V.I.11 Extended Durability Testing of an External Fuel Processor for SOFC*

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*Congressionally directed project

Objectives

The main goal of this project is to perform extended durability testing of the External Fuel Processor for the Rolls-Royce Fuel Cell Systems (RRFCS) 1-MWe solid oxide fuel cell (SOFC) power plant concept. The specific objectives are to:

- Conduct long-term tests in relevant environment of the External Fuel Processor.
- Determine long-term performance of critical components including catalysts, sorbents, heat exchangers, control valves.
- Evaluate the impact of ambient temperatures (hot and cold environments) on performance and component reliability.
- Determine system response and performance of process controls for transient operation.
- Identify any failure mechanisms.

Technical Barriers

This project addresses the following technical barriers from the Fuel Cells Section of the Hydrogen, Fuel Cells and Infrastructure Technologies (HFCIT) Program Multi-Year Research, Development and Demonstration (RD&D) Plan:

(A) Durability

(C) Performance

(G) Start-up and Shut-down Time and Energy/Transient Operation

These barriers will be addressed as they relate to the External Fuel Processor subsystem in the RRFCS 1-MWe SOFC power plant concept. The External Fuel Processor subsystem uses pipeline natural gas and air to generate all gas streams required by the fuel cell power plant for start-up, shut-down, low-load and normal operation. Thus it eliminates the need for on-site bottled gases.

Technical Targets

This project addresses Milestone 59 in the Fuel Cells section of the HFCIT Multi-Year RD&D Plan. Milestone 59 is to "evaluate fuel processing subsystem performance for distributed generation against system targets for 2011." These targets will be addressed as they relate to durability, performance (gas quality - sulphur in product stream), and transient response.

Characteristic	Units	2005 Status	DOE 2011 Targets	RRFCS 2011 Targets
Cold start-up time to rated power @ -20°C ambient	minutes	<90	<30	<30 from standby
Transient response time (for 10% to 90% power)	minutes	<5	1	1
Durability	hours	20,000	40,000	8,000
Survivability (min and max ambient temperature)	°C °C	-25 +40	-35 +40	-35[a] +40[a]
Sulfur content in product stream	ppbv (dry)	<10	<4	<80 ppb

[a] as limited by ambient conditions

Approach

The approach for this project focuses on using full-scale components from the External Fuel Processor. It includes the following:

Conduct demonstration tests in relevant environments for:

- Synthesis-gas subsystem for multiple startups and 1,200 hours of operation in a heated indoor test enclosure.

- Start-gas subsystem for multiple startups and 200 hours of steady-state operation in an outdoor test facility (hot and cold environments).
- Desulfurizer subsystem for 8,000 hours in an outdoor test facility (hot and cold environments).

Perform post-test inspections on:

- Subsystem components (catalysts, sorbents, piping, reactors, insulation, valves, heaters, heat exchangers, N_2-membrane, etc.).
- Deposits, signs of wear, damage, corrosion, erosion, and any failed components. Perform functional checks where possible.

Accomplishments

The project was initiated in January 2009. By the end of the second quarter of 2009 the following tasks were completed:

- Draft Hydrogen Safety Plan issued for comments.
- Completed mechanical installation of synthesis-gas subsystem in test enclosure.
- Confirmed operation of enclosure safety system.
- Electrical wiring for control system completed.
- Control software written and debugged.
- Specifications for outdoor test facility issued.

Future Directions

2009

- Complete synthesis-gas subsystem durability test (Fiscal Year 2009 Q3).
- Complete post-test inspections (FY 2009 Q4).
- Complete installation and commissioning of start-gas and desulfurizer subsystems (FY 2009 Q3).
- Being durability testing of start-gas and desulfurizer subsystems (FY 2009 Q4).

2010

- Complete durability testing of start-gas and desulfurizer subsystems (FY 2010 Q3).
- Complete inspections of start-gas and desulfurizer subsystems (FY 2010 Q4).
- Issue final report for project (FY 2010 Q4).

FY 2009 Publications/Presentations

1. Presentation at 2009 Hydrogen Program Annual Merit Review Meeting, M. Perna.

2. Presentation at 2009 Project Kickoff Meeting, M. Perna.