**ADVANCED WATER-COOLED PHOSPHORIC ACID
FUEL CELL DEVELOPMENT**

DOE/MC/24221--3144

**Quarterly Technical Progress Report No. 50
for April - June, 1992 Activity**

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FCR-12383

July 1992

Work Performed Under Contract No.

DE-AC21-88MC24221

Prepared for

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Morgantown Energy Technology Center
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MASTER

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PROGRAM HIGHLIGHTS

- Testing of the small area short stack is continuing. The stack has operated up to rated power with the expected cell performance. Total load time is about 3379 hours, and average cell voltage is 0.643 volts. Testing is continuing at conditions typical of on-site power plants for 3000 hours.

I. INTRODUCTION

The Advanced Water Cooled Phosphoric Acid Fuel Cell Development program is being conducted by International Fuel Cells Corporation (IFC) to improve the performance and minimize the cost of water-cooled, electric utility phosphoric acid fuel cell stacks.

The program adapts the existing on-site Configuration B cell design to electric utility operating conditions and introduces additional new design features. Task 1 consists of the conceptual design of a full-scale electric utility cell stack that meets program objectives. Tasks 2 and 3 develop the materials and processes required to fabricate the components that meet the program objective. The design of the small area and two 10-ft² short stacks is conducted in Task 4. The conceptual design also is updated to incorporate the results of material and process developments, as well as results of stack tests conducted in Task 6. Fabrication and assembly of the short stacks are conducted in Task 5 and subsequent tests are conducted in Task 6. The Contractor expects to enter into a contract with the Electric Power Research Institute (EPRI) to assemble and endurance test the second 10-ft² short stack. The management and reporting functions of Task 7 provide DOE/METC with program visibility through required documentation and program reviews.

This report describes the cell design and development effort that is being conducted to demonstrate, by subscale stack test, the technical achievements made toward the above program objectives.

II. STATUS

TASK 1 - CONCEPTUAL DESIGN

Objectives

The objective in this task is to define the conceptual design for a cell stack having a performance level of at least 175-W/ft² and a manufactured cost of less than \$400/kW. The stack must be capable of operating for a minimum of 40,000 hours at electric utility conditions.

Activity

This activity was completed. Conceptual design updates are reported in Task 4 as part of the stack design activity.

TASK 2 - COMPONENT DEVELOPMENT

SUBTASK 2.1 - MATERIALS DEVELOPMENT

Objectives

The objectives of this subtask are to provide an improved substrate, verify the stability of low cost substrate and electrolyte reservoir materials at pressurized cell operating conditions, and increase the thermal conductivity of the electrolyte reservoir.

Activity

This activity was completed.

SUBTASK 2.2 - SINGLE CELL TESTING

Objectives

The objectives of this subtask are to test subscale cells to evaluate improvements in cell components consisting of substrates, electrolyte reservoir plates (ERP), catalyst and matrix; verify performance and endurance of components fabricated for short stacks; optimize the hydrophobicity of catalyst layers made from the GSB-18 and GSB-18P catalysts for operation at power densities of 200 WSF or greater; evaluate a higher performing laboratory catalyst for this application, and define the permissible range of operating conditions.

Activity

This activity was completed.

TASK 3 - PROCESS DEVELOPMENT

SUBTASK 3.1 - SUBSTRATES

Objective

The objectives of this subtask are to develop the process technologies required to produce electrode substrates and electrolyte reservoir plates that meet the technical requirements and cost objectives established in the conceptual design.

Activity

This activity was completed.

SUBTASK 3.2 - INTEGRAL SEPARATOR

Objective

The objective of this subtask is to develop the process technology to fabricate integral separators, up to 10-ft² in size, that meet the technical requirements and cost objectives established in the conceptual design.

Activity

This activity was completed.

SUBTASK 3.3 - SEALS AND MATRIX

Objective

The objective of this subtask is to develop the technology to fabricate higher integrity seals and matrices that meet the technical requirements and cost objectives established in the conceptual design.

Activity

This activity was completed.

SUBTASK 3.4 - ADVANCED COOLERS

Objective

The objective of this subtask is to develop material and process technology to fabricate coolers 10-ft² in size that meet the technical requirements and cost objectives established in the conceptual design.

Activity

This activity was completed.

TASK 4 - STACK DESIGN**Objective**

The objective of this task is to update the full-scale conceptual design and to define designs for the two small area development stacks and one 10-ft² subscale stack.

Activity**Conceptual Stack Design**

No activity. The stack assembly drawings are complete based on 10-ft² subscale stack experience.

10-Ft² Subscale Stack

This activity was completed.

TASK 5 - FABRICATION

SUBTASK 5.1 - REPEAT COMPONENTS

Objective

The objective of this effort is to fabricate the repeat components for two small area development stacks and one 10-ft² subscale stack each consisting of approximately 30 cells. These stacks will be of the Configuration B cell design. The repeat components consist of the substrates, electrodes, electrolyte reservoir plates, and cooler assemblies.

Activity

10-Ft² Subscale Stack

The fabrication of repeat components for the 10-ft² subscale stack is complete. See Subtask 6.2 for discussion of post-test inspection activities.

SUBTASK 5.2 - NON-REPEAT COMPONENTS

Objective

The objective of this effort is to fabricate the non-repeat components for two small area development stacks and one 10-ft² subscale stack each of approximately 30 cells each. These stacks will be of the Configuration B cell design. The non-repeat components consist of the reactant manifolds, coolant manifolds, axial load system, power take-off hardware and the pressure containment vessel.

Activity

10-Ft² Subscale Stack

The fabrication of non-repeat components for the 10-ft² subscale stack is complete.

SUBTASK 5.3 - STACK ASSEMBLY

Objective

The objective of this effort is to assemble two small area development stack and one 10-ft² subscale stack of Configuration B cells.

Activity

10-ft² Subscale Stack

The assembly of the first 10-ft² subscale stack is complete.

SUBTASK 5.4 - COST ASSESSMENT

Objective

Estimate the manufactured cost of the full-height 10-ft² Configuration B cell stack assembly defined in the conceptual design activities (Tasks 1 and 4).

Activity

This activity was completed.

TASK 6 - STACK TESTING

SUBTASK 6.1 - SMALL AREA DEVELOPMENT STACK TESTING

Objective

The objective of this task is to obtain early feedback on improved Configuration "B" cell packages at atmospheric and pressurized operating conditions.

Activity

This activity was completed.

SUBTASK 6.2 - TEN SQUARE FOOT SUBSCALE STACK TEST

Objective

The objective of this task is to verify the scalability of the Configuration "B" cell design and evaluate the intermediate levels of achievement from Tasks 2.0 and 3.0.

Activities

Review of acid electrolyte data showed only minor non-uniformity of acid content within individual Electrolyte Reservoir Plates (ERPS). This suggests the earlier variability of acid data was most likely due to the collection techniques as previously suspected. Data from ERPS analysed in total is valid since all the electrolyte was collected for lab analysis and data from ERPS analyzed only in sections is suspect and will be tested as well.

SUBTASK 6.3 - ON-SITE SMALL AREA STACK TEST

Objective

The objective of this task is to provide technology verification by operating a Configuration "B" on-site short stack for an extended period of time.

Activities

The stack contains 32 cells with coolers spaced between every eight cells and includes processing changes intended to improve seal integrity and performance stability.

Testing that simulates power plant field operation continued during this reporting period. Total load time is 3379 hours. Nine load cycles have been performed. A summary of test activities is shown in Table 6.3-1.

The test plan and test conditions simulate typical on-site cell stack operation. At rated power, operating conditions are set to 80 percent fuel utilization, 60 percent air utilization and approximately 400°F average cell temperature. As shown in Figure 6.3-1, field operation is simulated by running two-week cycles that varies load between 50 ASF and 200 ASF.

The average stack voltage at 200 ASF was 0.643 volts at the end of this reporting period, as shown in Figure 6.3-2. The results of diagnostic tests conducted during this reporting period are shown in Figure 6.3-3 through Figure 6.3-7. Performance of the stack remains very stable and uniform.

Table 6.3-1. On-Site Small Area Stack Test Activities

Load Time (Hours)	Test Activity
0-7	Load Cycle 1 - Cell Acceptance Test Simulation <ul style="list-style-type: none"> • Cell break-in • 50 ASF, 100 ASF
7-37	Load Cycle 2 - Cell Stack Acceptance Test Simulation (continued) <ul style="list-style-type: none"> • 50 ASF, 100ASF, 200ASF • Diagnostic tests
37-57	Load Cycle 3 - Power Plant Acceptance Test Simulation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 150 ASF, 200 ASF
57-97	Load Cycle 4 - Power Plant Shipment Simulation <ul style="list-style-type: none"> • Electrolyte Concentration Reduction
97-152	Load Cycle 5 - Simulated Power Plant Field Operation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 200 ASF
152-1715	Load Cycle 6 - Simulated Power Plant Field Operation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 200 ASF • Diagnostic tests
1715-2147	Load Cycle 7 - Simulated Power Plant Field Operation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 200 ASF
2147-2858	Load Cycle 8 - Simulated Power Plant Field Operation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 200 ASF
2858-Present	Load Cycle 9 - Simulated Power Plant Field Operation <ul style="list-style-type: none"> • 50 ASF, 100 ASF, 200 ASF • Diagnostic Tests

Figure 6.3-1. METC On-Site Small Area

Figure 6.3-2. Small Area On-Site Short Stack Performance History

Figure 6.3-3. METC On-Site Small Area Stack Performance Calibrations

Figure 6.3-4. METC Small Area On-Site Short Stack Fuel Utilization Sensitivity

Figure 6.3-5. METC Small Area On-Site Short Stack Air Utilization Sensitivity

Figure 6.3-6. METC Small Area On-Site Short Stack Individual Cell iR Measurements

Figure 6.3-7. METC Small Area On-Site Short Stack Cross-Pressure Sensitivity

TASK 7 - MANAGEMENT AND DOCUMENTATION

Objectives

The objective of this task is to provide the program management necessary to maintain technical and budget control of the program activities, and to provide adequate documentation of its progress per contract requirements.

The following reports were submitted during the period May 1 through May 31, 1992.

- Monthly Status Report No. 48 for April 1992 activity (FCR-12327) was submitted on June 4, 1992.
- Monthly Cost Management Report No. 49 for May 1992 activity (FCR-12355) was submitted on June 12, 1992.
- Monthly Status Report No. 49 for May 1992 activity (FCR-12356) was submitted on July 6, 1992.
- Monthly Cost Management Report No. 50 for June 1992 activity (FCR-12382) was submitted on July 23, 1992.

An amendment is in progress to allow testing of On Site Small Area Short Stack (Subtask 6.3) beyond the 3000 hours stated in the current SOW.

END

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