Static Electricity Hazards and Control

Dirk Smith, President
Ionix Gas Technologies

...making gas delivery safer!
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.
STUDY INDICATES RISK TO LDC ASSETSPOSED BY STATIC ELECTRICITY

By Dirk G. Smith, Ionix Geo Technologies Inc.  April 2011 Vol. 230 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 1995. It recommended external static suppression procedures as well as procedures for static suppression during purging operations.

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 systems.

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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**.

<table>
<thead>
<tr>
<th>NTSB R/N</th>
<th>Location</th>
<th>Liquid</th>
<th>Gals leaked</th>
<th>Exp/Fire?</th>
<th>Natural Gas</th>
<th>Exp/Fire?</th>
<th>Cause</th>
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<td>PAB 10-1</td>
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<td></td>
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<td>Liq propane</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td></td>
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<td></td>
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<td>Yes</td>
<td>Yes</td>
<td>Ignited 4 minutes</td>
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<td>Pipeline</td>
<td>Gasoline</td>
<td>237,000</td>
<td>Yes</td>
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<td>1 ½ hours after leak</td>
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<td></td>
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<td></td>
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<td>Pipeline</td>
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<td></td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Ignited “within minutes”</td>
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</table>

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.*

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**Ionix Gas Technologies**
Making gas delivery safer...
Purpose of today's presentation

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 - 3rd party damage/ random
and they ignite because of static
2 current components of pipeline safety

Damage prevention
Leak prevention
   Metal pipe corrosion protection

I suggest there is actually a 3\textsuperscript{rd} component:

Suppression of static
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
Here’s the fundamental reason why you have SOP for static suppression:

Since gas moving inside pipe creates its own ignition source, you need to focus on preventing the cause of the ignition of the leak at least as much as the prevention of the leak.
Part 3

Implications of static for gas distributors

1. Safety issue - ignition
2. Integrity issue - electrostatic leaks
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
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
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
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
#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.
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 Leaks

Static creates holes in PE pipe.

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What is an electrostatic leak?

"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 pinhole leaks!
Common characteristics of electrostatic leaks

- 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.
Pinhole leaks 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.
• **Pinhole leaks 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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