



**10th QUARTERLY REPORT - PUBLIC PAGE
DTPH56-14-H-00002
"Full Scale Testing of Interactive Features for Improved Models"**

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1.0 Results and Conclusions

Task 2: Material Selection, Acquisition, and Characterization

ENGIE Lab CRIGEN continued the characterization work for Task 2b, including measuring the transverse and longitudinal tensile properties of Pipe 6. Pipe 8 underwent characterization as well, including chemical composition, perlite percentage, and micro-examination.

Task 4: Full Scale Testing of Complex Dents

Full scale dent fatigue test was carried out on Pipe D (24 inch OD, 0.375 inch wall thickness, Grade X-70). Restrained and un-restrained dents were using 4 inch round bar indenter. For un-restrained dents, the round bar indenter was transverse to the pipe axis and for restrained dents the round bar was along the pipe longitudinal axis. The test data recorded for the full scale tests includes indenter travel and force required to create the dent, strains, during indentation and cyclic pressure loading, dent profile and number of cycles to failure (leak).

Task 5a: Dent and Gouge Severity

Material characterization	PIPE 5 (24") Task 5a & Task 5b		PIPE 6 (12") Task 5a	PIPES 7 & 8 Defect removed from service Task 5c
	Pipe 5 characterized		Pipe 6 characterized	Pipe 7 characterized Pipe 8 in progress
Destructive characterization	5.4.1	5.5.1	6.6.1(**)	na
Burst test	5.4.2	5.5.2	6.6.2(**)	7.ext1.2
Pressure Swings Fatigue test	5.4.3	5.5.3	6.6.3(**)	na
Fatigue test & CP overprotection = environmentally assisted cracking	na	5.5.3.cp	na	8.ext2.3cp*
Fatigue test interacting defects, 2 spacings: i1 & i2 (Task 5b)	na	5.5.3i1 & 5.5.3i1' spacing 600 mm 5.5.3i2 & 5.5.3.i2' spacing 0 mm	na	na
Burst test combined with <u>axial</u> <u>load</u>	na	na	6.6.2a(**)	na
Pressure swings fatigue test with combined <u>axial</u> <u>load</u>	na	na	6.6.3a(**)	na
Numbering key: Pipe#.Defect type#.Test type#.Attribute with Test type#: 1 - destructive characterization, 2- Burst test, 3 - Fatigue test; Attribute: i interaction, cp cathodic protection, a axial load na: not applicable				
Legend			Defect created	
			Ongoing test	
			Destructive characterization / Burst test / Fatigue test performed	

Notes

*: 16" Pipe with defect removed from service is being characterized in Lab

**.: previous tool DIV00820 used to create defects on pipe 5 has been 'smoothed' into tool DIV00824 for pipe 6 thus numbering of defect is now 6.6.x instead of 6.5.x

The table above recalls the test matrix for dent and gouge defects. During this quarter, the tests that had been previously started were finalized. These tests are coded in green in the table.

Tool DIV00820 was reshaped so as to round off the edges following the tests results on Pipe 5 for defects 5.5.2 and 5.5.3 which were found too sharp at the gouge lateral edges.

Defect 6.6.1 was created. Defect 6.6.2 was created and submitted to a burst test. Graphs and results regarding this defect creation are in progress. Acquired experimental results are being processed.

Task 5b: Interaction between Defects

Defect 5.5.3 failed after 1792 fatigue cycles.

Defect 5.5.3i2 (adjacent to defect 5.5.3i2') failed after one cycle and it cannot be considered as a fatigue test. The following investigations are underway:

- ⇒ Material analysis
- ⇒ Extremely severe shape of the defect.

The analysis of recorded strain gauges' evolutions is in progress.

Task 5c: Dent and Gouge Defects Removed from Service

Pipe 8 was shipped to ENGIE Lab CRIGEN. The pipe was prepared for the fatigue test under cathodic overprotection. A piece of pipe was used to perform a polarization curve. The vessel was created and the defect dimensions will be measured again.

Task 6: SCC Colonies and SDO Modeling Coordination

The crack colony R154-im19 was replaced by a more readily available crack colony R156-im1. This colony will be used during the oil transmission pipeline loading test (R=0.5) in order to estimate crack growth rate and crack coalescence. Machined EDM notches maps were updated to better take into account discussions concerning the validation of UoA crack growth model and the new crack colony size.

The test protocol for oil transmission pipeline fatigue loading (R = 0.5) was validated on June 24th.

Six pipes were prepared to machine EDM notches:

- SCC1a is a part of pipe R156. The crack colony R156-im1 was characterized. The maximal measured depth is 1.7 mm and the length of the associated crack is 6 mm. The zone near R156-im1 crack colony has been examined by MPI in order to control that there is no other crack at locations where EDM notches will be machined.
- SCC1b is a part of pipe HP20. The zone where EDM notches will be machined was examined by magnetic particle inspection in order to control that there is no crack.
- SCC1c is a part of pipe HP20. The zone where EDM notches will be machined was examined by magnetic particle inspection in order to control that there is no crack.

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- SCC2a is a part of pipe R157-2. The zone near R157-2-im1/2 crack colony was examined by magnetic particle inspection in order to control that there is no crack where EDM notches will be machined.
 - SCC2b is a part of pipe R157-3. The zone where EDM notches will be machined was examined by magnetic particle inspection in order to control that there is no crack. However, crack colonies were found on this pipe and they will be sized to ensure they are not critical.
 - SCC2c is a part of pipe R156. It has to be examined by magnetic particle inspection.

Task 8: Dissemination of Results

The team has completed the following in the dissemination of the results.

- The project team held monthly internal meetings with the Technical Advisory Committee (TAC).

Task 9: Project Management and Reporting

The team has completed the following project management and reporting sub-tasks:

- The project team held regular teleconference meetings to track performance, schedule and budget.
- The project team completed and submitted the required monthly and quarterly reports.
- The project team presented at the Annual Peer Review on May 25, 2016.

1.1 Problems, Technical Issues or Major Developments

Task 4, Full scale testing is behind schedule. The team estimates that they will be able accelerate the testing in order to catch up by the end of the quarter.

2.0 Plans for Future Activity

Over the next 30-60 days, the following activities will be conducted:

Task 2: Material Selection, Acquisition, and Characterization

The team will perform material and dimensional characterization of Pipe 8, including actual diameter and thickness. The team will perform detailed characterization of defects 5.5.1 and 6.6.1, including destructive testing.

Task 4: Full Scale Testing of Complex Dents

Full scale testing of the dents will be continued that includes the dents interacting with welds.

Task 5a/b: Dent and Gouge Severity/ Interaction between Defects

ENGIE Lab CRIGEN will finalize result processing and prepare graphs for test 6.6.2. They will finalize result processing and prepare graphs for tests 5.5.3, 5.5.3cp, 5.5.3i1 and 5.5.3i2. They will perform a four point bending test for pipe 6 set up and preliminary testing

Task 5c: Dent and Gouge Defects Removed from Service

As soon as material characterization is finalized for Pipe 8, the team will define and launch fatigue test 8ext.2.3cp. They will create a polarization curve of Pipe 8 material to prepare the cathodic overprotection parameters for the subsequent test. The team will define the test parameters for fatigue test on Pipe 8: fatigue cycles, cathodic overprotection level.

Task 6: SCC Colonies and SDO Modeling Coordination

The team will manufacturer the 58 EDM notches, as well as, prepare and weld vessels SCC1a, SCC1b and SCC1c. ENGIE Lab CRIGEN will instrument and start of test SCC1 with fatigue loading typical of oil transmission pipelines. The team will characterize the material of the pipes used for vessels SCC1a and SCC2a, SCC2b and SCC2c, including yield strength, UTS, and Charpy V impact tests.