

## Development of an NDE Ultrasonic Inspection System for PE Butt Fusion Joints

**Description:** To develop an effective non-destructive instrument for examining PE pipe joints.  
**Status:** Design and fabrication of simulated “defects” in butt fusion joint samples are complete. Design and fabrication of “cold fusion” joint samples and detection are underway. Ultrasonic inspection system is under development.

### BENEFITS

Inspection of PE butt fusion joints has typically been performed by visual inspection. Under certain inspection parameters, the inspector would perform a visual examination of the butt fusion joint and judge it to be acceptable. The software and hardware developed in this project will provide additional inspection techniques to thoroughly examine the entire joint’s integrity. Construction inspectors and classroom instructors will have a means of performing non-destructive (NDE) butt fusion joint inspection beyond a visual and surface examination. The entire joint or volumetric examination of the butt fusion pipe wall and joint faces reveals the existence of any indication of “cold fusion”, delamination or debris that may affect the overall pressure retaining capability of the pipe.

### BACKGROUND

PE pipe has been used successfully by the gas industry for nearly four decades for distribution mains and residential services. Although failures of PE butt fusion joints occur infrequently, typically the cause is improper fusion. Previous efforts to develop NDE technologies to evaluate butt fusion joint integrity have been limited and never fully accepted or pursued. Past NDE technologies include the UltraMac (ultrasonic [UT] application), AIM 33 (phased array UT) and WZIM (requiring joint de-beading and surface analysis). At present there are no widely accepted devices to perform NDE on butt fusion

joints volumetrically. Figure 1 illustrates a typical butt fusion joint pipe cross section with roll back on the pipe outside diameter (top), inside diameter (bottom) and fused pipe wall faces (center). The pipe wall face (or volumetric) examination is the focus of this project.



Figure 1: PE Pipe Butt Fusion Cross Section

Advanced PE materials of today offer stronger, tougher and longer lasting pipe applications capable of larger diameters and higher pressures. NDE inspection of butt fusion joints reduces the risk of internal weak points which might affect the overall pipe integrity.

As a result, there is an industry need to better understand fusion parameters and defects impacting joint integrity and to develop an effective NDE instrument for evaluation. Figure 2 illustrates a portion of the prototype inspection instrument.

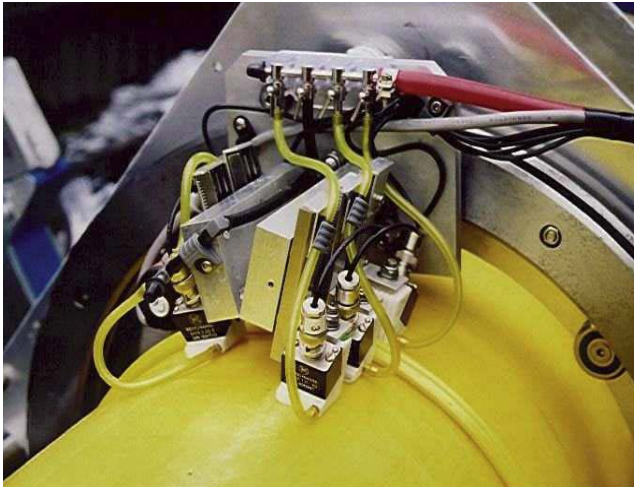


Figure 2: Prototype NDE UT Pipe Inspection System

### TECHNICAL APPROACH

An NDE UT instrument is being developed based on PE piping characteristics and long-term integrity testing results. Software interpretation of the NDE UT information will determine if the integrity of the joint is acceptable.

The objectives of the project are to: 1) determine detection capabilities of NDE UT for flaws in butt fusion pipe joints, 2) determine critical flaw sizes and quantities that reduce the short-term/long-term integrity of butt fusion, 3) design and develop an NDE UT system for inspecting butt fusion joints based on integrity testing results, and, 4) perform inspection trials and training of the new NDE system on various PE joints at NYSEARCH member company locations. Laboratory testing is being performed involving short term tensile tests on (72) pipe specimens and long-term “Whole Pipe Tensile Creep Rupture Testing” on (38) butt fusion pipe sections. These tests are to quantify the defect’s impact on butt fusion joint integrity and long-term performance.

### PROGRAM STATUS

The design and fabrication of “defective” joints have been completed and prototype NDE UT inspection components have been adapted for butt fusion inspection. The design and fabrication of “cold fusion” joints are underway and volumetric NDE UT is revealing identifying characteristics. The next steps will be to apply long-term testing of the “defective” pipe to evaluate the effects on joint integrity. The final step will be to complete design of the NDE UT instrument to characterize actual joint defects and provide an unbiased determination on its integrity.

### Highlights

- Automated and unbiased butt fusion inspection.
- Non-destructive, volumetric examination
- Targeted to detect “cold fusion”, debris and integrity problems in butt fusion joints.

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