

# External Quarterly Report

**Date of Report:** 8<sup>th</sup> Quarterly Report – September 30, 2023

**Contract Number:** #693JK3211RA0001

**Prepared for:** PHMSA DOT

**Project Title:** Assessment of Nondestructive Examination (NDE) and Condition Monitoring Technologies for Defect Detection in Non-Metallic Pipe

**Prepared by:** EWI

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**For quarterly period ending:** September 30, 2023

## 1: Items Completed During this Quarterly Period:

The eighth quarterly update meeting will be held on October 5, 2023, which is early in quarter nine and due to project team schedule availability. Work items completed this quarter includes: (1) Initial microwave NDE trials were completed and reported by Evisive, (2) Corrosion exposure and NDE to assess detection of reinforcement layer corrosion (3) Erosion testing, inner liner erosion NDE work, and a draft report. EWI is preparing a second project modification to scope, budget, and schedule with DOT-PHMSA, due to delays getting additional pipe materials. Pipe is now expected at the end of October, shifting our timeline to process the new pipe from April 2023 to October 2023.

Item #	Task #	Activity/Deliverable	Title
21	10	Submit 8 <sup>th</sup> Quarterly Report	8 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
28	13	Corrosion Damage summary Table	Corrosion Damage Added Scope
11	6	Task report summarizing erosion test procedure and results, and NDE inspection results	Perform inner liner erosion tests & assess NDE detection

## 2: Items Not Completed During this Quarterly Period:

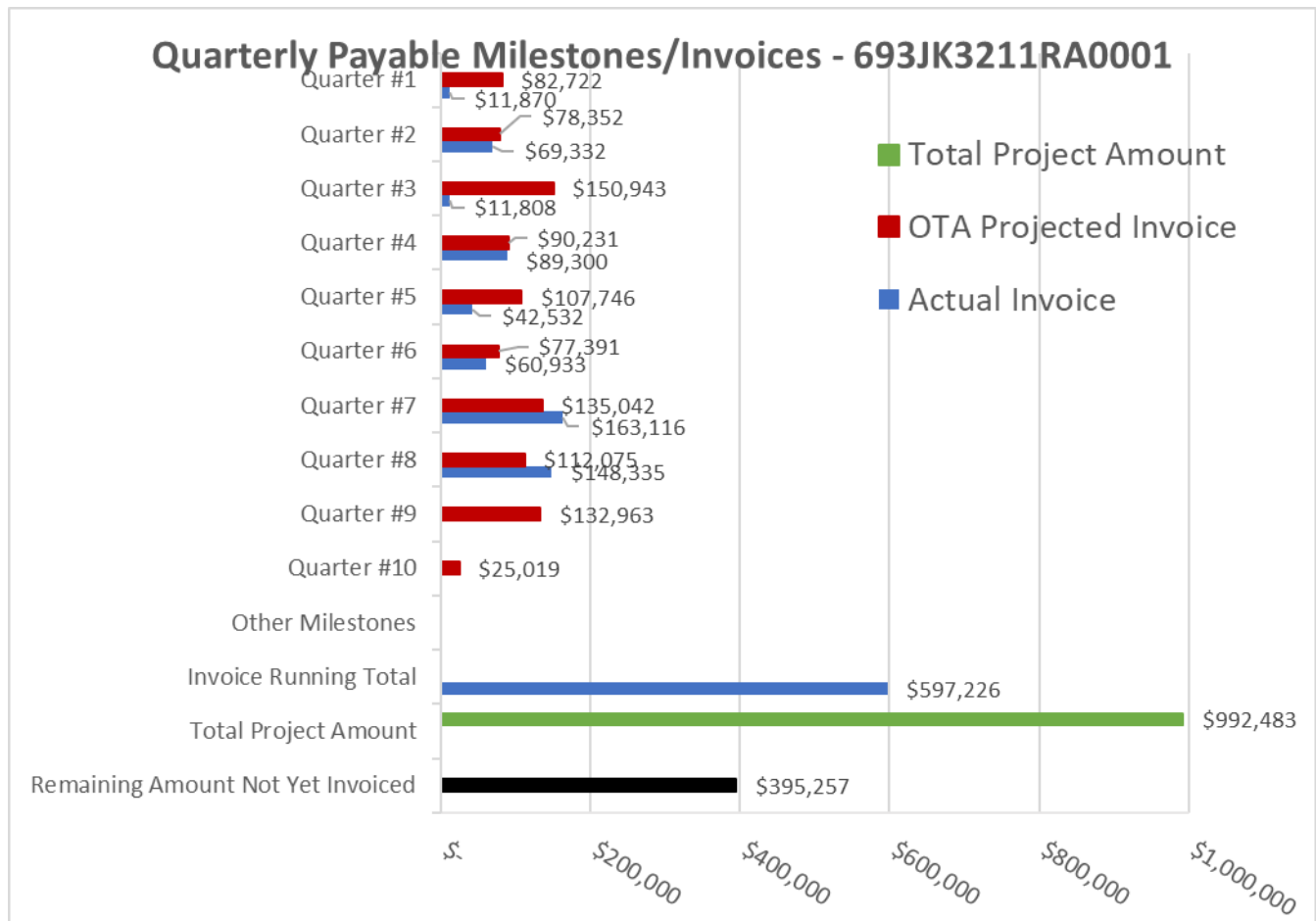
EWI anticipated receiving the modification documents in April per information provided by previous DOT-PHMSA program managers, the award came in June 2023. EWI paused completion of NDE work until additional funding was received and thus the NDE review will shift out based on schedule of review and receiving additional pipe materials from new project partners. Receipt of pipe samples from new partners - were expected by quarter 7. None of these samples have yet been received by EWI.

Item #	Task #	Activity/Deliverable	Title
14	4	Task 4 NDE Project Review	Review Progress to review NDE inspection data, outcome, and Trends
13	4	Task report summarizing NDE methods, procedures, and initial outcomes.	Comprehensive NDE trials on NMP samples and provide report summarizing procedures and initial outcomes

### 3: Project Financial Tracking During this Quarterly Period:

The actual spend is behind planned.

- EWI received a modification in June 2023 and anticipated receiving additional pipe materials as well. EWI is awaiting those materials as of September 30, 2023. Current updates expect the pipes to arrive late October 2023. EWI anticipates beginning change request CT scans and NDE work on these pipes. This material delay has caused a time delay, but EWI also has tried to use the opportunity to complete other tasks and allow for more efficient operating practices moving forward.



#### 4: Project Technical Status –

Item	Task	Activity/Deliverable	Title
1	10	Submit 1st quarterly report	1st Quarterly Status Report & Quarterly collaboration meeting
2	1	Task report summarizing findings of literature review	Literature review of recent research on NDE of polymers & composites - issue task report
3	2	NMP sample matrix detailing type of pipe and defects, anomalies, or damage per sample	Prepare detailed matrix of NMP samples
4	3	Develop NDE procedures for inspection of NMP samples using non-contact and 3 coupled UT methods, microwave inspection method and 2 thermography methods	Completion of written NDE procedures
5	10	Submit 2 <sup>nd</sup> Quarterly Report	2 <sup>nd</sup> Quarterly Status Report & Quarterly collaboration meeting
6	6	Task 6 Test Procedures and Chamber Assembly	Prepare & Provide a Written Test Procedure for Erosion Tests
7	4	NDE Review Progress to date (samples, procedures, early inspection data)	Task 4 NDE Project Review
8	10	Submit 3 <sup>rd</sup> quarterly report	3 <sup>rd</sup> Quarterly Status Report & Quarterly collaboration meeting
9	10	4 <sup>th</sup> Quarterly Status Report	4 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
11	6	Perform inner linear erosion tests & assess NDE detection	Task report summarizing erosion test procedure and results, and NDE inspection results
16	10	5 <sup>th</sup> Quarterly Status Report	5 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
26	10	Annual Review	Review Meeting (virtual)
15	10	6 <sup>th</sup> Quarterly Status Report	6 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
21	10	Submit 7 <sup>th</sup> Quarterly Report	7 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
27	10	Submit 8 <sup>th</sup> Quarterly Report	8 <sup>th</sup> Quarterly Status Report & Quarterly collaboration meeting
28	13	Corrosion Damage summary Table	Corrosion Damage Added Scope

**Task 1** – Literature Review was completed by EWI and NDE4zero’s Mark Lozev. The report was supplied to the project team on 3/31/2022.

**Task 2** – NMP Sample Matrix. EWI received additional pipes in late June and is updated the Matrix 10/31/2022.

**Task 3** – The internal NDE procedures have been developed. NDE procedures for external technologies have begun, Airstar provided their report on 6/27/2023.

**Task 4** – CT scanning was completed in mid-June on pipe samples that had been received by the project at that time. New pipe samples were received late summer 2022 and CT scanning was completed in December 2022. EWI NDE has begun testing selected pipe samples from this batch of

material. The NDE testing, and analysis is underway, data and images were shared at the Q4 meeting on 9/21/22 and Q5 meeting on 12/16/2022. Testing will continue for several months with EWI completing multiple forms of NDE.

Initial air coupled UT (ACUT) scans were completed by Airstar in March-April 2023. Methods for ACUT sensor calibration, determination of sensor offset distances and scanning direction have been identified. Early observations suggest good sensitivity for detecting minor manufacturing anomalies and for dealing with typical pipe eccentricity and dimensional variances (wall thickness variability, air gaps in unbonded pipes, etc.). Data analysis and reporting is in-process, but final reporting by Airstar is delayed. EWI is reaching out to Airstar to assess the reporting schedule to allow completion of this task. Pipe samples were supplied to Evisive in mid-June for initial microwave scans. Those scans and a report were provided to EWI in July.

EWI has been in discussion for coordinating EWI UT inspections on samples to be tested by GTI or CFER. These UT trials would be particularly valuable since the samples will be pressurized while being subjected to denting loads. All NDE work at EWI has been done without internal pressure. This can reduce sensitivity due to natural air gaps that can occur between the inner liner, reinforcement, and outer jacket in unbonded pipe when unpressurized.

Refinements in the thermography method have been made by implementing larger and higher wattage light sources, evaluating frequency of image scans, and assessing through-wall sensitivity using tapes, foils and small artifacts (zip ties, etc.) on the ID surface. Overall, sensitivity is improving and ability to sense through-wall from the OD has been demonstrated. Features of the reinforcement layer are now detectable in several test pipes.

EWI's initial plan for inducing mechanical and corrosion damage in selected pipe samples has begun now that the change request/project extension has been approved (June 5, 2023). It is hoped that pipe samples to be supplied by partners can be used for the intentional damage trials as well since they have a different reinforcement and manufacturing methodology than the other pipe samples. Completion of the damage trials has been pushed back one quarter in an effort to include these pipes in this task should they arrive during fall 2023.

In Quarter 8 EWI completed microwave NDE testing with Evisive LLC using 24GHz probes. Non-metallic pipes were fully volumetrically inspectable using Microwave NDE. Four pipes were scanned from the outside while mounted on a rotating lathe-type unit with probes mounted to a linear stage for testing. Full inspection results will be presented in an NDE report/presentation

**Task 6** – The entire erosion task has been completed. The cost share portion of this task was completed 5/31/ 2022 (Item #6 Task 6): erosion test cells have been built and a test method developed. The task began in December 2021 and was completed in June 2022. The federally funded portion of this work began in August 2022. Erosion testing and analysis on a total of nine pipes from three manufacturers has been completed and NDE inspections were completed in September 2023 which completes the federally funded portion of this task. To provide a realistic configuration where the flow path of the sand is in the same direction as pipe scratches and defects, EWI completed a test where a pipe was abraded internally circumferentially in line with the flow path of the sand. Post test analysis of the change in surface scratches was performed to approximate the amount of erosion that was induced by the impeller and sand throughout the test.

The goal of this testing is to create a laboratory scale representative test to be able to quantify internal pipe erosion and erosion rate. This data will be able to be used to create a lifetime use prediction model for the NMP.

**Task 10** – The 1<sup>st</sup> quarterly status report was provided on 1/4/22. The 2<sup>nd</sup> quarterly status report was provided on 3/31/2022. The 3<sup>rd</sup> quarterly status report was provided on 6/30/2022. The 4<sup>th</sup> quarterly status report was provided on 9/30/2022. The fourth quarterly collaborative meeting occurred on 9/21/2022. The Fifth quarterly meeting was hosted on 12/16/22 with its quarterly report submitted on 1/4/2022. TAP attended two meetings 7/13/2022 and 11/29/2022, TAP was invited to the quarterly meeting on 12/16/2022 and these meetings will be combined going forward. The 6<sup>th</sup> quarterly meeting occurred 3/30/2023. The 7<sup>th</sup> quarterly report was completed on 6/29/2023. The 8<sup>th</sup> quarterly meeting is scheduled for 10/6/2023. The most recent quarterly report on 9/30/2023 was the 8<sup>th</sup> quarterly report.

The next quarterly meeting will occur in December 2023, the thirteenth is currently the date EWI is targeting and will discuss with the partners during our October 5<sup>th</sup> quarterly presentation.

**Task 13** – Non-destructive evaluation of corrosion of a steel reinforced non-metallic pipe was performed intermittently over a period of 41 days. Corrosion was targeted in two locations of the pipe: a small hole on the outer jacket and a small hole on the inner jacket exposing the steel wire. Prior to corrosion, a full 360-degree inspection was performed on the outside of the pipe and a 120-degree inspection was performed on the inside of the pipe.

At the end of the corrosion study with ultrasonic inspection an infrared video was recorded for 40 seconds or more to capture the heat transfer through the pipe and the steel wires.

## 5: Project Schedule –

The project schedule has been updated to incorporate the modification requested in March 2023 and awarded in June 2023. The proposed schedule assumed EWI would receive pipe by June 1, 2023. With delays to the aware and pipe arrival EWI anticipates updating the below schedule when pipes arrive now expected October 2023.

Task	Description	Quarter											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Literature Review & Report	X	X										
2	Selection, Procurement & Preparation of Pipe Samples	X	X	X	X	X							
3	Draft NDE Procedures		X	X	X	X							
4	NDE Trials			X	X	X	X						
5	NDE Validation & Assessment					X	X	X					
6	Characterization of Erosion Properties and Detectability		X	X	X	X	X	X	X				
7	Development of NDE Procedures and Best Practice Guide									X	X		
8	Establish Field Inspection Requirements									X			
9	Virtual Workshop								X	X			
10	Progress Meetings (virtual and in-person)			X			X		X				
	Annual Review				X				X				
	Quarterly Progress Reports	X	X	X	X	X	X	X	X	X	X		
	Final Report									X	X		
11	NDE Subcontractors and GTI travel							X		X			
12	NDE and Mechanical Damage								X				
13	NDE and Corrosion Damage									X			
PM	Program Management	X	X	X	X	X	X	X	X	X	X		

The schedule will be finalized when the new partner's pipe is made available to EWI for testing.