CAAP Quarterly Report

06/30/2024

Project Name: *Easy Deployed Distributed Acoustic Sensing System for Remotely Assessing Potential and Existing Risks to Pipeline Integrity*

Contract Number: *693JK3215002CAAP*

Prime University: *Colorado School of Mines*

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Reporting Period: *[03/31/2024 – 06/30/2024]*

Project Activities for Reporting Period:

During the past period, our primary focus has been on the remaining tasks (Tasks#3-6). The specific major accomplishments are summarized as follows:

1. Before transitioning the pipeline from the "supported" to the "unburied" configuration, we made a strategic decision to repeat some of our experiments with more robust and systemic controls, which will be crucial and useful for future journal paper publications. This decision was based on the fact that once the pipeline configuration was changed to "unburied", it would not be possible to revert it back to the previously "supported" configuration. The test matrix that has been completed is shown in Table 1 below. The findings are similar to what have been reported so far. A more detailed data analysis and summary of findings will be included in the next annual report.
2. We have successfully modified the pipeline layout from the "supported" to "unburied" configuration. The pipeline is now laid on sand, held by wooden boxes. This configuration facilitates easier execution of "buried" experimental studies in the next step. A tarp was placed underneath the leakage point to prevent blowing sand during the leakage experiment. **Figure 1** shows the picture of the pipeline setup, and **Figure 2** shows the picture of the 1-meter test section. The wooden boxes were halfway filled with sand before placing the pipeline on top. Additional sand was added to the sides to ensure the pipe remained steady and secure, minimizing vibrations. We anticipate observing different vibration patterns from the previous experiments using "supported" setup, which will be discussed in the next quarterly report.
3. During this reporting period, we completed the corrosion experiments using the severely corroded 1-meter test section with a tiny leak (2~3 mm) at the pipe bottom. Preliminary data analysis showed that the external cables effectively detected the minor leakage. We will need to further process the signals from the internal cables to better understand their detectability of the minor leakage, and the results will be included in the next quarterly

report. The remaining corroded test section without leakage will be tested in the next quarter after the students return from their summer internships.

Table 1. Repeated Text Matrix for Tasks#3-6

Tasks	**Tested 1-meter section at the middle of the pipeline**	**Number of supports**	**Air flow rates (m/s)**	**End Valve Opening***
Task#3: Detection of Corroded Spots on Pipeline Interior Surface	Three corroded pipes: a 3-mm corroded pipe, a 5-mm corroded pipe, and a severely corroded pipe with minor leakage	4, 5	2, 6, 10, 14, 18	0%
			11	100%, 50%, 0%
Task#4: Detection of Dent/Deformation on pipeline	Two dented pipes with two dent sizes: small and large	4, 5	2, 6, 10, 14, 18	0%
			11	100%, 50%, 0%
Task#5: Detection of Infrastructure Damage	One pipe with no defects	4, 5	2, 6, 10, 14, 18	0%
			11	100%, 50%, 0%

* The experiments with the different valve openings at the end of the steel pipe (please refer to the previously quarterly report) were designed to study the sensitivity of the distributed acoustic sensing with different pressures while the background flow rate remains the same.

Figure 1. Pictures of the "unburied" pipeline.

Figure 2. Pictures of the 1-m test section.

Project Financial Activities Incurred during the Reporting Period:

The following table summarizes the financial activities and the corresponding expenses during the reporting period. Also shown are the total budget and the total expenses so far. Please note that the actual amount for the expenses might be slightly different from the numbers in the final financial report, since some of the expenses occurring in late of the quarter may not be included in the university's financial system that we use for managing the funds and expenses by the time the report is submitted. Normally, it takes several days for an expense to be shown in the system after its occurrence.

In this quarter, we are in the preparation to apply for a no-cost extension, and work on the budget for the remaining funds and time period. We plan to use the remaining funds, mainly from tuition and experimental expenses, to support the students in the form of salaries, to ensure the project progresses smoothly and that more students will receive education on relevant topics on pipeline safe transportation. Details will come later separately in the no-cost extension application package.

Items\Budget and Expenses		Total Budget for Year 3	Total Expenses in Year 3	Expenses During Reporting Period
1	Faculty Salaries and Wages including Fringe Benefits	$29,471	$21,149.79	$21,149.79
2	Student Salaries	$33,949	$36,858.29	$6200.07
3	Graduate Student Tuition	$47,186	$17,503.50	$0
4	Experimental Expenses (experimental work supplies, services, maintenance, cables, etc.)	$27,000	$6082.69	$3186.42
5	Travel	$3,000	$0	$0
6	Indirect Costs (51.5%)	$48,578	$33,006.75	$15,726.18
Total		**$189,183**	**$114,601.02**	**$46,262.46**

Project Activities with Cost Share Partners:
The cost shares are the AY efforts of the PI and co-PIs. Activities are the same as above.

Project Activities with External Partners:
No external partners.

Potential Project Risks:
Besides the factors, such as weather, Edgar Mines' operating schedule, and students' course/exam schedule, another primary factor affecting project progress is that both students assigned to this project are undertaking summer internships this year. Considering all the factors, we are currently preparing a request for a no-cost extension, which is expected to be submitted soon. We are very optimistic that the project will be completed with the extension.

Future Project Work:
The research progress in the next 30 days will be very limited, as the students are gone for summer internships. In the next 60-90 days, we are planning to

1. Further process the data that we have collected in this quarter for the "supported" pipeline.
2. Perform experiments for Task#3 using the corroded pipe without leakage under "unburied" configuration.
3. Perform detailed data analysis for Task#3 using the "unburied" configuration.
4. Submit the no-cost extension request.

Potential Impacts to Pipeline Safety:
Tasks#1 and #2 can potentially help identify and characterize the possible liquid accumulation in a gas gathering or transmission pipeline using DAS, while Tasks#3-6 will potentially help detect the internally corroded surface, deformation, infrastructure damage, and leakage in a gas pipeline.