the Energy to Lead

Track Session #3
Anomaly Detection/Characterization
Ongoing GTI Research and Industry Gaps/Needs

- PHMSA Government/Industry Pipeline R&D Forum
- June 24-25, 2009
- Washington D.C.
- by Daniel Ersoy, GTI

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Outline

Some Ongoing GTI/PHMSA/OTD Sponsored Projects Related to Anomaly Detection/Characterization:

1. Phase Sensitive Methods to Detect Disbonded/Continuous Coatings
2. Broadband Electromagnetic (BEM) Inspection of Steel/Cast Iron Pipes
3. Determining Leak-Rupture Boundary for Low Stress Pipe
4. Non-metallic Joint Quality Assessment

Industry Gaps/Needs Remaining - Metallic and Polymer Systems

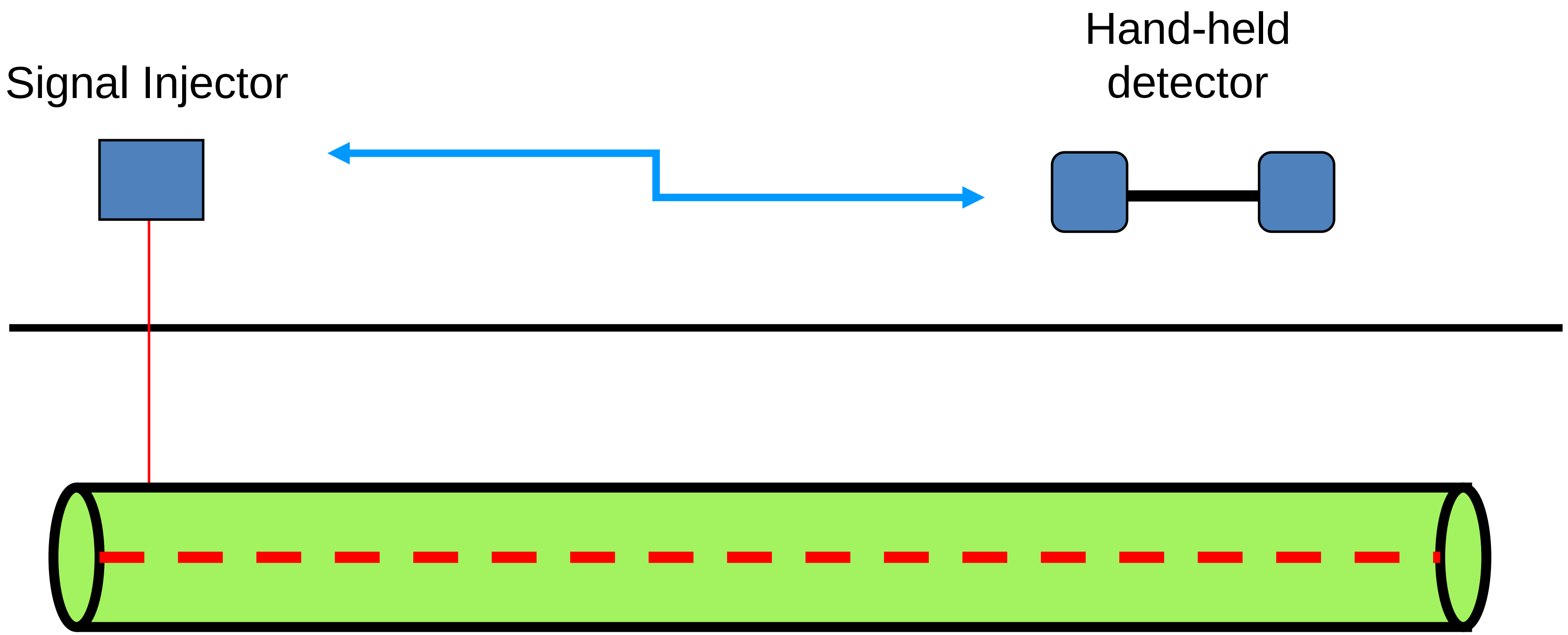
1. Phase Sensitive Methods to Detect Disbonded/Continuous Coatings

- **Objective:** To investigate above ground survey techniques (e.g., similar to ACVG) using both *magnitude* and *phase* to detect disbonded coatings on buried steel pipes.
- **Sponsorship:** U.S. DOT/PHMSA and GTI Sustaining Membership Program (SMP).
- **Contact:**

Christopher J. Ziolkowski - chris.ziolkowski@gastechnology.org

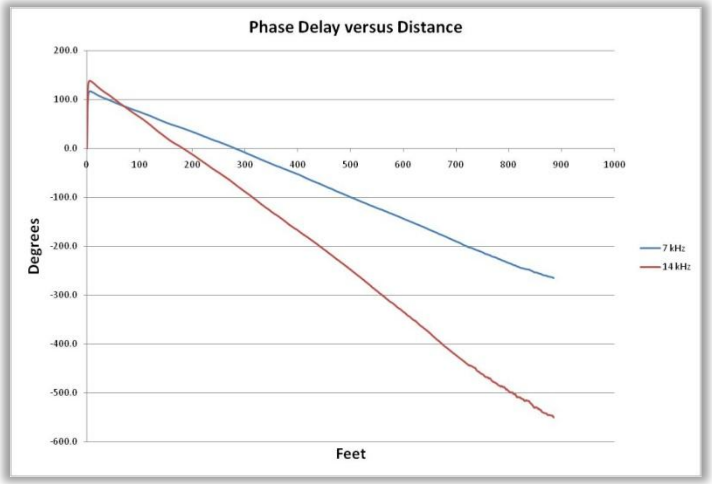
Disbondment Detector

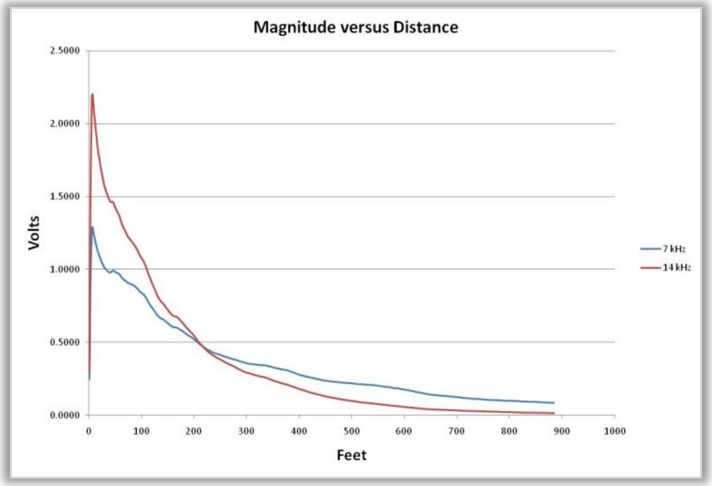
> Two components synchronized by a wireless link:
  - Signal injector connected to pipe, and
  - Hand-held detector.



Disbondment Detector

Prototype captures magnitude, phase, and odometer reading.





Disbondment Detector

> **Status:**

- Completed a working prototype,
- Successfully tested on lab fabricated disbondments,
- Completed a 900 foot local utility pipe segment assessment.
- Excavations have shown disbondment detector has initial agreement with other above ground surveys and excavated condition (anomalies).

> **Next Steps:**

- Additional validations needed. Soliciting funding to locate and excavate suspected disbondments that would not be investigated (excavated) under normal procedures.

2. Broadband Electromagnetic (BEM) Inspection

> **Objectives:**
  – Demonstrate the effectiveness of BEM, and
  – Provide training to participating utilities.

> **Sponsorship:** provided by Operations Technology Development (OTD), NFP and U.S. DOT/PHMSA.

> **Contacts:**
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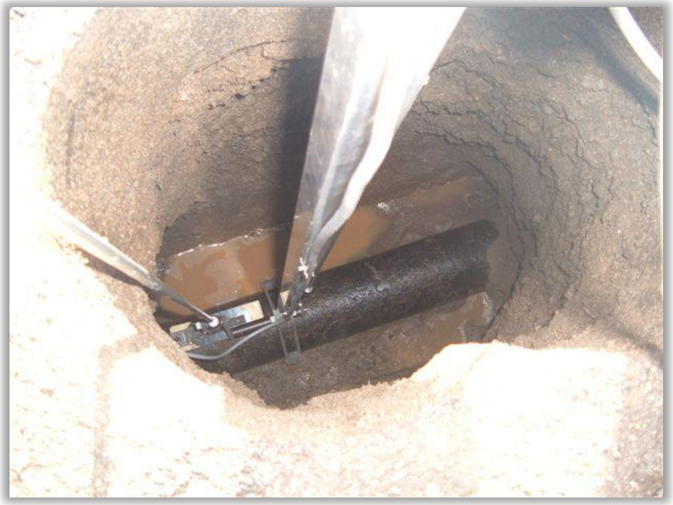
  – Technical - Christopher J. Ziolkowski chris.ziolkowski@gastechnology.org

Broadband Electromagnetic (BEM) Inspection

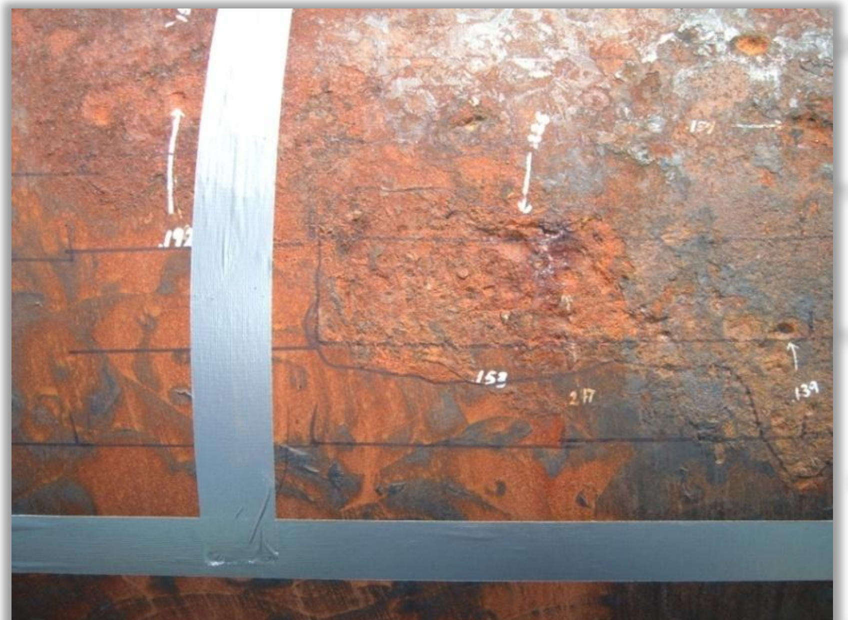
> **Background:**
  - The BEM uses a magnetic field to induce a current in the pipe.
  - These currents produce a decaying secondary magnetic field influenced by the pipe material.
  - Analysis of this secondary magnetic field provides an indication of the state of the pipe (e.g., wall thickness).

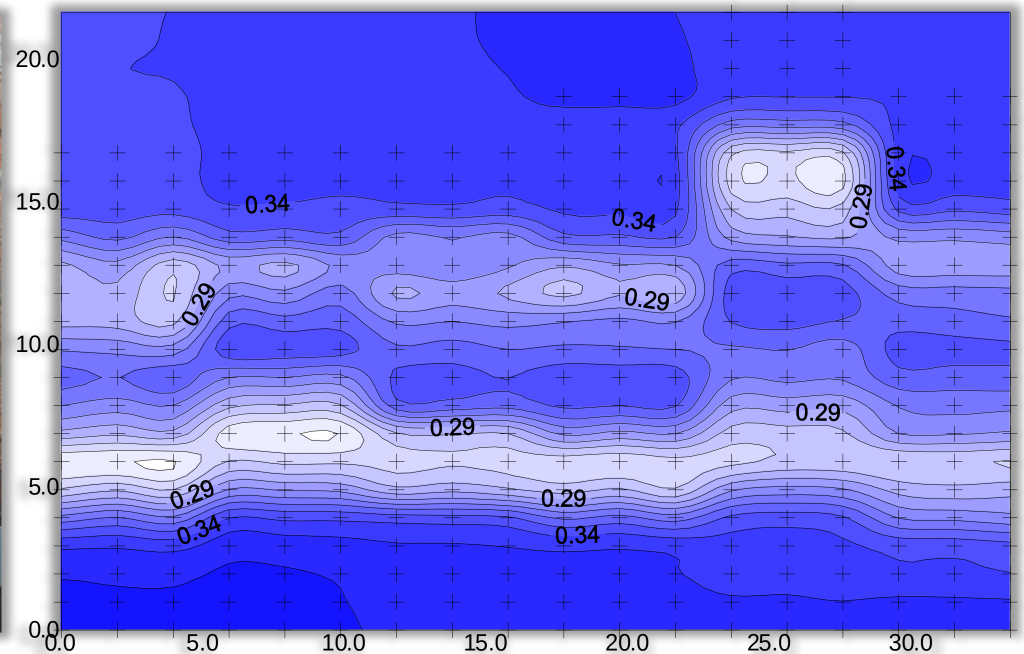


> **Problems/Needs:**
  - Measure wall loss on metal piping without the need to remove the coating, and
  - Perform direct assessment examinations within a keyhole.

Broadband Electromagnetic (BEM) Inspection

Example Scan





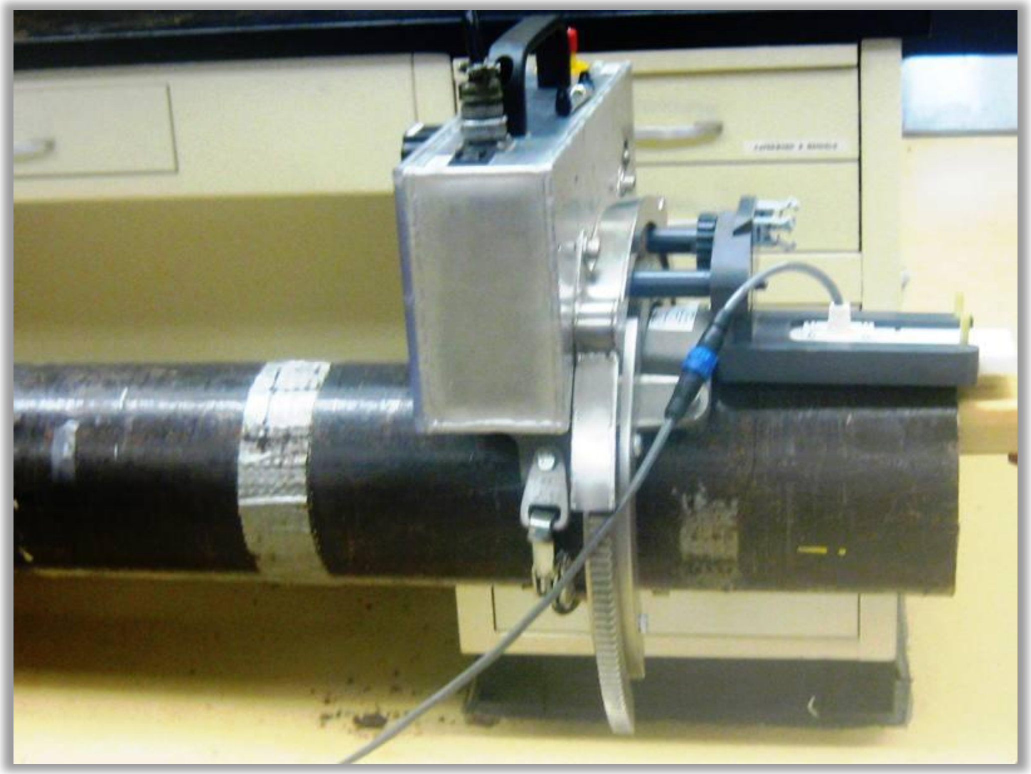
Broadband Electromagnetic (BEM) Inspection

> **Status:**

- Laboratory validation of the BEM sensors with Full Encirclement Unit (FEU) has been completed.

> **Next Steps:**

- Enhancements to the BEM,
- Documentation and procedures for the effective use of BEM, especially in a keyhole, and
- Perform Field Evaluations.



3. Determining Leak-Rupture Boundary for Low Stress Pipe

> **Objectives:**
  - Using the latest incident & full-size testing data and mathematical models, determine the leak-rupture boundary as a function of pipe materials/vintage, construction practices, size (diameter/wall thickness), etc.;
  - This will provide regulators and operators with information, based on sound engineering principles, that allows the selection of the most appropriate integrity management process.

> **Sponsorship**: provided by Operations Technology Development (OTD), NFP.

> **Contacts:**
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    - Daniel Ersoy daniel.ersoy@gastechnology.org

Determining Leak-Rupture Boundary for Low Stress Pipe

> **Problems/Needs:**

1. U.S. DOT Part 192 Subpart O - all transmission segments in High Consequence Areas (HCAs) to complete a baseline assessment by December 17th, 2012 and pipeline operators want to ensure that their limited assessment resources are focused on the highest risk segments in HCAs.
2. Many past studies indicate that failure by rupture occurs at a pressure that produces a hoop stress above 30% of the pipeline's SMYS.
3. Operators need the technical basis to understand which segments could possibly fail by leak versus rupture, and
4. Regulators need the technical justification that forms the basis for allowing alternative integrity management options including the potential for allowing low stress pipelines to be included under Distribution Integrity Management regulations.

Determining Leak-Rupture Boundary for Low Stress Pipe

> **Major Tasks:**

1. Set up Steering Committee and Stakeholder Group (done),
2. Conduct Incident and Full-Scale Testing Review:
    - Compile Reports/Information which Contain Incident Reviews (focus >1999 for U.S. and all dates for International),
    - Collect, Organize, & Summarize all U.S. and International Applicable Codes, Regulations, and Standards (noting low-stress "call outs"), and
    - Categorize Incident Review by Multiple Parameters (steel type, wall, diameter, etc.).
3. Mathematical Modeling:
    - Identify Categories of Safety Threats (Mechanical Damage, Corrosion, etc.),
    - Model Selections Based on Root-Cause Categories, and
    - Validate Model Results Based on field, lab, numerical analysis data.
4. Stakeholder Reviews and Final Report.
5. Standards Input.

Determining Leak-Rupture Boundary for Low Stress Pipe

> **Status**:
  - Commissioned Steering Committee and Stakeholder Group,
  - Drafted Requests For Proposals (RFPs) for the Incident Review and Mathematical Modeling Tasks; sent RFPs to 10 potential contractors,
  - Received nine (9) proposals, currently under review, and
  - Will kickoff the Incident Review and Modeling Tasks in July 2009.

> **End Result**:
  - Report summarizing incident review and modeling tasks regarding the predicted failure boundary. It will be broken out by:
    - Different pipe materials, vintages, sizes (diameter and thickness), weld types, etc., and
    - There may be multiple leak-rupture boundaries depending on the pipe material, construction practice, and size/dimensions.

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4. Non-metallic Joint Quality Assessment

- **Objective:**
  - To develop ultrasonic data analysis methods and scan patterns for inspecting the fusion quality of PE heat fusion joints including socket fusion couplings, tees, and saddle fittings and electrofusion (EF) couplings and saddle tees.
  - To develop ultrasonic data analysis methods to determine ovality and pipe insertion angle after the joint is made.
- **Sponsorship:** Operations Technology Development (OTD), NFP, DOT/PHMSA
- **Contacts**:
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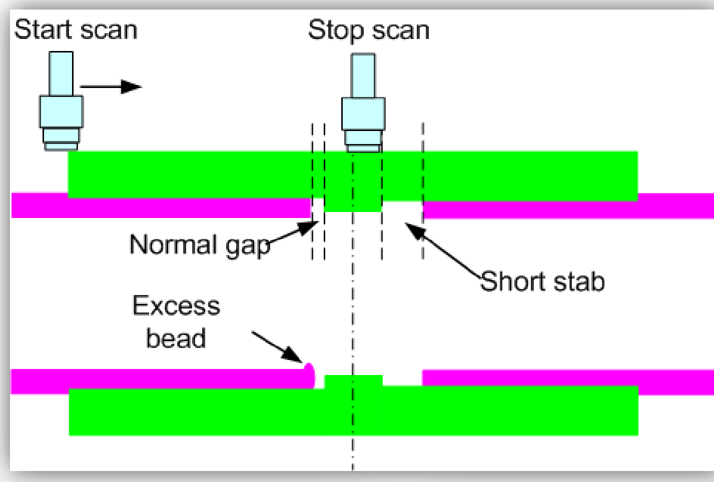
Non-metallic Joint Quality Assessment

> **Need:**
  - To determine the quality of heat fusion joints for plastic pipe, and
  - To have automated inspection techniques that require minimum expertise of non-destructive testing by the operator.

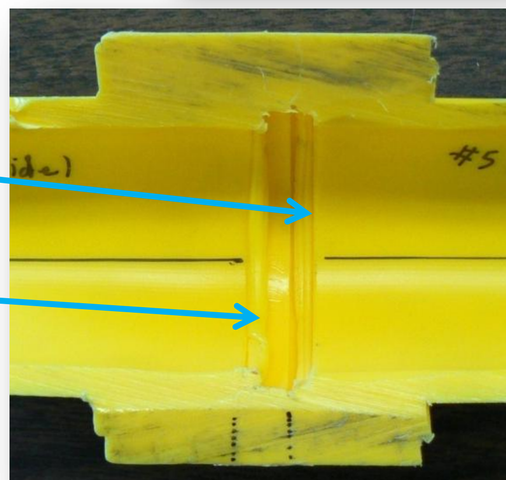
> **Value to the End User:**
  - Improved safety and reduced costs because poor quality joints will be identified and eliminated before they are buried, and
  - Elimination of joints that exceed ovality limits.

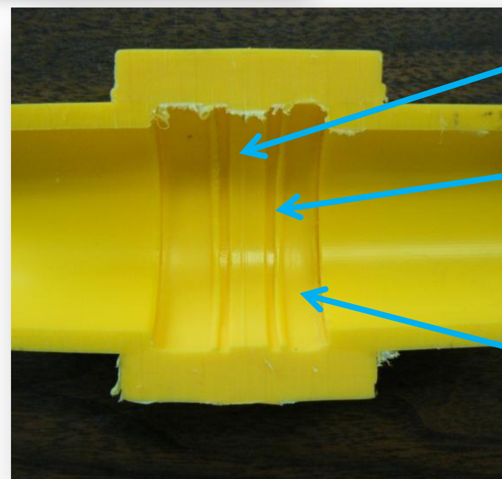
Non-metallic Joint Quality Assessment



Normal bead

Excess bead





Step in coupling

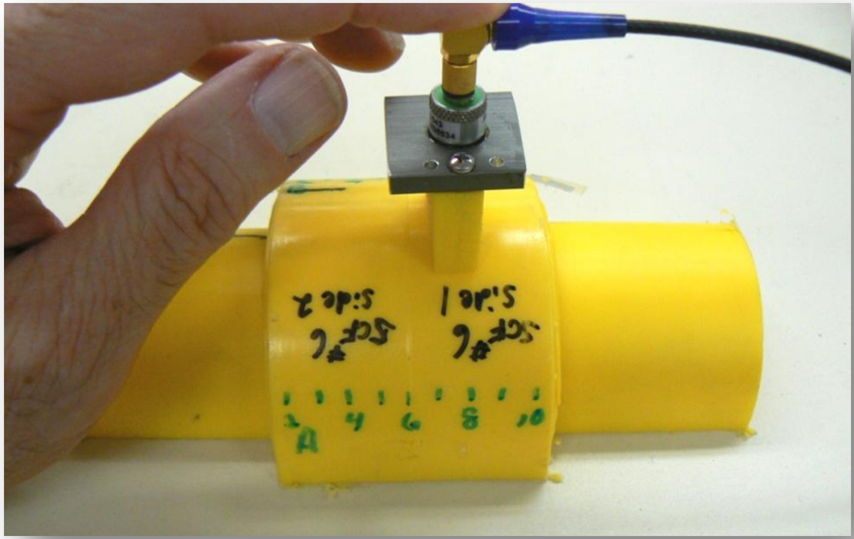
Bead formed in heating coupling

Short stabbed

Examples of detectable features

Non-metallic Joint Quality Assessment

> **Status:**
  - Determined scan patterns for various fittings,
  - Developed analysis techniques that do not require the operator to view waveforms,
  - Developed techniques to determine ovality and angle of pipe insertion after the joint is made, and
  - Correctly identified flaws in socket tee joints that failed in the field.
  - Currently working on development of analysis methods for EF fittings, then
  - Complete final report.



Industry Needs/Gaps - Metallic and Polymer Systems

Metallic System Gaps

1. Above ground technique to detect graphitic corrosion and cracking in cast iron pipes.
2. Above ground (or in pipe) method to determine the difference between metal loss due to corrosion and/or mechanical damage (dents, bends, gouges, etc.).
3. Extend Guided Wave inspection range to allow longer crossing inspections and develop a fitting to facilitate keyhole-based GW inspections.

Polymer/Plastic System Gaps

1. Above ground (or in pipe) method to locate plastic pipe butt fusions and fittings (e.g., saddles, couplings, tees, etc.).
2. Develop a nondestructive evaluation (NDE) method to detect anomalies in fused sockets, couplings, saddles, etc. (i.e., beyond just butt fusions).
3. Foundational study to characterize anomalies in composite (e.g., reinforced thermoplastic) pipe, fitting, and joining methods.
4. Determine the anomaly damage thresholds for modern plastic materials (e.g., bimodal, high density PE's) related to: squeeze-off, bending, and appurtenance / fitting affects.

>QUESTIONS ?