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.
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
Question:
In the 15 year NTSB study
Were there more LIQUID pipeline incidents
Or NATGAS pipeline incidents?
### Incident Summary

<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>Ignite time</th>
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<tbody>
<tr>
<td>PAR-09-1</td>
<td>Pipeline</td>
<td>Liq propane</td>
<td>Unknown</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>PAR-08-01</td>
<td>Inside bldg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PAR-07-02</td>
<td>Pipeline</td>
<td>Ammonia</td>
<td></td>
<td></td>
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<td>Yes</td>
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<td></td>
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<td>Yes</td>
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<td>PAR-06-01</td>
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<td></td>
<td></td>
<td></td>
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<td>Yes</td>
<td></td>
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<tr>
<td>PAR-04-02</td>
<td>Storage tank</td>
<td>Diesel</td>
<td>Unknown</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>PAR-04-01</td>
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<td>Yes</td>
<td>Ignited 4 minutes</td>
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<td>PAR-02-02</td>
<td>Pipeline</td>
<td>Gasoline</td>
<td>237,000</td>
<td>Yes</td>
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<td>Yes</td>
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<td>PAR-02-01</td>
<td>Pipeline</td>
<td>Fuel oil</td>
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<td>No time noted</td>
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<td></td>
<td>Ignited by car</td>
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<td>Pipeline</td>
<td>Liq butane</td>
<td>Unknown</td>
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<td></td>
<td></td>
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<tr>
<td>PAR-98-01</td>
<td>Pipeline</td>
<td>Fuel oil</td>
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<td></td>
<td></td>
<td></td>
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<td>Gasoline</td>
<td>475,000</td>
<td>No</td>
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<td>Submerged-pipeline</td>
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<tr>
<td>PAR-95-01</td>
<td>Pipeline</td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Ignited “within”</td>
</tr>
</tbody>
</table>

### Key Statistics

- **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.
Answer:

In the 15 year NTSB study there more LIQUID pipeline incidents
Or NATGAS pipeline incidents?

Why did you think more NATGAS?
Because virtually ALL NATGAS pipeline incidents IGNITE
While virtually NO LIQUID pipeline incidents ignite!
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.

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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

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#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...making gas delivery safer!
#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
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
   PE pipe electrostatic protection

I suggest there is actually a 3rd 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
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
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
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)

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Static Ignitions

The 5 Most Dangerous Static Ignition Gas Operations

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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 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
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.
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 leaks in PE pipe

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Basics of static in PE pipe

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

So what happens when static builds up inside a BURIED 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.
Electrostatic Pinholing in PE Service Lines

By Ray A. Ward, Gas Systems Engineer, Memphis Light, Gas and Water and Dirk Smith, President, Ionix Technologies Inc.

Abstract
This paper will document a case of pinholing in PE natural fuel gas distribution pipe that has significant implications for local distribution companies (LDCs). Memphis Light, Gas and Water (MLGW) installed a 1” IPS PE service line according to the PE pipe manufacturer’s recommendations. After installation the service line passed the pressure test for integrity and was stubbed for later service installation. No gas flowed through the line, electrostatic pinholing and can damage installed PE pipe beyond repair requiring removal and replacement.

Background
The first field evidence of electrostatic pinholing was documented in an article in 1989 by Mark Staker at Mountain Fuel Supply. In 1984 Mountain Fuel repair crews discovered an electrostatic pinhole leak after a squeeze-off procedure. Additional research of industry reporting pinholing incidents discovered pinholing during purging and through multi saddles and inline tees when 3rd party damage breaking a service line resulted in increased gas flow.

What is pinholing?
Pinholing is the creation of a hole between the inside and outside walls of the pipe. It can be caused by a material defect or electrostatic discharge.
Section view of electrostatic pinhole

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...making gas delivery safer!
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.

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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.

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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.

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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.