipe O & M operations – Hazards and Control

Dirk Smith, President
Ionix Gas Technologies

Goals of this session

1. Gain working understanding of static electricity in PE gas pipe.
2. Learn to recognize the 4 static threats in your field operations.
3. Review available static suppression technologies.
4. Suggest Best Practices.

What is static electricity

Static electricity is so called because it is an electrical charge at rest because it resides on an electrical insulator.

How is static electricity created

Friction of one electrical insulator against another displaces electrons which accumulate on one of the surfaces.

Mother nature doesn't like electrical imbalances

The physical world is intended to be at electrical neutrality. Mother Nature will remedy the problem if you don't.

The 4 Basics of Static Electricity in PE pipe

As determined by research done by
the Gas Research Institute

#1 – Static starts INSIDE pipe

The movement of gas inside pipe creates static on the inside walls of the pipe.

Why? That's where the friction is!

This is the most important takeaway today because this is the root cause of ALL static issues you encounter.

"When PE pipe is charged by dust or particulate flowing in the gas (triboelectrification), charge is generated initially in the interior of the pipe."

Gas Research Institute report 92-0460

Technical Perspective, page iv, line 3

#2 - Once static is created, it just doesn't "go away…"

It will not conduct away ***since it is sitting on a non conducting material***.
That is why it is called "static" electricity.
It must be deliberately dissipated.

"Charges imparted to the interior PE pipe surfaces act as point sources and are immobile because of the inherent high resistivity of PE."

Gas Research Institute report 92-0460
Introduction, page 1 line 4.

#3 - Static is induced on the outside of pipe

This is why you have an
external static dissipation procedure.

“The electric field resulting from the interior charge induces exterior charge on the pipe."

Gas Research Institute report 92-0460

Technical Perspective, page iv, line 3

#4 - Static WILL arc

Static charges WILL arc and ignite a gaseous mixture if the interior static charge is exposed to ground.

”The interior charge problem is still evident after gas flow has been cut off, and a defective section of pipe is cut for repairs by using a saw or circular cutter. When a metal object penetrates the inner wall of a charged pipe, a spark discharge is inevitable."

Gas Research Institute report 92-0460
Charge Removal Procedures, pg 1 line 5

These 4 basics of static create 4 threats

1. Ignition – Personal and property threat
2. Electrostatic leaks – Integrity threat
3. Shock – Personal threat
4. Electrostatic burnout of electronics – Integrity threat

If you manage static electricity in your system, these 4 threats disappear.

OSHA Hazard Information Bulletins
Static Electricity Buildup in Plastic Pipe

September 30, 1988

MEMORANDUM FOR: REGIONAL ADMINISTRATORS

THROUGH: LEO CAREY
Director
Office of Field Programs

FROM: EDWARD J. BAIER
Director
Directorate of Technical Support

SUBJECT: Safety **Hazard Information Bulletin** on Static Electricity Buildup in Plastic Pipe

The Dallas Regional Office has brought to our attention a potential hazard associated with the buildup of static electricity in plastic pipe used in the conveyance of flammable gas. Accidents including a fatality have been noted in investigations conducted by the Lubbock, Texas and Columbus, Ohio Area Offices. Explosions occurred due to the combination of a flammable gas-air mixture and the discharge of static electricity by arcing. These occurrences should not be confused with fires caused by heat generated by high pressure flammable gas discharges caused by small leaks.

Static charge on a plastic pipe can be generated by friction during the physical handling of the pipe in storage, shipping, installation, and repairing operations. Also, flowing gas in an operational plastic pipe containing particulate matter in the form of scale, rust, or dirt can generate static electricity. Other causes of static charge include gas flow disrupters such as pipe elbows, valves, neckdowns, and leaks.

The American Gas Association (AGA) in its February, 1985 Plastic Pipe Manual for Gas Service (Catalog No. XR0185, American Gas Association, 1515 Wilson Blvd., Arlington, VA 22209) states: "When conditions exist that a flammable gas-air mixture may be encountered and static charges may be present, such as when repairing a leak, squeezing off an open pipe, purging, making a connection, etc., arc preventing safety precautions are necessary." (Squeezing off involves clamping down a plastic pipe to stop flow upstream of a leak or rupture. This can be done with smaller-diameter pipe, typically two inches or less.)

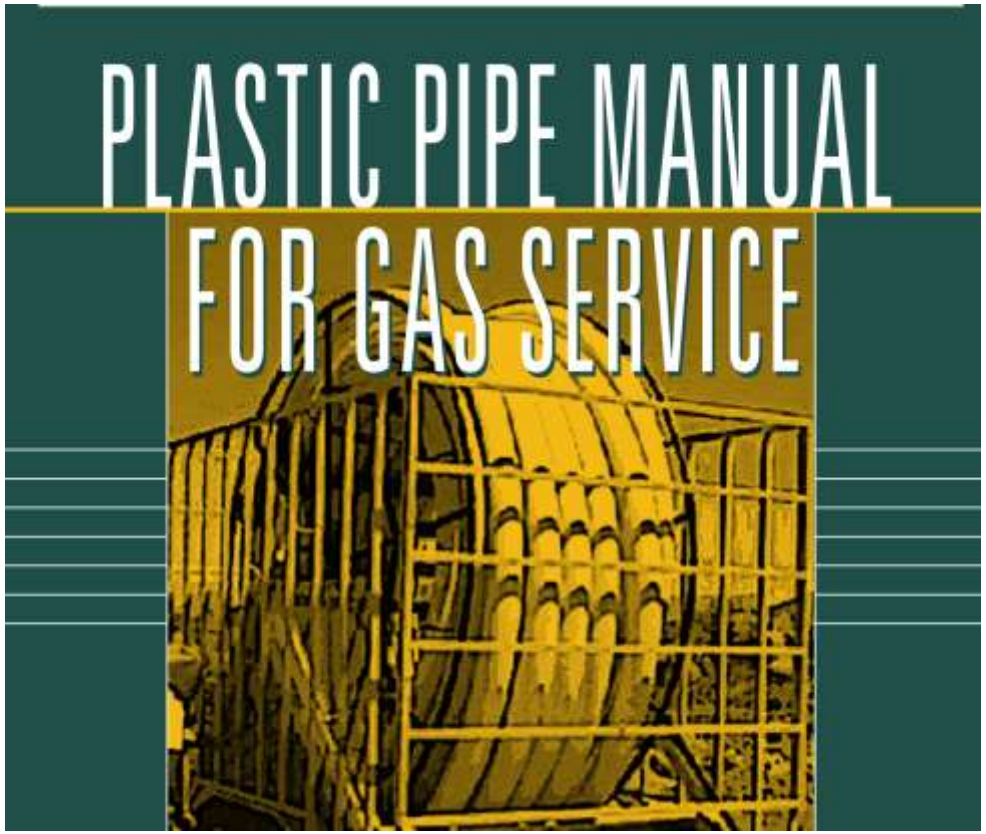
The AGA Plastic Pipe Manual in Chapter VI, p. 57, "Maintenance, Operation, and Emergency Control", also urges the following recommended additional precautions.

Other similar techniques such as dissipating the static charge buildup with wet rags or a bare copper wire are used but may not be as effective.

1. The use of a grounded wet tape conductor wound around or laid in contact with the entire section of the exposed piping.
2. If gas is already present, the pipe should be wet with a very dilute water solution of dishwasher-type detergent starting from the ground end. The tape should then be applied immediately and left in place.
3. The tape should be kept wet by occasional applications of water. Where ambient temperatures below 0 degrees C. (32 degrees F.) are encountered, glycol may be added to the water to maintain tape flexibility. The tape should be grounded with a metal pin driven into the ground.
4. Do not vent gas using an ungrounded plastic pipe or tubing. Even with grounded metal piping, venting gas with high scale or dust content could generate a charge in the gas itself and could result in an arc from the dusty gas cloud back to the pipe and ignition. When venting, it should be done at a down-wind location remote from personnel or flammable material.
5. Ground the tools, such as saws, etc., that come in direct contact with the pipe.
6. In all cases, appropriate safety equipment such as flame-resistant clothing appropriately treated to avoid static buildup and respiratory protection equipment should be used.

Please note that requirements for operation and maintenance of pipelines, including plastic pipelines, are specified in 49 CFR 192. These requirements are enforced by the Department of Transportation, Office of Pipeline Safety, for those operations under its regulatory authority. Operations not so covered would normally fall under OSHA jurisdiction.

Please distribute this bulletin to Area Offices, State Plan States and Consultation Projects.



- In 1973 AGA Plastic Pipe Manual advised on static suppression before working on PE pipe.
- If you think ignorance of the threat of static electricity can be an affirmative defense in civil liability case, you will be quickly and sorely disappointed.

Threat #1
Ignitions of leaking gas

Your public relations nightmare becomes true

The unique problem of distributing gas in PE pipe

It creates its own ignition source

Static Electricity

Here is summary of how GRI says gas ignitions actually occur:

If there is an ignition of leaked/leaking gas,

in the absence of a known ignition source,

given that the passage of natural gas inside a pipe creates static,

the most probable cause of the ignition is that static electricity has arced to ground in the presence of a gaseous mixture.

EVERY ignition MUST have an ignition source!

What makes a situation a potential static ignition risk

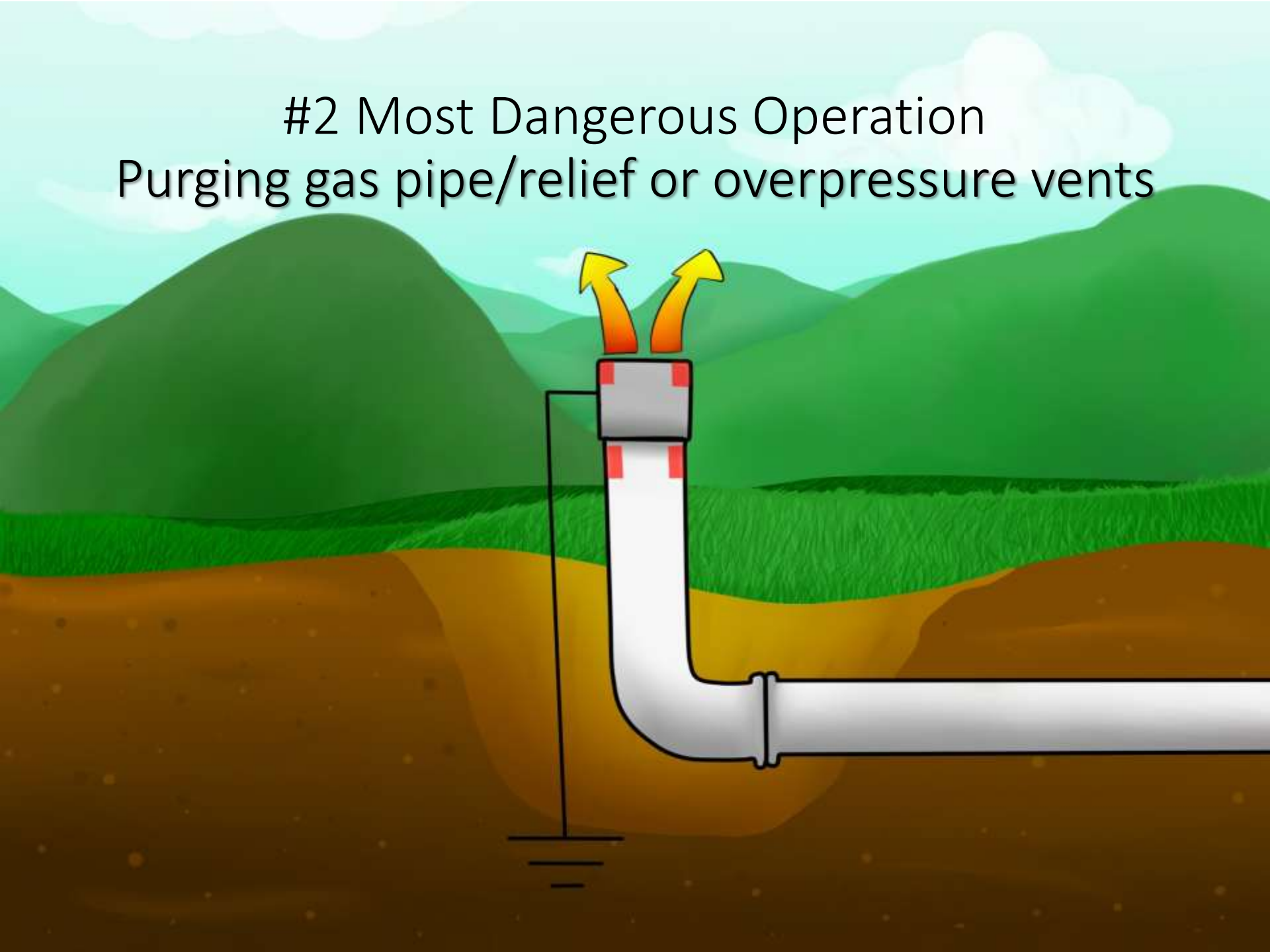
1. Interior pipe surface static exposed
2. Gaseous mixture
3. Proximity to electrical ground (tool/worker/dirt)

The 5 Most Dangerous Static Ignition Gas O&M Operations

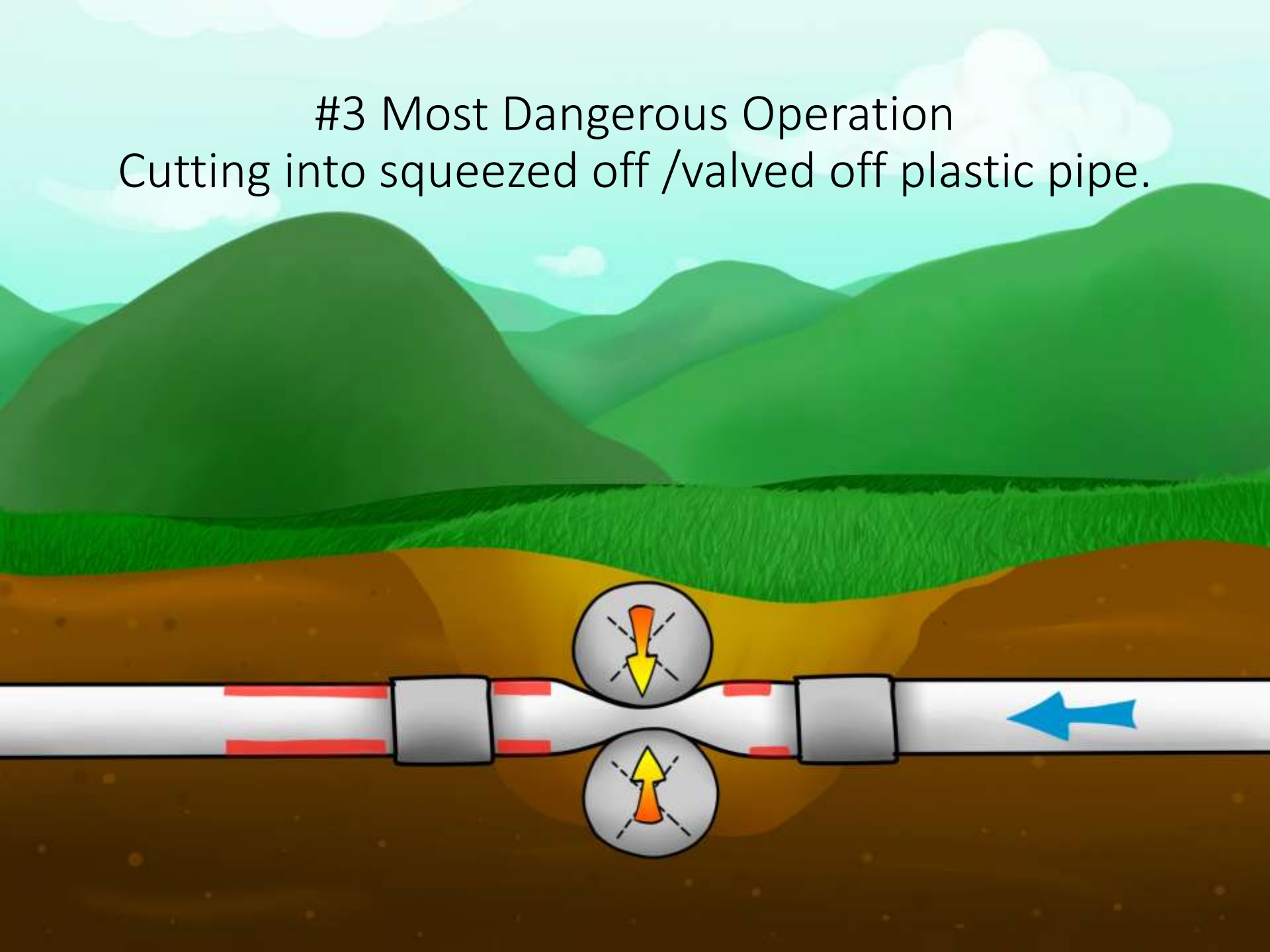
In all these 5 operations
you must remember that
there is both
exterior static
and
interior static
that must be addressed


#1 Most Dangerous Operation
3rd party damage repairs
or O&M operations

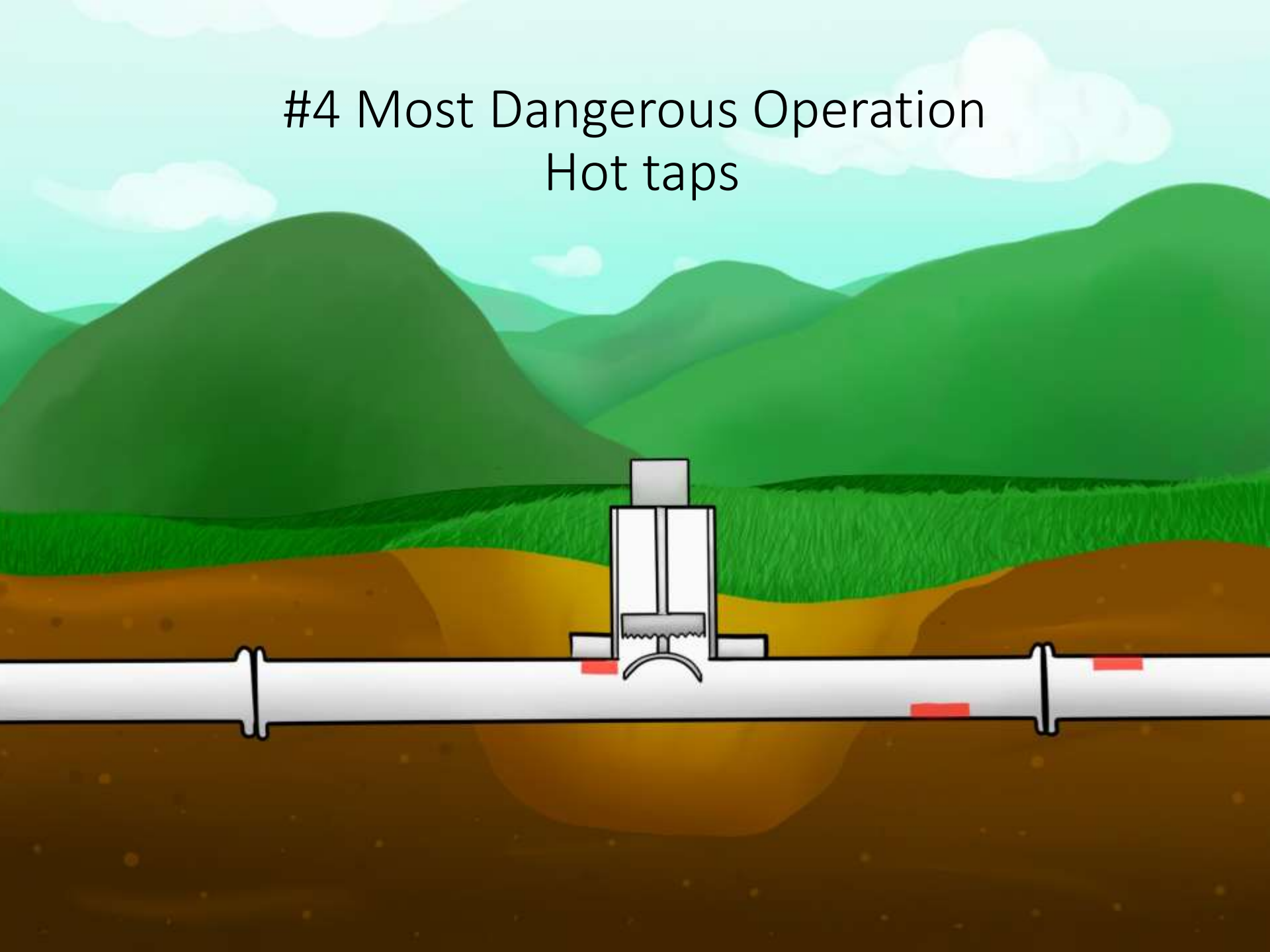
#2 Most Dangerous Operation
Purging gas pipe/relief or overpressure vents



#3 Most Dangerous Operation
Cutting into squeezed off /valved off plastic pipe.



#4 Most Dangerous Operation
Hot taps



#5 Most Dangerous Operation

Plastic pipe previously under pressure removed from service opened up, cut into or reached into.

Accident Report Detail

Accident: 69886.015 - One Employee Is Killed In Natural Gas Explosion; Four Employ

Accident: 69886.015 -- Report ID: 0454731 -- Event Date: 11/26/2014

Inspection	Open Date	SIC	Establishment Name
1010771.015	11/26/2014		Memphis Light, Gas & Water Department

At 10:30 a.m. on November 26, 2014, five employees were caught in an explosion d ue to a natural gas leak. Static electricity ignited the gas leak and one emplo yee was killed with four others burned.

Keywords: burn, explosion, gas leak, natural gas, static electricity

Employee Details

Employee #	Inspection	Age	Sex	Degree	Nature	Occupation
1	1010771.015	35	M	Fatality		Installers And Repairers

Video grab of Memphis ignition

When you want to skip your static suppression procedure, remember this face.

2 of 3 simple and effective static ignition prevention takeaway actions

Dissipate static on ALL exposed pipe – plastic or metal – from a safe distance.

Distance is your friend.

Be *RUTHLESS* in compliance of your company's static suppression procedures. Allow NO exceptions. Field audit for compliance.

Static Electricity is very unforgiving of mistakes.

Static in metal pipe

1. Don’t automatically assume because a pipe is metal there is no static ignition risk.
2. Coatings, corrosion or electrical isolation can allow friction of passing gas to create patches of static on those electrically isolated patches.
3. In those electrically isolated spots static can be present and all the basics of static apply.

Feb 10 2011 Hanoverton OH 10:30PM - AP photo used by permission

Pigging Operations

OSHA has reported 2 fatalities by explosions in launching and retrieving pigs

When you launch or retrieve a pig, during that time you have:

1. ***Gaseous mixture***
2. ***Exposure to ground***
3. ***Personnel nearby***

<u>Pig Launcher static prep:</u>

Before inserting pig in launcher spray inside the launcher with a reach tool. DO NOT REACH INTO LAUNCHER TO SPRAY! Also spray the pig prior to insertion.

<u>Pig Receiver static prep:</u>

Spray inside the receiver before operation if possible. DO NOT REACH INTO RECEIVER TO SPRAY! If not spray into the receiver after pig retrieved so static dissipated for next pig receiving.

Threat #2
Electrostatic Pinhole Leaks

Static creates leaks in PE pipe

What is an electrostatic pinhole?

”The charge conditions across the pipe wall can increase high enough to exceed material breakdown. This breakdown phenomenon produces a small burned hole (about the size of a pinhole) through the pipe wall that can leak minute quantities of gas."

Gas Research Institute report 92-0460

Introduction page 1, 2nd paragraph.

Static Electric Pinholing Through Polyethylene Pipe

MARK STAKER, Training Coordinator
Mountain Fuel Supply Company

INTRODUCTION

Static electricity pinholing occurs when dust or dirt particles are present in the gas stream and a high volume of flow exists through a restriction.

Prime examples are: broken lines, flow control through a squeeze off zone, close proximity of tube turns, saddle fittings near a break, etc. These circumstances create a sufficient static charge to build on the inside of the pipe, which can exceed the dielectric strength of the plastic pipe. When this occurs, the discharge can cause a pinhole through the pipe wall.

Thus far, our investigation indicates that prevention is the best solution in preventing electrostatic pinhole damage:

- Keep pipe end caps in place at all times before fusion takes place.
- Pig pipe sections, as needed.
- Purge new piping systems with a reusable steel purging fitting.
- Purge existing dead ends before tying on a new piping system.
- Vacuum new piping systems to eliminate the need to purge.

In August of 1984, our first field failure by a static electric discharge was brought to our attention. A contractor crew installing a 1½ inch medium-density polyethylene line was in the process of filling and purging a new piping system. Controlling the flow of natural gas was done through a squeeze-off unit. It was during this process that a cracking or popping sound was heard in the vicinity of the squeeze-off or flow-control area. Inspection of the section of pipe revealed a small leak on the edge of the squeeze cheek area. A brittle squeeze failure was first diagnosed, which was later dismissed.

Closer examination of the failure revealed some small black dots (pinholes) that were leaking. Not fully understanding what had happened, our scraping of squeeze-off areas was emphasized. Field personnel were asked to look consciously for this pinholing leak. These efforts resulted in six pinholing squeeze-off failures reported in a two-week period, all of which were determined to be caused by static pinhole discharge. See Figures 1, 2, 3, and 4.

Only three known static pinholing discharges had been reported throughout the gas industry at this time. Evidence again had shown that a static charge had developed on the inside wall of the plastic pipe in sufficient voltage to cause a pinhole discharge. During this time frame, samples of pinhole discharge were sent to our pipe manufacturers for evaluation and verification. The results and information received are

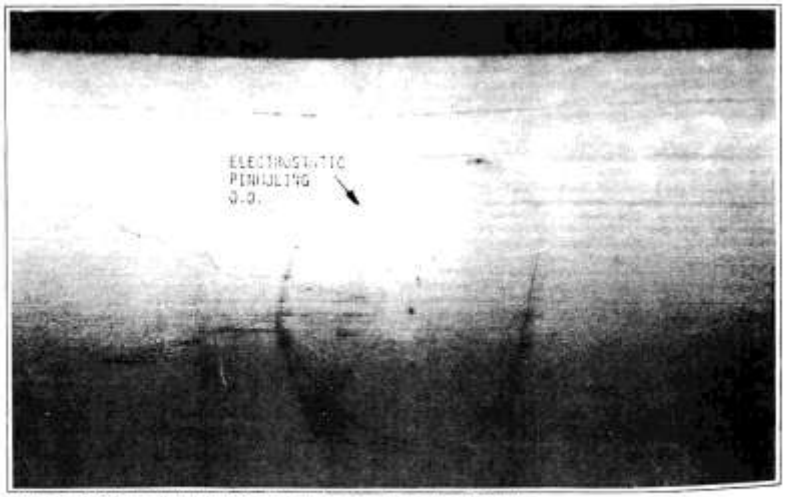


Figure 1. This 2" I.P.S. electrostatic pinhole occurred when purging a new piping system.

Pinholes are created during squeeze off

Section view of electrostatic pinhole

Pinholes can be created during the normal operation of gas transport

”Even under apparently normal operations when the pipe is not being squeezed, pin holing is observable because of high-turbulent flow conditions occurring near tees, elbows, etc."
Gas Research Institute report 92-0460
Introduction page 1, 2nd paragraph.

PS – If your system has experienced pinholes, that demonstrates you have static in your distribution system

Brown grass over poly service lines prime indicator of electrostatic pinhole leaks

Pinholes occur first in service lines

1. **Leak call with brown grass spots tracking service line.**
2. **Multiple leaks in line.**
3. **If leaks close together the gas pools to a unsafe concentration**

Under Part 192.1007, this is a known DIMP risk and you are required to address and mitigate the risk

January 5, 2015

PHMSA issued final ruling prohibiting rework/regrind in PE fuel gas pipe.

What is regrind?

Why did they come to this conclusion?

Amendment 192–119

DEPARTMENT OF TRANSPORTATION

Pipeline and Hazardous Materials Safety Administration

49 CFR Parts 192, 193, 195, 198, and 199

[Docket No. PHMSA–2011–0337; Amdt. Nos. 192–119; 193–25; 195–99; 198–6; 199–26]

RIN 2137–AE85

Pipeline Safety: Periodic Updates of Regulatory References to Technical Standards and Miscellaneous Amendments

AGENCY: Pipeline and Hazardous Materials Safety Administration (PHMSA), Department of Transportation (DOT).

ACTION: Final rule.

SUMMARY: PHMSA is amending the Federal pipeline safety regulations to incorporate by reference new, updated or reaffirmed editions of the voluntary consensus standards that are applicable to pipelines subject to the requirements of the Federal pipeline safety regulations. This final rule also makes non-substantive editorial corrections clarifying regulatory language in certain provisions. These changes are minor and do not require pipeline operators to undertake any significant new pipeline safety initiatives.

DATES: This final rule is effective March 6, 2015. The incorporation by reference of certain publications listed in this final rule is approved by the Director of the Federal Register as of March 6, 2015.

FOR FURTHER INFORMATION CONTACT:

Technical Information: Mike Israni by phone at 202–366–4571 or by email at mike.israni@dot.gov.

Regulatory Information: Cheryl Whetsel by phone at 202–366–4431 or by email at *Cheryl.whetsel@dot.gov.*

SUPPLEMENTARY INFORMATION:

I. Background

The National Technology Transfer and Advancement Act of 1995 (NTTAA) (Pub. L. 104–113; March 7, 1996) directs Federal agencies to use voluntary consensus standards and design specifications developed by voluntary consensus standard bodies instead of government-developed voluntary technical standards when appropriate. The Office of Management and Budget (OMB) Circular A–119, "Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities," sets the policy for Federal use and development of voluntary consensus standards. As defined in OMB Circular A–119, voluntary consensus standards are technical standards developed or adopted by domestic and international organizations. These organizations use agreed-upon procedures to update and revise their published standards every three to five years to reflect modern technology and best technical practices.

The legal effect of incorporation by reference (IBR) is that the incorporated material is treated as if it were published in full in the Federal Register and the Code of Federal Regulations (CFR). This material, like any other properly issued rule, has the force and effect of law. Congress authorized incorporation by reference to reduce the volume of material published in the Federal Register and the CFR (see 5 U.S.C. 552(a) and 1 CFR part 51). Congress granted authority to the Director of the Federal Register to determine whether a proposed IBR serves the public interest. Unless expressly provided otherwise in a regulation, if a provision of a standard incorporated by reference conflicts with a regulation, the regulation takes precedence.

New or updated standards often further innovation and increase the use of new technologies, materials and management practices that improve the safety and operations of pipelines and pipeline facilities. Because pipeline safety regulation involves a great deal of technical subject matter, there are 64 standards and specifications that have long been incorporated by reference in 49 CFR part 192, Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards, 49 CFR part 193, Liquefied Natural Gas Facilities: Federal Safety Standards, and 49 CFR part 195, Transportation of Hazardous Liquids by Pipeline. PHMSA regularly reviews updates to currently referenced consensus standards as well as new editions of standards to ensure that their content remains consistent with the intent of the pipeline safety regulations. Previous updates to incorporate industry standards by reference were published on August 11, 2010 (75 FR 48593), February 1, 2007 (72 FR 4655), June 9, 2006 (71 FR 33402), June 14, 2004 (69 FR 32886), February 17, 2000 (65 FR 7721), June 6, 1996 (61 FR 2877), and May 24, 1996 (61 FR 26121). The list of publications that PHMSA has incorporated by reference is found in 49 CFR 192.7, 193.2013, and 195.3.

PHMSA employees participate in more than 25 national voluntary consensus standards-setting organizations that address pipeline design, construction, maintenance,

Federal Register / Vol. 80, No. 1 / Monday, January 5, 2015 / Rules and Regulations

Page 165–180

Key research used by PHMSA for their decision

“Analysis of Microscopic Leaks in Polyethylene Gas Distribution Piping”

- Electric Power Research Institute (EPRI)

“Electrochemical Treeing in Cable”

- Phelps Dodge Cable and Wire (January 1978)

“Deterioration of Water Immersed Polyethylene-Coated Wire by Treeing”

- Takao Miyashite (IEEE Member – March 1971)

PHMSA's reasoning for including this research in their decision:

"These reports indicated that rework could potentially be an issue of concern, particularly through breakdown of dielectric properties, the development of pinhole leaks and static discharge"

5 January 2015 Federal Register

Restating PHMSA's conclusion:

There is an ongoing problem of pinholes leaks in PE pipe which we want to prevent and regrind/rework could be contributing to this problem and that's the reason for this rule.

PE pinhole leaks are a known integrity threat

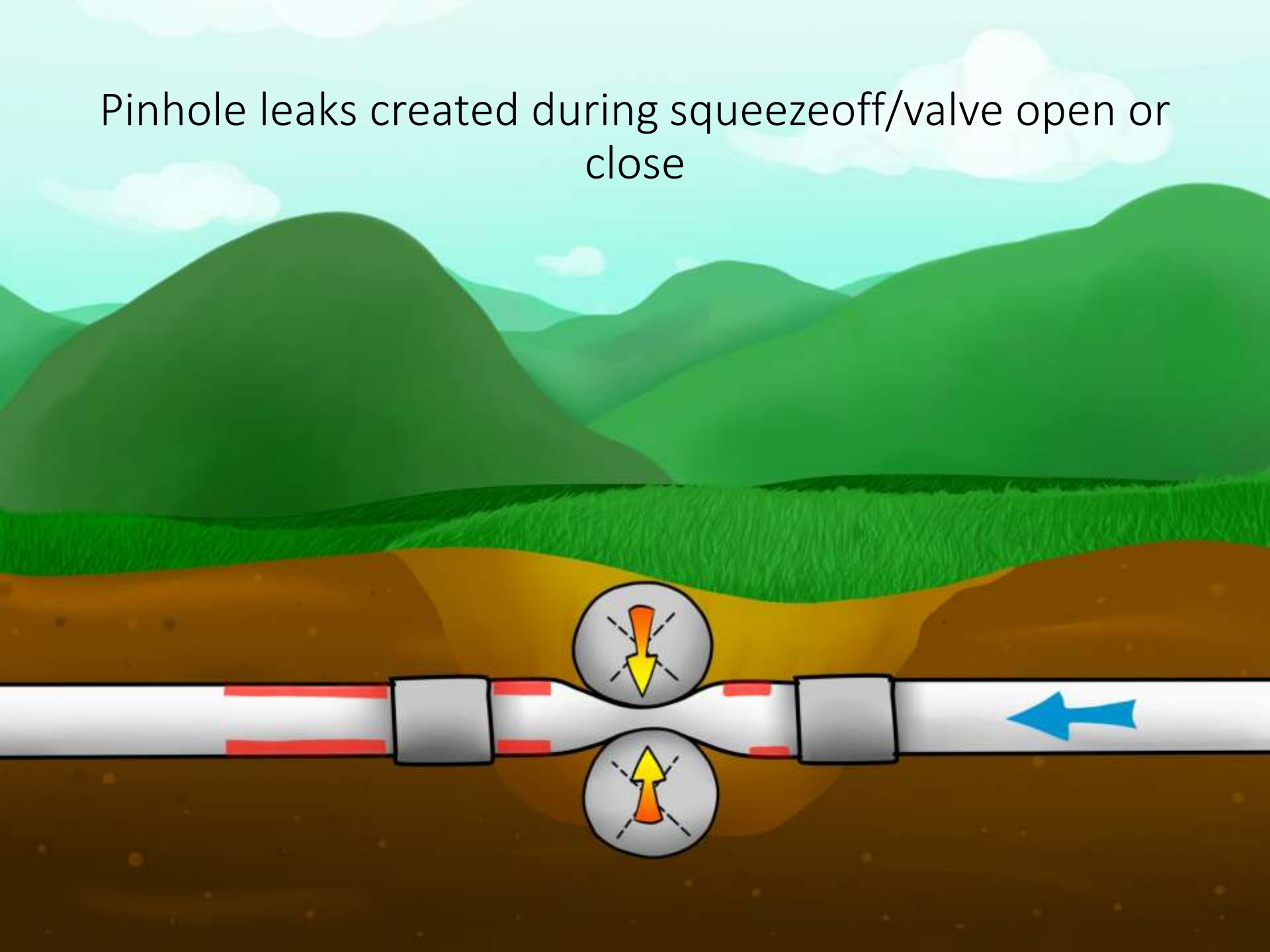
The same static that created the pinholes can ignite the leaking gas.

"Figure 1. There wasn't much question of where this fire started – at the gas meter and the incoming gas lines. While no traditional ignition source was nearby, the static electricity created by the leaking gas likely lead to a discharge – an arc – that caused the fire'"

FIRE FINDINGS – Pg 2 Fall 2005 – Col. 13, NO. 4

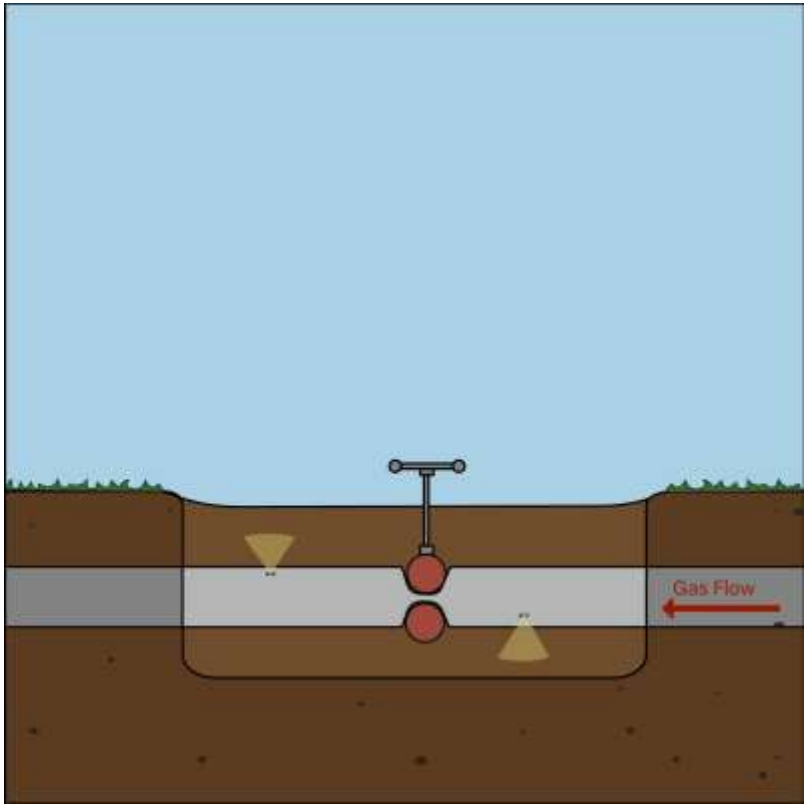
FIRE FINDINGS
Information for Broadening Your Knowledge of Fire Origin and Cause

Pinhole leaks created during squeezeoff/valve open or close



Check for pinhole leaks after squeeze off

- After repairs are completed, soap ALL exposed pipe for pinholes.



Threat #3
Electrostatic Shocks to workers

Electrostatic shocks to workers

The 3 Most Dangerous Static Shock Gas Operations

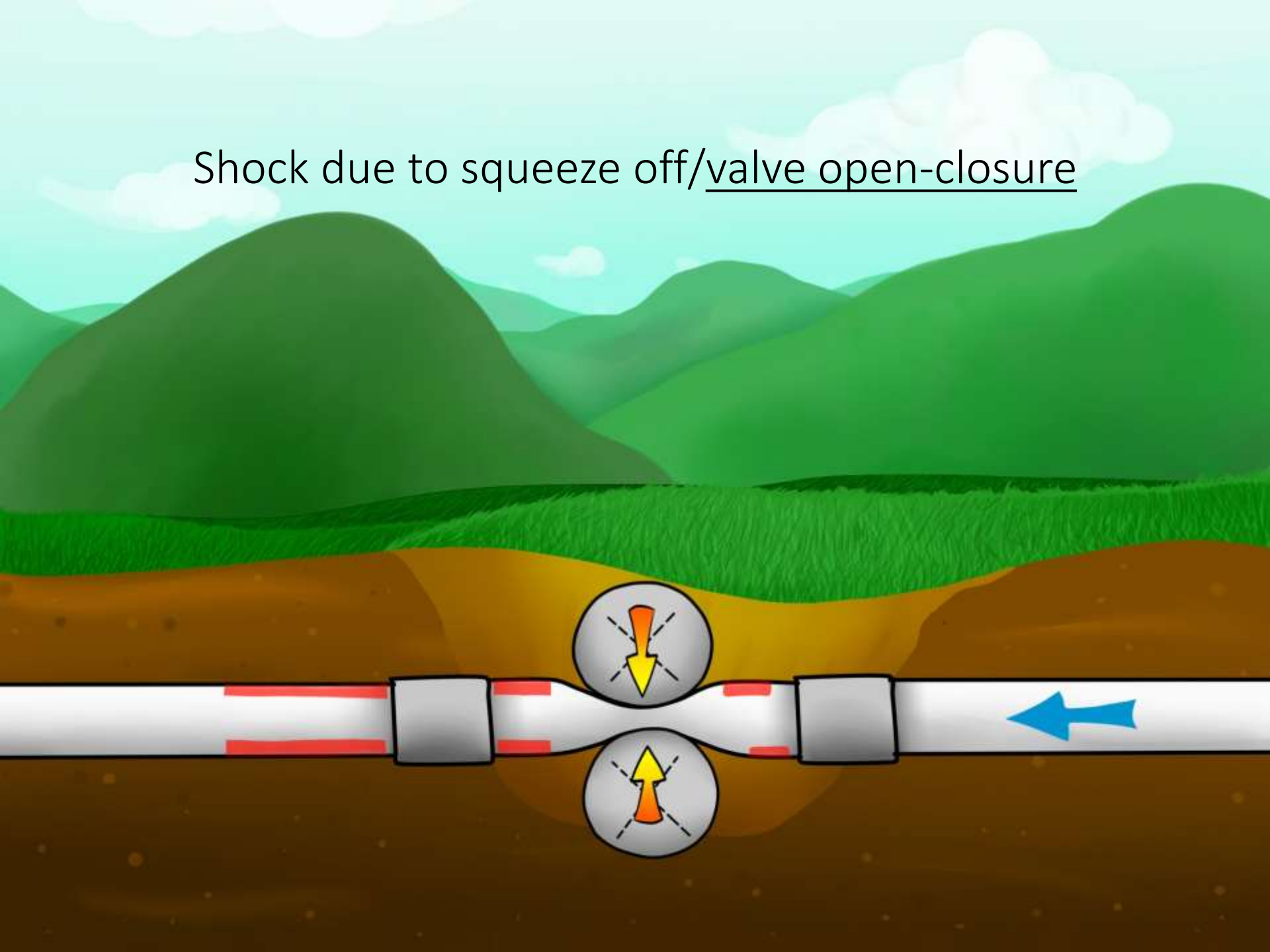
Shock threat

Keep safe distances from known high voltage situations (Squeeze off, cutting into pipe, purging)

until at least external static is dissipated

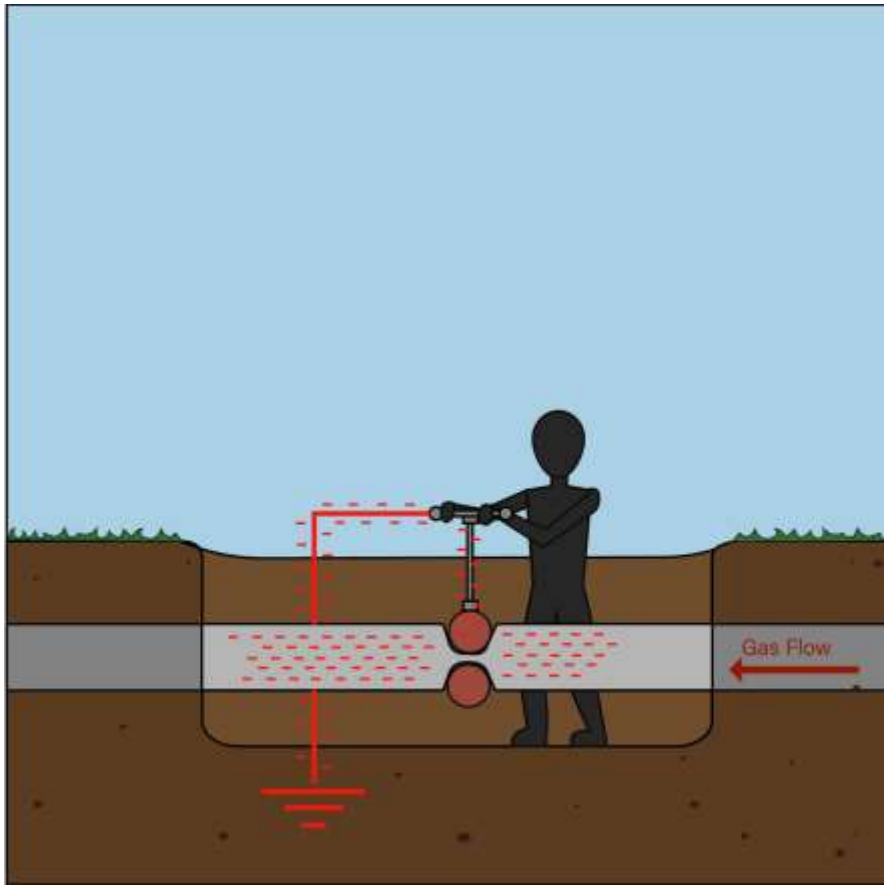
keeping in mind there is an interior static charge.

Shock due to squeeze off/valve open-closure



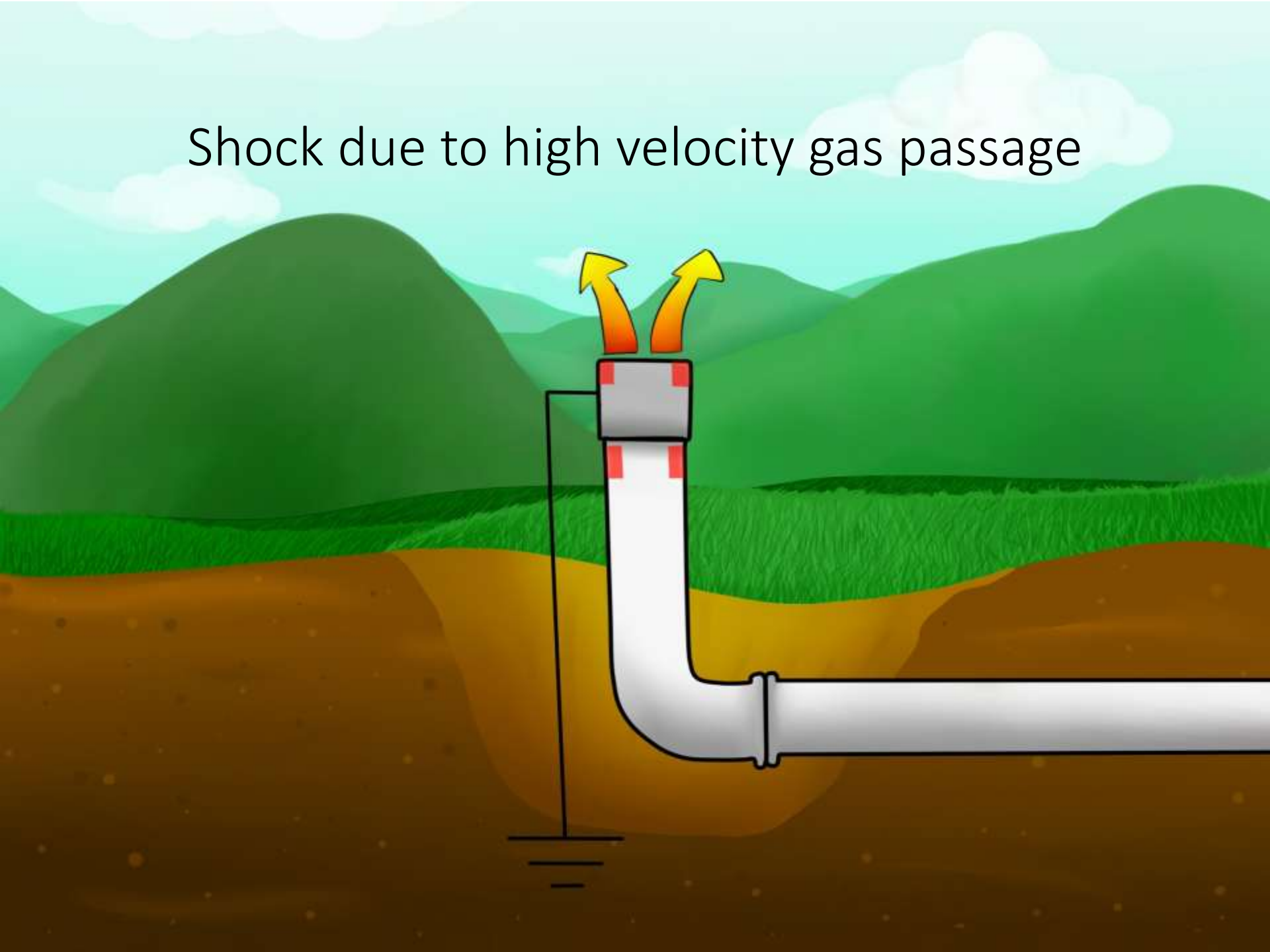
Tool grounding is a worker protection

- IT IS NOT A STATIC SUPPRESSION PROCEDURE.
- DO NOT disable or remove grounding systems on your tools.



Shock due to cutting into pipe “hot spots”.

Shock due to high velocity gas passage



Threat #4
Electrostatic Burnout of electronics

Static burnout of electronics in pipelines

If you are experiencing electronics burnout in meters, telemetry or remote electronics that cannot be explained it can very possibly caused by the static buildup inside PE pipe in that line.

Electronics is all low voltage circuits and very sensitive to any static charges.

If this case, internal static suppression necessary to prevent this burnout. There is NO SOP to prevent this.

Kansas incident of locating transmitter burnout.

Static Mitigation Technologies

External static suppression

- Grounding - Wet rags (1974)
- Topical Antistat - IGT Aerosol Static Suppressor (2010)

Internal static suppression

Ionix Static Suppression Cartridges

External static suppression

Grounding / wet rags

Grounding – wet rags/film
Problem of using wet rags or plastic film to dissipate static on external surfaces

- In order to apply the rags/film to eliminate static, you have to come in contact with the very surfaces you're concerned could ignite from static.
- You can't visually confirm there is a good electrical connection grounding the charge.
- Not suitable for operations which need static suppression – i.e. hot taps, purging.
- It's only as effective as it is properly applied and kept wet.

External static suppression – topical antistat

- Dissipates static chemically on a molecular level.
- Instantaneous – Reliable – Versatile – Spray ANY surface.
- A field procedure which is easy for field personnel to do.
- Overcomes wet rags inherent limitations of limited operational use and verification of grounding.
- Makes static suppression procedure easy for field workers. Far less labor to use than burlap.

IGT Aerosol Lab tested by Gas Technology Institute Testing Lab

- Doesn't affect PE
- Doesn't affect fusing
- Non flammable
- As effective as wet burlap in eliminating static
- No legacy issues

REPORT

GTI TESTING LABORATORIES

1700 South Mount Prospect Road | Des Plaines, Illinois | 60018

gti. testing laboratories

Evaluation of Aerosol Static Suppressor

Project. No. 02109
Report No. ML-623

Report Issued: 2/27/2008

Prepared For:
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ACCREDITED

3rd of 3 simple and effective static ignition prevention actions

3. Update your static suppression technology to a topical anti-stat. One application and you don't have to monitor for wetness and its easy to apply to every exposed surface.

ANY external static mitigation DOES NOT eliminate the internal source of static!

"Prior to this project, standard safety procedures involved wrapping the pipe with wet soapy burlap. This procedure is effective for neutralizing exterior charge accumulation but does not affect the interior charge."

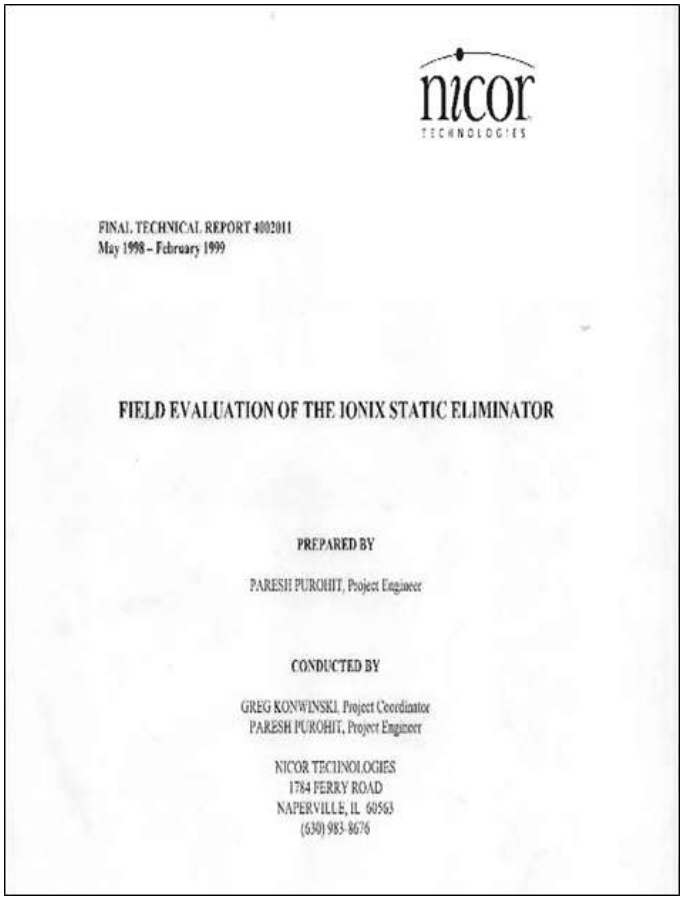
Gas Research Institute report 92-0460 Technical Perspectives page iv, line 7.

Internal static suppression

Ionix Static Suppression Cartridges

Ionix Static Suppression Cartridges for internal static suppression

- Theory of Operation – by suppressing interior static you prevent electrostatic pinhole creation.
- In operation for over 10 years in various systems throughout the US.
- Proven to prevent pinhole leaks by suppressing interior static.
- 11 year in system operation in Midwest municipal gas system achieved 90% reduction in system pinhole leaks – reduced leak calls and repair costs.
- It's "cathodic protection for poly pipe".
- Secondary benefit – it suppresses the primary cause of ignitions – static electricity.



nicor TECHNOLOGIES

FINAL TECHNICAL REPORT 4002011
May 1998 – February 1999

FIELD EVALUATION OF THE IONIX STATIC ELIMINATOR

PREPARED BY

PARESH PUROHIT, Project Engineer

CONDUCTED BY

GREG KONWINSKI, Project Coordinator
PARESH PUROHIT, Project Engineer

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Review of O & M best practices

- Spray ALL exposed pipe – poly or metal.
- If 3rd party damage pipe blowing, spray antistat as close as possible to break and all surrounding ground.
- Check for pinholes after squeeze off.
- Be vigilant for shock risk during and after poly squeeze off and poly/metal valve open and closure.
- Tool grounding is a WORKER protection – not a static suppression procedure.

Final review of main points

- Static should be presumed to be present when working on gas distribution systems. It naturally occurs in the transport of gas. Metal and poly.
- External static suppression procedures will only prevent ignitions caused by *external* static. Spray ALL exposed pipe surfaces.
- External static suppression procedures are ineffective in eliminating ignitions caused by *internal* pipe static.
- Pinhole leaks are caused by internal static – not defective manufacturing. They can only be prevented by internal static suppression.
- Static ignites gas, shocks workers, creates leaks and burns out electronics. It's an injury and integrity issue.
- To prevent the 4 threats of static in PE pipe, internal static suppression is necessary.

A Zebra’s Life

The reason we prevent leaks is to prevent ignitions

Leaks will occur – so you need to eliminate the probable source of ignitions of leaks – static electricity

Remember –
leaks aren't the enemy – ignitions are!

Dirk Smith

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This presentation can be presented at your gas association's meeting. Just contact me for dates.

PDF of PHMSA Part 192 Code book – email me.

Call to order or for your local distributor

IGT Aersol Static Suppressor

www.TheIonixGasStore.com

If interested in our internal static suppression system, please call or email for a no obligation quote