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TECHNICAL PROGRESS REPORT
FOR
THE MAGNETOHYDRODYNAMICS
COAL-FIRED FLOW FACILITY

For The Period
April 1, 1994 - June 30, 1994

July 1994

Work Performed Under Contract No. DE-AC02-79ET10815

Prepared for:
The United States Department of Energy

Prepared by:
The University of Tennessee
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PREFACE

The purpose of this report is to provide the status of a multi-task research and development program in coal fired MHD/steam combined cycle power production. More detailed information on specific topics is presented in topical reports. Current emphasis is on evaluating technology for the Steam Bottoming Cycle Program. The approach taken was to design test components that simulate the most important process variables, such as gas temperature, chemical composition, tube metal temperature, particulate loading, etc., to gain test data needed for scale-up to larger size components.

Previous reports have provided comprehensive data on NO_x and SO_x control, radiant heat transfer, particulate control (baghouse and wet and dry electrostatic precipitators), environmental monitoring, and analyses of test data on the convective heat transfer components (superheater and air heater) with eastern, high sulfur coal firing. For this quarter, continued analyses of the data for previously completed eastern coal testing and western coal proof-of-concept (POC) tests were extremely limited due to the loss of additional personnel in downsizing the organization for program closeout. Detailed data analyses will be contained in test reports, topical reports or technical papers to the extent permitted by resources available.

ABSTRACT

In this quarterly technical progress report, UTSI reports on the status of a multi-task contract to develop the technology for the steam bottoming portion of a MHD Steam Combined Cycle Power Plant. The report describes the facility maintenance and environmental work completed, status of completing technical reports and certain key administrative actions occurring during the quarter.

In view of current year budget reductions and program reductions to closeout the MHD program, downsizing of the UTSI work force took place. No further testing occurred or was scheduled during the quarter, but the DOE CFFF facility was maintained in a standby status.

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SECTION I

OBJECTIVE AND SCOPE OF WORK

Under Contract No. DE-AC02-79ET10815, the overall objective initially was to advance the technology of direct coal-fired MHD components and systems required for MHD power generation operating under conditions simulating those of central power stations. The specific objectives of the DOE Coal-Fired Flow Facility (CFFF) were to resolve experimentally and analytically the key technical areas of concern identified or found to occur in direct coal-fired MHD systems with moderate to high ash carryover. The key areas involved (1) combustor performance, (2) ash/seed particle collection efficiency from the exhaust gas stream, (3) effects of plugging, fouling and corrosion during normal operation, (4) performance of candidate materials in a direct coal fired MHD environment and (5) the operation, conditions, procedures and equipment needed to meet pollution control requirements.

In view of the conclusion of the MHD proof-of-concept program and acquisition of data, DOE directed UTSI to take the following actions:

- a) contract closeout;
- b) property disposition;
- c) reporting and archiving of data; and
- d) environmental remediation

In support of the above objectives and the DOE FY1994 MHD Program Plan, a revised contract statement of work (SOW) and management plan were approved by DOE. The technical approach now focuses on the following four (4) tasks described below:

TASK I - Contract Management and Close Out

This task provides for the overall management of the program which entails the planning, organizing, scheduling, directing, coordinating and controlling of the resources required in the close out of the contract. Specific support staff functions include project control, reporting, accounting and financial affairs, government property administration, and contract administration.

TASK II - Facility and Property Disposition

This task provides for the maintenance of the CFFF in a standby condition until final disposition of the facility is made. All government owned property and equipment will be documented and controlled, and worn or unusable material will be recommended for applicable disposition.

TASK III - Data Reporting and Archiving

The contractor shall collect all data generated during the proof-of-concept testing program and place in a retrievable condition by identifying and documenting in accordance with its nature, format, quantity and repository. Data to be archived will be selected on the basis of certain criteria.

TASK IV - Site Environmental Compliance and Remediation

The Coal Fired Flow Facility site shall be subject to a DOE-directed project environmental characterization whereby site compliance and remediation requirements and actions will be identified and documented. The contractor shall accommodate this effort by providing accessibility to all pertinent areas and relative information and documentation as needed to perform the environmental characterization.

The contractor shall be prepared to perform the tasks necessary for site remediation and site restoration as determined by the site characterization study and as decided upon by the U.S. Department of Energy, and within the limitations of allocated costs.

CFFF PROGRAM GOALS AND SCHEDULE

Figure 1 shows the major program tasks presently scheduled/completed during the April through June 1994 period, plus those tasks projected through September 1994.

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FIGURE 1. SCHEDULED TASKS

SECTION II

SUMMARY OF TECHNICAL PROGRESS

This section addresses the technical progress of work conducted during the period April 1 through June 30, 1994, according to the objectives and scope of work tasks outlined in Section I. Figure 2 is an overview of the DOE MHD Coal Fired Flow Facility (CFFF) at UTSI, and Figure 3 is a schematic of the current LMF test train.

TASK I - CONTRACT MANAGEMENT AND CLOSEOUT

The final October-December 1993 and January-March 1994 Quarterly Technical Progress Reports were issued to DOE.

The revised Management Plan and contract statement of work were issued to DOE and approved for implementation. As stated earlier in Section I, these documents contain the key features for management and closeout of the contract, maintenance of the CFFF in a standby condition and disposition of the property and equipment, collection of generated data, reporting and archiving, and meeting site environmental and remediation requirements.

TASK II - FACILITY AND PROPERTY DISPOSITION

No MHD testing was scheduled or performed during this quarterly period.

Activities this quarter continued to be focused on facility preventive maintenance and repairs to keep the CFFF in a standby status. Weekly and monthly equipment maintenance procedures were performed for facility air compressor systems, cooling water pumps, coal processing system motors, steam boiler systems, ID and FD fans, and fire water system equipment. Efforts to reduce the facility electrical power usage were continued during this period.

During this period, the following electrical and data system maintenance items were accomplished:

- Performed periodic operational checkout and disk backups on the Data General MV1500 computers to maintain operation.
- Continued to add users to the computer ethernet links via fiber optics for improved communications capability.

FIGURE 2. Overview of the Coal-Fired Flow Facility

FIGURE 3. CFFF Integrated MHD Bottoming Cycle Schematic

- Performed electrical/electronics repairs to CFFF plant equipment as necessary to maintain the operational capability. This includes equipment such as personal computers, data acquisition system components, heat tracing, and lighting.
- Calibrated pressure and temperature secondary standards.

TASK III - DATA REPORTING AND ARCHIVING

Tube samples from the superheater test module (SHTM) test sections one and two were being prepared for microscopic analysis under the SH/AH tube corrosion studies effort.

Work also continued on the topical reports related to the MHD POC test program and on the final issue of the 2000 Hours Testing on Eastern Coal Technical Summary Report.

The Thirty-Second Symposium on Engineering Aspects of MHD (SEAM) at the Westin William Penn Hotel in Pittsburgh, Pennsylvania, was attended by UTSI personnel during June 27-30, 1994. The following papers were presented:

- "Control Monitors for the Superheater Inlet Region," B. C. Winkleman, T. V. Giel, Jr., P. R. Jang and R. L. Cook
- "Preliminary Design Calculations for a Prototype 600MW_e MHD Steam Combined Cycle Power Plant," J. N. Chapman and N. R. Johanson
- "Natural Gas Fired MHD Steam Combined Cycle Power Plant Potential," J. N. Chapman, D. Erb and L. W. Crawford
- "CFFF Testing of Ceramic Elements for MHD Generators," J. T. Lineberry, P. J. Christiansen and V. Hruby
- "Measurement of Particle Size Distributions On-Line at the CFFF," T. V. Giel, J. K. Holt, J. R. Douglas, J. Holve and M. P. Bonin

TASK IV - SITE ENVIRONMENTAL COMPLIANCE AND REMEDATION

Conducted analyses of CFFF holding pond water for total dissolved solids, total suspended solids, and pH to support environmental monitoring. Effluent from the CFFF holding ponds was monitored for pH, solids, temperature, flow, metals (copper, iron, magnesium, zinc, selenium), oil/grease, and total phenols and adjusted pH as required. Replaced pumps used to introduce acid to the ponds and to stir ponds. Mowed grass around ponds. Submitted monthly Discharge Monitoring Report (DMR) to the State of Tennessee. Arranged for the analysis of copper, iron, magnesium, zinc, and oil/grease.

UTSI was still awaiting a response from DOE to its letter of March 18, 1994, containing planned action items and cost estimates for the disposal, site remediation and restoration for the CFFF and adjacent areas which was prepared in response to the DOE-conducted site environmental characterization audit held in March 1994.

GLOSSARY

AH	- Air Heater
ASTM	- American Society for Testing and Materials
BGC	- Bendix Gas Chromatograph
BH	- Baghouse, particulate capturing device using a fabric type filter bag
B&W	- Babcock & Wilcox
CARS	- Coherent anti-Stokes Raman spectroscopy
CERCLA	- Comprehensive Environmental Response Compensation and Liability Act
CFFF	- Coal Fired Flow Facility
CS(n)	- Cooling Section where n = number of section
CDIF	- Component Development Integration Facility
DCW	- Diagonal Conducting Wall
DDAS	- Digital Data Acquisition System
Diagnostic Channel	- A substitute channel in place of generator channel
DNCF	- Dry Normal (i.e. standard pressure and temperature) cubic foot
Downstream	- From exit of diffuser outlet to stack
DFO	- Diffuser outlet probe
DG	- Data General Computer
E	- Emissivity or velocity fraction
ECF	- Energy Conversion Facility
EFM	- Electric Field Meters
EPRI	- Electrical Power Research Institute
ESP	- Electrostatic Precipitator
EDX	- Energy Dispersive X-ray
Flow Train	- Test facility including all components from the vitiation heater to the stack
GC	- Gas Chromatograph
GC/MS	- Gas Chromatograph/Mass Spectrometer
GIS	- Geographic Information System
HPT	- High Pressure Test
HR/SR	- Heat Recovery/Seed Recovery
HTAH	- High Temperature Air Heater
HVT	- High Velocity Thermocouple
ICAP	- Inductively Coupled Argon Plasma
IMPS	- Intrusive Multi-Probe System
IT	- Inlet Transition
ITAH	- Intermediate Temperature Air Heater
ITC	- Integrated Topping Cycle
LDV	- Laser Doppler Velocimeter
LMF(n)	- Low Mass Flow Test, where n = number of test
LPS	- Light Pipe Sensor
LV	- Laser Velocimeter
MCP	- Multicolor Pyrometer
MHD	- Magnetohydrodynamics
MPS	- Miscellaneous Process Sampling
MSE	- Mountain States Energy
MSU	- Mississippi State University
NPDES	- National Pollution Discharge Elimination System
NSPS	- New Source Performance Standard
ONR	- Office of Naval Research
PAD	- Pulsed Amperometric Detector
PE/AS	- Potassium Emission/Absorption System
PGC	- Perkin Elmer Gas Chromatograph
PMS	- Particle Measuring System
POC	- Proof-of-Concept
PSD	- Particle Size Distribution System
PTO	- Power Take-Off
RCRA	- Resource Conservation and Recovery Act
RF1	- Radiant Furnace #1 Position
SCA	- Specific Collection Area for ESP
SCI	- Secondary Combustor Inlet
SCO	- Secondary Combustor Outlet
SCR	- Silicon Controlled Rectifier
SEDS	- Sample Extraction/Dilution System
SER	- Site Environmental Report
SEM	- Scanning Electron Microscope
SHTM	- Superheater Test Module
SIDA	- Silicon Diode Array
SLR	- Sodium Line Reversal
Sootblower	- Device for removing particulate collection on heat transfer surface
T/C	- Thermocouple
TCLT	- Two Color Laser Transmissometer
TGA	- Thermogravimetric Analyzer
TS(n)	- Test Section, where n = number of section
TTIRC	- Technology Transfer Integration and Review Committee
Upstream	- That part of the Flow Train from the vitiation heater to the exit of the diffuser
UTSI	- The University of Tennessee Space Institute
VIES	- Visible/Infrared Emission Spectrometer
WBDAAS	- Wide Band Data Acquisition and Analysis System

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