Attachment J.1
FINAL PROJECT SUMMARY REPORT

PROJECT IDENTIFICATION INFORMATION

1. BUSINESS FIRM AND ADDRESS: Engineering Mechanics Corporation of Columbus (Emc^2), 3518 Riverside Drive, Suite 202, Columbus, OH 43221.

2. DOT SBIR PROGRAM: Pipeline and Hazardous Material Safety Administration (PHMSA) Research Topic No: 14.2-PH1; Research Topic Title: New non-destructive evaluation methods to quantify remaining strength of line pipe steel and or pipeline fittings.

3. DOT CONTRACT: CONTRACT NUMBER: DTRT5715C10023

4. PERIOD OF PERFORMANCE: From: January 29, 2015
To: October 28, 2015

5. PROJECT TITLE: A Novel Approach to Establishing Remaining Strength of Line Pipe and Fittings with Corrosion Type Defects

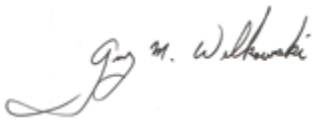
SUMMARY OF COMPLETED PROJECT:

The US DOT's PHMSA is exploring technologies and methods which could increase the integrity, reliability and safety of the U.S. pipeline network. Corrosion metal loss is one of the major damage mechanisms to gas transmission pipelines worldwide. Current methods to assess the remaining strength of corroded pipelines, such as the ASME B31G (including the Modified B31G) and RSTRENG models that have been incorporated into the US Code of Federal Regulations may be inadequate and perhaps non-conservative for higher grade line pipe, X65 and above. Also recent work supported by PHMSA has shown that existing methods may be non-conservative.

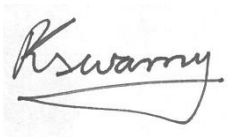
During this Phase 1 effort, Emc^2 has established the feasibility of a novel mathematical and computational model to assess the remaining strength of pipelines and fittings with natural corrosion type defects. Specifically, (i) the "Simulation of Natural Corrosion via Computation" (SNC^2) methodology has been successfully demonstrated to model corrosion type defects, (ii) carefully selected laboratory experiments were conducted to demonstrate that the remaining strength of pipe and fittings is strongly determined both by the grade of the steel and for older steels the failure criterion is a function of the notch acuity at the corrosion defect, especially in higher grade (> X65 or higher) steels, (iii) the failure behavior of an older low grade steel and a modern X80 steel had ductile tearing start prior to maximum load in the blunt flaw specimens, showing that a stress-based criterion for corrosion flaws with no crack initiation criterion would over predict the failure pressure, and (iv) the methodology can be successfully scaled for commercial, rapid-time application on the cloud using high performance computational clusters. The SNC^2 methodology would not only be applicable to old, new, and higher grade steels, but many conditions that cannot be addressed by the B31G type methods, i.e., high longitudinal stresses, corrosion flaws that might have greater circumferential extent than axial extent, multiple corrosion patch interactions.

The data in this final report shall not be released outside the government without permission of the contractor for a period of four years from the completion date (October 28, 2015) *of this project from which the data was generated.*

APPROVAL SIGNATURES



PRINCIPAL INVESTIGATOR (Signature)



PROJECT DIRECTOR (Signature)

Dr. Gery M. Wilkowski
PRINCIPAL INVESTIGATOR (typed)

Dr. Prabhat Krishnaswamy
PROJECT DIRECTOR (Typed)