

Static electricity in gas O&M operations - Hazards and Controls

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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 a basis for development/evaluation of your own static suppression procedures based upon how static operates and the known risks in gas O&M operations.
4. Basics of static in PE pipe apply from wellhead to delivery.

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 ignite a gaseous mixture, shock the worker or create a leak



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

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 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 create 4 Threats caused by static

1. Ignition
2. Shock
3. Electrostatic leaks
4. Electrostatic burnout of electronics

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

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!

Statutory mandate

Part 192.751

Each operator shall take steps to minimize the danger of accidental ignition of gas in any structure or area where presence of gas constitutes a hazard of fire or explosion...



Static Ignitions

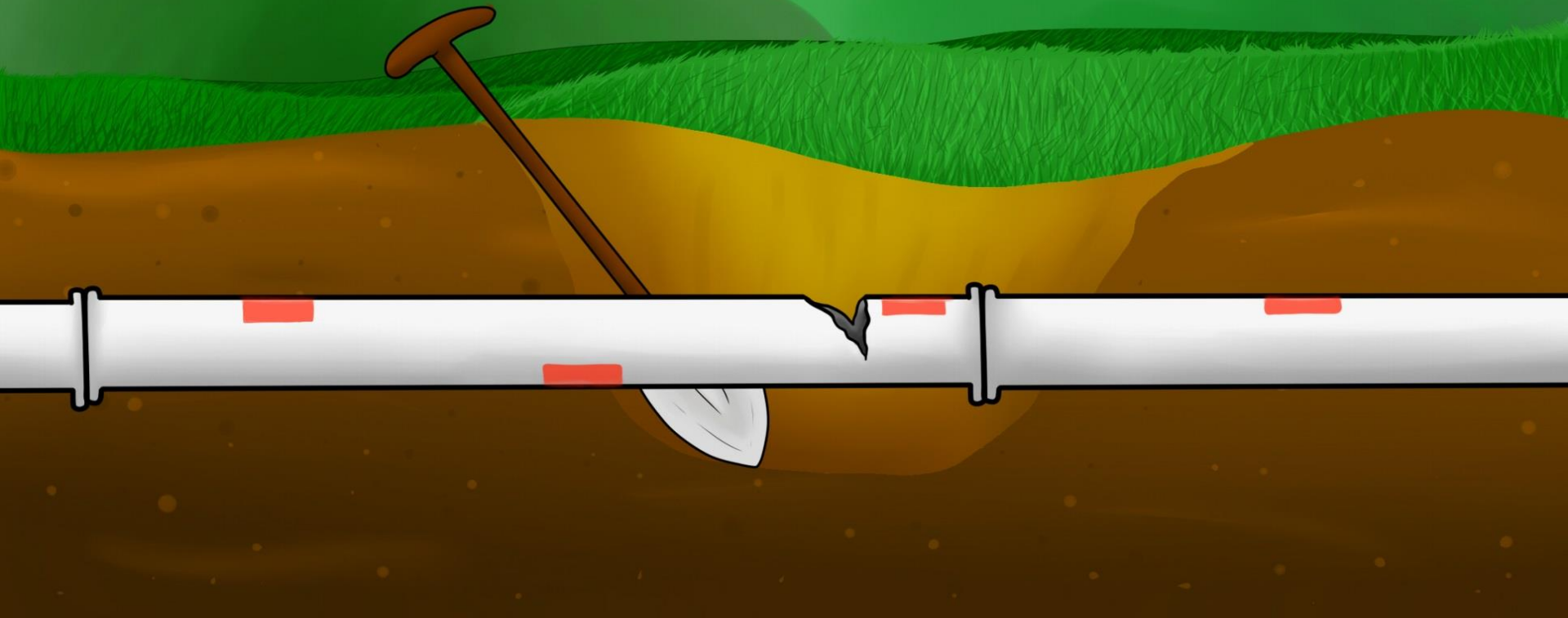
**The 5
Most Dangerous
Static Ignition
Gas Operations**

What makes a situation a potential static ignition risk

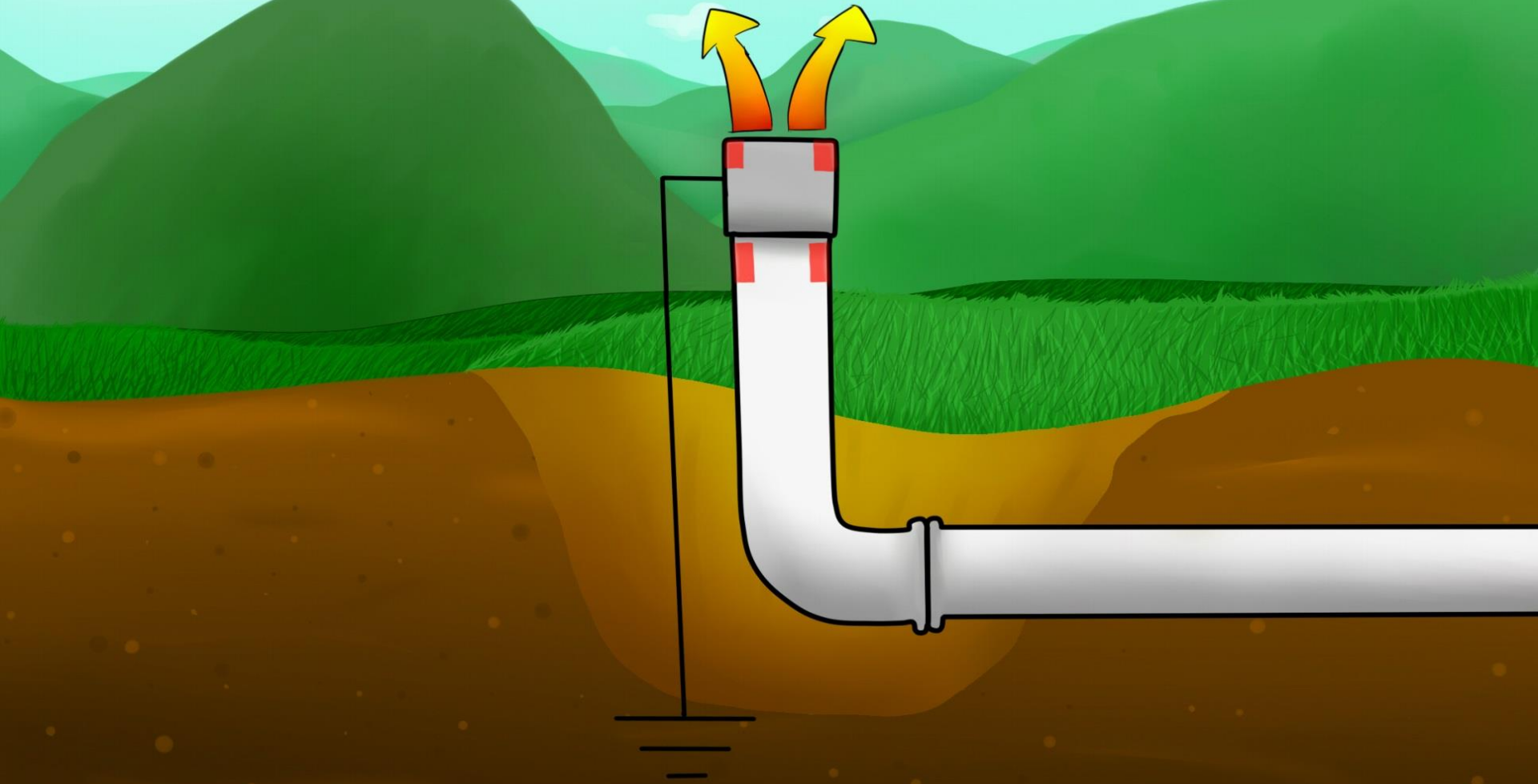
1. Interior pipe surface static exposed
2. Gaseous mixture
3. Proximity to electrical ground (tool/worker/dirt)

**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

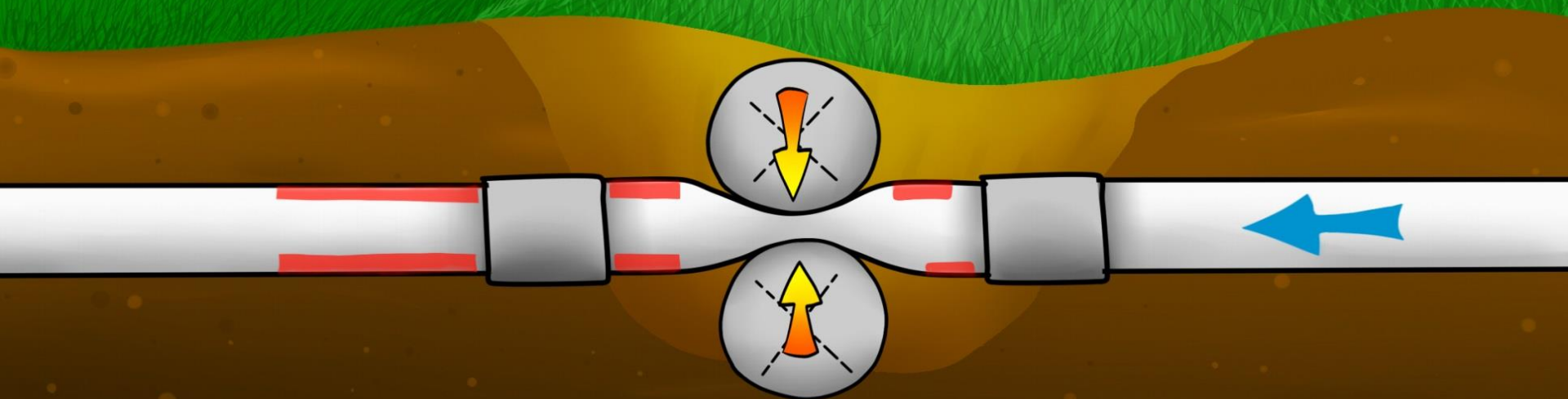


#2 Most Dangerous Operation Purging gas pipe

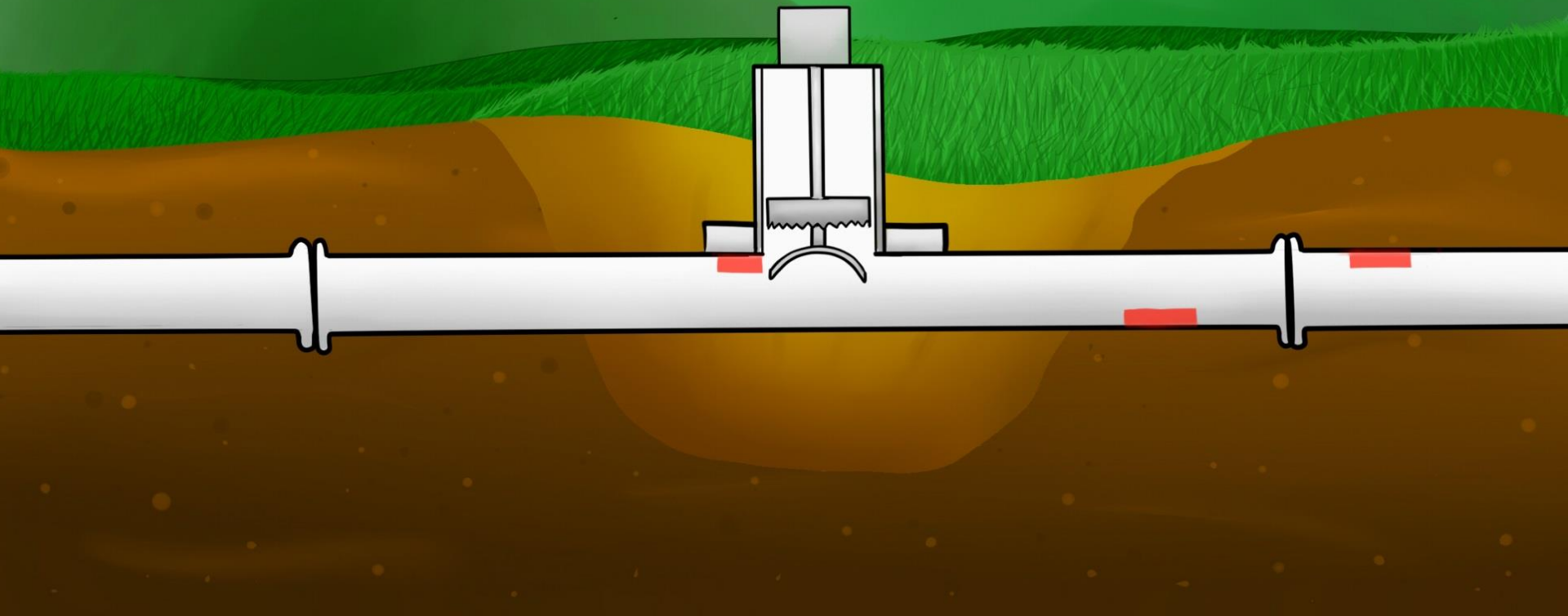


#3 Most Dangerous Operation Plastic pipe squeeze off.

This is a SHOCK danger rather than IGNITION danger

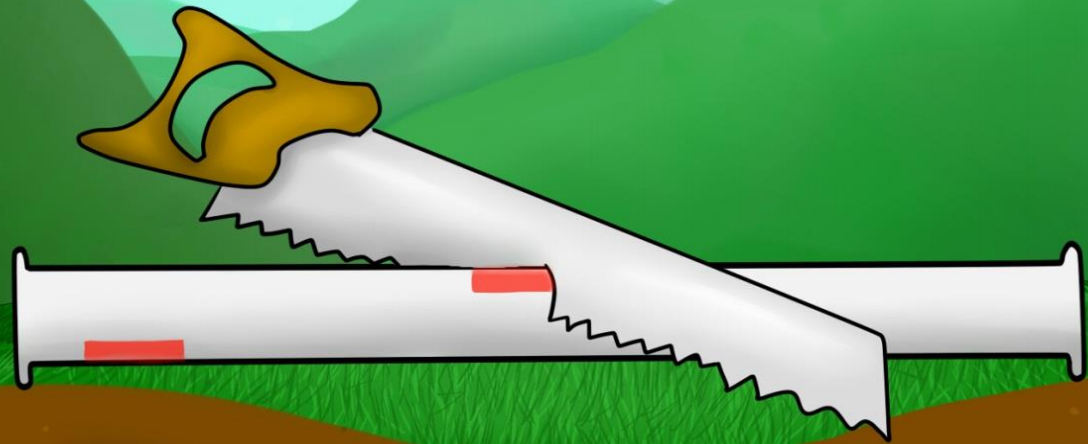


#4 Most Dangerous Operation Hot taps



#5 Most Dangerous Operation

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



**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.**

This will reduce the possibility 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.**

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

1. **Management buy-in – prevention is cheaper than remediation. (Increased Workers Comp/liability) Alagasco**
2. **Using the 5 most dangerous as a starting point, add, delete or re-prioritize tasks based upon your operations. (i.e. pig launcher)**
3. **Make sure the MEANS used to eliminate the identified static risk is EFFECTIVE. (“Bucket Man”)**
4. **Make static suppression procedures easy to use and redundant (“cowboy resistant”)**

2 simple and effective static ignition prevention actions

1. Dissipate static from a safe distance whenever possible. Use remote static dissipation procedures.
2. Be *RUTHLESS* in your enforcement of the procedures you develop. Be consistent and comprehensive.

Metal pipe considerations

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 spots all the basics of static apply.



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

Electrostatic Pinhole Leaks

Static creates leaks in PE pipe

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 1¼ 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 soaping 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

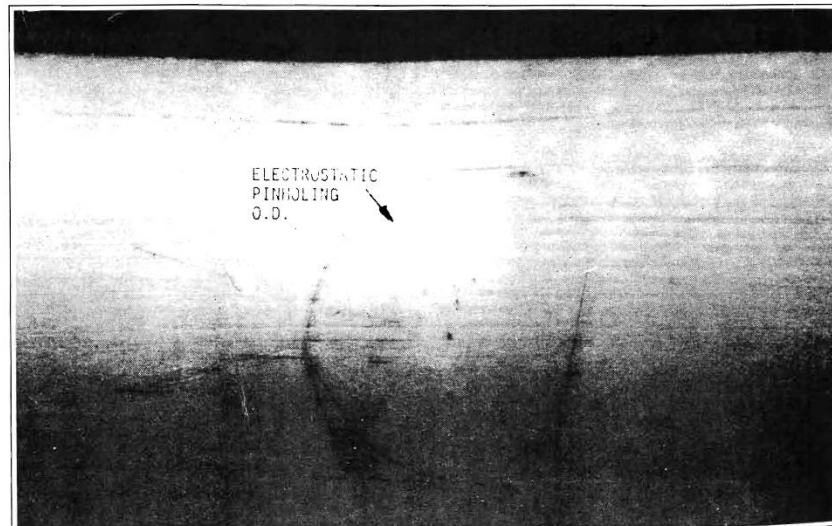


Figure 1. This 2" I.P.S. electrostatic pinhole occurred when purging a new piping system.

Basics of static in PE pipe

1. Static originates inside the pipe.
2. Static charges don't "go away".
3. Mother Nature will seek electrical neutrality.

So what happens when static builds up inside a BURIED PE pipe?

Section view of electrostatic pinhole



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.

Pinhole Leaks were the motivating factor in passage of the “No Regrind” in PE pipe rule in 2015

ALL MDPE pipe will pinhole when internal static reaches 510 volts per mil of wall thickness – regrind present or not

(other materials fail at different voltages depending on their dielectric constant)

Pinholes can be created during the normal operation of gas transport

"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!



The problem is electrostatic pinholes will accumulate.

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.
- They will continue and increase in number over time.

Since static creating pinholes originates
INSIDE the PE pipe:

Pinholes can only be eliminated by system wide
INTERIOR static suppression installed upstream
of the pinholing.

One distributor had a 88% reduction in
pinholes leaks when interior static suppression
installed.

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.

Statutory mandate

Part 192.1007 Gas Distribution Pipeline Integrity Management (IM)

(5) (d) Identify and implement measures to address risks.

Determine and implement measures designed to reduce the risks from failure of its gas distribution system. These measures must include an effective leak management system (unless all leaks are repaired when found).

Electrostatic Burnout of electronics

Static burns out sensitive electronic devices

Electrostatic burnout of electronics

If you are experiencing electronics burnout in meters, telemetry or remote electronics that cannot be explained it can very possibly be 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 is necessary to prevent this burnout.

Kansas incident of locating transmitter burnout.

Static Mitigation Technologies

External static suppression

- Wet rags (1984)
- Topical antistat (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.


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

<i>REPORT</i>	
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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 ACCREDITED CERTIFICATE #0881	

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.

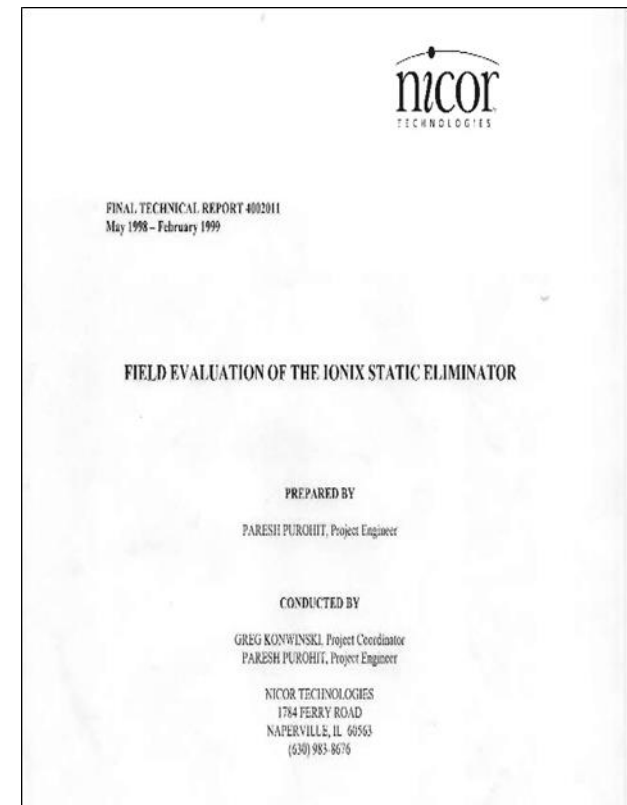
Internal static suppression

Ionix Static Suppression Cartridges



Ionix Static Suppression Cartridges for internal static suppression

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



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 will only 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.
- Electronics burnout of equipment over wide area probably caused by internal static and NOT lightning.
- To prevent the 4 threats of static in PE pipe, internal static suppression is necessary.

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