

# Static Electricity Hazards and Control

Dirk Smith, President  
*Ionix Gas Technologies*

# Who is Ionix Gas Technologies and why am I here?

- IGT has developed a suite of products to eliminate static inside and outside PE pipe.
- Because we are called in when static incidents occur, we have industry anecdotal history to draw upon.

# Goals of this session

1. Gain working understanding of static electricity in PE gas pipe.
2. Learn to recognize static ignition risks in your field operations.
3. Provide basis for development/evaluation of your own static suppression procedures based upon how static operates and the known risks in gas O&M operations.


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**STUDY INDICATES RISK TO LDC ASSETS POSED BY STATIC ELECTRICITY**

By Dirk S. Smith, Ionix Gas Technologies Inc. | April 2011 Vol. 238 No. 4



The danger of static electricity in natural gas distribution pipe has been well-documented by third-party industry associations and federal oversight agencies. The American Gas Association issued static electricity precautions in the Plastic Pipe Manual in 1985. It recommended external static suppression procedures as well as procedures for static suppression during purging operations.

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In 1988 the Occupational Safety and Health Administration issued a safety hazard information bulletin about static electricity in natural gas operations as a result of at least one fatality linked to static electricity. As recently as September 2010, the federal government's Chemical Safety Board issued urgent safety recommendations concerning purging and ignitions as a result of its investigation into the Feb. 7, 2010 Kleen Energy natural gas explosion.

Despite these advisories, many local distribution companies may believe they don't have a risk issue with static electricity in their systems and therefore do not need to include static electricity mitigation in their

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Directional drilling rigs,  
large



Article published in April 2011 Pipeline and Gas Journal  
 Comparison of fuel pipelines incidents that rise to NTSB incident level  
 Compared only In ground right of ways – no bridges, inside buildings,  
 underwater, storage tanks  
 1995 – 2010 - 15 years of NTSB investigated incidents

**Blue** indicates a **FLAMMABLE LIQUID** pipeline incident.

**Red** indicates a **NATURAL GAS** pipeline incident.

NTSB R/N	Location	Liquid	Gals leaked	Exp/Fire?	Natural Gas	Exp/Fire?	
<del>PAB-10-1</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<b>PAR-09-1</b>	<b>Pipeline</b>	<b>Liq propane</b>	<b>Unknown</b>	<b>Yes</b>			<b>Ign cause unkwn</b>
<del>PAB-08-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAB-07-02</del>	<del>Pipeline</del>	<del>Ammonia</del>					
<del>PAB-07-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAB-06-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAB-04-02</del>	<del>Storage tank</del>	<del>Diesel</del>	<del>Unknown</del>	<del>Yes</del>			
<b>PAR-04-01</b>	<b>Pipeline</b>	<b>Crude oil</b>	<b>252,000</b>	<b>No</b>			
<del>PAB-04-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<b>PAR-03-01</b>	<b>Pipeline</b>				<b>Yes</b>	<b>Yes</b>	<b>Ignited 4 minutes</b>
<b>PAR-02-02</b>	<b>Pipeline</b>	<b>Gasoline</b>	<b>237,000</b>	<b>Yes</b>			<b>1 ½ hours after leak</b>
<b>PAR-02-01</b>	<b>Pipeline</b>	<b>Fuel oil</b>	<b>149,000</b>	<b>No</b>			
<del>PAR-01-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<b>PAB-01-03</b>	<b>Pipeline</b>	<b>Gasoline</b>	<b>564,000</b>	<b>No</b>			
<b>PAB-01-02</b>	<b>Pipeline</b>	<b>Crude oil</b>	<b>489,000</b>	<b>No</b>			
<b>PAB-01-01</b>	<b>Pipeline</b>	<b>Diesel fuel</b>	<b>53,500</b>	<b>No</b>			
<del>PAB-00-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAR-00-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<b>PAB-99-03</b>	<b>Pipeline</b>	<b>Diesel</b>	<b>84,700</b>	<b>No</b>			
<b>PAB-99-02</b>	<b>Pipeline</b>				<b>Yes</b>	<b>Yes</b>	<b>No time noted</b>
<b>PAB-99-01</b>	<b>Pipeline</b>	<b>Gasoline</b>	<b>30,000</b>	<b>No</b>			
<b>PAB-98-02</b>	<b>Pipeline</b>	<b>Liq butane</b>	<b>Unknown</b>	<b>Yes</b>			<b>Ignited by car</b>
<b>PAR-98-01</b>	<b>Pipeline</b>	<b>Fuel oil</b>	<b>956,000</b>	<b>No</b>			
<del>PAR-98-01*</del>	<del>Pipeline</del>				<del>Yes</del>	<del>Yes</del>	<del>Submerged pipeline</del>
<b>PAB-98-01</b>	<b>Pipeline</b>	<b>Gasoline</b>	<b>475,000</b>	<b>No</b>			
<del>PAB-98-02</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAR-97-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<del>PAR-96-01</del>	<del>Inside bldg</del>				<del>Yes</del>	<del>Yes</del>	
<b>PAR-95-01</b>	<b>Pipeline</b>				<b>Yes</b>	<b>Yes</b>	<b>Ignited "within minutes"</b>

29 incidents – 15 natural gas – 13 haz fuel – 1 ammonia (Excl. 11 in bldg.)  
 13 Liquid Fuel incidents – 80% of incidents – Ignition rate – 16% (1 kwn igtn)  
 3 Natural Gas pipeline incidents – 20% of incidents – Ignition rate – 100%  
 The high visibility of natgas leaks due to fact they virtually always ignite.

# **Eliminating ignitions of natural gas leaks since a major cause of life and property loss**

This key issue in future pipeline safety improvement

What's happening on the transmission level occurring at the  
distribution level.

***Imagine if there were no natgas explosions***

# **Underlying assumption of current pipeline safety:**

**Preventing leaks stops ignitions  
through**

- 1. Damage prevention**
- 2. Regulations of codes and standards**

## **Problem with that assumption:**

**Leaks still occur**

**Intentional – during repair ops**

**Unintentional – 3<sup>rd</sup> party damage/random**

**and they ignite because of static**

## 2 current components of pipeline safety

Damage prevention

Leak prevention

Metal pipe corrosion protection

PE pipe electrostatic protection

***I suggest there is actually a 3<sup>rd</sup> component:***

Suppression of static – the ignition source

# Revised comprehensive assumption of pipeline safety:

Prevent leaks AND Suppress the ignition source by

- 1. Damage prevention
- 2. Regulated codes and standards
- 3. Static suppression of ignition sources

***This will stop ignitions***

## Part 1

# The basics of static electricity

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 static electricity is 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.



Arcing can either ignite a gaseous mixture or shock the worker

## Part 2

# The 4 Basics of Static Electricity in PE pipe

# #1 – Static starts INSIDE pipe

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

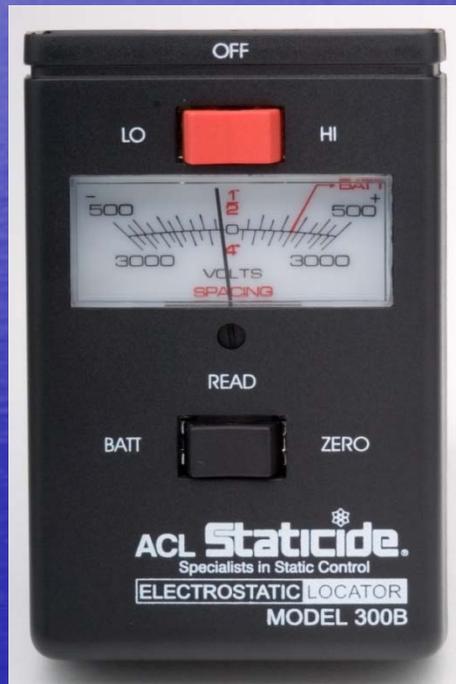
Why? That's where the friction is!

*This is the most important takeaway today because it 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*

# Measuring static



#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 a wet rag 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*

# Here is summary of how GRI says static 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.

# The unique problem of distributing gas in PE pipe

It creates its own ignition source





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

Here's the fundamental reason why you need to have SOP for static suppression

You need to focus on preventing the cause of the ignition of the leak at least as much as the prevention of the leak.

# Static Mitigation Technologies

## External static suppression

- Wet rags (1984)
- Topical antistat (2010)

## Internal static suppression

- Ionix Static Suppression Cartridges

# Static Mitigation Technologies

## External static suppression - grounding



## 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.

- Wet rags for static do not eliminate static electricity inside PE pipe.

**"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.

Wet rag/external static dissipation procedures are only bandages in the treatment of static electricity in your systems.

They treat a symptom and are not a cure.

# Static Mitigation Technologies

External static suppression – topical antistat



Dissipates static chemically on a molecular level.

Instantaneous – Reliable – Versatile

Overcomes wet rags inherent limitations

# 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

**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

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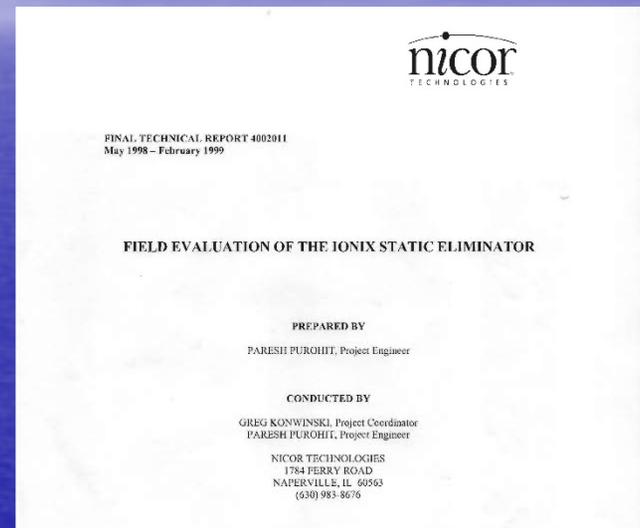
# Static Mitigation Technologies

Internal static suppression – Ionix Static Suppression Cartridges



# Ionix Interior Static suppression Lab tested by NICOR Labs

- Installed in actual system
- Were able to dissipate static in system
- When removed static returned.
- One city saw 90% reduction in PE leaks



## Part 3

# Implications of static for gas distributors

1. Safety issue - ignition
2. Integrity issue - electrostatic pinhole leak  
(the leaking gas can in turn cause an ignition)

# Static Ignitions

## The 5 Most Dangerous Static Ignition Gas Operations

# 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)

# #1 Most Dangerous Operation

3rd party damage repairs  
pr O&M operations



Procedure:

If the gas flow has been squeezed off:

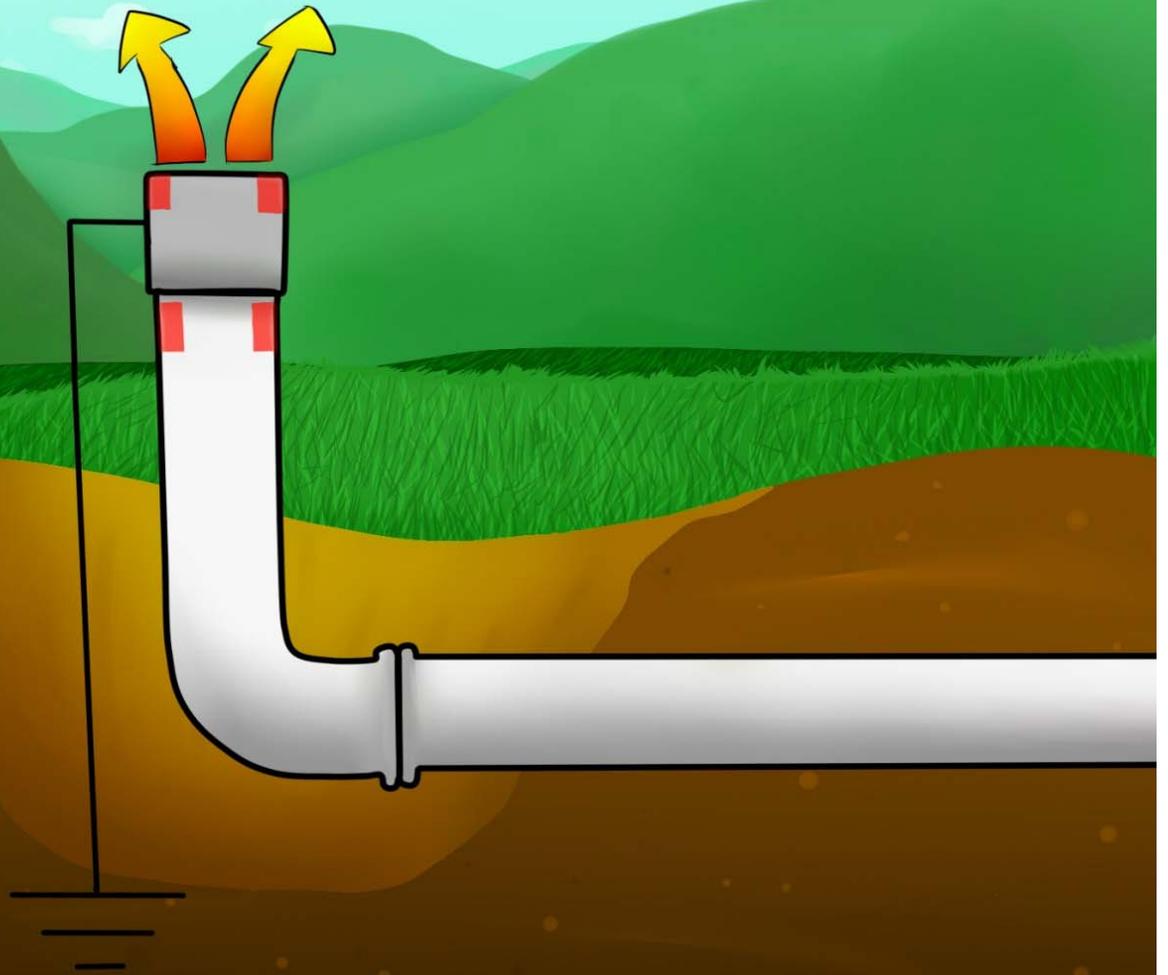
1. Do not let anyone in the pit until static has been dissipated.
2. Spray inside the broken pipe ends.
3. Spray the outside of the pipe.
4. Just because gas flow cut off DO NOT assume there is no static or ignition risk.

If the gas flow has NOT been squeezed off or will not be squeezed off:

1. Before any enters the pit, begin spray on the outside of the pipe as close to the blowing gas as possible.
2. Repeat as often as necessary to keep the surface blue (indicating the gas flow has not pushed away the antistat).

# #2 Most Dangerous Operation

## Purging gas pipe



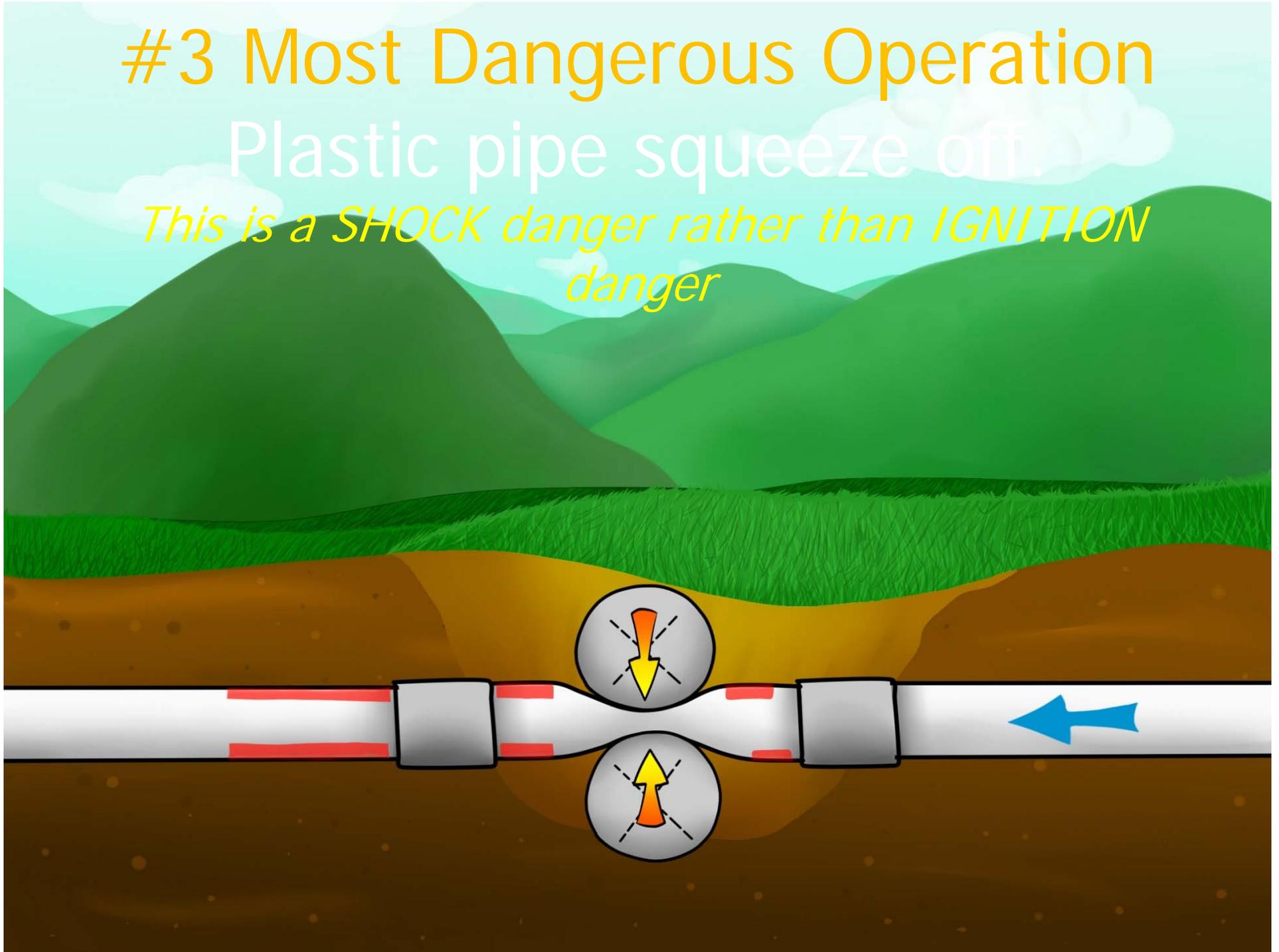
## Procedure:

1. After purging stopped, remotely spray into the pipe opening coating all inside 6" down from top edge.
2. Spray around outside of pipe from top to 12" down.
3. If using a metal grounded purge pipe end, do this for metal and repeat for the plastic pipe when the metal pipe is removed.

# #3 Most Dangerous Operation

Plastic pipe squeeze off.

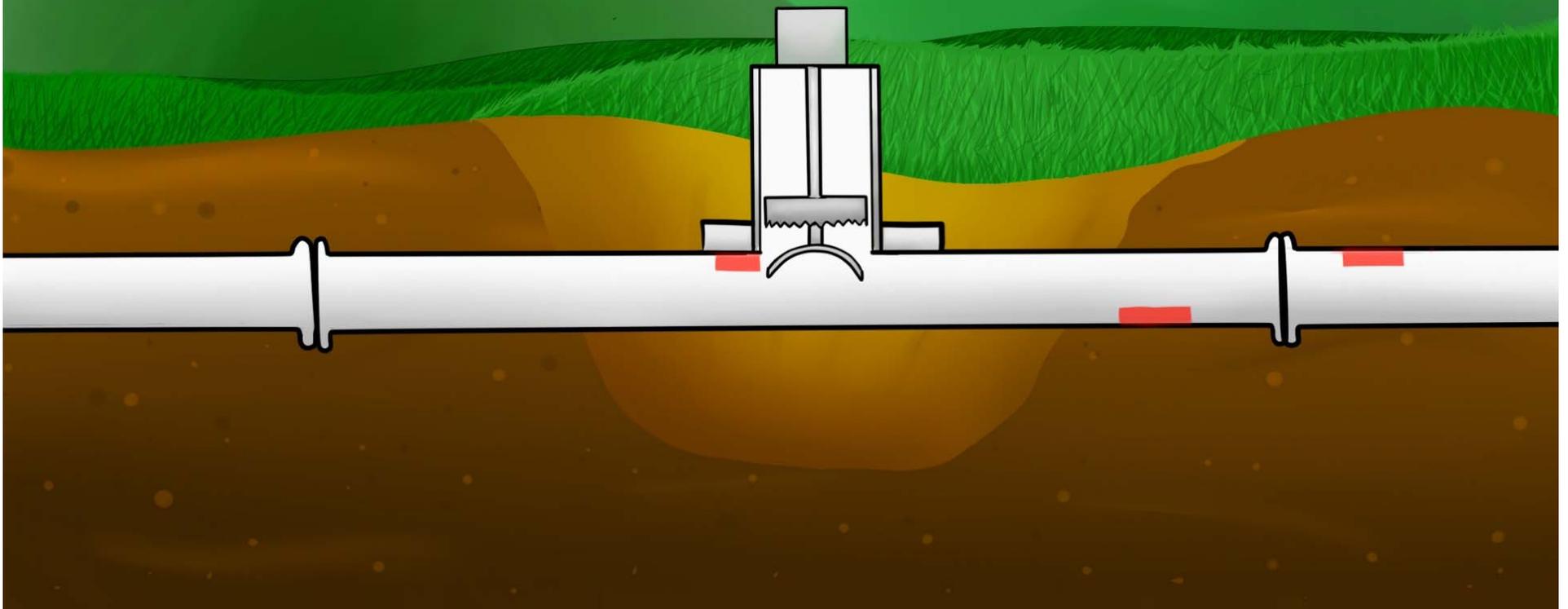
*This is a SHOCK danger rather than IGNITION danger*



## Procedure:

1. Before squeezeoff spray at least 12" in either direction from point of squeezeoff.
2. After squeezeoff repeat the procedure if the pipe will be touched.

# #4 Most Dangerous Operation Hot taps

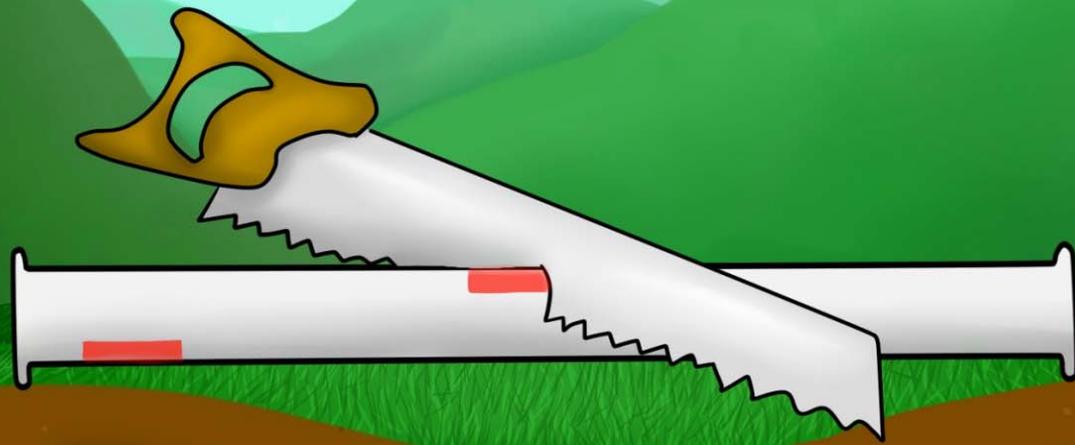


## Procedure:

1. Before or after attaching tap, spray all surfaces inside the tap.
2. Spray any tool end to be used in the tapping.

# #5 Most Dangerous Operation

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



## Procedure:

1. Approach the pipe ends and spray into the pipe as far as you intend to reach.
2. If you are cutting into a pipe, spray into the cut to dissipate any interior static you may come in contact to the tool.
3. If opening a pipe, spray a 1" band around the area to be opened.

**Evaluating your company's SOPS for  
static suppression  
focusing on eliminating static where  
research has determined it resides  
in these 5 O&M operations will  
drastically reduce the risk of an  
unintended ignition.**

**Won't guarantee you will never have a static  
ignition – no one can guarantee that.**

## How to evaluate your company's static ignition risk reduction SOPS

1. Using the 5 most dangerous as a starting point, add, delete or re-prioritize tasks based upon your operations. (i.e. pig launcher)
2. Make sure the MEANS used to eliminate the identified static risk is EFFECTIVE.
3. Be *RUTHLESS* in your enforcement of the procedures you develop.
4. Make procedures easy to use and redundant ("cowboy resistant")

# You will drastically reduce the incidence of a static ignition

1. It is risk based.
2. It is selective.
3. It is cost effective since it directs resources only to the operations your experience has shown a risk exists.

# Electrostatic Pinholing

Static creates holes 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.*

## Section view of electrostatic pinhole



## Pinholes can be created during the normal operation of gas distribution

*"Even under apparently normal operations when the pipe is not being squeezed, pinholing is observable because of high-turbulent flow conditions occurring near tees, elbows, etc."*

Gas Research Institute report 92-0460  
*Introduction page 1, 2nd paragraph.*

# Pinholes are not due to pipe manufacturing defects

In all our field experience, when gas companies sent pinholed pipe samples to independent labs to determine the cause of the pinholes in their sample, 100% of the time the lab identified the cause as static and NOT manufacturing defects.

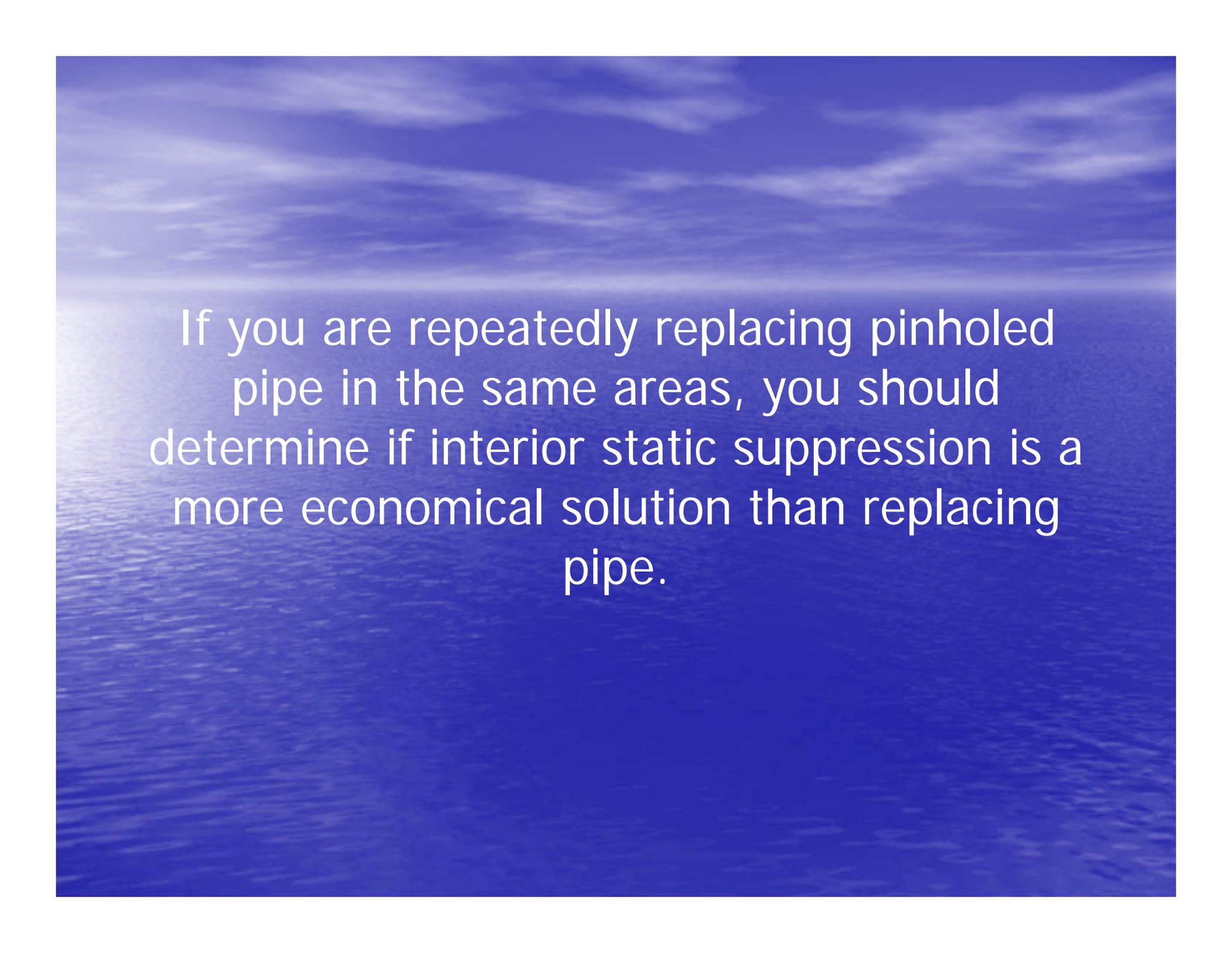
**Repeated replacement of pinholed pipe will NOT stop pinholes!**



# Common characteristics of electrostatic pinholes

- Most pinholes occur in 1" or smaller plastic service lines.
- There seems no pattern for number of pinholes in pipe. I've seen 1 hole, 2, 3, 5 holes in pipe.
- Only observed in PE pipe - no PVC yet.
- It is not limited to one pipe brand.
- Pinholes cluster in groups of lines in geographical areas.

Pinholes can only be eliminated  
by system wide interior static  
suppression installed at the gas  
delivery point.



If you are repeatedly replacing pinholed pipe in the same areas, you should determine if interior static suppression is a more economical solution than replacing pipe.

# Final review of main points

- Static is normal in distribution systems.
- Static is an ignition AND integrity issue.
- ALL static issues can be traced to static originating INSIDE pipe which is caused by the flow of gas through the pipe.
- Current external static suppression procedures, if uniformly and properly followed during the most dangerous static ignition operations, are sufficiently effective for most operation procedures to prevent ignitions caused by external static.
- Current external static suppression procedures are ineffective in eliminating ignitions caused by internal pipe static.
- Pinholes can only be stopped by internal static suppression.

# Main Final Point

You will not make a significant statistical improvement in your current pipeline safety of NATURAL GAS until there is an INTENTIONAL effort by you to address the suppression of static electricity as an IGNITION and LEAK source in gas pipelines.

Corollary proposition:

“IGNITIONS are your enemy – not LEAKS...”

# Final exam

1. Static in gas distribution systems originates \_\_\_\_\_ the gas pipe.

- a. outside
- b. inside
- c. Washington DC

2. Exterior static dissipation does \_\_\_\_\_ to eliminate the source of static inside gas pipes.

- a. everything necessary
- b. nothing

3. In the event of a gas ignition, in the absence of an identifiable ignition source, the Gas Research Institute says the probable cause of the ignition is \_\_\_\_\_  
\_\_\_\_\_ inside the exposed pipe arcing to ground in a gaseous environment.

a. static electricity

b. falling debris

## A Final Thought

The purpose of pipeline safety is to build consumer confidence in the safety of natural gas as an energy choice.

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