Texas Commission on Environmental Quality
New Technology Research & Development (NTRD) Program
Monthly Project Status Report

Contract Number: 582-11-11145-3264

Grantee: The University of Texas at Austin (UT-CEM)

Report for the Monthly period: September 2012

Date Submitted: October 5, 2012

Section I. Accomplishments

Provide a bulleted list of project accomplishments as well as a description of their importance to the project.

- Performed maintenance on hydrogen station and attempted to correct natural gas booster compressor leak.
  - Installed new piston rings on natural gas booster compressor
  - Reset valve assembly in first stage of booster compressor. Upon inspection, this valve was found to be dislodged from its seat.
  - Replaced damaged belt on the station's exhaust fan
- The natural gas booster compressor on the hydrogen station, which feeds the reformer, continues to leak and not build pressure at the rate needed to sustain the reformer. Gas Technology Institute (GTI) has rebuilt both stages (seals, valves and rings) and the problem still persists. With GTI direction, UT-CEM performed additional testing of the compressor after the piston rings were installed. Temperature measurements at each stage were recorded and reported to the compressor manufacturer, and an additional leak was located. However, the test results did not provide the manufacturer with a definitive cause. The team decided to order a new compressor, which is scheduled to ship to Austin on October 25, 2012.
- The bus continued to experience problems that prevented it from beginning passenger service. The fuel cells were shipped to Hydrogenics, tested, and repaired. Return Material Authorizations (RMA) reports for the fuel cells are included as Attachment A. Hydrogenics performed the diagnosis and repair at no cost to the project as they are committed to supporting the demonstration.
- The bus overnight charger failed early in September 2012. The problem was traced to a failed communication component. Since the charger manufacturing no longer produces or supports this particular charger, spare parts were not readily available. Proterra had a spare charger, however, and were able to ship it to Austin and replace the current charger. (Prior to shipping to Austin, the charger was shipped to the manufacturer for recertification.) The replacement charger is operating normally and the old charger remains in Austin as a source of spare parts if needed in the future.

Indicate which part of the Grant Activities as defined in the grant agreement, the above accomplishments are related to:

> *Task 2.5: The PERFORMING PARTY will operate the hydrogen fuel cell hybrid-electric bus in a realistic working environment over a twelve month period, including using the hydrogen generation and fueling station as the bus's primary fuel source.*

Section II: Problems/Solutions

Problem(s) Identified: Report anticipated or unanticipated problem(s) encountered and its effect on the progress of the project

a) The natural gas boost compressor, which feeds fuel to the reformer, experienced a loss of performance and possible air infiltration. The compressor was unable to achieve full pressure and a rate high enough to sustain the reformer requirements for heating and hydrogen generation.
b) Proterra and Hydrogenics continued to work the fuel cell problems.
c) The bus overnight charger failed early in September 2012.

Proposed Solution(s): Report any possible solution(s) to the problem(s) that were considered/encountered

a) The compressor has a leak and is introducing air diluted methane to the burners. GTI ordered new piston rings and they were installed the week of September 2, 2012.
b) The fuel cells were shipped to Hydrogenics and repaired. See attached RMA reports. Bench testing at Hydrogenics show the fuel cells are operating normally.
c) Proterra found the charger had a failed communication component, which wasn't allowing it to communicate with the bus. Spare parts were not readily available, but a spare charger was available.

Action(s) Conducted and Results: Describe the action(s) taken to resolve the problem(s) and its effect

a) The new piston rings did not solve the natural gas booster compressor problems. Additional testing by UT-CEM did not provide further definitive clues as to the cause of the leak. GTI has ordered a new compressor and plans to install it in late October or early November 2012. Results to be determined.
b) Hydrogenics and Proterra will install and test the fuel cells on the bus the week of October 8, 2012. Results to be determined.
c) Proterra shipped the replacement charger to Austin and installed it the last week of September 2012. The new charger is operating normally.

Section III. Goals and Issues for Succeeding Period:

Provide a brief description of the goal(s) you hope to realize in the coming period and identify any notable challenges that can be foreseen

- Install and test fuel cells on the Proterra bus week of October 8, 2012.
- Perform driving test of the bus and schedule driver training. New Fall Semester drivers need to be trained. Goal is to begin passenger service by end of October or early November 2012.
- GTI will schedule a trip to Austin upon receipt of a firm delivery date of the new natural gas booster compressor. Additional maintenance activities to be performed during that trip will include:
  - Replace check valve on priority panel; valves are now in Austin.
  - Take hydrogen gas sample and analyze at GTI's facilities in DesPlaines, Illinois. Since natural gas compressor is down, GTI was unable to take samples during August.

Date: 10/05/2012

Authorized Project Representative's Signature

NOTE: *Please attach any additional information that you feel should be a part of your report or that may be required to meet the deliverable requirements for tasks completed during this reporting period.*

ATTACHMENT A
Hydrogenics Fuel Cell RMA Reports

HYDROGENICS
SHIFT POWER | ENERGIZE YOUR WORLD

Repair Report Date: 1 October 2012

Customer: Proterra (Austin Bus) RMA 817

Equipment: S100413, STANDARD HYPM (16 KW) FCPM, P/N 1020511

Serial Number: 01016140-0707003

Date of Manufacture: 14/Sep/2007

Warranty expiration: 14/Jan/2009

Work Report

1. Replace the DOMEL air blower 52 VDC. The one which came back with the FCPM has been found mechanically damaged.
2. Replace the H2 FPR – older revision – prone to failure; Observed advanced corrosion on the dome side.
3. Repaired-replace the REED valve on the recycle pump 1- damaged
4. Replaced recycle pump controller: burned out terminal block and wiring harness
5. Upgraded the DAR boards to the latest revision
6. Upgraded the ECU code software- enabled the EW safety, Recycle pump safety and eFCVM low voltage E-stop

FAT Passed with following Observations:

1. Max power=16.16 kW @ 300 AMPS
2. Stack voltage=53.87 VDC
3. Coolant flow rate=30 slpm

Notes and Recommendations

We also have tested the performance of the FCPM with the EMP WP 25 water pump (this water pump has been used by Proterra for replacing the TOTON water pump). Due to the lower coolant flow rate when WP 25 is used, I recommend do not exceed a load of 14 KW@260 amps. When the power level is higher there is not enough cooling and the FCPM eventually will shut down: Over temperature E-Stop.

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Serial Number: 01016140-0707002

Date of Manufacture: 14/Sep/2007

Warranty expiration: 14/Jan/2009

Work Report

1. Check the H2 FPR – OK
2. Repair-replace the REED valve on both recycle pumps - damaged and recovered the missing parts of the valves from the stack Anode In .
3. Upgraded the DAR boards to the latest revision
4. Upgraded the ECU code software- enabled the EW safety, Recycle pump safety and eFCVM low voltage E-stop

FAT Passed with following Observations:

1. Max power=16 kW @ 320 AMPS
2. Stack voltage=50 VDC
3. Coolant flow rate=30 slpm

Notes and Recommendations

We also have tested the performance of the FCPM with the EMP WP 25 water pump (this water pump has been used by Proterra for replacing the TOTON water pump). Due to the lower coolant flow rate when WP 25 is used, I recommend do not exceed a load of 14 KW@260 amps. When the power level is higher there is not enough cooling and the FCPM eventually will shut down: Over temperature E-Stop.