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# Innovative Advanced Hydrogen Mobile Fueler

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Contract No: DE-EE0007275

## Subcontractors:

- Air Liquide, Houston, TX
- Hydrogen Technology & Energy Corporation, Vancouver, Canada
- Quong & Associates, Inc., San Francisco, CA
- Manta Consulting, Carmel, CA

Project Start Date: July 1, 2016  
Project End Date: June 30, 2021

## Overall Objectives

- Design and build an Advanced Hydrogen Mobile Fueler (AHMF).
- Deploy the AHMF to support a network of hydrogen stations and vehicles in the United States.
- Gather and analyze fueling data for the National Renewable Energy Laboratory (NREL) technology validation team

## Fiscal Year (FY) 2019 Objectives

- Complete construction and assembly of the AHMF.
- Complete safety, performance, and functional testing of the AHMF.
- Select host demonstration sites.

## Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of

the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan<sup>1</sup>:

- Hydrogen Storage
- Lack of Hydrogen Refueling Infrastructure Performance and Availability Data
- Codes and Standards.

## Contribution to Achievement of DOE Milestones

This project will contribute to achievement of the following DOE milestones from the Technology Validation and Hydrogen Safety, Codes and Standards sections of the Fuel Cell Technologies Office Multi-Year Research, Development, and Demonstration Plan<sup>1</sup>:

### Target 1 Technology Validation:

- Milestone 2.3: Validate fuel cell electric vehicles achieving 5,000-hour durability (service life of vehicle) and a driving range of 300 miles between fuelings
- Milestone 3.4: Validate station compression technology provided by delivery team
- Milestone 3.8: Validate reduction of cost of transporting hydrogen from central production to refueling sites to <\$0.90/gge.

### Hydrogen Safety, Codes and Standards:

- Milestone 2.19: Validate inherently safe design for hydrogen fueling infrastructure
- Milestone 3.4: Develop hydrogen material qualification guidelines including composite materials.

## FY 2019 Accomplishments

- Procured and received all major and long-lead AHMF components and subsystems for assembly at the Hydrogen Technology & Energy Corporation (HTEC) manufacturing facility.
- Completed placement and installation of all major equipment in the trailer and began

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<sup>1</sup> <https://www.energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-multi-year-research-development-and-22>

- wiring and plumbing for hydrogen and liquid nitrogen systems.
- Completed fabrication of the mounting brackets for the hydraulic valves, instruments, and sensors.
- Continued development of an inspection and test plan for release of the AHMF.
- Contracted with an independent third party to conduct a comprehensive review and certification of the AHMF prior to the demonstration phase.

## INTRODUCTION

This project will design, develop, deploy, and analyze the economic viability of a mobile fueling system for hydrogen. The project team proposed use of the AHMF to support a network of stations in the United States. As part of the design activity, the project team is to define the preferred network of stations in collaboration with an automaker. The team will select a U.S. network that will support hydrogen vehicles on the road. The automaker(s) support the project by providing specifications based upon vehicle requirements and will support evaluation of the AHMF with respect to compliance with specific fueling performance criteria. The AHMF will have the capacity to fuel 10–20 fuel cell vehicles per day, consistent with the requirements of the H70 fueling category. The AHMF will operate without remote power connections, be modular for easy transport and deployment, and have the ability to provide expanded daily capacity and multiday operations through the use of delivered gaseous hydrogen.

The final design reflects the target specifications identified for storage, fueling, performance, usage, etc., which are included in Table 1.

**Table 1. AHMF Specifications**

Specification	Description
Pressure Class	H70 (70 MPa) after compressing high bank storage
Pre-Cooling	T30 (-30°C) or T40 (-40°C)
Performance	Up to 15 kg per hour, 100–120 kg in 8–10 hours
Fueling Protocol	SAE J2601-2014 table based for 2–7 kg tanks SAE J2799-2014
Setup	One hour for limited performance, 8 hours for full performance
Storage	Up to 170 kg H <sub>2</sub> at 45 MPa with ability to connect to external storage
Power	On-board 480 VAC, low-noise, low-emissions diesel generator with option of using external power
Usage	Dispenser human-machine interface allows fueling by minimally trained users

## APPROACH

The project has two primary phases, each consisting of several key tasks and milestones.

The first phase involved the design, development, and construction of the AHMF, moving from the conceptual design through completion of assembly and testing, until the AHMF is ready to deploy. The first phase contains two key decision points: (1) the final design review and (2) the completion of AHMF construction and testing.

The second phase will demonstrate the AHMF over 18 months at a minimum of three site locations. Key data will be collected in collaboration with participating automotive companies. Fueling data will be provided to NREL quarterly for review and analysis; economic data will be included in the project's final report.

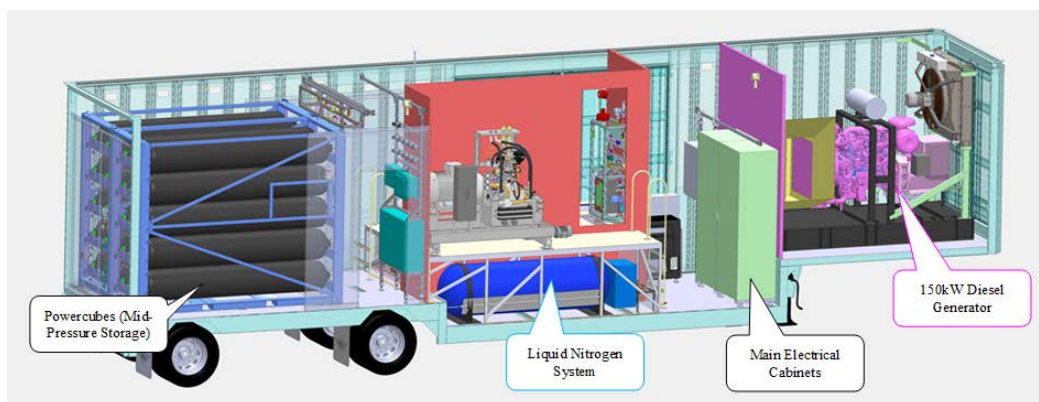
## RESULTS

Assembly of the AHMF is currently being completed at HTEC's Vancouver manufacturing facility. The team solicited input from selected automotive companies (potential users of the AHMF) and DOE to determine crucial design specifications and parameters for the AHMF and its components. The team decided to use Air Liquide's C100 station design as the base design for this project. The design utilizes several components from the C100, with appropriate modifications to accommodate the AHMF specifications and mobile approach. The AHMF will be a self-contained, full-performance mobile hydrogen station.

The following major components and equipment were procured and installed in the trailer:

- Custom 45-foot dual axle trailer
- Diesel generator
- HTEC PowerCubes (2)
- High-pressure tanks
- Compressor
- Heavy-duty chiller unit
- Liquid nitrogen Blueeze system
- Liquid nitrogen cooling system components
- Heat exchanger
- Air compressor
- Coolant pump
- Electrical panels
- Hydrogen flow meter
- Nozzle assembly
- Dispenser and point-of-sale hardware
- Frame and fire protection system
- Various valves, gauges, and fittings
- Various pressure and temperature sensors.

Please see Figures 1–3 for a complete layout of the AHMF.



**Figure 1. AHMF trailer—right side view**

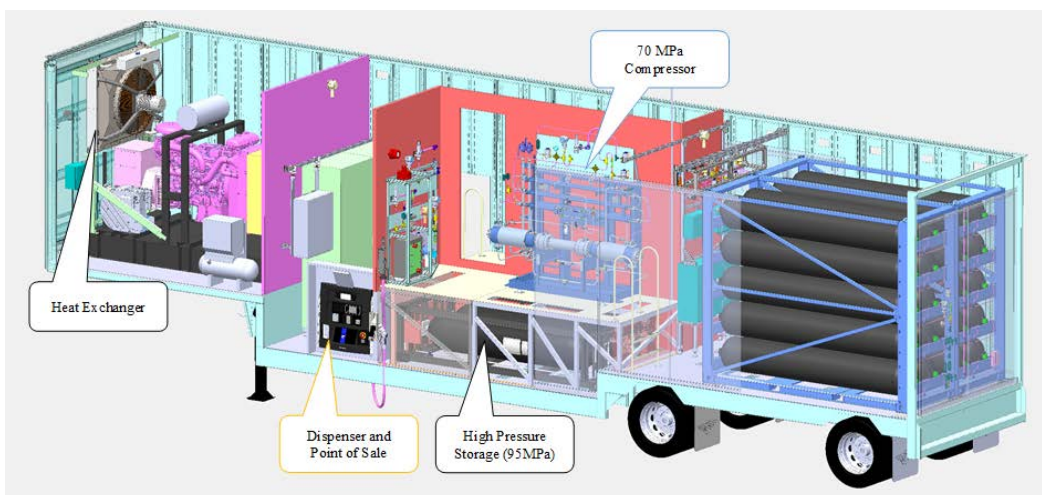


Figure 2. AHMF trailer—left side view

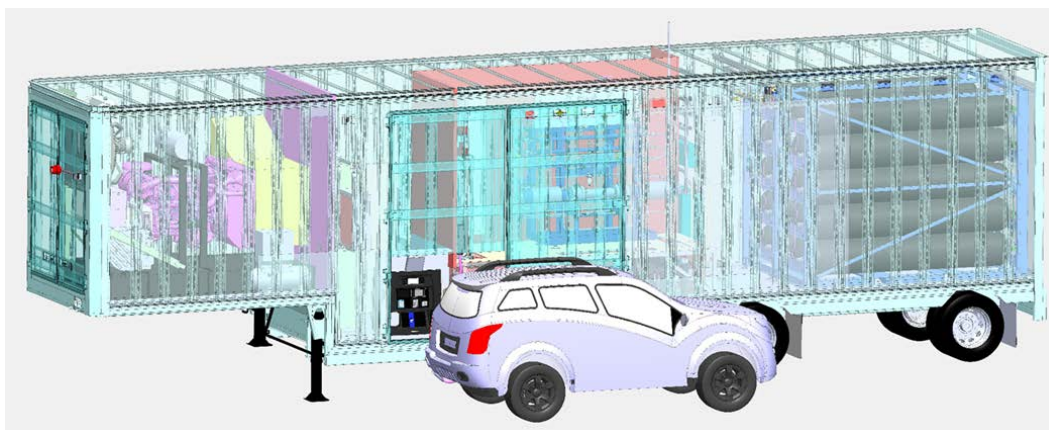


Figure 3. AHMF trailer—left side view with trailer walls and car

Specific to this project, Air Liquide received a U.S. Department of Transportation Special Permit for 95-MPa hydrogen transport.

The AHMF build is nearly complete, with the team working to finalize the electrical wiring, plumbing for the hydrogen and liquid nitrogen systems, and the venting for the PowerCubes. All interior and exterior safety systems have been identified and are being fitted for installation.

A Nationally Recognized Testing Laboratory (NRTL), which will certify that the AHMF meets certain codes and standards, has begun its initial review. Approval from the NRTL will provide confidence to the permitting officials and will help reduce the time and complexity to receive a permit.

The project team has begun the site selection process. Representatives of major automotive companies with fuel cell vehicles have been interviewed, as have stakeholders such as potential users and infrastructure planners. The team is looking at both California and the Northeast U.S. as potential sites.

## CONCLUSIONS AND UPCOMING ACTIVITIES

The team is preparing for factory acceptance testing and pre-commissioning of the trailer modules. In addition, the trailer will be put through a purge and pressure test as the final step before delivery of the finished AHMF. After testing is complete, the mobile fueler will be delivered to Air Liquide for an 18-month demonstration.

The team will gather and analyze the data collected from the validation testing and demonstration. Data collected will be reported to NREL quarterly and made available to DOE in conjunction with an economic analysis at the end of the program.

### **FY 2019 PUBLICATIONS/PRESENTATIONS**

1. Sara Odom and Spencer Quong, “Innovative Advanced Hydrogen Mobile Fueler.” Presented at the DOE Hydrogen and Fuel Cells Program 2019 Annual Merit Review and Peer Evaluation Meeting, Crystal City, VA, May 1, 2019.