Plastic Piping Information

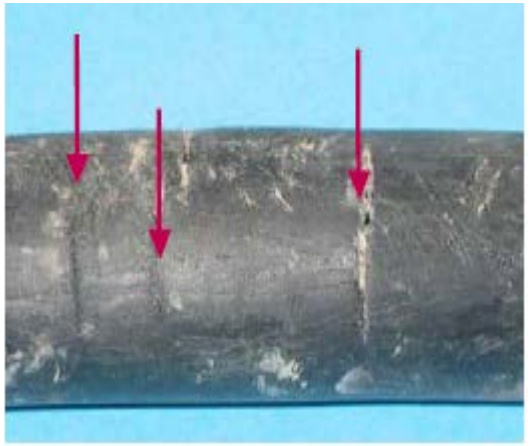
Harold Winnie
Project Manager, Central Region
PHMSA Office of Pipeline Safety

Plastic Pipe Construction Issues

Installation – Handling Issues

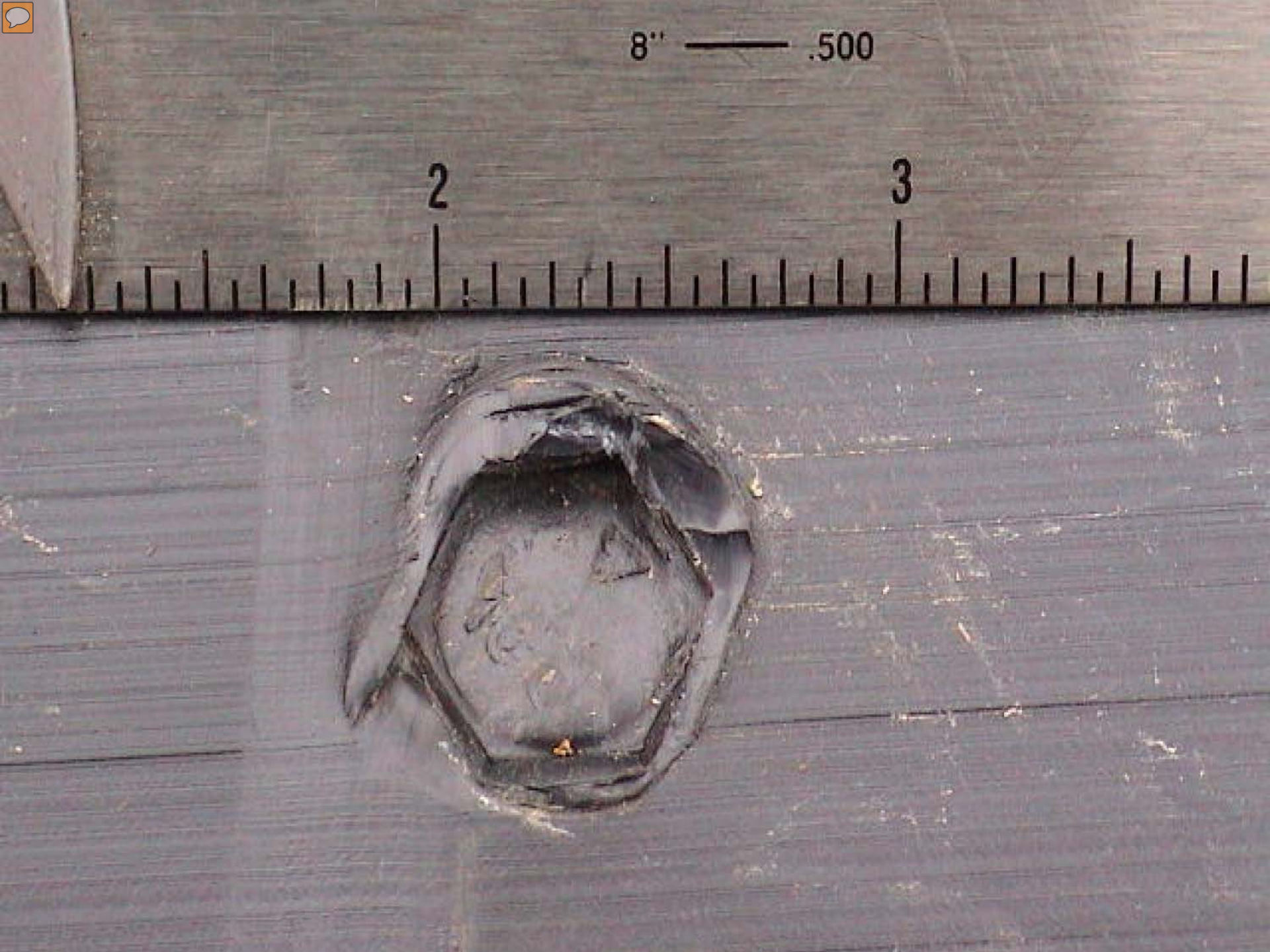
Handling

Rock Impingement



Bending


DEERE
OCT 8 2002


8'' .500
2
3


W.R. THORPE CO
USEFUL FORMULAS
AREA = 0.7854 X D²
CIRCUM = 3.1416 X D
SURFACE = 3.1416 X DXL
PRESSURE = 2 S T / D
S = FIBER STRESS
T = WALL THICKNESS
D = PIPE DIAMETER
P = PRESSURE
L = LENGTH
7.48 U.S. GAL. = 1 CUBIC FOOT
42 U.S. GAL. = 1 BARREL
1 CU. FT AIR
= 0.0809 LBS
EXTRA HEAVY
2" .218
3" .300
4" .337
6" .432
8" .500
STANDARD
2" .154
3" .216
4" .237
6" .280
8" .322
10" .365
12" .375
.400
.450
.500
3/8"
7/16"
1/2"
1
2
3


W.R. THORP
SURFACE = 3.1416 X DXL
PRESSURE = 2ST / D
S = FIBER STRESS
T = WALL THICKNESS
D = PIPE DIAMETER
P = PRESSURE
L = LENGTH
1 CU. FT AIR
EXTRA HEAVY
1
2
3


CAUTION
CAUTION


BP

Recent Fusion Issues

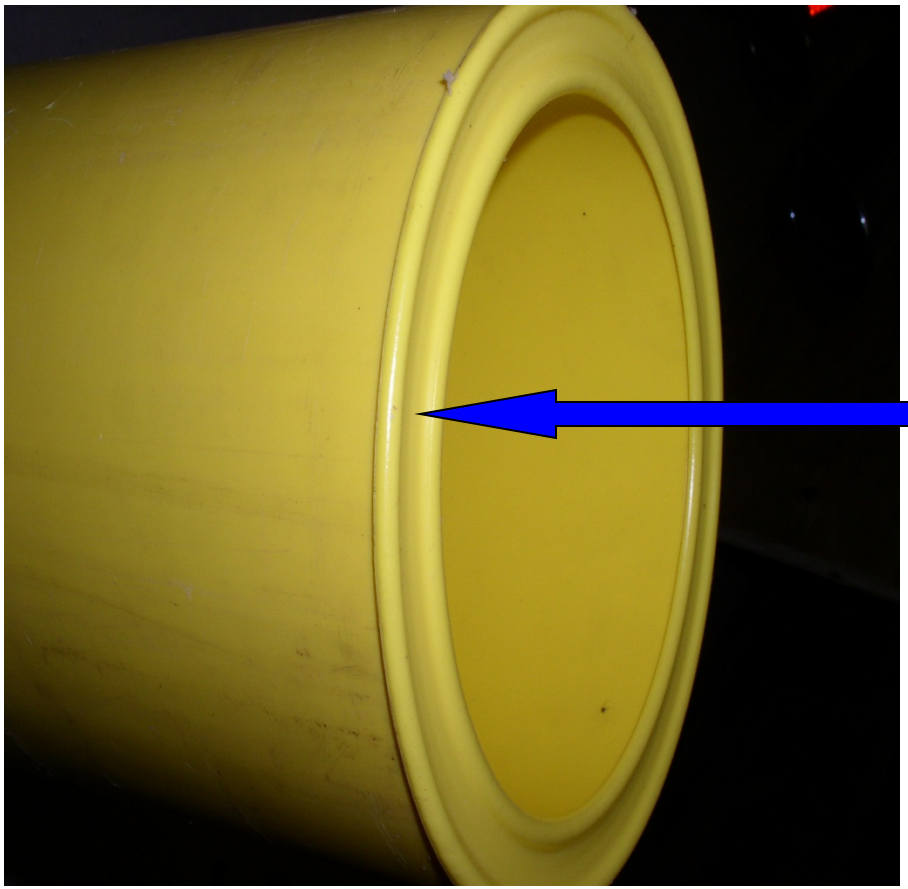
Proposed Third Person Inspection Rule has been Temporarily Suspended


GDY20 GAS


PIPE 6500 GAS PIPE
feed direction


CASE
No.28

Butt Fusion Procedures



"COLD FUSION"

Note the concave effect in the wall of the pipe. The melt has been pushed out of the fusion area. This will produce a bad joint.

UNACCEPTABLE


A
B
DO NOT USE


PERFORMANCE PIPE
81M 2X3/4 IPS RTB STT 80 PSI-12
1104123 12 06 0783 W
ASTM D-2513 / D-2683 CEE PE
MADE IN USA
03/08/2013


03/08/2013


03/18/2013

2016 Investigation

- 1980 - Installed 1500 feet of 4 inch plastic pipe in – 40 foot lengths = 38 joints
- Recent Failure Caused Explosion and 3 injuries
- 8 Previous Leaks from 1983 to 2012
- Failed to investigate cause of the leak failures

2016 Investigation

- Never integrated previous failures investigations into this incident.
- Never reviewed - 1980's what was there fusion procedures?
- Did they do proper Root Cause Analysis?

Rapid Crack Propagation Failure

Rapid Crack Propagation Failure

Arrest of Rapid Crack Propagation

RCP arrest in PE100 pipe

U.S. Department of Transportat
Pipeline and Hazardous Ma
Safety Administration

ADB-07-01 (02)

Adding:

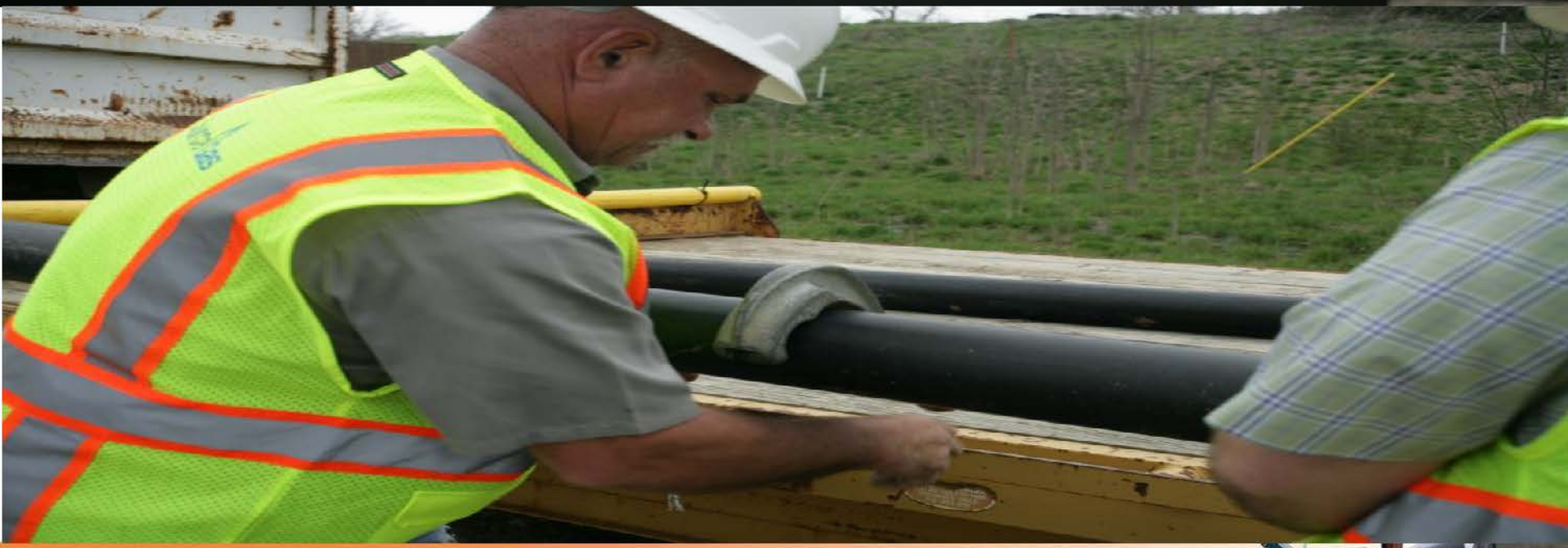
- Delrin insert tap tees
- Plexco service tee Celcon (polyacetal) caps.

ment F
ansportation


PLEXCO

Polyamides

PA 11 and PA 12



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To Protect People and the Environment From the Risks of Hazardous Materials Transportation

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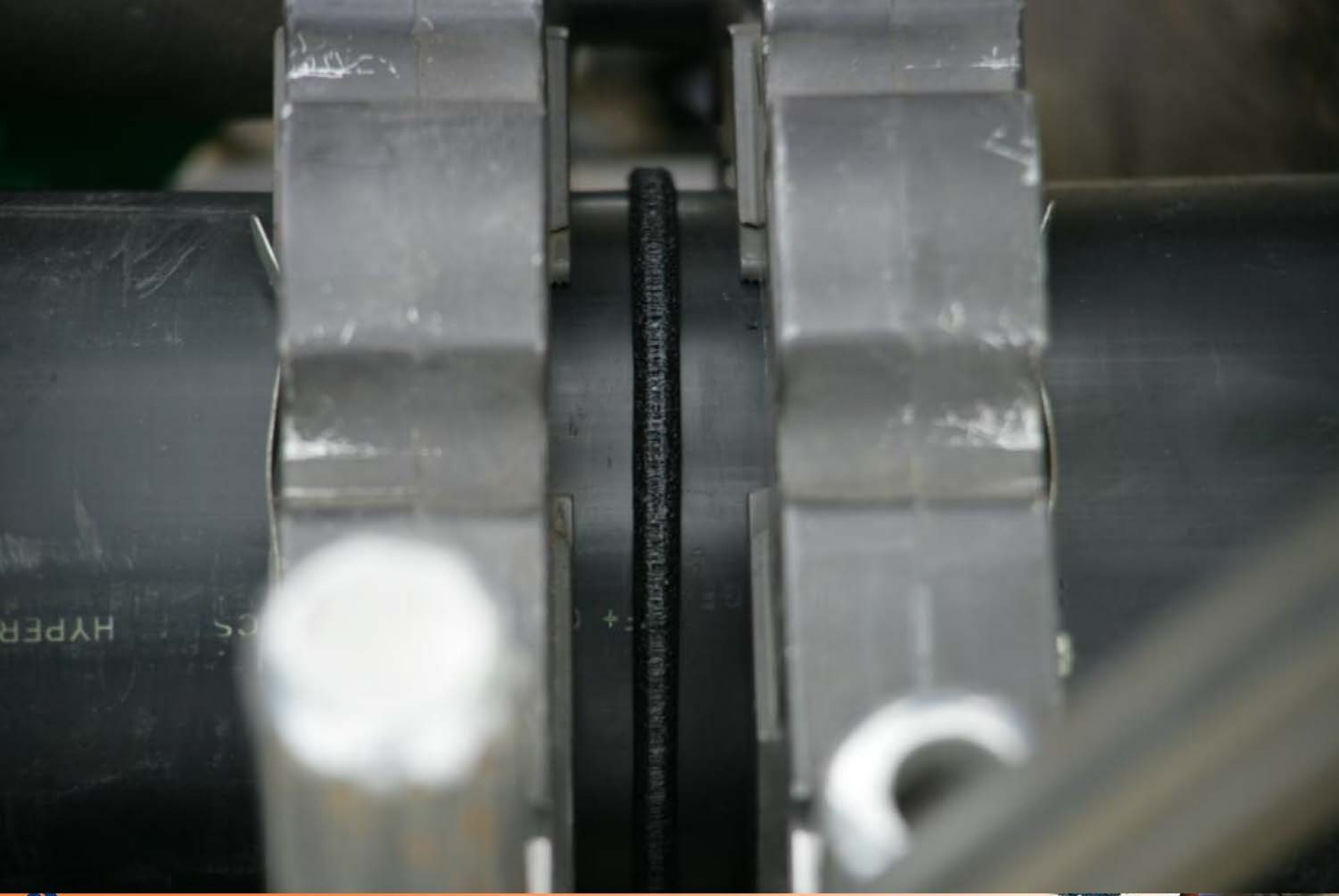

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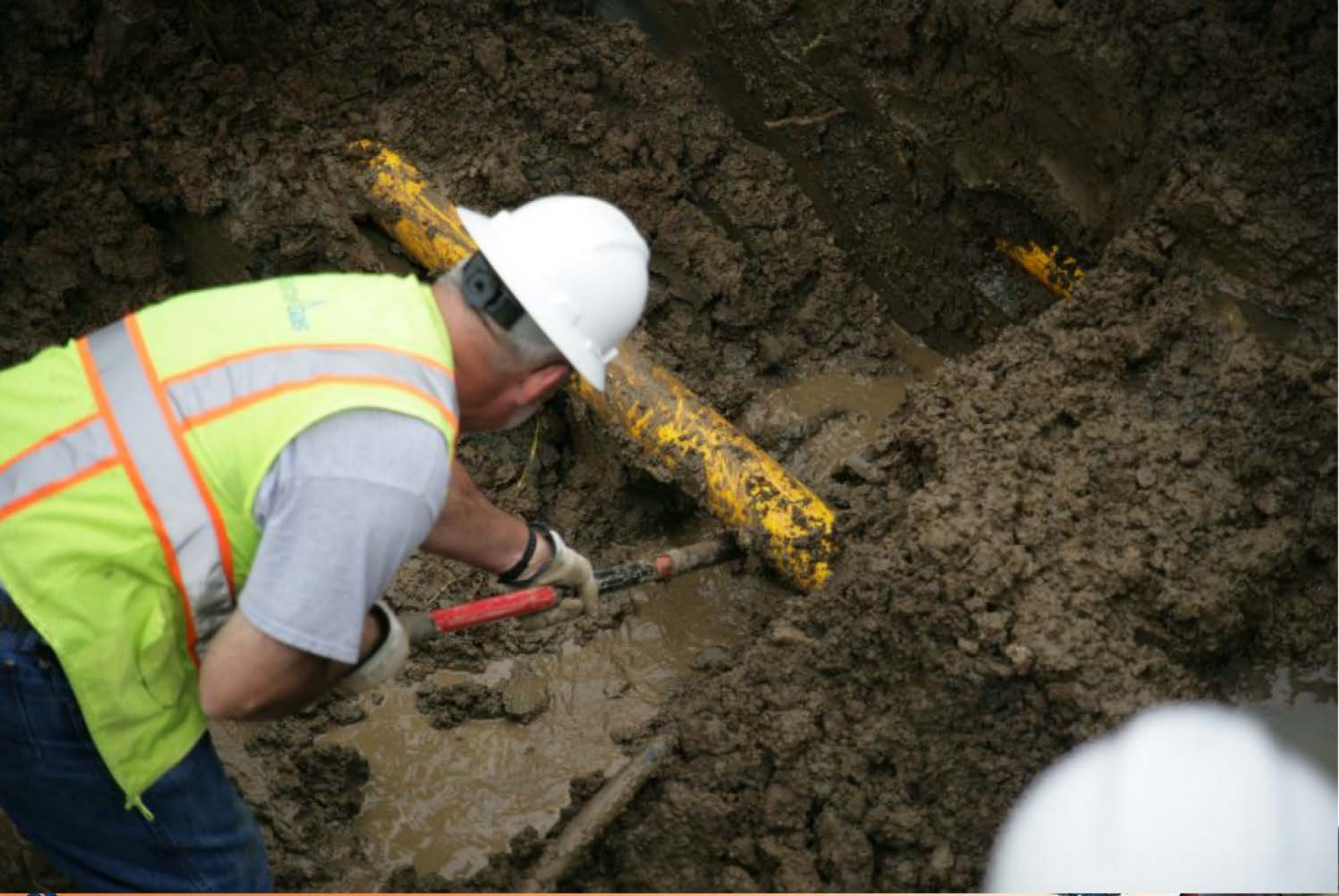

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4.5 inches


4.6 inches

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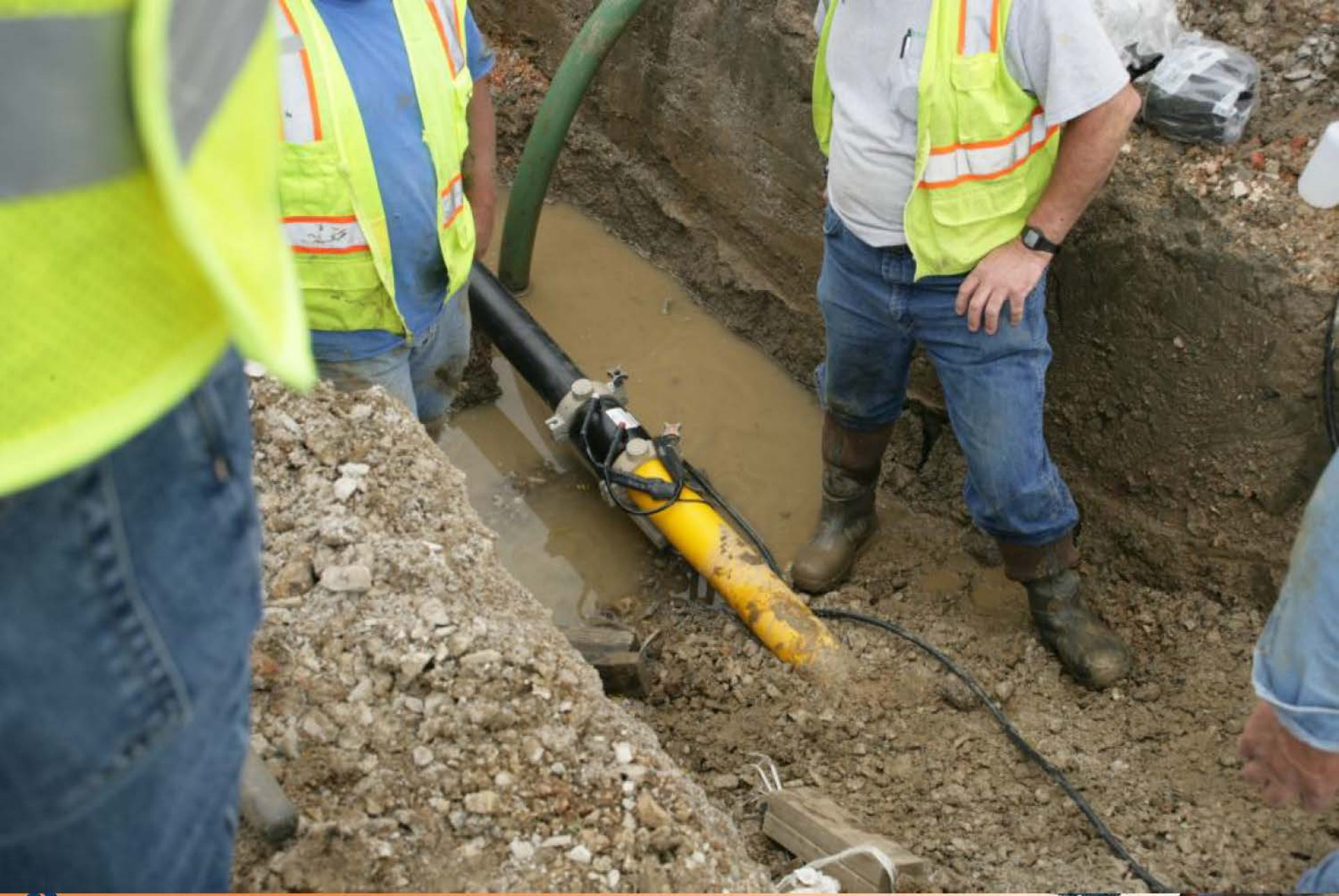

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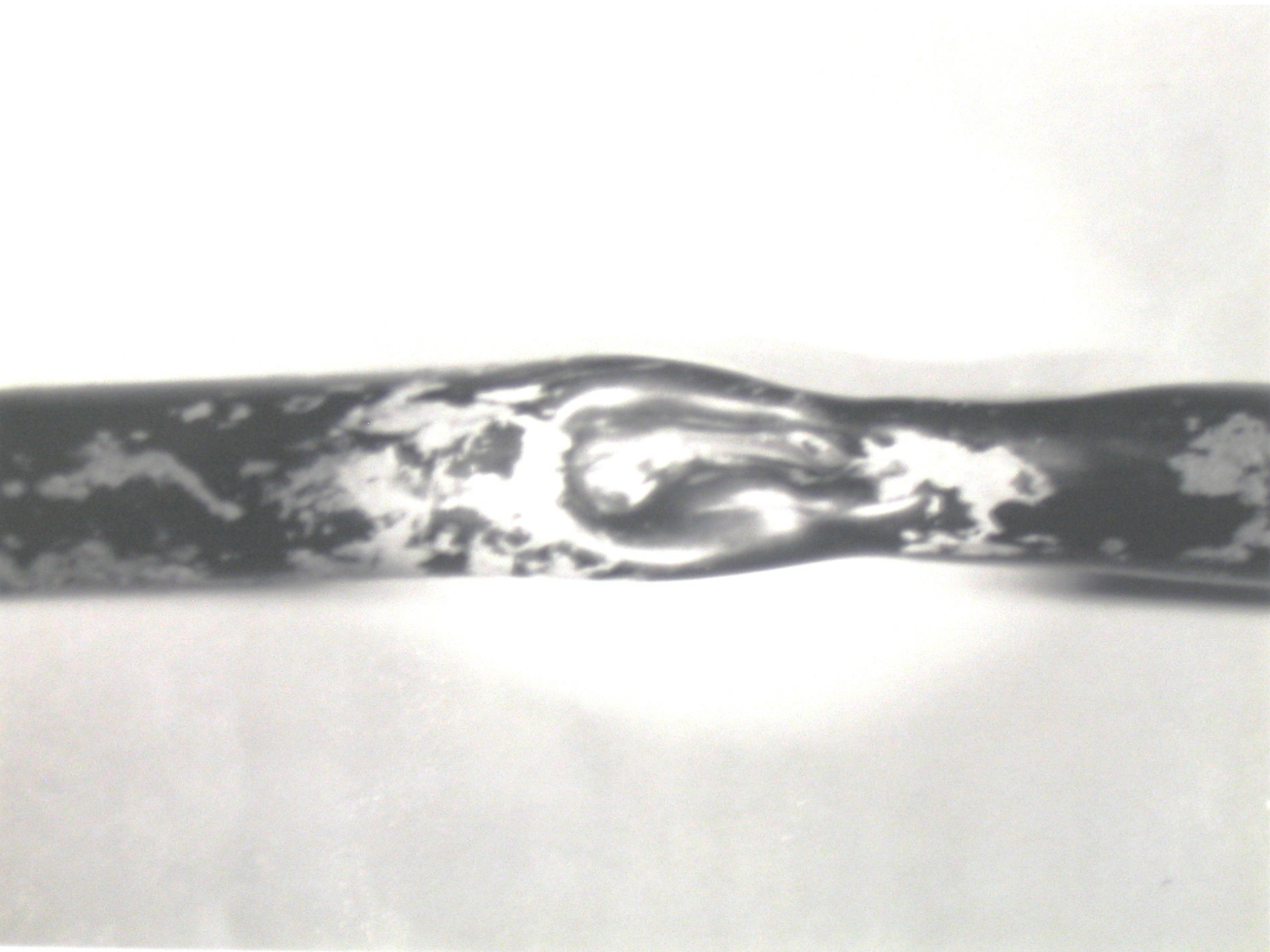
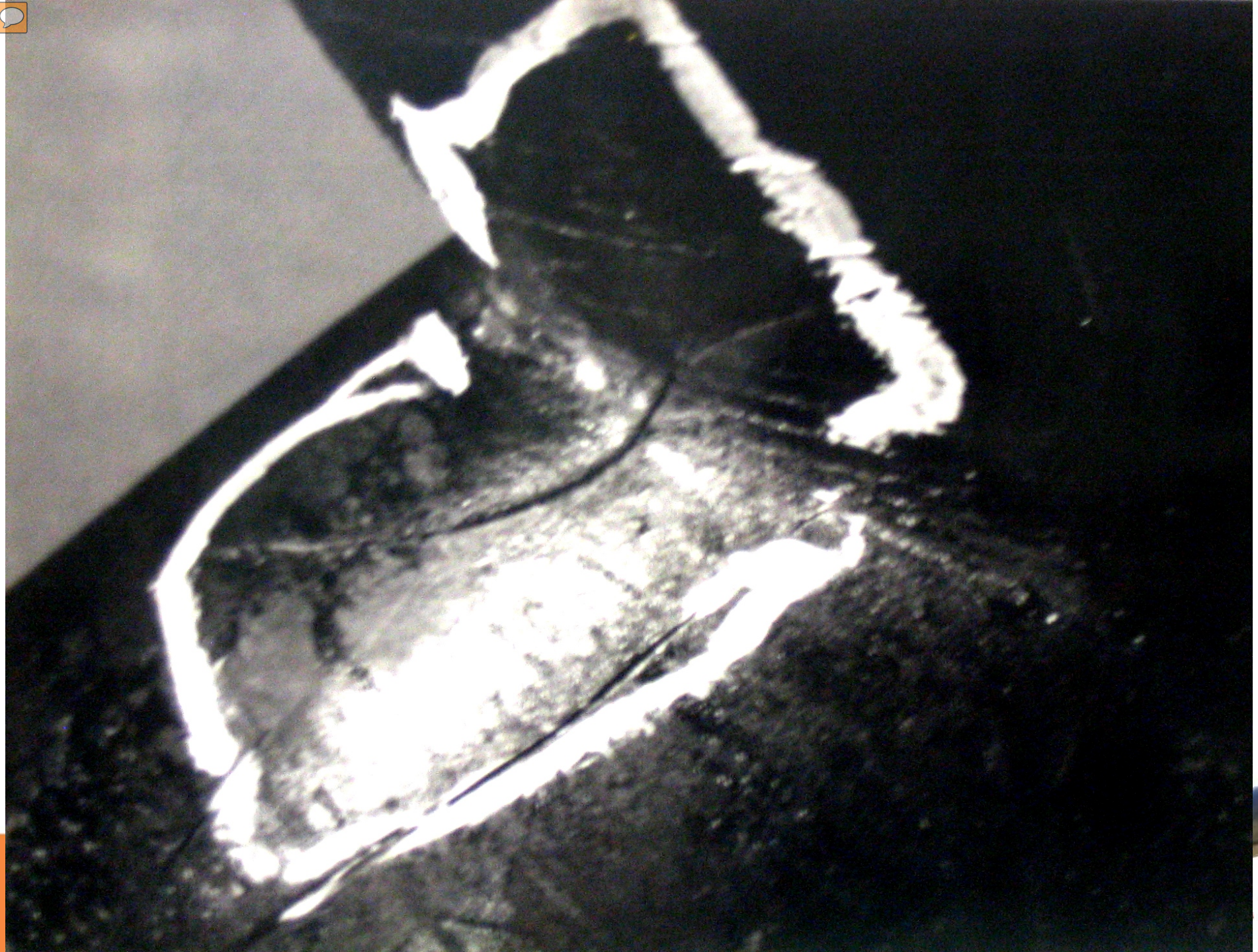
Other Issues





Ultra Violet Issues

Outdoor Storage/UV Exposure

- ASTM D2513-99 Outdoor Storage Stability
  - stored outdoors unprotected – 2 yrs. date of manufacture.
  - Over 2 yrs. must meet the requirements of this part
- Changed - effective March 6, 2015

ASTM D2513-09a

- March 6,2015 - No Rework - Section 4.2 Excepted
- 4.10 *Outdoor Storage Stability*—PE materials shall be Code C or E as defined in Specification D3350.
- Code C material
  - contain 2 to 3 percent well dispersed carbon black, and due to the absorptive properties of the carbon black,
  - considered to be stabilized against deterioration from unprotected exposure to UV for not less than **10 years**.
- Code E material
  - shall be stabilized and protected against deterioration from unprotected UV exposure for not less than **3 years**.

Federal Code

§192.321 Installation of plastic pipe.

- (g) Uncased Plastic pipe may be **temporarily installed above ground** level under the following conditions:
- (1) The operator [a person who engages in the transportation of gas] must be able to demonstrate that the **cumulative aboveground exposure** of the pipe does not exceed the manufacturer's recommended maximum period of exposure or 2 years, whichever is less.
- (2) The pipe either is **located where damage** by external forces is unlikely or is otherwise protected against such damage.
- (3) The pipe adequately resists exposure to ultraviolet light and high and low temperatures.

ASTM D2513-09a - PE only

- PHMSA incorporate ASTM D2513-09a,
- "Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings,"
- Except Section 4.2, "Rework Material."

The revisions are summarized below:

- § 192.7, ASTM D2513-09a **incorporated by reference**
- § 192.59, **new paragraph (d)** to prohibit rework after the effective date of this final rule and used in pipeline systems subject to Part 192.
- § 192.63(a)(1), clarifying that ASTM D2513-87 applies to plastic pipe and fittings made of **materials other than polyethylene**.
- § 192.123(e)(2), stipulate ASTM D2513-09a for **PE pipe only**.
- § 192.191, clarifying that ASTM D2513-99 is applicable to plastic materials **other than polyethylene**.
- § 192.283(a)(1)(i), clarifying that ASTM D2513-99 is applicable to plastic materials **other than polyethylene** and is adding a reference to ASTM D2513-09a applicable to polyethylene plastic (PE) materials only.
- Part 192, Appendix B, Section 1, **adding ASTM D2513-09a to the list** of pipe specifications.

What Does that Mean?

- PE Pipe exposed to UV
  - Storage Code E – 3 years
  - Storage Code C – 10 years
  - Temporary Above Ground Code E or C – 2 years max exposure –date of manufacture
- Other Pipe exposed to UV
  - Storage and temporary above ground -2 years
- What about Yellow Stripe and 8100 Yellow coated?

Hydro Carbon Permeation Issues


07/11/2011

Appendix X1.7.2.2

- During the heat fusion joining of PE piping that has been in service
  - conveying fuel gases that consist of, or
  - that include heavier hydrocarbons, the
- PE surfaces being heated in preparation for fusion sometimes exhibit a *bubbly* appearance.
  - This bubbling is the result of the rapid expansion (by heat)
  - Causing passage of absorbed heavier hydrocarbon gases through the molten material.
- Heat fusion (butt, socket, saddle, or electrofusion)
  - Joint strength may be reduced by the presence of the heavier hydrocarbons.

When is it a concern?

- Pimputkar et al **(8)** concluded that for a system
  - **operating at 50psi** and
  - conveying a mixture of as high as 16 volume percent in methane
- the propane concentration in PE will be under 0.2 percent,
  - sufficient to sometimes show some bubbling, but
  - not high enough to effect any significant degradation in fusion strength.
- However, if the **concentration of propane in PE exceeds 0.2 percent,**
  - risk of a rapid and large drop in fusion strength.
- **Field tests** to verify the level of contamination and subsequent degradation of joint strength are **not currently available**.
- Therefore, in the case of PE pipe that has previously been installed in these types of services, one should use mechanical fittings to join or repair the pipe.

TR – 22 / 2013

- PE piping is the only approved plastic piping under NFPA 58, *Liquefied Petroleum Gas Code*, (vapor LP-Gas)
- Code-complaint, PE lines must transport gas only in a **vapor state**, and therefore, must operate at **30 psig or less to avoid LP gas liquefaction**.
- Vapor LP-Gas is one of those fuel gases, which can be safely piped in PE gas piping systems.
- codified under US DOT CFR Title 49 Part 192. By reference, **Part 192 identifies ANSI/NFPA 58** – installation standard

NFPA 58 Restrictions

- Piping for vapor LP-Gas distribution.
- NFPA limits the size of PE piping to 2”
- NPS piping with a nominal OD of 2.375”.
- Maximum operating pressure of PE vapor LP-Gas piping systems to 30 psig.
- Refer to NFPA 58 for the details of these and other installation

USE RECOMMENDATIONS

- Plastic material to qualify for use as a vapor LP-Gas piping system
  - Recommended **by the manufacturer** for such use,
  - **Qualified** using vapor LP-Gas as the medium,
  - Hydrostatic design basis (HDB) category of **at least 1250 psi** (8.6 MPa) at 73°F (23°C)
  - **Design factor of 0.25** is recommended (see also PPI TR-9 on recommended design factors)
- NFPA maximum recommended **operating pressure of 30 psig** for LPG systems (see X1.3.4)
  - **Minimizes** the possible occurrence of condensates
  - Adequate consideration of the effect of LPG fuels on the **long-term strength of PE piping."**
- Studies that propane, propylene and butane, when in the liquid phase, can cause a greater **reduction in long-term strength**, up to 40 %.

Effects of Hydrocarbon Permeation PE Strength and Fusion Performance

- PHMSA R&D - objective of this project is to develop a validated method to be used by any plastic testing laboratory to quantify the effects of hydrocarbon permeation on:
  - 1) the fusibility of plastic pipe,
  - 2) the life expectancy of existing fused joints that have been subjected to hydrocarbon permeation,
  - 3) the Hydrostatic Design Basis (strength) of plastic pipe, and
  - 4) the impact on slow crack growth

- https://primis.phmsa.dot.gov/matrix/FilGet.rdm?fil=10327&c=1&s=31CB4A4F663746DD90401E9ABF4314FC

GTI Report 12-31-2015

- True stress strain curves at all temperatures **clearly show the softening effect** of the hydrocarbon permeation at low strains.
- Permeated materials are **up to 55% weaker** at low strains relative to non-permeated material.
- Strains below 30% the softening effect of the HHC permeation is equivalent to an approximately **20°C (36°F) temperature increase in non-saturated material** i.e. at 73°F the saturated material behaves like non-saturated material at 109°F.
- True stress and true strain at break are fairly constant for each material group with up to **20% reduction in strength at break**.
- The implications of these two findings are as follows:
  - i. Caution should be exercised in applications **where the creep resistance** of the polyethylene material is essential to the operation of the system.
  - ii. The long term hydrostatic strength of the pipes **may need to be reduced by 20%** to account for the break strength reduction.

Concern

- Mechanical Fittings.
  - Loss of Creep Resistance
  - Resistance to Mechanical Pullout
  - Could be impaired due to the softer material.
- May warrant further investigation
  - where hydrocarbon permeation is detected.
  - some utilities specifically use mechanical fittings

- NFPA 58 Guidelines?

How does the gas distribution industry use the information in this GTI Report that was funded by PHMSA and is currently on the PHMSA website?

Need Testing?

- For additional information on how GTI can test your pipeline to determine the chemical design factor in the presence of liquid hydrocarbons (from inside or outside the pipe) contact:

Dr. Gene Palermo
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(865) 995-1156

Dennis Jarnecke- GTI
Dennis.Jarnecke@gastechnology.org
(847) 544-3415

Be Careful and Be Safe

If it doesn't look right – It probably isn't....