FINAL PROJECT SUMMARY REPORT

1. BUSINESS AND FIRM ADDRESS

Creare LLC, 16 Great Hollow Road, Hanover, NH 03755

2. DOT SBIR Program

U.S. Department of Transportation/OST-R

3. DOT CONTRACT

6913G620P800098

4. PERIOD OF PERFORMANCE

07/17/2020 – 01/15/2021

5. PROJECT TITLE

Robust, Field-Ready, Inline Tool for The Accurate Measurement of Pipe Bending Stresses and Crack Detection

6. SUMMARY OF COMPLETED PROJECT

Creare is developing robust, field-ready, inline inspection (ILI) tools for the accurate detection of cracks, other anomalies, and quantification of pipe bending stress. ILI tools are typically utilized to detect corrosion features, bends, and dents from the pipe interior. Common ILI technology may not accurately reflect the risk associated with mechanically damaged pipeline sections. For example, while pipe wall operating stresses may safely exceed 70% of the yield strength, much higher local stress levels may be present around defects due to stress concentrations. Consequently, there is an immediate need for a quantitative method for assessing mechanical damage based on crack detection and for measuring stress.

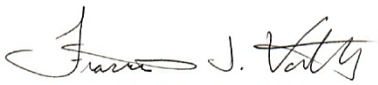
Our solution to address these technological challenges and the existing market gap, employs: (1) a novel Dual Frequency Nonlinear Ultrasound (DFNU) technique which has proven to be capable of detecting and characterizing cracks as small as 0.2 mm in length; (2) a magnetic flux leakage (MFL) technique that operates at high resolution; and (3) a magnetic Barkhausen noise (MBN) based stress measurement technique with closed-loop magnetic flux feedback control operating at millimeter-scale spatial resolution, making it ideal for monitoring local stress variations around defects, welds, and cracks. These sensors are integrated into modular, rugged, field-ready packages for inline transportation and pipeline inspection.

Our Phase I efforts focused on the fabrication and laboratory-level feasibility demonstration of the proposed sensing approaches. We created proof-of-concept facilities and explored and demonstrated: (1) the ability to detect cracks/defects using an innovative ultrasound technique

which captures the acoustic signature differences generated structural cracks; (2) the ability to detect cracks/defects using a magnetic flux leakage (MFL) technique; and (3) the measurement of bending/tensile stress using magnetic Barkhausen (MBN). Creare then took this information and lessons to further refine our modular sensor ILI platform design. Finally, we outlined a path to transition of our technology and created a teaming arrangement for Phase II and beyond.

Our successful Phase I results have provided a strong foundation for further technology development as part of our Phase II work. During Phase II, we plan to develop prototypes of the individual sensing platforms and conduct extensive laboratory testing. These tests will be used to evaluate and refine our tools' functionality and operation. We then plan to integrate our sensor prototypes onto an ILI robot and conduct higher fidelity tests. Finally, we plan to demonstrate the tools performance, during a Pilot study, at the Pipeline Research Council International (PRCI) test facilities; where we plan to invite PHMSA representatives, potential investors, and pipeline operators. These field demonstrations will introduce our technology to the oil and gas pipeline inspection community and lay the foundation for future commercialization.

APPROVAL SIGNATURES

Name	Title	Date
 Francisco I. Valentín	Principal Investigator	02/25/2021
 Nicholas Kattamis	Project Engineer	02/05/2021
 Robert Kline-Schoder	Sr. Technical Advisor and Company President	02/25/2021