Static Electricity Hazards and Control

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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.

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

Observations

- There were more Hazardous Liquid Fuel incidents than Nat Gas.
- Probability of Haz Liq Fuel igniting – 10%
- Probability of Nat Gas igniting – 95%

Why?

3 Lines of Defense for Pipeline Safety

- Damage Prevention - 811
- Regulations/codes/standards
- Suppression of the primary source of ignitions – static electricity.

Goals of this session in order to reduce the source of static ignitions

1. Gain working understanding of static electricity in PE (and steel) gas pipe.
2. Learn to recognize static ignition risks in field operations.
3. Provide basis for development/evaluation of static suppression procedures.

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 why static suppression is important

- 811 didn't work because contractor hit pipe. – 1st Line of Defense
- Standard procedures didn't prevent ignition. – 2nd Line of Defense
- Ignition occurred causing personal injuries and property damage. – 3rd Line of defense

Here's why you need the 3rd line of Defense

Since gas moving inside pipe creates its own ignition source,

you need to focus on preventing the source of the ignition of the leak

at least as much as the prevention of the leak itself.

Static Mitigation Technologies

1. External static dissipation:
    1. Grounding (wet rags)
    2. Topical antistat (neutralization on contact)

2. Internal Static Suppression
    1. Static suppression cartridges

Grounding (wet rags)

Topical antistat

Ionix Static Suppression Cartridge

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

1. 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.
2. You can't visually confirm there is a good electrical connection.

3. 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.

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)

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/earth)

Static Ignitions

The Most Dangerous Static Ignition Gas Operations

#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

Plus squeeze off has benn documented to cause pinholes

Evaluating your company's codes/standards for static suppression <u>focusing on eliminating static where research has determined it resides</u> in these 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 suppression procedures

1. Using the most dangerous operations as a starting point, add, delete or re-prioritize tasks based upon your operations. (i.e. pig launcher)
2. Make sure the procedure 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 probability of static ignition incident

1. It is risk based.
2. It is selective.
3. It is cost effective.

Electrostatic Pinholing

Static creates holes in PE pipe.

What is an electrostatic pinhole?

Since static starts INSIDE pipe…..

"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

(and documented to be created during squeezeoffs)

"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, 100% of the time the lab identified the cause of pinholes 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 upstream of pinholing.

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.

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

Final Thought

All 3 lines of defense against ignitions are necessary for effective pipeline safety:

1. Damage prevention
2. System integrity (codes/standards)
3. Suppression of the ignition source

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