



MWM-Array Characterization of Mechanical Damage and Corrosion DOT 460: DTPH56-10-T-000009

OPS ACCOMPLISHMENTS

Pipeline Safety Research and Development for Focus area

Challenge

To deliver a cost competitive, easy-to-use and reliable tool for "in-the-ditch" characterization of mechanical damage (MD) and stress corrosion cracking (SCC) for buried pipelines, as well as internal and external corrosion imaging through insulation and weather protection (called corrosion under insulation, CUI) for exposed pipelines. Specific technical challenges include: (i) repackaging of the JENTEK MWM-Array technology (currently in use for commercial and military aircraft engine and spacecraft inspection) for field inspections of pipelines; (ii) detection of corrosion and SCC through coatings and insulation including internal corrosion, from outside the pipeline; and (iii) high-resolution imaging of mechanical damage including defect geometry and stress.

An SBIR Success Story: Funding began with two DOT PHMSA SBIRs. Follow-on work is ongoing under PHMSA BAA funding and substantial matching funds from Chevron, the Pipeline Research Council International (PRCI), pipeline operators and other oil majors. Total DOT funding: \$1,200,000, non-government funding over \$1,500,000, to date. Over 40 patents have been issued to JENTEK.

Technology Description

The MWM-Array is an inductive sensor that operates like a transformer in a plane. The MWM-Array is based on the original MWM[®] (Meandering Winding Magnetometer) developed at MIT in the 1980s. A rapid multivariate inverse method converts impedance data into images of surface geometry (from the lift-off response), stress and microstructure changes (based on the permeability response) and metal loss from a combination of the lift-off and wall thickness images. Ongoing tasks in the DOT 460 program are to develop (i) enhanced characterization capability for mechanical damage; (ii) low-frequency internal corrosion imaging; (iii) enhanced SCC/corrosion imaging through coatings (iv) investigate weld inspection capability; (v) scanners and durable packaging for field and (vi) to perform evaluation of capability, transition planning, and begin development of manuals and standards. The option program includes additional tasks with expanded focus on cracks and welds. The MWM-Array technology and MR-MWM-Array (that uses solid state sensing elements for deeper penetration) provide both cost reduction through rapid and convenient field inspections and enhanced damage assessment to support safe pipeline operation.



Successful Field Demonstration of MWM-Array Mechanical Damage and Crack Imaging.

Accomplishments

- ◆ Demonstration of detection capability for CUI, MD, SCC and fatigue cracks (under DOT 304) and preliminary In-Line Inspection (ILI), i.e., inspection from inside the pipe, capability (under DOT 306), following SBIR funding.
- ◆ Successful development of initial mechanical damage characterization capabilities, including residual stress/microstructure imaging, magnetic profilometry, and SCC imaging with and without coatings.
- ◆ Successful field demonstrations of mechanical damage imaging, as a feasible method for verifying and ranking ILI detections in-the-ditch.
- ◆ Successful field demonstrations for SCC cluster mapping, with ongoing development of crack depth estimation capability for SCC assessment.
- ◆ Successful laboratory capability demonstration for CUI, with field trials planned for late 2011 (Demo target is 2 in. insulation with metallic weather protection layer).
- ◆ First pull-test demonstration of MWM-Array ILI tool prototype for metal loss.
- ◆ Over \$1,500,000 of funding from target customers including oil companies, PRCI, pipeline operators and service providers.

Contact

AOTR name: James Merritt

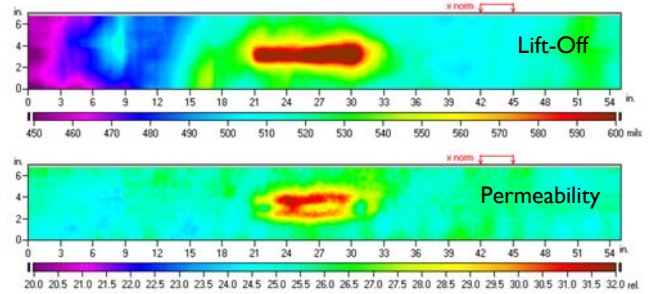
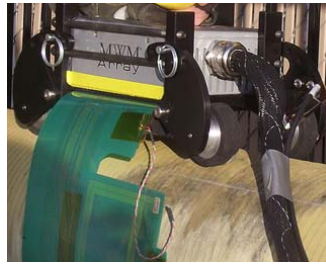
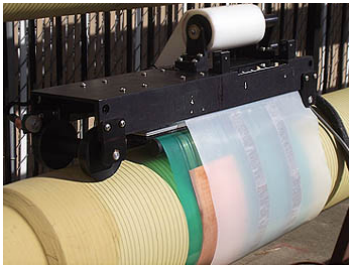
Agreement Officer Technical Representative (AOTR)

Office phone number:
(303) 683-3117

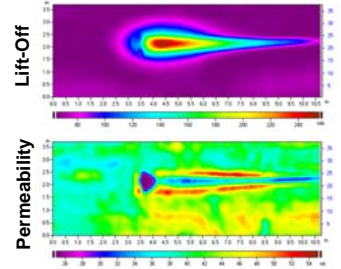
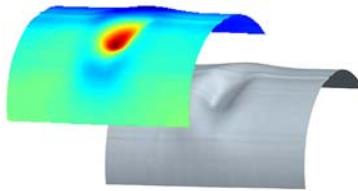
E-mail address:
james.merritt@dot.gov

JENTEK Principle Investigators:
Dr. Neil Goldfine,
Dr. Andrew Washabaugh,
Dr. David Jablonski,
Mr. Todd Dunford
Office phone number:
(781) 642-9666
Email: jentek@shore.net

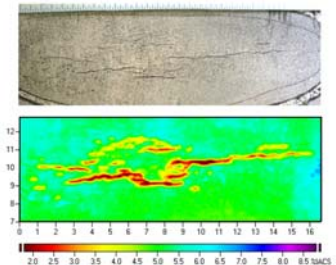
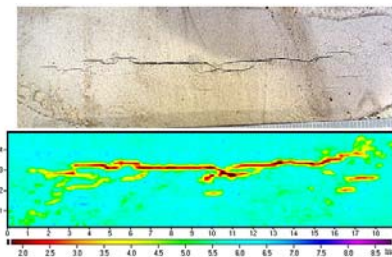
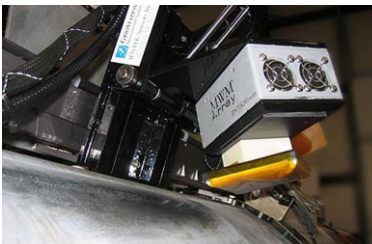
CUI: Corrosion Under Insulation



MD: Mechanical Damage Imaging



SCC: Stress Corrosion Cracking



Benefits

This research will advance pipeline safety by providing new methods for (i) in-the-ditch ranking and verification of ILI indications, including mechanical damage, corrosion and SCC; (ii) CUI imaging for both internal and external corrosion from outside of above ground pipelines, to enable more frequent inspection at substantially reduced costs for both piggable and unpiggable lines; (iii) convenient, low cost, durable in-the-ditch and above ground packaging for field inspections, and (iv) potential for development of a low cost ("cleaning tool integrated") ILI solution.

Future Activities

In the remainder of this project, JENTEK Sensors will (i) further develop the CUI capability, targeting inspection thru 2-in. insulation with weather protection, (ii) improve packaging and field hardness of the system, (iii) develop the low frequency MR-MWM-Array technology with solid state sensing elements for wall thickness imaging (for metal loss characterization), (iv) enhance characterization capability for MD, SCC, and CUI, and (v) complete several field trials supported by oil primes and pipeline operators.

Partners in Success

- ◆ JENTEK Sensors, Inc.
- ◆ Chevron, Applus/RTD
- ◆ PRCI
- ◆ Pipeline operators and other oil majors



JENTEK[®] Sensors

