Hydrogen Contaminant Detector

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**The Hydrogen Fueling Infrastructure Research and Station Technology Project**

**Objective:** Ensure that FCEV customers have a positive fueling experience relative to conventional gasoline/diesel stations as vehicles are introduced (2015-2017), and transition to advanced refueling technology beyond 2017.

<table>
<thead>
<tr>
<th>Reference Station Design</th>
<th>Hydrogen Contaminant Detector</th>
<th>Hydrogen Station Equipment Performance (HyStEP) Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Goal: Develop station designs based on state-of-the-art components and characterize cost, throughput, reliability, and footprint.</td>
<td>• Goal: Develop requirements for inline fuel quality system for installation at stations</td>
<td>• Goal: Develop a hydrogen station test device to validate station compliance with SAE J2601/HGV 4.3.</td>
</tr>
<tr>
<td>• Results: Five detailed reference station designs were published in a report yesterday.</td>
<td>• Results: Report released yesterday identifying the current state of the HCD market, and gaps between that and use requirements.</td>
<td>• Results: Device design review is complete</td>
</tr>
<tr>
<td>• Impact: Helps station developers evaluate site suitability, encourage interchangeability, cost transparency, inform roll-out scenarios, and AHJ education.</td>
<td>• Impact: FCEVs will no longer be the “canary in the coal mine” when it comes to contaminants.</td>
<td>• Impact: HyStEP will allow for safe, effective qualification of stations without using actual vehicles, which is the status quo.</td>
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H2FIRST Long-term Objectives

- Reduce the installation cost of a hydrogen fueling station to be competitive with conventional liquid fuel stations.
- Improve the availability, reliability, and cost while ensuring the safety of high-pressure components.
- Focus a flexible and responsive set of technical experts and facilities to help solve today’s urgent challenges and the future unpredicted needs.
- Enable distributed generation of renewable hydrogen in a broader energy ecosystem.
H2FIRST Project Coordination

DOE FCTO Decision Authority

H2USA HFSWG Coordination Activity

H2FIRST Project Coordination Activity

Add key external partners

Pre-Proposal

Full Proposal

Needs, Ideas, Feedback

Project Status & Results
Overview

Timeline
• Task Start Date: Q4 2014
• Task End Date: Q3 2015
• Percent Complete: 95%

Budget
• Total Task Budget: $30k
  – DOE Share: $30k
  – Funds Spent To-date: $15k

Barrier – Safety Codes and Standards
A. Safety Data and Information:
   Limited Access and Availability

Partners
• National Labs: NREL* and SRNL
• California Air Resources Board
• SAE Fuel Cell Interface Task Force
• DOE-EERE-FCTO
*Task lead
Objective and Relevance

**Goal** - Ensure high quality fuel is dispensed to FCEV customers for optimal FC operation by testing for critical contaminants in the fuel before it is dispensed

**Impact**
- Educate station operators about contaminants relevant to station type
- Inform station developers of current status of relevant technology
- Validate stated performance of analyzers
- Determine requirements for station integration
- Provide information for technology developers
  - Define application requirements
  - Provide a gap analysis between requirements and status of current technology
A hydrogen contaminant detector (HCD) is defined as a gas analyzer and integration apparatus. An integrated HCD must identify and report poor quality fuel BEFORE it is dispensed to FCEV customers.
### Desired Characteristics vs. Challenges

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<th>Challenges</th>
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</table>
| Ease of station integration | - Multiple Station configurations  
- Extreme gas pressure and temperature  
- Hazardous environment rating |
| Contaminants Detected | - SAE J2719 identifies large list of contaminants  
- Not all contaminants are probable in stations |
| Levels of Detection | - SAE J2719 concentration levels difficult to achieve with current tech |
| Cost | - Current technology is laboratory grade  
- Expensive  
- Maintenance is frequent and specialized |

*Near term solution not likely “one size fits all”*
Approach: Refine the Application

- Unfeasible to detect all contaminants listed in SAE J2719 at required levels
- Not meant to replace regular sampling and laboratory testing
- Target station characteristics to reduce requirements of HCD

**External Inputs**
- CARB
- SAE WG
- OEMs

**Anticipated prevalent station concepts**
- Likely contaminants
- Contaminant Concentrations that indicate process upset

**Affordable HCD**
Approach: HCD Current Focus

- **First deliverable (milestone)**
  - HCD Requirements Definition
  - Market survey of viable HCD technologies
  - Report published

- **Develop proposal for second phase**
  - Integrate technologies into research and commercial station
  - Gather input from DOE, industry and project team

*First phase report published, second phase under proposal*
Accomplishments: First Deliverable

- ENGINEERING REQUIREMENTS – developed with input from industry, state agencies, codes and standards committees
  - Detection abilities
    - Types
    - Concentrations
  - Cost
  - Availability
  - Ambient environmental
  - Gas sampling
    - Pressure
    - Temperature
    - Volume

Customer and functional requirements determined and compared
Accomplishments: First Deliverable

- ENGINEERING REQUIREMENTS – station integration

Possible HCD Location

Location 1

Location 2

Location 3

*Constituents are examples
Accomplishments: First Deliverable

- ENGINEERING REQUIREMENTS

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<thead>
<tr>
<th>Contaminant</th>
<th>Detection Level Requirements (ppmv)</th>
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<tbody>
<tr>
<td></td>
<td>HCD 1 (SMR)</td>
</tr>
<tr>
<td>Water</td>
<td>50</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>2</td>
</tr>
<tr>
<td>Total Sulfur</td>
<td>0.04</td>
</tr>
<tr>
<td>Ammonia</td>
<td>1</td>
</tr>
<tr>
<td>Total Hydrocarbons (as C₁)</td>
<td>20</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Parameter</th>
<th>Nominal Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>Location 2</td>
</tr>
<tr>
<td>Process Pressure (bar)</td>
<td>&lt; 300</td>
</tr>
<tr>
<td>Process Temperature (°C)</td>
<td>-20 &lt; T &lt; 100</td>
</tr>
<tr>
<td>Ambient Temperature (°C)</td>
<td>-35 &lt; T &lt; 45</td>
</tr>
</tbody>
</table>

Device requirements defined for different stations
Accomplishments: First Deliverable

- **MARKET SURVEY** - 8 week study into currently available, potential hydrogen contaminant detectors
  - Survey responses from 10 companies
  - Multiple technologies explored
    - Gas chromatograph, mass spectroscopy, Fourier transform infrared spectroscopy, non-dispersive infrared spectroscopy, laser absorption continuous wave cavity ring down spectroscopy and concentrator technologies
  - Gap analysis on state of technology versus engineering requirements

Current state of the market compared with device requirements

Credit: www.picarro.com
Accomplishments: HCD Gaps

The gray bars indicate the current state of the market. The blue diamond indicates engineering requirements.
HCD Next Steps – Proposal Highlights

- Work with HCD manufacturers to obtain units for testing
  - Anticipate devices will be ready by June 2015 or sooner
- Design and build integration and sampling apparatus
  - 70MPa capable near the dispenser
- Communicate with project team to identify most important aspects of testing
- Develop test plan for bench-top testing and station integration
  - Verify performance in lab first
- Generate report on performance, maintenance and costs

Phase 2 proposal for component testing submitted
Summary

• Accomplishments
  – A hydrogen contaminant detector was defined
  – Challenges were presented for installation at commercial stations
  – A set of engineering requirements was developed
  – A market survey was performed on applicable technologies
  – An analysis was conducted to highlight the gaps between HCD requirements and the current state of technology

• Stakeholders who benefit
  – Station developers
  – Station operators
  – Legislative bodies
  – Technology developers
  – Automotive OEMS
  – FCEV customers