DOT PHMSA Internal Quarterly Report

Date of Report: 6th Quarterly Report Ending March 31, 2024
Contract Number: 693JK32210004POTA
Prepared for: USDOT PHMSA
Project Title: Advancing Hydrogen Leak Detection and Quantification Technologies Compatible with Hydrogen Blends
Prepared by: GTI Energy
Contact Information: Chris Moore, 847-768-0688, cmoore@gti.energy
For quarterly period ending: March 31, 2024

1: Items Completed During this Quarterly Period:

The 6th Quarterly Status Report was accomplished during this quarter of work and was 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 yet been completed, but is still progressing and will be complete by the next quarterly report for the period ending June 30th, 2024.

3: Project Technical Status:

ACTIVITY: LABORATORY TESTING

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

Laboratory Testing has not been completed due to delays in the lab setup and the procurement of devices/sensors and gas mixtures. However, there has been good progress for both the sensor testing being conducted at SENSIT and the instrument testing being done at GTI Energy. For the sensor testing, as discussed previously in the Evaluation Framework, the individual sensors being tested will be focused on four types:

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 1 below contains all the sensors that will be included divided by type and subcategorized by design:

Table 1. Descriptions and Pictures for Sensors used in Laboratory Testing

Flammable Sensors		
Metal Oxide Semiconductor	Figaro 2611: semiconductor gas sensor with high sensitivity to methane gas	
	FIS SB11A00: semiconductor gas sensor for methane and other hydrocarbons	
Pellistor-Catalytic	Alphasense CH-A3: Standard catalytic sensor	
	DDS GS+701: Standard catalytic sensor	
	SGX VQ548MP: Micro-Electrical-Mechanical Systems (MEMS) catalytic sensor	
Thermal Conductivity	Nevada Nano MPS: (MEMS) thermal conductivity type sensor	
NDIR	Cubic SJH: Nondispersive infrared (NDIR)	
	Winsen MH-440D: Nondispersive infrared (NDIR)	
Air Toxic Sensors		
Electrochemical	Alphasense H2S-AH: Electrochemical H2S	
	DDS GS+4H2S: Electrochemical H2S	
	Alphasense CO-AF: Electrochemical CO	
	DDS GS+4COF: Electrochemical CO	

	Alphasense CO-AX: Electrochemical CO low H2 Cross Sensitivity	
	DDS GS+4CO2H: Electrochemical CO low H2 Cross Sensitivity	
Oxygen Sensors		
Galvanic	Alphasense O2-A3: Lead-based galvanic O2	
	DDS S+4OX3: Lead-based galvanic O2	
Electrochemical	Alphasense LFO2-A4: Lead-free electrochemical O2	
	DDS S+4OXLFP: Lead-free electrochemical O2	
Hydrogen Specific		
Metal Oxide Semiconductor	FIS SB-19-03: Hydrogen MOS	
	Figaro 2616: Hydrogen MOS	
Electrochemical	Alphasense H2-AF: Electrochemical hydrogen	
	DDS GS+4H2: Electrochemical hydrogen	
Pellistor-Catalytic	SGX VQ21TSB: Hydrogen enhanced catalytic	

The lab setup for sensor testing has been finalized.

For the instrument testing, GTI Energy has been conducting a variety of tests at each of the gas mixtures listed below in Table 2.

Table 2. Gas Mixtures Used for Laboratory Testing by Hydrogen Percentage

Hydrogen Percentage	Methane Concentration (ppm)	Hydrogen Concentration (ppm)
0%	10	0

Hydrogen Percentage	Methane Concentration (ppm)	Hydrogen Concentration (ppm)
	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). The setup for these laboratory tests has been completed, where a demand regulator is attached to a gas cylinder extending to an electronic valve to allow venting to the atmosphere when not undergoing tests.

The team is planning on including more thorough data analysis as part of the next task looking at possible sensor designs and gap analyses. We will likely examine some different variance analyses or an analysis of the covariance of a few different factors to help demonstrate hydrogen's effect on the devices and sensors.

ACTIVITY: FIELD TESTING

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

The project team has begun to draft plans for field testing that would limit the number of confounding variables and ameliorate the data retrieval and analysis task for this project. In line with this, field safety plans have been constructed in advance of the first field visit that will occur in Q3 of 2024. The field-testing agreements for two companies have been completed and final details are being ironed out regarding their facilities' capabilities regarding size and duration of simulated leaks and their upper blending limits. Final

decisions on which devices to bring will be made soon and based on the Evaluation Framework completed in previous quarters. There will be more discussions with the participating utilities as the test matrices are finalized weeks before their respective testing dates in April and June of this year.

ACTIVITY: SIXTH QUARTERLY STATUS REPORT

Item Title: Submit Fifth Quarterly Status Report
Item Number: 6
Task Number: 8

The sixth quarterly status report (this report) will be completed and submitted on schedule (on or before March 31st, 2024)

ACTIVITY: PROJECT MANAGEMENT

Item Title: N/A
Item Number: N/A
Task Number: 9

During this quarter, GTI conducted project scheduling, budgeting, establishment of data management strategies, preparation of reports, and organization of required meetings.

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	1 - Q4 2022	2 - Q1 2023	3 - Q2 2023	4 - Q3 2023	5 - Q4 2023	6 - Q1 2024	7 - Q2 2024	8 - Q3 2024	9 - Q4 2024	10 - Q1 2025	11 - Q2 2025	12 - Q3 2025
1	Project Scoping and TAP												
2	Literature Review												
3	Develop Evaluation Framework												
4	Laboratory Tests												
5	Develop New Hydrogen Sensing Schemes												
6	Field Tests												
7	Statistical Analysis and Final Report												
8	Project Management												