DOT PHMSA Public Quarterly Report

Date of Report: 9th Quarterly Report Ending December 31, 2024
Contract Number: 693JK32210004POTA
Prepared for: USDOT PHMSA
Project Title: Advancing Hydrogen Leak Detection and Quantification Technologies Compatible with Hydrogen Blends
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For quarterly period ending: December 31, 2024

1: Items Completed During this Quarterly Period:

The 9th Quarterly Status Report, Determining Field Testing Locations and Sensor Development Activities were all accomplished this quarter and were drawn from Attachment #3, Technical and Deliverable Payable Milestone Schedule (in the contract) from the sixth payable milestones. These items were completed during this reporting period and are the corresponding items included on our next invoice.

2: Items Not Completed During this Quarterly Period:
Laboratory Testing has not been completed yet but is progressing well and will be integrated into future quarterly reports as work continues to be accomplished.

3: Project Technical Status:

ACTIVITY: LABORATORY TESTING

Item Title: Complete laboratory testing
Item Number: 10
Task Number: 4

Laboratory testing is still ongoing in this quarter and there has been good progress for both the sensor testing being conducted at SENSIT Technologies and the instrument testing being conducted at GTI Energy. An in-depth analysis of the sensor testing to date is shown in the sensor development activity

For the instrument testing, GTI Energy has been conducting a variety of tests at each of the gas mixtures listed below in Table 1.

Table 1. Gas Mixtures Used for Laboratory Testing by Hydrogen Percentage

Hydrogen Percentage	Methane Concentration (ppm)	Hydrogen Concentration (ppm)
0%	10	0
	1,000	0
	5,000	0
	25,000	0
	100% Methane	0
5%	9.5	.5
	950	50
	4,750	250
	23,750	1,250
10%	9	10
	900	100
	4,500	500
	22,500	2,500
20%	8	2
	800	200
	4,000	1,000
	20,000	5,000

For each device and gas tested, 3-5 repeats are being run to ensure that there is consistency among the measurements. The quantities that are being measured include the initial concentration reading (which tends to vary by device), the time it takes for the device to reach 90% of the actual concentration (T90), the maximum concentration reading, the minimum concentration readings, and the time it takes to get back down to 10% of the maximum reading (T10). New green hydrogen cylinders have also been acquired and have been used for testing in recent weeks. An assortment of multi-gas monitors, handheld laser methane detectors, leak survey instruments, and CGIs have been tested already with some still yet to undergo a second round of testing.

A preliminary data analysis has been done on our first round of testing for CGIs and leak survey instruments that demonstrated a need to reconfigure select elements of our testing procedure. Namely, the inclusion of bump tests in between testing to ensure that each device is properly calibrated before introducing new methane/hydrogen blends into the testing apparatus. This second round will also help the project team to conclude how many replicants need to be done for each instrument to allow more certainty in the accuracy of measurements at different percentages of hydrogen blends.

ACTIVITY: SENSOR PACKAGE

Item Title: Propose sensor package to accommodate the maximum amount of hydrogen
Item Number: 16
Task Number: 5

Work done for this task built upon work done in the previous quarter examining existing gaps in sensor technology. The project team crafted an interim report for the sensor package proposal that was submitted to the PRIMIS server alongside this quarterly report. Specific results from the sensor package proposal will be updated as more data is gathered and analyzed following the completion of laboratory and field testing campaigns.

Table 2 below shows a summary of some of the hydrogen effects that have been observed on different sensor groups and sub-groups. The sensor groups are based on the four types of sensors that were described in depth in the Evaluation Framework:

1. Current state-of-the-art flammable gas detection sensors
2. Air toxic H2S and CO detection sensors
3. Oxygen detection sensors (both galvanic and electrochemical)
4. Hydrogen specific gas detection sensors

Table 2. Hydrogen effects on the different sensor technology

Sensor Group	Technology	Kinetics	Accuracy	Stability	Temperature	Humidity
1	Optical Absorption	No Impact	Under report LEL	No Impact	No Impact	No Impact
1	MOS	No Impact	Over-report LEL	No Impact[1]	No Impact	Minimal Impact[2]
1	Catalytic	No Impact	Minimal Increase LEL	No Impact[1]	No Impact	No Impact
1	MEMS TC LEL	No Impact	Minimal Impact[3]	No Impact	No Impact	No Impact
1	MEMS TX XR	No Impact	Over-report LEL	No Impact	No Impact	No Impact
1	NDIR	No Impact	Under-report LEL	No Impact	No Impact	No Impact
2	H2S	N/A	High False Pos/Neg	Erratic Recovery	No Impact	No Impact
2	CO	N/A	High False Pos/Neg	Slow Recovery	Small Increase	No Impact
2	CO-H2	N/A	High False Pos/Neg	Slow Recovery	Small Increase	No Impact
3	O2 Lead Galvanic	No Impact	No Impact	No Impact	No Impact	No Impact
3	O2 Electrochemical	No Impact	High False Neg	Increased Recovery	No Impact	No Impact

1. Devices are known to be adversely affected by high concentrations of gas. At LEL levels hydrogen does not cause any impact to device stability

2. Impact of humidity was found to depend on MOS device manufacturer but was significantly smaller than the impact of hydrogen and can be disregarded.

Impact was 5% LEL or lower on accuracy in both positive and negative amounts.

ACTIVITY: FIELD TESTING

Item Title: Determine field testing locations
Item Number: 14
Task Number: 6

The first two field tests were accomplished in Q2 and Q3 of 2024 ahead of the initial project schedule for a variety of hydrogen blends. A Hi-Flow sampler was used to help estimate leak rate beyond the capabilities of the sponsor's training facility with the number of indications and maximum concentrations being documented from each of the devices. Data analysis is still pending on this initial field test.

The project team completed the second of three field trials at a sponsor's facility in June but were not able to test up to 20% hydrogen blends, the project team will attempt to compensate for this at our 3rd and final field test in February 2025. 16 individual leaks were made on belowground, aboveground, and appliance assets. Each flow rate was again recorded with the high flow sampler. Data analysis for this campaign is also ongoing. The project team did notice again that lower flow rate leaks with higher blend concentrations may impact detection performance, especially on belowground leaks. This observation has not been substantiated in data review at this time. Each detector was used in a typical survey pattern over each leak to detect the emission. This was repeated a total of ten times for each instrument.

A third field trial has been confirmed for February 2024 that will finalize results obtained from the first two field trials. Data analysis on the first two field trials is ongoing and will help to inform the design of the 3rd and final field campaign.

ACTIVITY: NINTH QUARTERLY STATUS REPORT

Item Title: Submit Ninth Quarterly Status Report
Item Number: 17
Task Number: 8

The ninth quarterly status report (this report) will be completed and submitted to PHMSA's PRIMIS server in both public and internal-facing formats

ACTIVITY: PROJECT MANAGEMENT

Item Title: N/A
Item Number: N/A
Task Number: 8

During this quarter, GTI conducted project scheduling, budgeting, establishment of data management strategies, preparation of reports, and organization of required meetings. The project team also hosted a TAP meeting on October 11th to update TAP members on the progress of laboratory testing, field testing, and our data analysis.

5: Project Schedule:

The project schedule is shown below in Table 3 with the submittal time of this quarterly report outlined in red.

Table 3. Project Schedule

Task	Description	Q4 2022	Q1 2023	Q2 2023	Q3 2023	Q4 2023	Q1 2024	Q2 2024	Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025
1	Project Scoping and TAP												
2	Literature Review												
3	Develop Evaluation Plan												
4	Laboratory Tests												
5	Develop New Hydrogen Sensing Schemes												
6	Field Tests												
7	Statistical Analysis and Final Report												
8	Project Management												