# Eleventh Quarterly Report March – May 2016

Date of Report: *June 1, 2016*

Contract Number: DTPH56-13-T-000008

Prepared for: *Pipeline and Hazardous Materials Safety Administration, TransCanada Pipe Lines, Enbridge Pipeline, Marathon Pipe Line, and Koch Pipeline*

Project Title: "In-Ditch Validation Methodology for Determination of Defect Sizing"

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*Project Status*

***Item 35, 36, & 37 – Prepare Draft, Address Comments, and Issue Public Version of Phase-1 Report.***

The Phase 1 report is in progress and will be issued in June. A public version of the report should follow in July.

**Task 12 & 13 Evaluate IWEX performance under laboratory and field conditions**

***Item 42 –Equipment-IWEX unit for Kiefner metallurgical lab for evaluating IWEX performance under laboratory conditions.***

Currently the research unit is still available for use in Columbus. Eventually this unit will be exchanged for a production unit to be compatible with newer software for consistency in processing and interpretation. There are units available in Rotterdam when this becomes necessary.

***Item 52 – In-kind Purchase of IWEX units for Evaluation of IWEX performance under field conditions.***

An additional IWEX unit was acquired in Edmonton as an in-kind contribution to the project. This will bring the total number of IWEX units in North America to 4 including the research unit in Columbus. An additional unit is planned and will be acquired when necessary for the number of scans occurring. Processing units and transducers are ready and available in

Rotterdam and can be delivered upon project need, in addition linear scanners can be built in Houston with a short lead time.

**Task 14 Enhancement of the current data acquisition IWEX algorithm**

***Item 45 – Parameter study to find which parameters influence the IWEX image the most.***
***Item 46 – Develop and test enhanced IWEX data acquisition routines to determine wall thickness variations.***
***Item 71 – Develop Materials test setup for Enhanced IWEX data acquisition.***
***Item 61 Q13 Task 11 – Develop & implement field application software.***

The goal of Task 14 is to improve image alignment and focusing of the IWEX system by improving the understanding of various parameters. Items that may be affecting imaging are the wall thickness, pipe curvature, wedge standoff, etc. The goal is to improve the underlying assumed geometrical model of the system and the pipe and to develop procedures for implementing this on a routine basis in the field using modifications to the existing IWEX imaging software. Because this is a core competency of the Rotterdam physics group the work largely falls under their purview, with the help of the North American technical staff to provide a range of data on real pipe that can be used to study all of the potential variables.

Engineering assistance on the project from the Rotterdam Technical Competency Center returned in mid-quarter. Efforts have focused this quarter on analyzing data collected at the PRCI TCC. The data collected appears to suffer from a thick couplant layer between the pipe surface and the transducer wedge. This standoff appears to be caused by a thick layer of paint. The paint was used to map the areas for scanning on the pipes by the PRCI contractor responsible for running the testing exercise. Much of the effort focused on using this additional layer for quantifying standoff effects for proper image alignment. Because no samples produced significant wall thickness variations this parameter was not studied this quarter. Routines were developed to improve calibrations based on full matrix capture (FMC) data sets.

***Item 63 – Coordinate In-Kind Field and lab testing with enhanced data acquisition.***

Because of the multiple parameter studies, an attempt to better coordinate the field trials with the data parameter studies was initiated with the goal to make better use of data from ERW seams in the parameter studies. A variety of full matrix capture (FMC) data is being obtained from the in-kind trials in order to provide a variety of conditions to the Rotterdam group for these parameter studies.

An effort to compare SCC coupons with IWEX data has been delayed another quarter by the contributor supplying the samples until June or July. The SCC coupons will have CT scans performed and should eventually lead to 3-D comparisons between IWEX and the CT scans.

In-kind 8-in ERW laboratory trials were performed at the Kiefner lab. This consisted of testing 6 to 8 pipe pups with probable ERW seam anomalies. Data acquisition for these trials was completed in March.

In-kind trials on 30-in flash weld were conducted in the 11th quarter. The pipes were in Houston and the scans were completed in March.

A major coordination effort was conducted on 10 pipes at the PRCI TDC. Wouter Westerveld of the Rotterdam TCC who was in Houston for another project, was able to stay for an additional week to observe and assist with the scanning of these pipes. FMC's from these pipes are a significant part of the study.

**Task 15 Development of an automated defect detection, identification, & sizing module**

***Item 64 – Develop module for automatic and manual detection of features***

The goal of Task 15 is to develop interpretation software to speed and improve analysis of image files to produce reports describing the detection, identification, and sizing of anomalies. Originally this was an effort of the Rotterdam physics group; the amendment brings this effort closer to the personnel performing the inspections by linking a programmer more closely to the technicians performing inspections. The goal is to quickly detect features, assist inspectors in identifying the type of feature detected, and then if appropriate to develop a profile of the anomaly so that a failure pressure can be calculated for the feature.

Initial efforts were performed on automated detection and sizing by Ron Ostafichuk. The most significant achievement this quarter is an automated reporting feature which will allow faster reporting in the field. Currently it is estimated that for every day spent scanning in the field it takes 3 days of interpretation to produce a report. This enhancement will help reduce the laborious effort of reporting. Automatic detection and sizing are a critical part of the eventual effort needed to produce an efficient report. Improvements were made in this area, laying the groundwork for further improvements in upcoming quarters.

Next quarter will be working with the physics group in Rotterdam to improve upon automatic feature detection and sizing, in addition to collaborating on a compressed file format to reduce the image file size and allow easier sharing of files for interpretation and eventual sharing with operators and ILI vendors.

**Task 16 Development of an inversion algorithm**

The goal of Task 16 is to develop next generation imaging software to improve the accuracy of the image for identification and sizing of anomalies. Because this is a cutting edge task the staff working on this project is closely associated with the University of Delft group where the IWEX concept was born back in 2004-07. This quarter one of the doctoral students from the Delft group was hired to accelerate work on the project. Initial work will be with theoretical models of anomalies that are similar to features that could be found in real ERW seams or SCC in the pipe body. Toward the end of the project we hope to work with actual full matrix capture (FMC) data from the IWEX system.

***Item 50 – Develop Inversion scheme (Matlab).***

An initial inversion scheme has been developed with initial testing. The inversion appears to produce reliable results from these initial tests.

***Item 59 – Validate inversion method.***

Validation of the initial inversion scheme was started this quarter, but not complete. Validation must be done by a different scheme than the method to produce the initial modeling results. In this case validation data will be developed with FEA data. Later during other rounds of testing we expect to test using experimental data obtained on pipe. However this will need to wait for a more complete inversion model that includes the OD surface and a setup to simulated the wedges used in the current IWEX seam weld system.