DOE/PC/90274--T11

TRW Applied Technology Division
Space & Technology Group
Redondo Beach, CA 90278

TRW

MHD Technology Transfer, Integration and Review Committee

Semi-annual Status Report

Period of Performance:
July 1988 – March 1989

Report No. MHD-ITC-89-307

Prepared for
U.S. Department of Energy
Pittsburgh Energy Technology Center
Pittsburgh, Pennsylvania

Contract No. DE-AC22-87PC90274

MHD Integrated Topping Cycle

Notice

DOE/PC/90274--T11

DE92 007932

MHD TECHNOLOGY TRANSFER, INTEGRATION AND REVIEW COMMITTEE

Second Semi-Annual Status Report
July 1988 through March 1989

MHD Integrated Topping Cycle Project
Report No. MHD-ITC-89-307

Date Submitted:
October 1989

Prepared for:
U.S. Department of Energy
Pittsburgh Energy Technology Center

By:
Applied Technology Division
TRW Space and Technology Group
One Space Park
Redondo Beach, CA 90278

Contract Number:
DE-AC22-87PC90274

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SUMMARY

As part of the MHD Integrated Topping Cycle (ITC) project, TRW was given the responsibility to organize, charter and co-chair, with the Department of Energy (DOE), an MHD Technology Transfer, Integration and Review Committee (TTIRC). The Charter of the TTIRC, which was approved by the DOE in June 1988 and distributed to the committee members, is included as part of this Summary. As stated in the Charter, the purpose of this committee is to: (a) review all Proof-of-Concept (POC) projects and schedules in the national MHD program; to assess their compatibility with each other and the first commerical MHD retrofit plant; (b) establish and implement technology transfer formats for users of this technology; (c) identify interfaces, issues, and funding structures directly impacting the success of the commercial retrofit; (d) investigate and identify the manner in which, and by whom, the above should be resolved, and (e) investigate and assess other participation (foreign and domestic) in the U.S. MHD Program. The DOE fiscal year 1989 MHD Program Plan Schedule is included at the end of this Summary.

The MHD Technology Transfer, Integration and Review Committee's activities to date have focused primarily on the "technology transfer" aspects of its charter. It has provided a forum for the dissemination of technical and programmatic information among workers in the field of MHD and to the potential end users, the utilities, by holding semi-annual meetings. The committee publishes this semi-annual report, which presents in Sections 2 through 11 capsule summaries of technical progress for all DOE Proof-of-Concept MHD contracts and major test facilities.

In the future, TRW and the the TTIRC will assume a more active "integration and review" role in the POC program. With completion of the retrofit conceptual designs and the selection of the Phase II seed regeneration contractor, the task of integrating the POC program can proceed with increased intensity. The overall MHD system integration effort will encompass all the major projects in the POC program, i.e., the Integrated Topping Cycle, Integrated Bottoming Cycle, Seed Recovery/Regeneration process, and Retrofit Conceptual Designs, which are compiling the technical data base needed to scale MHD to retrofit power plant sizes. TRW and the TTIRC Executive Committee are in the process of reviewing schedules, test plans, test results, design requirements, and system studies for POC program activities to identify technology "gaps" and incompatibilities among the various POC projects which could lead to collection of an incomplete technical data base. Under the auspices of the committee, engineering studies will be performed, technical and programmatic evaluations will be conducted, and recommendations will be made to the DOE on ways to enhance the effectiveness and efficiency of the integrated Proof-of-Concept program so as to minimize the risks of proceeding with an MHD plant retrofit.

Revision III 5/03/88

CHARTER FOR THE MHD TECHNOLOGY TRANSFER, INTEGRATION AND REVIEW COMMITTEE

This Charter has been prepared under Contract No. DE-AC22-87PC90274 for the U.S. Department of Energy (DOE), Pittsburgh Energy Technology Center (PETC) by TRW Inc., the prime contractor for MHD Integrated Topping Cycle (ITC) Project

CHARTER - ARTICLES

The purpose of the MHD Technology Transfer, Integration and Review Committee (MHD TTIRC) is to:

1. Review all Proof-of-Concept (POC) projects and schedules to assess their compatibility with each other and the first commercial MHD Retrofit Plant.
2. Establish and implement an appropriate technology transfer format for potential future users of MHD technology.
3. Identify integration interfaces, technical issues, and funding structures that have direct impact on the success of the first commercial MHD retrofit plant and successful MHD entry into the commercial marketplace.
4. Investigate and identify the manner in which and by whom, the above interfaces, issues and structures should be resolved.
5. Investigate and assess the potential for other participation, both foreign and domestic, in the U.S. MHD program, including the first commercial MHD retrofit plant.

CHARTER - MEMBERSHIP

The MHD Technology Transfer, Integration and Review Committee is comprised of:

The Department of Energy
Prime contractor for the MHD Integrated Topping Cycle
Prime contractor for the MHD Integrated Bottoming Cycle
The contractor for the MHD Combustor
The contractor for the MHD Channel
The contractor for the MHD Power Conditioning
The contractor for the MHD Seed Regeneration
The contractor for the MHD Retrofit Conceptual Design
Operating contractor for CDIF
Operating contractor for CFFF
Other equipment suppliers to the utility industry
Potential users of MHD technology
Investors in MHD technology
Participating universities
Participating national laboratories

CHARTER - OPERATION

ORGANIZATION

The organizational structure of the TTIR Committee shall be in accordance with Figure 1. The General Committee participants include the organizations

Attachment III

involved in the MHD Topping Cycle, Bottoming Cycle, Seed Regeneration, Retrofit Conceptual Design, potential future users of MHD, Universities and other parties cost sharing in the program. Proposed changes to the listed Committee Charter Membership or organizational participants of Figure 1 will be accomplished only as discussed herein.

GENERAL COMMITTEE MEETINGS

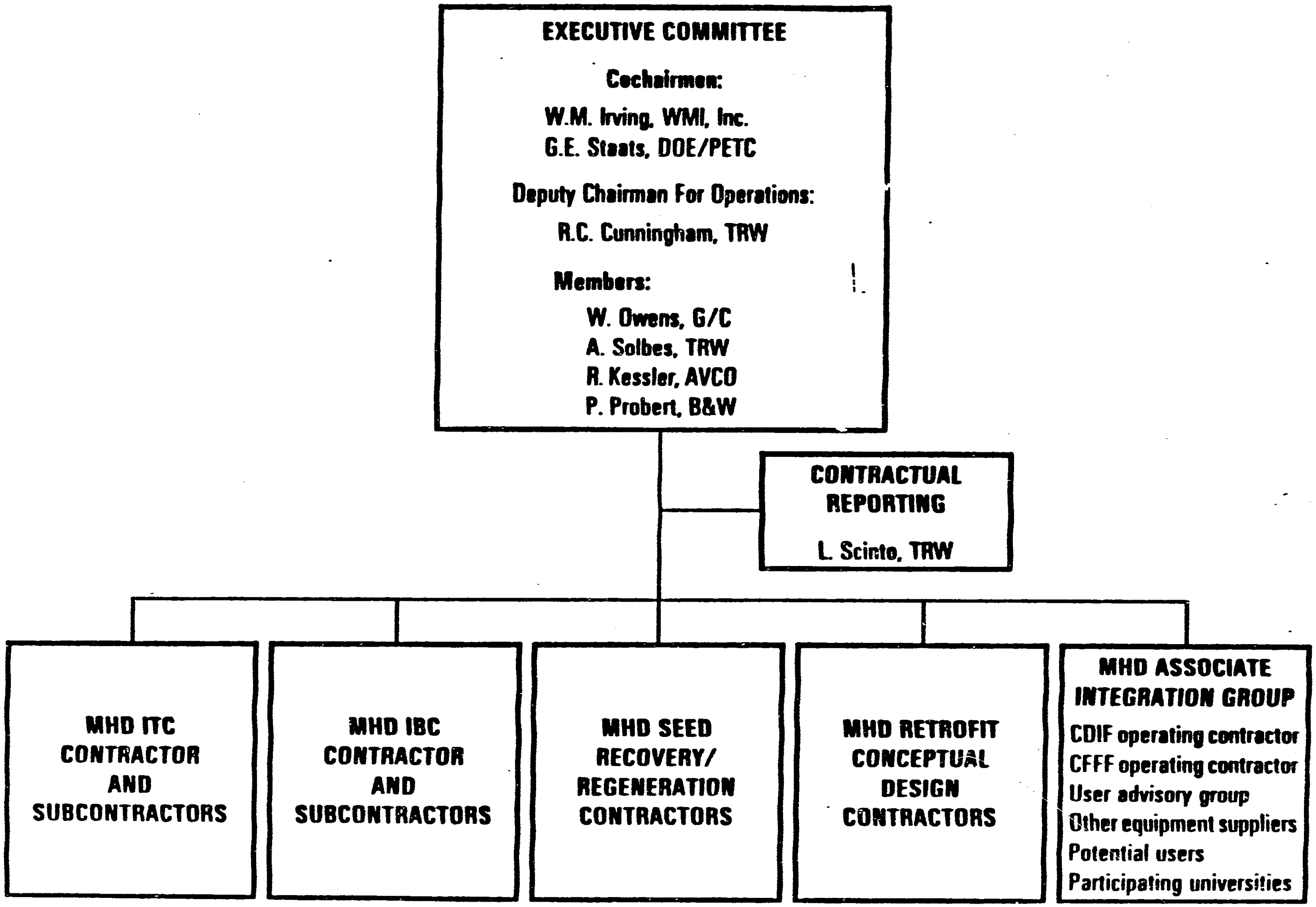
The frequency of the General Committee meetings will be semi annually, with a single participant from each organization attending, plus Executive Committee members. The MHD TTIR General Committee shall meet at alternate U.S. east or west locations, beginning with the June 1988 SEAM meeting in Tennessee, at a location to be determined. The meeting dates and locations will be selected by the Executive Committee members.

The meetings will be cochaired (presiding alternately) by Gary E. Staats of DOE/PETC and William M. Irving of WMI, Inc. Each participating organization shall submit a person's name and an alternate to be responsible to the Committee for accomplishment of the Charter Articles. The TRW Deputy Chairman for Operations, in conjunction with the Committee Cochairmen, will schedule the meetings, arrange for the accommodations, prepare the agenda, distribute the minutes and action items, inform the Committee members of the planned Charter operation and will essentially manage the day-to-day operations of the TTIR Committee. The agenda for the first Committee meeting will emphasize themes, vectors and goals. The subsequent meetings will emphasize program accomplishments, schedule status, interface issues and other appropriate matters as defined in the Articles of this Charter.

Listed below are the specific organizations that are Charter Members in the TTIR Committee:

Argonne National Laboratory
Arizona Public Service
AVCO/Textron
Babcock & Wilcox
DOE
Edison Electric Institute
EPRI
General Dynamics
Gilbert/Commonwealth
Houston Lighting and Power Co.
MHD Development Corporation
Mississippi State University
MIT (Plasma Fusion Center)
Montana Power Company
Montana State University (Rosa)
MSE, Inc.
Pennsylvania Power & Light Co.
Southern Services Co.
TRW Inc.
UTSI
Westinghouse, AESD
Westinghouse, R&D Center
WMI, Inc.

MHD Integrated Topping Cycle
TTI&R Committee Organization



01-ORG5-3583/03c (02-11-88)

The Executive Committee will act as the Membership Committee and will take care of any changes proposed.

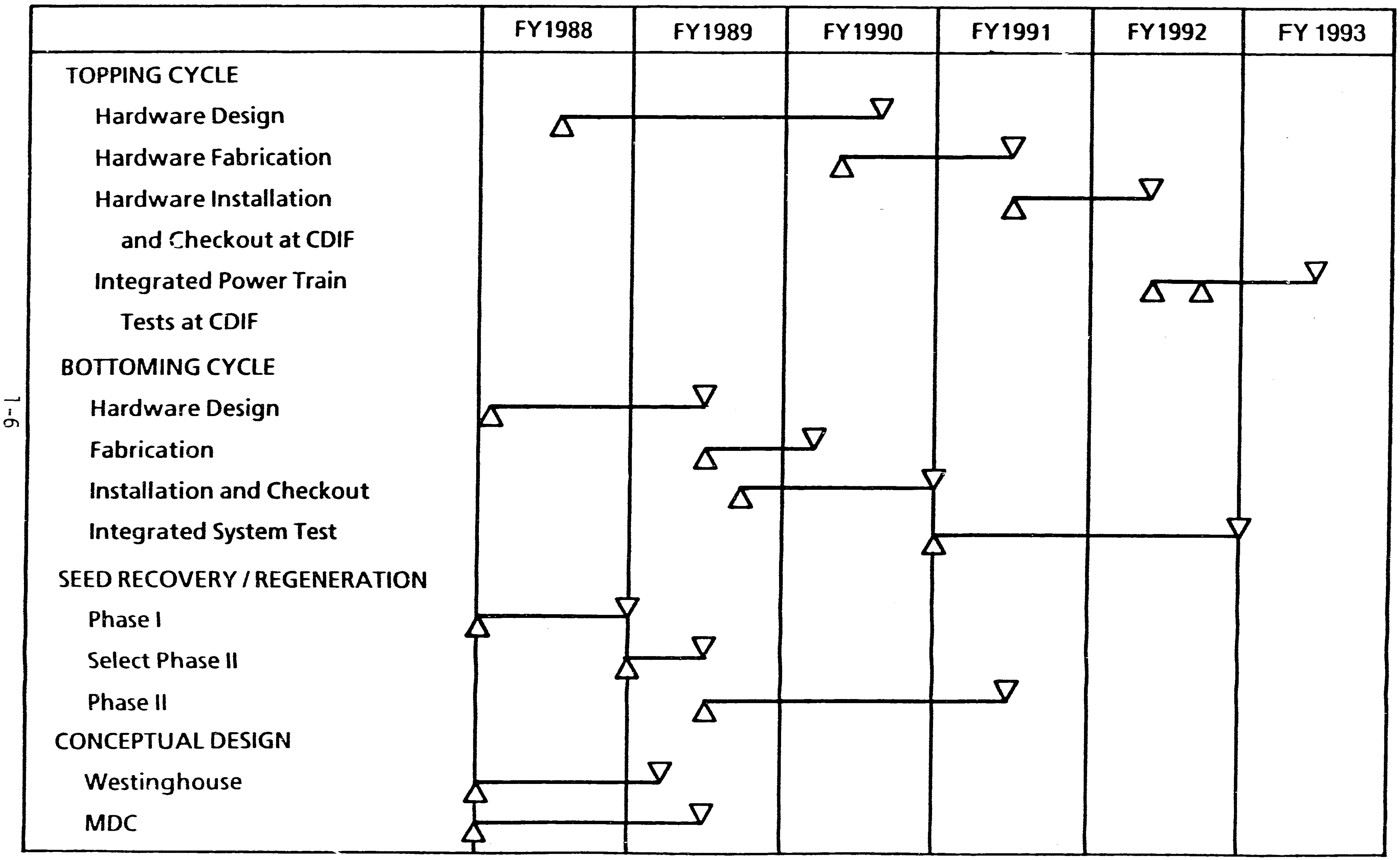
EXECUTIVE COMMITTEE MEETINGS

The Executive Committee is comprised of the industry and DOE Cochairmen, the Deputy Chairman for Operations, and Committee members (see Figure 1). Election to the Executive Committee may be accomplished by a simple majority including one Cochairman constituting a quorum. This Committee will convene to plan the activities of the semi-annual General Committee meetings, discuss salient technical integration and technology transfer issues, and resolve other issues covered by the Articles of this Charter. The Executive Committee is empowered to appoint subcommittees from the General Committee membership to help resolve any specific issues covered by this Charter. The meeting dates and locations will be selected by the Committee Cochairmen and the Deputy Chairman for Operations will again make all arrangements, etc.

SEMI-ANNUAL CONTRACTUAL REPORTS

TRW will prepare semi-annual progress reports based on inputs from MHD contractors. The semi-annual contractual report inputs shall be in rough draft format, together if possible with a MultiMate Word Processing Disk (or compatible equivalent) and all original art work suitable for reproduction. All report inputs will be due at TRW within 30 days after the General Committee meetings. These semi-annual progress reports, including a collation of the MHD TTIR Committee meeting minutes, will be combined and distributed.

DOE FY 1989
MHD PROGRAM SCHEDULE



No /16.008

CONTRACT TITLE:

MHD Integrated Topping Cycle
DE-AC22-87PC90274

DATE:

January 1989

PRIME CONTRACTOR:

TRW Space and Technology Group
One Space Park; Redondo Beach, CA 90278

REPORTING PERIOD:

July 1988 to
January 1989

MAJOR SUBCONTRACTORS:

Avco Research Laboratory/Textron
Westinghouse Research and Development Center

PROJECT MANAGER:

J.M. Bauer
(213) 814-0245

PERIOD OF PERFORMANCE

9/30/87 to
9/28/92

1. CONTRACT OBJECTIVE

The objectives of this effort are to design, construct and deliver all prototypical hardware necessary to conduct long-duration integrated MHD topping cycle proof-of-concept tests at the Component Development and Integration Facility in Butte, Montana, and to complement the existing engineering data base so as to allow scale-up of the MHD power train to an early-commercial scale retrofit MHD power plant.

2. TECHNICAL APPROACH

In order to achieve the program goal of demonstrating the durability and reliability of critical MHD topping cycle components at the 50 MW_t scale, prototypical hardware will be operated at the CDIF for over 1000 hours. In general, the approach capitalizes on the existing R&D data base to design, fabricate, check out, deliver, integrate and test new prototypical power train components. Specifically, the following tasks will be performed:

- Task 1 - Systems Engineering Studies
- Task 2 - Prototypical Combustor Design, Fabrication and Delivery
- Task 3 - Prototypical Channel Design, Fabrication and Delivery
- Task 4 - Diffuser Section Design, Fabrication and Delivery
- Task 5 - Power Conditioning Design, Fabrication and Delivery
- Task 6 - Test Engineering Activities at CDIF
- Task 7 - Hardware Repair/Replacement
- Task 8 - MHD Technology Transfer, Integration and Review Committee
- Task 9 - Quality Assurance
- Task 10 - Integrated Project Management

3. PROGRESS SUMMARY

Task 1 - Systems Engineering

Systems engineering activities focused on defining and documenting prototypical power train operating conditions and system design requirements and interfaces. A draft Preliminary Design Document and a draft Quality Assurance Plan were released and a System Requirements Document is being prepared. Required modifications to the CDIF to support prototypical power train testing were defined.

Task 2 - Combustor Design (TRW)

Testing was performed with a one-third scale plexiglass model of the 50 MW_t combustor (see Figure 1). The model was used to characterize the effects on mixing of different second stage oxidizer injection configurations. Seed distribution in the exit section of the combustor was also studied. The model is now being used to test ways to improve oxidizer mixing in the second stage and to evaluate different designs for low-pressure oxidant injection.

Additional hardware was fabricated to simulate the possible design configurations which could be used in a prototypical combustor to support Phase 2 of design confirmation testing on the 50 MW_t workhorse combustor at TRW.

A 20 MW_t coal combustor test program was conducted at Avco using an Avco oil-fired ash-injected combustor and a TRW second stage duct. The test program concentrated on identifying the effects of slag carryover and two-stage combustion on the performance of the MHD generator. Test results indicated that (1) the axial position of the second stage oxidizer injector is a significant parameter in power train performance, and (2) second stage mixing and generator performance is sensitive to the spatial distribution and mixing of the oxygen injectors.

Prototypical combustor design activities focused on design requirements development, materials studies, and design configuration analyses. Both the materials studies and configuration analyses identified new and potentially better approaches to the prototypical combustor design. A new TRW design concept was developed for cooling the prototypical combustor which utilizes modular cooling panels. The new design offers improved maintainability and scaleability over a tube-membrane design. A 20 MW_t combustor spool piece was designed which employs these cooling panels. It will be fabricated, and then tested in the Avco Mark VI facility in 1989.

Task 3 - Channel Design (Avco)

An engineering development task for improved sidewall (i.e., insulating wall) life is included as part of the Avco ITC program to ensure that the lifetime requirement of the prototypical channel (2000 hrs) will be met. Sidewalls are the life-limiting component of coal-fired MHD channels because they support the highest electric fields, the

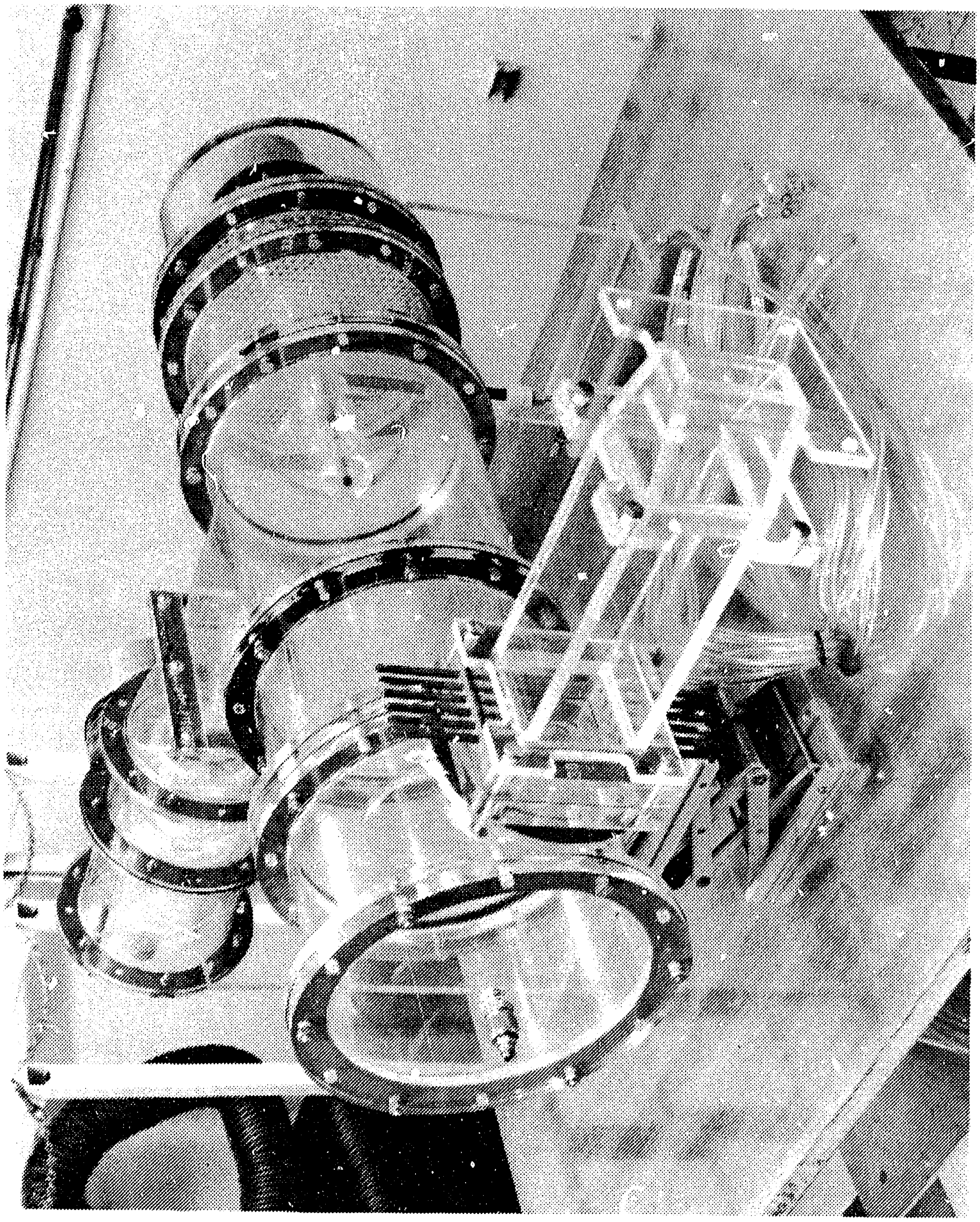


Figure 1. Cold Flow Model

transverse Faraday field plus the axial Hall field. Recent investigations include several engineering approaches to minimize the problems caused by cathode slag polarization (iron-oxide injection and modified electrode wall designs). Several experiments were also carried out to help understand the physical mechanisms responsible for creating the high voltage insulator gaps and to assess the feasibility of controlling the slag resegmentation frequency by external switching circuits (slagging/external shorting experiments). Finally, the effects of cathode shorting on the overall channel operating characteristics were studied (bare wall/external shorting tests).

Another approach to increase channel wall (electrode walls and sidewalls) life is to develop alternative designs and/or to select suitable corrosion resistant cladding materials for the wall elements. Duration tests are currently underway in the Avco Mark VII facility to identify potential candidates for electrode and sidewall materials and designs. These generator tests are being conducted under prototypical operating conditions with Rosebud ash and sulfur addition. Promising test electrode and peg configurations will later be tested in the Mark VI and CDIF coal-fired channels. Subcontracts have been awarded to several firms to develop and supply samples of ceramic/metallic clad pegs (and bars) for test in the Mark VII channel.

Modifications are being implemented on the CDIF 1A1 workhorse channel side walls. The cathode side wall end pegs are being fabricated from copper capped with tungsten-copper rather than from a single tungsten-copper piece. The use of tungsten-copper capping is being incorporated into the design of the segmented bar side walls to reduce side wall wear. In addition, a design change to the side wall to cathode wall joint is being implemented to reduce arcing and burn-through of the joint gas seal. The hosing and wiring are being re-packaged to allow the channel to fit into the magnet bore without concern for interference. This measure will improve channel operational reliability while minimizing, (1) hose and wiring routing, and (2) channel to facility interconnection problems during channel installation.

Parametric studies were undertaken to study alternative prototypical channel designs and their potential gains in performance relative to the existing CDIF 1A1 diagonally loaded MHD channel. Of particular interest are those channel designs that yield more favorable fluid dynamic and electrical performance. Sensitivities of generator performance to inlet Mach number, diffuser efficiency, diagonal connection, oxidant N/O, axial distribution of the cross-sectional aspect ratio, and axial leakage resistance were investigated and several candidate design were selected.

Two hundred and fifty-six prototypical current control devices for the 1A4 channel are currently being fabricated. The manufacturing of the cabinets in which these devices will be housed are completed (see Figure 2). The deliveries of some of the sub-assembled parts to Avco are in progress; final assemblies will take place in 1989.

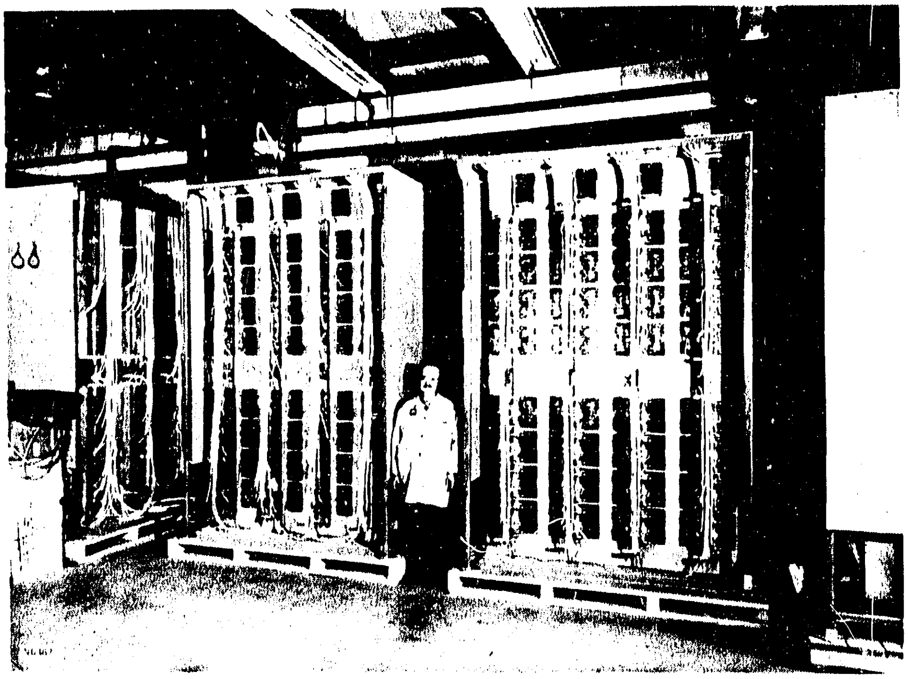


Figure 2. Current Control Cabinets

Task 5 - Current Consolidation Design Support (Westinghouse)

This subcontract calls for development and construction of MHD power management hardware which would consolidate 30 electrodes at each end of the prototypical CDIF channel and 16 electrodes at each end of the Avco Mark VII channel. Since prior work under an Avco subcontract had been aimed toward consolidation of all 112 electrodes of the Mark VII channel, the prior circuit designs had to be modified to the new condition of consolidating only end electrodes. A potential defining converter had to be added to the Avco breadboard hardware.

In collaboration with Avco, the requirements for the overall system were redefined, and the circuit designs were modified where necessary. Breadboard models of each of the required circuits were built and tested to verify their performance prior to proceeding with fabrication of the final hardware. Fabrication of the circuit boards for the control of the thyristors in the consolidation converters and potential defining converter has been completed. Machining of the heat sinks for the thyristors has been completed and assembly of the consolidation converter modules can now be started. All required electrical components have been ordered; over 95% have been received and the balance are expected by the end of January 1989. The overall control scheme and considerations regarding interfaces with the Avco facility have been reviewed and resolved with Avco.

Task 6 - CDIF Test Support

TRW and Avco continued to provide engineering support and data analysis for the 50 MW_t workhorse power train testing at the CDIF. Testing and data analysis to improve power output remained a high priority. The most significant series of tests involved changing second stage oxidizer injection configurations. A 40% increase in channel power output was realized as a result of run condition and heat loss changes to the combustor. TRW and Avco will continue to support the testing at CDIF throughout the duration of the ITC program.

The coal-fired precombustor and continuous slag rejector assembled under the MHD Phase IV contract were delivered to the CDIF. Installation of the CFPC was initiated. Testing is scheduled to resume in the second calendar quarter of 1989. Planning for the CFPC test series and for the prototypical Design Verification and Duration testing was begun.

Task 8 - Technology Transfer/Integration

Between July 1988 and January 1989, the Executive Committee met once and the second semi-annual General Committee meeting was held. The Committee identified programmatic and technological issues related to the retrofit of an exiting power plant. The first semi-annual (January - June 1988) TTIRC Status Report to DOE was published.

Task 9 - Quality Assurance

A draft Quality Assurance Plan was released and QA activities were initiated.

4. PLANNED ACTIVITIES

The second phase of the 50 MW_t workhorse combustor Design Confirmation testing will be conducted in 1989. Prototypical design features such as domed head end closures, square slag tap openings and tubular baffle designs will be evaluated.

AIC/second stage testing will be completed, and testing of a TRW 20 MW_t coal-fired combustor will be conducted at Avco in the Mark VI facility. This testing will allow optimization of combustor configurations (particularly the second stage) and evaluation of materials and designs for the prototypical channel and combustor prior to the Critical Design Reviews.

Combustor design activities will continue throughout 1989. Additional materials evaluation support will be provided by Argonne National Laboratory under subcontract.

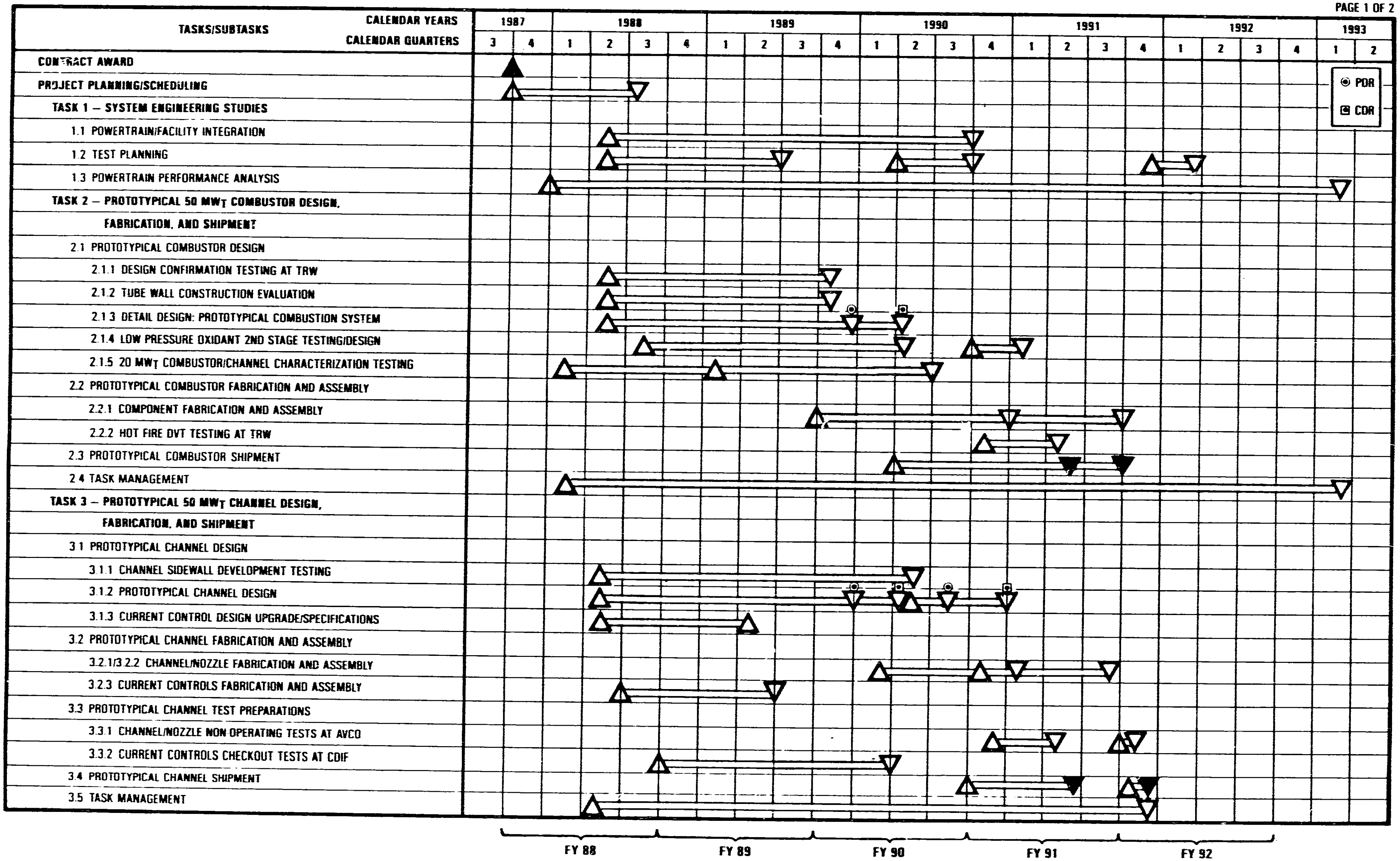
Duration tests currently under way in the Mark VII will continue in order to identify potential candidates for electrode and sidewall materials and designs. Prototypical channel design and engineering activities will carry on in preparation for the Preliminary Design Review. The current control fabrication and assembly activities are scheduled to be completed in mid-1989.

Assembly of the current consolidation converters and the potential defining converter will continue and completion of fabrication is scheduled for April 1989. Assembly of the control and instrumentation hardware and writing of the software will begin in February 1989, and will be completed by the end of April. During May, all assembled hardware modules will be pretested and debugged. During June, the complete system will be tested prior to delivery to Avco.

5. SCHEDULE

A copy of the overall schedule for the ITC project is attached.

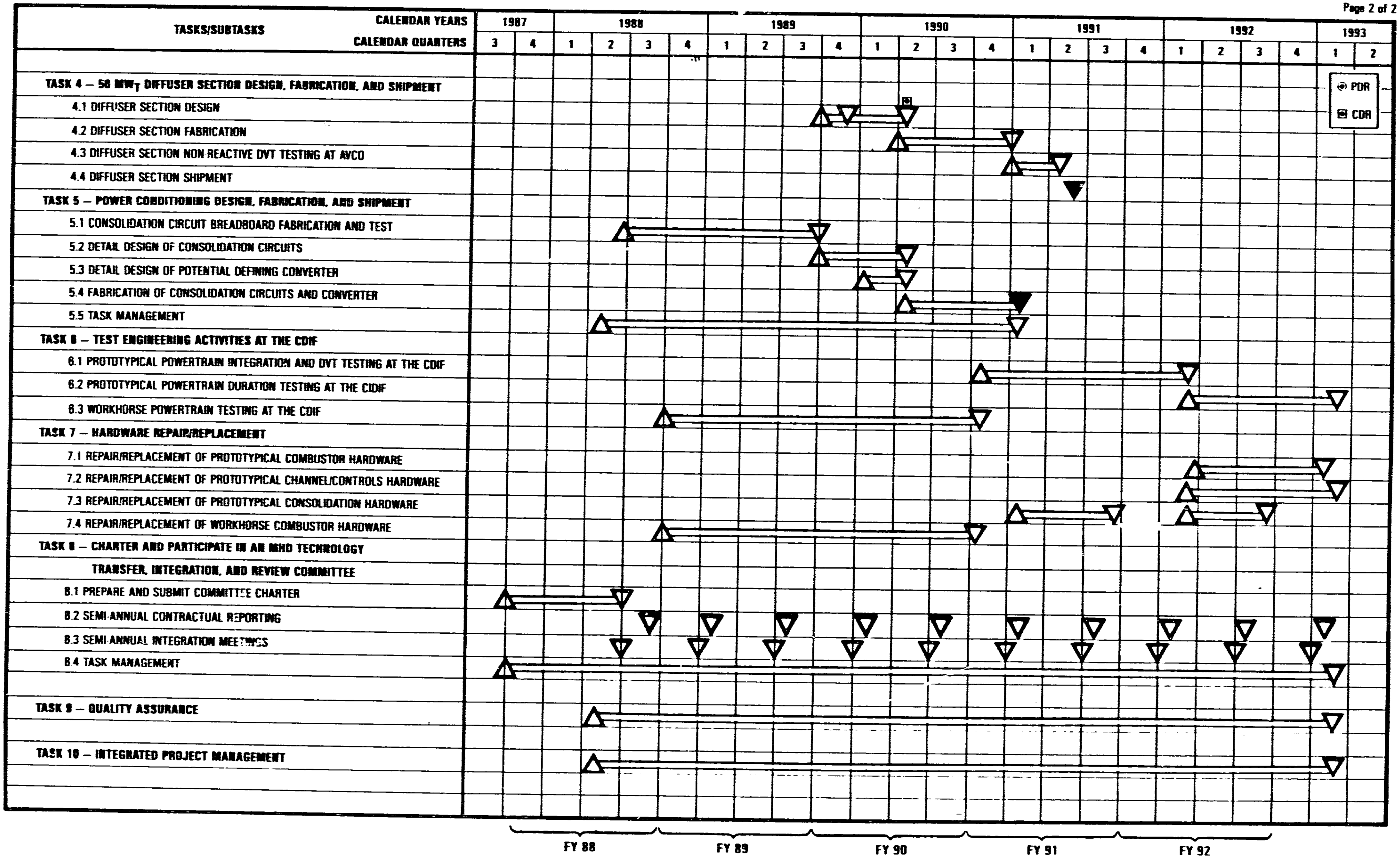
MHD ITC Project
Program Plan and Schedule
Rev. 1/13/89



MHD ITC Project

Program Plan and Schedule

Rev. 1/13/89



CONTRACT TITLE AND NUMBER:
Integrated MHD Bottoming Cycle
DE-AC22-87PC90281

DATE:
March 8, 1989

CONTRACTOR:
Babcock & Wilcox Company
1562 Beeson Street, Alliance, OH 44601

REPORTING PERIOD:
July 1, 1988 to
December 31, 1988

PROJECT MANAGER:
Paul B. Probert
(216) 829-7494

PERIOD OF PERFORMANCE:
September 11, 1987 to
March 11, 1989

1. CONTRACT OBJECTIVE

Design, procure, install, and check out subsystems and components to modify or augment the existing DOE Coal-Fired Flow Facility located at the University of Tennessee Space Institute, Tullahoma, TN.

2. TECHNICAL APPROACH

There are four tasks:

1.) Design, procure, install modifications to the existing coal pulverizing and drying system at CFFF, to handle high moisture western coal.

2.) Design, procure, install an automated seed/ash conveying system.

3.) Prepare a design and procurement/installation enabling package for an Intermediate Temperature (1200-1500°F) Air Heater.

4.) Participate in the DOE Technology Transfer, Integration, and Review Committee.

3. PROGRESS SUMMARY

Task 1 - Modifications to CFFF to Handle High Moisture Western Coal

Engineering analysis and data on drying of western high moisture coal in commercial pulverizers showed Montana Rosebud coal with 30% moisture cannot be dried to the required 3% moisture in the pulverizer. Bids on coal dryers were received from three vendors. Suitable quantities of 3/4" x 0 Montana Rosebud coal were sent to the three vendors (representing fluidized bed, tray, and steam tube rotary dryer types). Visits were made by representatives of DOE/PETC, Gilbert Commonwealth, and B&W to each of the three vendors to witness coal drying demonstration tests in their type equipment. The Wyssmont tray type dryer was recommended for installation at CFFF.

Task 2 - Automated Seed/Ash Handling System

This system will collect seed/ash mixture from the various superheater hoppers, baghouse and electrostatic precipitator, weigh it, and transport it to the existing spent seed storage tank for disposal. Samples of seed/ash mixture from CFFF were sent to vendors for their evaluation prior to submitting bids. A visit to Macawber, Inc. was made by representatives of DOE/PETC, Gilbert Commonwealth, Hudson Engineering, and B&W to witness a demonstration of the Macawber Densveyor system handling CFFF seed/ash mixture. This trip also included a commercial installation of a Macawber system handling particulate material in a large malleable iron foundry. The comments from the Preliminary Design Review have been incorporated in the design report.

4. PLANNED ACTIVITIES

It is planned to conduct a Preliminary Design Review on the modifications to the coal drying and pulverizing system and a Critical Design Review on the automated seed/ash conveying system at CFFF in early February, 1989.

SEMI-ANNUAL REPORT TO THE TTIRC

CONTRACT TITLE AND NUMBER
MHD Bottoming Cycle Component Testing
at the Coal Fired Flow Facility
DE-AC02-79ET10815

DATE
January 26, 1989

CONTRACTOR
The University of Tennessee Space Institute
Tullahoma, TN 37388

REPORTING PERIOD
July 1988 through
December 1988

PRINCIPAL INVESTIGATOR
Joel W. Muehlhauser
(615) 4̲5-0631

PERIOD OF PERFORMANCE
March 1988 through
April 1989

1. CONTRACT OBJECTIVES:

(No Change)

2. TECHNICAL APPROACH:

(No Change)

3. PROGRESS SUMMARY:

During this reporting period, two tests were conducted at the CFFF. These tests added 353 hours to bring the cumulative total of POC testing with Illinois #6 coal to 856 hours.

LMF4-O - The objective of this test was to run continuously for 100 hours and accumulate a total of 250 hours overall. The test was conducted in September and both objectives were accomplished. The total time of operation was 252.1 hours with the longest continuous portion being 111.5 hours. No significant problems were observed with any of the flow train components.

LMF4-P - The objective of this test was to operate for 100 hours and obtain data on sootblowing pressures and the ease of ash removal from the ESP with increased outlet diameter and vibrators installed. The test was conducted successfully in November with a total of 101.3 hours.

A sootblowing experiment was conducted during LMF4-P with a fixed 1/2 inch nozzle positioned 9.75 inches in front of a TS1 tube. The objective was to determine the required peak impact pressure (PIP) required for effective deposit removal. Ten second blows at 5 successively higher impact pressures were made at intervals of 50, 150, and 300 minutes during the course of the test. Percent deposit thickness removal by each blow was determined from video recordings. Curvefits to the resulting data indicate that cleaning can be achieved, at least for the short term. Also, the curves trend upward beyond about 40 hours, indicating improving rather than worsening cleaning with time. This test, and LMF4-O, was conducted with the molar K_2/S ratio < 1.1 .

During LMF4-O and LMF4-P, the flow rate through the ESP was varied in a series of steps to determine the effect of specific collection area (SCA) on particulate collection efficiency. According to the Deutsch equation of precipitator performance, the efficiency should be proportional to the exponential of the SCA. Although some data scatter was observed, preliminary results indicate for the conditions evaluated that an SCA of 400 - 450, may meet the NSPS standards. In future testing, more data will be collected for other conditions at various specific collection areas.

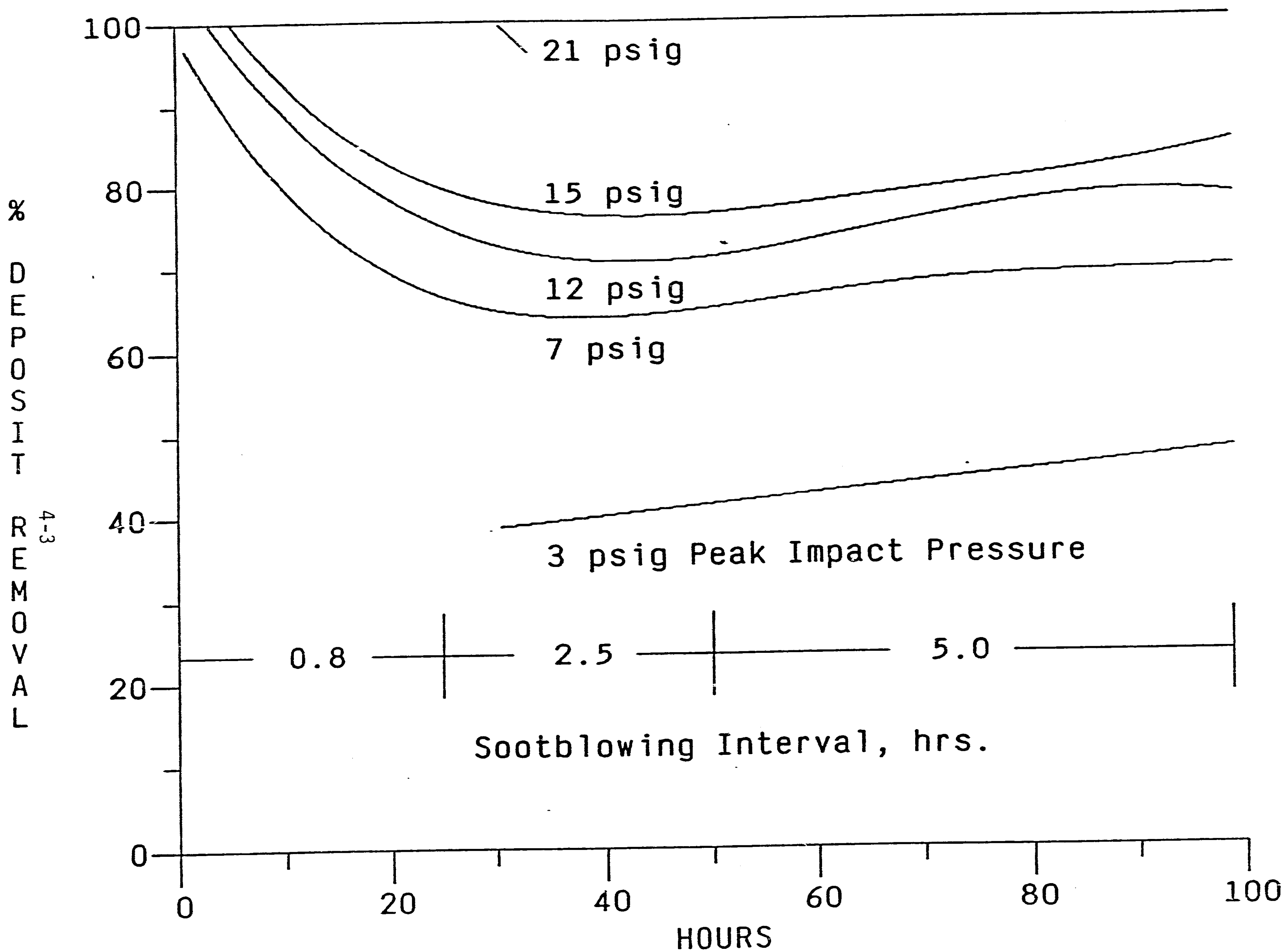
4. PLANNED ACTIVITIES AND SCHEDULE:

Long duration proof-of-concept testing will be continued on Illinois #6 coal during the period January 1, 1989 through December 31, 1989, for a total of 525 hours bringing our total POC test hours on Illinois #6 to 1381 hours. The remaining 619 hours to complete 2000 hours are planned to be completed during 1990.

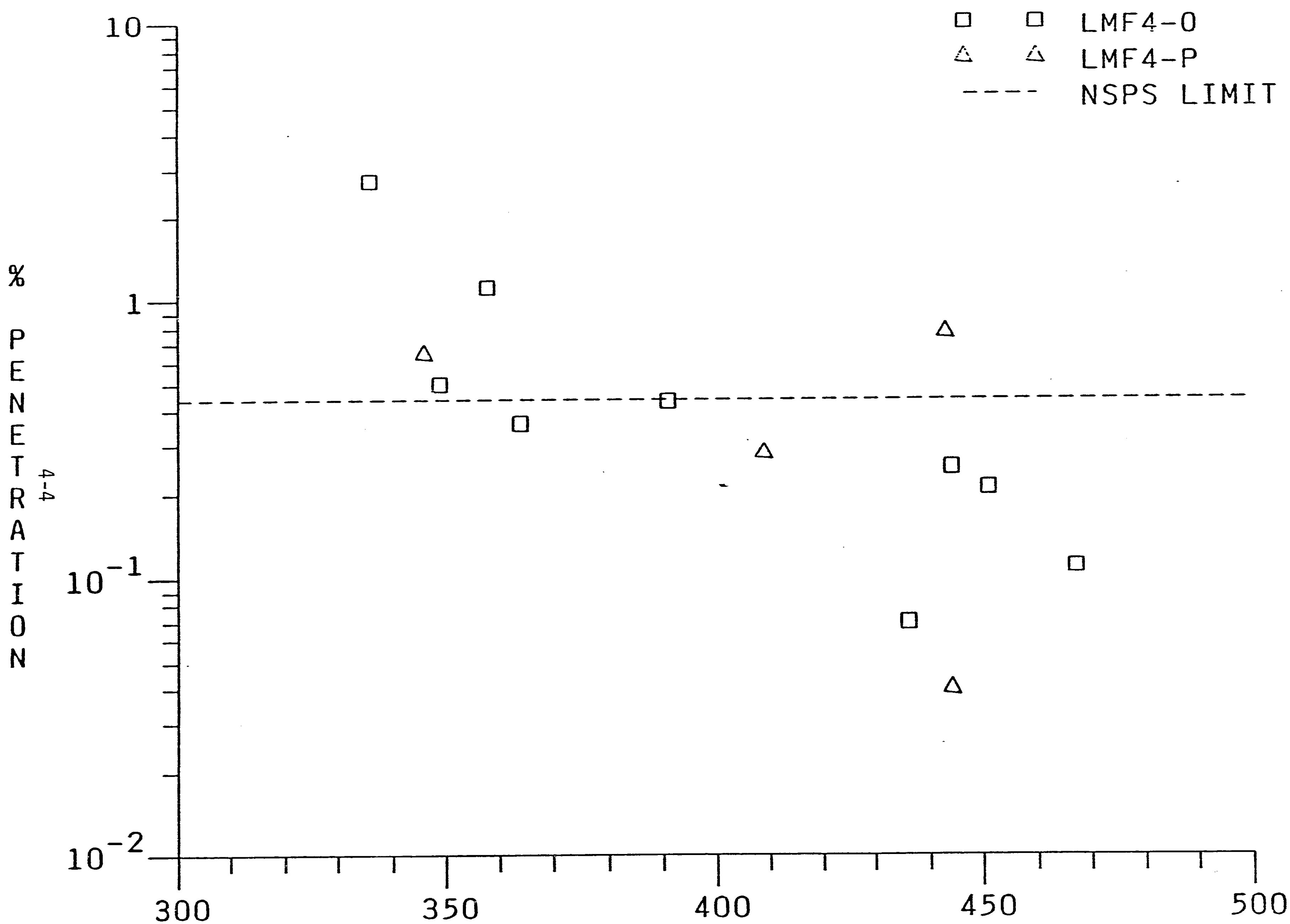
The tube spacing in the upstream portion of the SHTM are currently being rearranged to suit the gas temperature regime dictated by the retrofit studies. This work is planned to be completed during April 1989 and a 100 hour checkout test performed during May 1989.

An automated ash handling system from the SHTM, AH, ESP, and BH is planned for completion in December, 1989, and the conversion of the CFFF coal processing system to handle up to 30% moisture Montana Rosebud coal is planned for completion in September, 1990.

Shakedown tests and POC testing with the Rosebud Coal are planned to start in November, 1990.

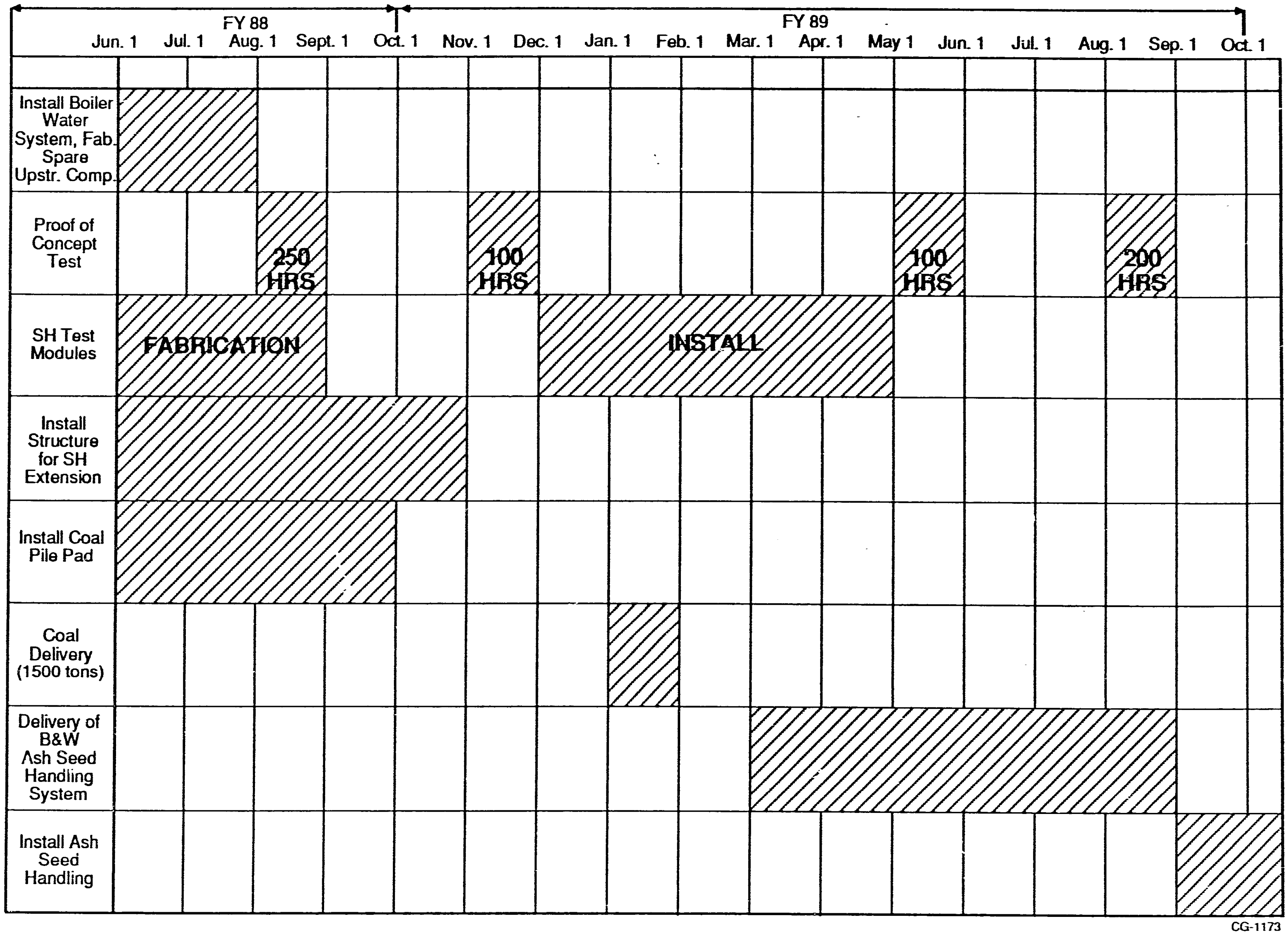


Sootblower Performance



ESP SCA VS. % PENETRATION TESTS LMF4-O AND LMF4-P

FY 88 / 89 CFFF Schedule



Milestone Schedule and Status Report

1. Contract Identification	2. Reporting Period	3. Contract Number
OPERATION OF THE COAL-FIRED FLOW FACILITY	12/1/88 - 12/31/88	DE - AC02 - 79ET10815
4. Contractor: Name, Address	**5. Contract Start Date**	**6. Contract Completion Date**
THE UNIVERSITY OF TENNESSEE SPACE INSTITUTE TULLAHOMA, TENNESSEE 37388	10 - 01 - 78	04-30-89

7. ID	Reporting Category - Contract Line Item or Work Breakdown Structure Element	FY 89 OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	* COSTS ACCRUED	EAC**
I	TESTING		A▼						B▽			C▽		734	3441
II	STUDIES / ANALYSES / REPORTS	A▽ I▼	A◆	B▼	A▽ C▽ I▽	D▽		A▽ I▽	E▽	F▽ G▽	A▽ I▽		H▽	133	702
III	COMPONENT DEVELOP-MENT & TEST FACILITY MODIFICATIONS	A▼						B▽ C▽	D▽			E▽	F▽	61	301
IV	FACILITY OPERATION, MAINTENANCE, AND REPAIR	B▼			B▽			B▽			B▽			430	1858
V	ENVIRONMENTAL CONTROL	C▼			C▽			A▽ B▽ C▽			C▽		D▽	65	335
VI	MANAGEMENT AND ADMINISTRATIVE SUPPORT													129	628
	TOTAL COSTS													1552	7265

11. Remarks: * COSTS APPEAR IN THOUSANDS, BASED ON MIS REPORTING SYSTEM.
** EAC - ESTIMATE AT COMPLETION OF SEP. 30, 1989

▽ PLANNED
▼ COMPLETED
◇ RESCHEDULED

12. Signature of Contractor's Project Manager & Date

13. Signature of Government Representative & Date

MS-0034

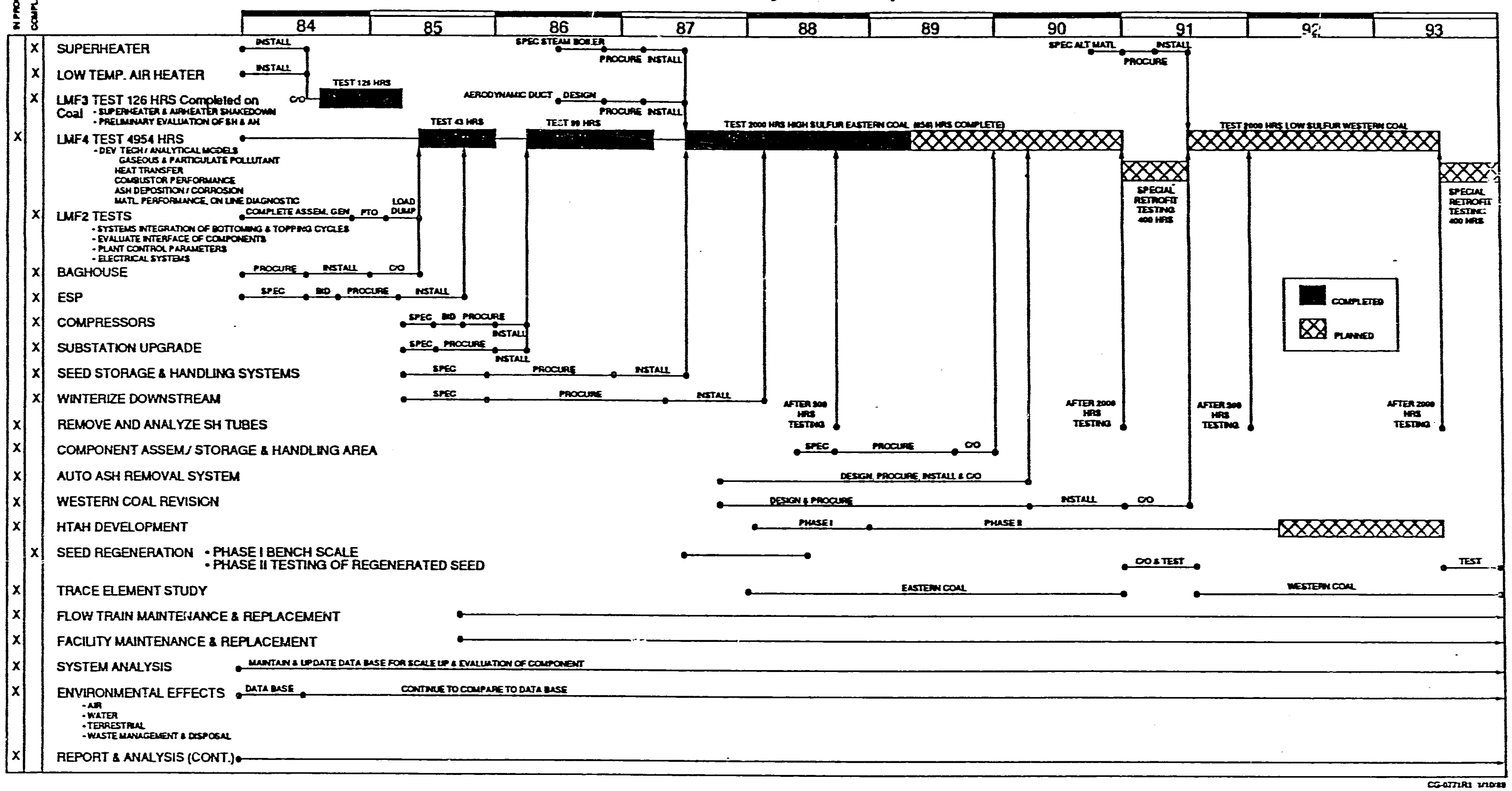
MILESTONE LOG

IDENTIFICATION NO.	DESCRIPTION	ACTUAL COMPLETION DATE	PLANNED COMPLETION DATE	EXPECTED COMPLETION DATE	COMMENTS
	TESTING				
I A	POC Long Duration Test (100 hours)	Nov 88	Nov 88		Completed 101 hours on coal
I B	Checkout Long Duration Test (100 Hours)-Bottoming Cycle Mods		May 89		
I C	POC Long Duration Test (200 Hours)		Aug 89		
	STUDIES/ANALYSES/REPORTS				
II A	Submit Quarterly Technical Progress Report To DOE		Jan 89		For Oct-Dec 88
II B	POC 100 Hour Summary Test Report	Dec 88	Dec 88		
II C	MHD Contractors Review Meeting Report		Jan 89		
II D	Annual Fire Experience Report		Feb 89		
II E	Issue Topical Report on SHTM Tube Corrosion and Deposits		May 89		
II F	SEAM Papers Reporting Major MHD Results		Jun 89		
II G	100 Hour Checkout Summary Test Report		Jun 89		
II H	POC 200 Hour Summary Test Report		Sep 89		
II I	Quarterly Report on Occupational Injuries/Illnesses, Property Damage or Motor Vehicle Accidents		Jan 89		For Oct-Dec 88

MILESTONE LOG

IDENTIFICATION NO.	DESCRIPTION	ACTUAL COMPLETION DATE	PLANNED COMPLETION DATE	EXPECTED COMPLETION DATE	COMMENTS
	COMPONENT DEVELOPMENT & TEST FACILITY MODIFICATIONS				
III A	Complete Installation of Concrete Pad for Coal Pile	Oct 88	Oct 88		
III B	Complete Venturi Repair/Replacement		Apr 89		
III C	Complete Procurement and Installation of Sootblower Air Compressor		Apr 89		
III D	Complete Extension/Modifications to SHTM		May 89		
III E	Complete Installation/Programming of new CFFF Data Acquisition Computer		Aug 89		
III F	HTAH Development Continued		Sep 89		
	FACILITIES OPERATIONS, MAINTENANCE & REPAIR				
IV A	Maintain Preventative Maintenance Program		N/A		Continuous
IV B	Quarterly Calibration Check Of All Data Taking Instrumentation		Jan 89		For Oct-Dec 88
IV C	Maintain And Upgrade Data Acquisition System		N/A		Continuous
	ENVIRONMENTAL CONTROL				
V A	Issue Annual Site Environmental Report - FY88		Apr 89		
V B	Complete Construction of Particle Sizing Shelter		Apr 89		
V C	Issue Quarterly State Environmental Reports		Jan 89		For Oct-Dec 88
V D	Complete Annual Personnel Physical Exams		Sep 89		
	MANAGEMENT AND ADMINISTRATIVE SUPPORT				
VI A	Fulfill All DOE Administrative Requests		N/A		Continuous

Coal Fired Flow Facility MHD Proposed Plan FY 1984 - 1993



REPORT FOR MHD TECHNOLOGY
TRANSFER, INTEGRATION AND REVIEW COMMITTEE

CONTRACT TITLE AND NUMBER:

MHD Seed Recovery/Regeneration Phase I
DE-AC22-87-PC79672

DATE:

1/24/89

CONTRACTOR:

TRW Applied Technology
One Space Park-01/2270
Redondo Beach, CA 90278

With unfunded assistance by Fluor-Daniel, Inc.
Irvine, CA 92714

REPORTING PERIOD:

6/01/88 to
10/01/88

PROJECT MANAGER:

Robert A. Meyers
(213) 813-9439

PERIOD OF PERFORMANCE:

10/1/87 to
10/1/88

1. Contract Objectives

   a. Achieve >90% potassium recovery and regeneration

   b. Achieve target cost level 20% lower than wet limestone FGD

   c. Environmentally acceptable operation

   d. Designs and cost estimates for POC and 300 MW(t) units

2. Technical Approach

Utilize reaction of preformed calcium formate solution to convert spent seed potassium sulfate to potassium formate which is oxidized to potassium carbonate. This is a TRW patented technology - known as the Econoseed Process. Produce calcium formate separately in a very high throughput pressure reactor. This approach avoids potassium losses and saves considerable high pressure reactor costs.

TRW laboratory tested and patented the Econoseed Process in the early 1980's. This process has been found to operate rapidly in ambient pressure, and temperatures of about 70° C, to provide a quantative yield of regenerated potassium seed and was estimated to provide a product that would cost approximately one half that of buying replacement potassium seed. Meanwhile, TRW has performed several chemical processing pilot plant projects for the Department of Energy and the Environmental Protection Agency which successfully demonstrated technologies for coal desulfurization, coal water mixture hydraulics and erosion/corrosion evaluation and, presently, desulfurization and demineralization of coal. The resulting pilot facilities (see photographs on next page) which were built with approximately $7M of Department of Energy and TRW funds and maintained and upgraded by the TRW facilities organization, provide a cost effective test bed for POC testing of the Econoseed Process. because of the importance attached to the development of MHD technology, Fluor-Daniel, Inc., has utilized its discretionary funds to assist TRW in engineering and cost aspects of this project.

3. Progress Summary

Engineering assessment of the data obtained in benchscale testing shows that the process is technically and economically feasible and is ready for testing at POC scale. Major conclusions are:

1. Seed can be regenerated at a total cost per unit potassium of approximately $0.23/lb in the dry potassium formate form or $0.27/lb as dry potassium carbonate form - this is less than half the potassium cost of $0.63 if purchasing new potassium carbonate (there would be an additional and undefined cost for spent seed flyash disposal if not regenerated.)

2. As originally proposed, existing DOE facilities at TRW (see photographs) are capable of use as a seed regeneration POC and can be ready in time to regenerate CFFF spent seed for the CDIF testing schedule.

3. The POC plant is a flexible unit which can be run at a nominal 250 lbs/hr or as low as 50 lbs/hr should spent seed be in short supply.

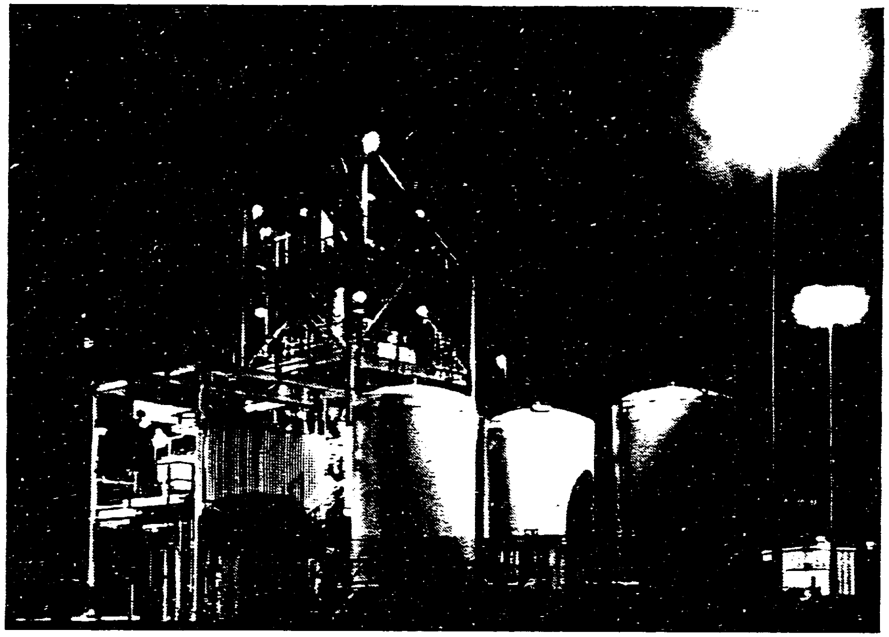
4. Benchscale data shows no buildup of coal derived sodium in either flyash or the seed regenerated from once-through CFFF flyash and further, the sodium content is reduced in the seed regeneration by the Econoseed Process.

5. Neither the calcium formate nor the potassium formate reactors are major cost items as the residence times are on the order of a few minutes as compared with, for example, the formate process where the two reactors are combined into one very large pressure reactor with a residence time of one to two hours.

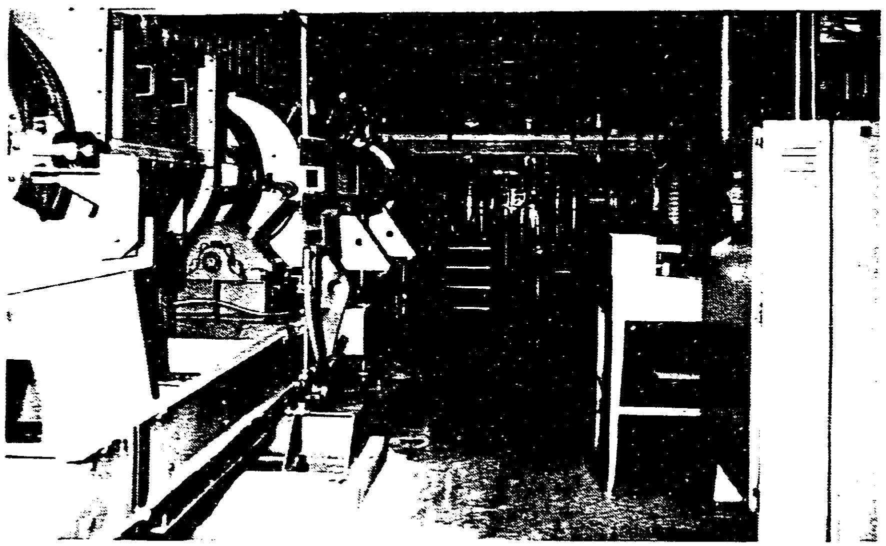
4. Future Plan

TRW, together with its pre-qualified subcontractor, Fluor-Daniel, Inc., have submitted a proposal to the Department of Energy to design, construct and operate a proof-of-concept test plant for the Econoseed Process.

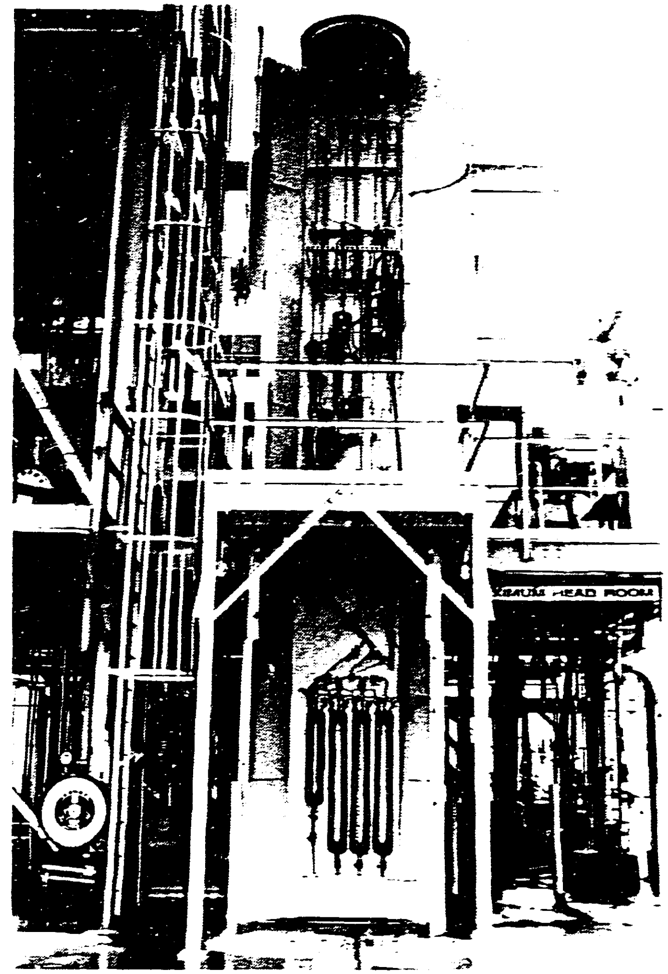
TRW



DOE/TRW POC Facility



Kiln Reactor and Separator



High Pressure System

CONTRACT TITLE AND NUMBER:	DATE:
MHD Seed Recovery/Regeneration, Phase I DE-AC22-87PC79670	March 8, 1989
CONTRACTOR: Babcock & Wilcox Company 1562 Beeson Street, Alliance, OH 44601	REPORTING PERIOD: July 1, 1988 to December 31, 1988
PROJECT MANAGER: Paul B. Probert (216) 829-7494	PERIOD OF PERFORMANCE: September 28, 1987 to September 28, 1988

1. CONTRACT OBJECTIVE

The primary objective of this Phase I MHD Seed Recovery and Regeneration Contract is to demonstrate conceptual feasibility of a potassium recovery process based on sulfate reduction and subsequent sulfur release. Bench-scale tests of the key unit operations will be conducted. These tests will provide sufficient process information to design and cost estimate a 30 Mw(t) Proof-of-Concept demonstration facility. A cost estimate for application of the technology to a commercial scale 300 Mw(t) MHD system will also be prepared.

2. TECHNICAL APPROACH

The project team assembled by the prime contractor, Babcock & Wilcox, includes Westinghouse Electric Corporation, Argonne National Laboratory, and the University of Tennessee Space Institute. The technical tasks in this study are:

1.)	Potassium Sulfate Reduction:	(W) and ANL
2.)	Seed/Ash Separation:	(W) and UTSI
3.)	Potassium/Sulfur Separation:	B&W and (W)
4.)	Unit Operation Evaluation and Selection	All
5.)	Design and Cost Estimate for a. Proof-of-Concept Plant b. 300 Mw(t) Demonstration	B&W, Hudson Engr.

3. PROGRESS SUMMARY

The bench-scale experimental work on the K_2SO_4 reduction process was completed. The gas/solids (kiln type) process proposed by Westinghouse was selected for this study. Bench-scale tests at B&W and the University of Akron confirmed that design data from commercial (sodium based) paper mill recovery systems can be applied to this (potassium based) sulfur removal process. The conceptual design and cost estimate for a 300 Mw(t) seed regeneration process in the original proposal was updated based on these data. A design and cost estimate for a proof-of-concept plant was prepared. The Final Report on Phase I and Proposal for Phase II (Design, Construction, and Testing of a POC Seed Regeneration Plant) were submitted to DOE/PETC in October, 1988.

4. PLANNED ACTIVITIES

The submittal of the Final Report and Proposal for Phase II completes work on this contract until DOE completes evaluation of the Phase II proposals and announces an award for Phase II.

CONTRACT TITLE AND NUMBER:
MHD Seed Regeneration Project
AA-70/ANL 49747

DATE:
January 20, 1989

CONTRACTOR:
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

REPORTING PERIOD:
From: June 1, 1988
To: September 30, 1988

PROJECT MANAGER:
Dr. William M. Swift
(312)/972-5964

PERIOD OF PERFORMANCE:
From: October 1, 1987
To: September 30, 1988

1. Contract Objective

The objective of this project was to obtain design information for the development of a seed regeneration process based on a molten seed reduction reactor (K_2SO_4 to K_2S) followed by a modified Tampella process for the recovery of potassium as K_2CO_3. The work was in support of the B&W Phase I Seed Regeneration Project.

2. Technical Approach

Bench-scale kinetic experiments were conducted to determine the rate of reduction of K_2SO_4 to K_2S in a high-temperature molten-pool reactor. Thermodynamic and phase-equilibrium calculations were also performed to determine potential interactions between the molten seed and the ash in the coal (reductant). The data were used to develop a process flowsheet and the required heat and mass balances for the molten-salt reduction step in a proof-of-concept seed regeneration plant. In addition, experiments were conducted to identify suitable refractories for the full-scale reactor.

3. Progress Summary

Process Thermodynamics. The thermodynamics of the reduction reaction [$K_2SO_4 + 2C = K_2S + 2CO_2$] was studied using the SOLGASMIX chemical and phase equilibrium computer program. The analysis investigated the effects of temperature (1000 to 1300 K), air-to-fuel stoichiometric ratio (0.45 to 0.85) and seed-to-coal ratio (1.0 to 3.5) on the distribution of potassium in the reaction products. A system of 16 elements and approximately 100 relevant compounds was considered. The results of the calculations were used to estimate the potential "loss" of K during the reduction of K_2SO_4 to K_2S as a function of temperature, stoichiometry, and seed-to-coal ratio. The results of the thermodynamic simulations indicated that in order to minimize the potential loss of K, the reduction process should be operated at or below 1100 K, at an overall stoichiometry equal to or less than 0.65 and a seed-to-coal ratio in the range of 1.5 to 2.5. The results of the thermodynamic analysis were also used together with the kinetic results (see below) to calculate the heat and mass balance for the flowsheet of the molten-pool reactor reduction step.

Refractory Testing. Fourteen refractories were tested for their compatibility with a K_2S/K_2SO_4 seed mixture. The samples were machined into the shape of a cylindrical cup, filled with a mixture of K_2S/K_2SO_4, and then heated to 1000 °C in a high-temperature autoclave reactor for up to 100 h in a reducing atmosphere. The refractory specimens were then sectioned and examined for penetration and/or corrosion of the refractory by the seed mixture. The results indicated that several magnesia-chromia spinels and magnesia spinels (as well as a high alumina specimen) were resistant to penetration and/or reaction with the molten alkali salts. Although these refractories exhibited good corrosion resistance, additional tests would be required to determine the ability to withstand thermal cycling and the mechanical stresses of a dynamic system.

Kinetic Experiments. The kinetics of the reduction reactions were investigated in a bench-scale reactor. The reaction vessel was 15.2-cm I.D. by 40.6 cm deep. Initially, attempts were made to continuously feed sulfated seed and coal (reductant) to the reactor vessel to determine the conversion of the K_2SO_4 to K_2S as a function of residence time, seed-to-coal ratio, air-to-coal ratio and reactor temperature. As a result of serious problems encountered in feeding solids to the small high-temperature reactor, the majority of the tests were conducted on a batch basis using a reducing gas mixture of 30%CO/10%CO_2/70%N_2. The progress of the reaction (reaction rate and conversion) was followed by measuring the change in the CO_2 concentration in the reactant gas. The kinetic data was then used with the thermodynamic analysis to develop a process flow sheet and the necessary mass and energy balance data. The selection of a separate reactor (gasifier) to generate the reducing gases from the coal was based on: 1) the difficulty in feeding a seed/coal mixture below the surface of a liquid melt; and 2) the potential formation of high amounts of K_2SiO_3, a water soluble compound that would be difficult to treat in the Tampella process.

Report. A report of the results was submitted to B&W for inclusion in the final report of the B&W Phase I Seed Regeneration Project

4. Planned Activities

In a selection process, Babcock and Wilcox elected to proceed with the Westinghouse kiln reactor for the reduction step during Phase II of their seed regeneration process development program. As a result, no additional work is planned to develop the molten-pool type reduction reactor.

5. Schedule (attached)

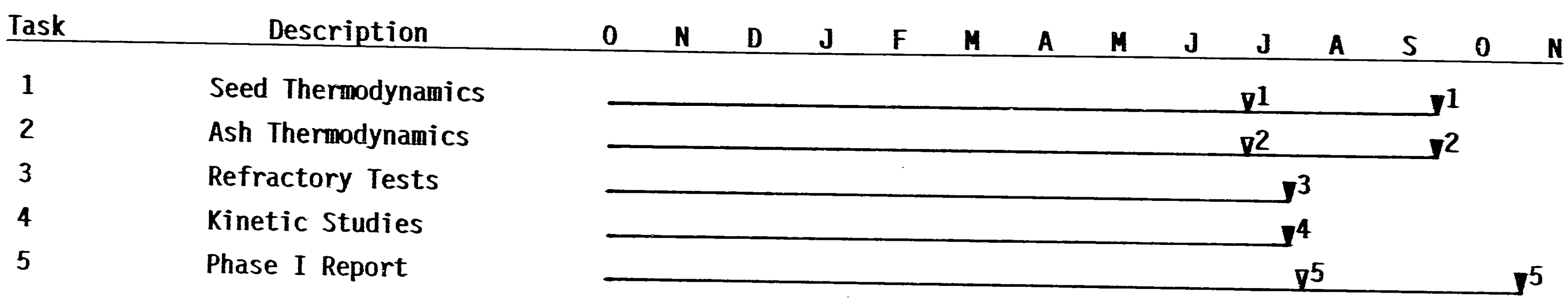
MHD Seed Regeneration Project

Milestone Log

Milestone No.	Description	Completion Date Planned	Revised	Actual
1	Complete Thermodynamics Seed Chemistry	4/30/88	6/27/88	9/15/88
2	Complete Thermodynamics Ash Chemistry	4/30/88	6/27/88	9/15/88
3	Complete Refractory Tests	4/30/88	7/8/88	7/8/88
4	Complete Reactor Kinetic Studies	4/30/88	7/8/88	7/8/88
5	Phase I Report	9/30/88	7/18/88	10/15/88

MHD Seed Regeneration Project

Project Schedule



CONTRACT TITLE AND NUMBER:
MHD Heat & Seed Recovery Technology Project
ANL-70/ANL 49745

DATE:
January 20, 1988

CONTRACTOR:
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

REPORTING PERIOD:
From: June 1, 1988
To: December 31, 1988

PROJECT MANAGER:
Dr. William M. Swift
(312)/972-5964

PERIOD OF PERFORMANCE:
From: July 1, 1976
To: September 30, 1989

1. Contract Objective

The objective of this project is to address technical issues related to the integration of the MHD topping and steam bottoming cycles. Through modeling and experimentation, design information will be obtained that can be used in conjunction with the proof-of-concept testing at the CFFF and CDIF to reliably integrate the MHD topping and bottoming cycles in the design of the first-generation MHD retrofit plant.

2. Technical Approach

Since 1976, Argonne National Laboratory (ANL) has been investigating problem areas related to the design of an MHD steam plant. Computer models of the important chemical and transport processes have and are continuing to be developed in support of experimental activities at ANL and other MHD test facilities to provide the necessary component and system design information for the design of the first-generation MHD plant. Work during the current reporting period focused on, (1) completing the modification of the ANL 3-D channel code to incorporate a multigrid solution algorithm for improved speed and accuracy of computation, (2) the analysis of radiation heat transfer data obtained in the FEUL facility, and (3) the testing of alloys for the steam and air-heater convective sections of the MHD steam plant.

3. Progress Summary

3-D Channel Code. During the reporting period, additional verification testing of the multigrid 3-D channel model was completed. The code was used to analyze experimental data reported for the Mark II MHD generator of the Institute of Electrical Engineering in Beijing, China. The code predictions of axial pressure distribution, Faraday voltage and current, and the total extracted power were in good agreement with the reported experimental data. The code and the user's manual were submitted to DOE for review. Release of the code and the user's manual to the National Energy Software Center has been delayed pending the comments of the reviewers selected by DOE to evaluate the code. Although the reviewer's comments are expected during the month of January, 1989, final release of the code could be delayed an additional one to two months depending on the complexity of the reviewer's comments.

Materials Studies. Test data obtained on the corrosion of several ASME-coded alloys and their weldments at conditions simulating the maximum and intermediate temperature conditions of the ITAH were presented in the previous report and at the 1988 SEAM Conference. During the reporting period, a topical report on the result of the air heater tests was prepared and issued to the MHD community. Tests were also initiated to evaluate various alloys at the anticipated conditions of the steam superheater tubes in the MHD retrofit plant. Exposure of the selected alloys at gas and metal temperatures of 2200 and 1050 °F will reach 2000 h during the month of February, 1989. A visual examination of the specimens after 500 h of exposure revealed no obvious signs of serious corrosion. Due to the extensive corrosion of nearly all the ITAH alloys examined during the earlier tests, a meeting has also been held with the other bottoming cycle contractors to discuss additional test work related to the issue of alloys for the intermediate temperature air heater.

A contract has also been put in place between TRW and ANL for ANL to provide support in the evaluation, testing and identification of alloys for the TRW slagging combustor. Preliminary results from this activity should be available for the next report.

Radiation Heat Transfer. As reported previously, thermal transients in the data from the latest radiation heat transfer tests conducted in the ANL FEUL facility prevented definitive determination of the K-atom effect on total gas emissivity and comparison with model predictions. Additional effort to resolve the apparent thermal transients and/or to define additional radiation heat transfer tests has not been completed. Due to the importance of radiation heat transfer to the performance of such critical components as the radiant boiler and slagging combustor, efforts are continuing to resolve the issues related to testing in the FEUL facility. Additional tests to assess both K-atom and slag particle contributions to radiation heat transfer are planned.

NO_x Kinetics. Although some preliminary planning has been done with respect to the design of a small-scale one-dimensional flow reactor for obtaining kinetic data on NO_x decomposition, progress on this task has been delayed. Efforts will be expedited during the coming months to complete the design analysis and begin fabrication and assembly of the experimental equipment.

Particle Evolution Analysis. During the current reporting period, a draft of a paper presenting the results of the analysis of particle size and number density data (obtained by Mississippi State University during tests at MSU and the ANL FEUL facility)) using the ANL particle evolution code, EVOL, was submitted to a journal for publication. The article has been accepted for publication. A topical report will also be issued on the results of this work following the final submission of the paper for publication.

Fouling. Effort during the current reporting period has also been directed toward the completion of two topical reports that will present, a) the results of the most recently completed fouling experiments in the FEUL facility, and b) a more general report summarizing the ANL fouling test program.

4. Planned Activities

Following the receipt and incorporation of the reviewer's comments, the 3-D channel code and associated user's manual will be made available to the MHD community through the National Energy Software Center. Work on the design and fabrication of a system for measuring NO_x kinetics will be expedited during the remainder of the current fiscal year. The materials work will continue with the completion of the superheater materials tests and the initiation of additional air heater materials tests. The evaluation of suitable alloys for the TRW slagging combustor is a new initiative that is just getting underway. Work on radiation heat transfer and the topical reports related to fouling and the particle evolution analysis are scheduled to be completed.

5. Schedule (attached)

Argonne National Laboratory
Heat and Seed Recovery Technology Project

Milestone Log
(Revised 10/1/88)

Milestone No.	Description	Completion Date Planned	Revised	Actual
1	Channel Code to NESC	07/31/88	03/31/89	
2	Slagging Combustor Modeling Report	09/30/90		
3	Initiate Superheater Materials Tests	07/31/88	10/01/88	11/01/88
4	Topical Report on Materials Tests	11/30/89		
5	Radiation Heat Transfer Topical	06/30/88	12/31/89	
6	Complete NO_x Reactor Design	07/31/88	09/30/89	
7	Roport on NO_x Kinetic Studies	09/30/90		
7	Fouling Topical (Thermal Properties)	03/31/88	12/31/88	
8	Fouling Topical (Program Review)	07/31/88	01/31/89	

Project Schedule FY 1989

Task	Description	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O
1	3-D Channel Model			∇1								∇1						
2	Slagging Ccmbustor Model																	
3	Materials Tests			∇3		∇3	▼3											
4	Radiation Heat Transfer		∇5															
5	CFFF Support																	
6	NO_x Kinetics			∇6														∇6
7	Fouling			∇8					∇7	∇8								

CONTRACT TITLE:	DATE:
MHD Seed Recovery and Regeneration Based on the Formate Process DE-AC22-87PC79671	January 1989
CONTRACTOR:	REPORTING PERIOD:
The University of Tennessee Space Institute Tullahoma, Tennessee 37388	July 1988 to January 1989
PROJECT MANAGER:	PERIOD OF PERFORMANCE
A.C. Sheth (615) 455-0631	September 1987 to October 1988

1. CONTRACT OBJECTIVE

The DOE sponsored program at the University of Tennessee Space Institute (UTSI) is part of the DOE's two phase program targeted at achieving the proof-of-concept (POC) scale testing of the most suitable seed recovery and regeneration concept. The objectives of this DOE program include:

- Generate necessary design data base for selected seed regeneration option
- Evaluate potential to recycle >90% of potassium in sulfur-free form
- Generate reliable overall cost for a 300 MW_t plant
    - Include capital, operating and maintenance cost
    - Compare with flue gas scrubbing option
- Determine buildup of impurities and identify/develop methods to control the buildup of undesirables
- Determine environmental acceptability and identify appropriate disposal methods

Evaluate impact on MHD system economics and performance

2. TECHNICAL APPROACH:

To accomplish the above objectives in Phase I, the following approach was used:

- Refine/re-evaluate process configuration and feed stream definitions.
- Design, procure, and construct bench scale test equipment.

- Develop a test plan for bench scale testing.
- Perform bench scale tests.
- Evaluate bench scale data.
- Upgrade POC and 300 MW_t plant designs and costs.
- Compare with FGD option.
- Report results identifying data needs for Phase II testing (e.g., reliability, etc.).
- Prepare and submit a Phase II proposal.

The activities described above were grouped into five major tasks for ease of monitoring the progress of the Phase I efforts.

- Task 1 - Design and set-up bench scale experimental test equipment
    - Refine and re-evaluate process configuration and feed stream definitions
    - Construct bench scale test equipment
- Task 2 - Bench scale testing
    - Develop bench scale test plan
    - Perform bench scale tests for key processing steps
- Task 3 - Evaluation of bench scale tests
- Test 4 - Upgrade POC and 300 MW_t plant designs
    - Compare economics with FGD option
    - Identify data needs and potential areas of improvement to be achieved in POC plant
- Test 5 - Project reporting and management

3. PROGRESS SUMMARY

All of the tasks described above were successfully completed. The Phase I final report was submitted to DOE/PETC. In the Phase I efforts, the following key steps of the formate-based seed reprocessing option were evaluated at the bench scale level:

- Dissolution of baghouse/electrostatic precipitator (BH/ESP) material
- Lime digestion of slag (i.e. potassium aluminosilicates)

- Settling, filtration and centrifugal separation of the feed stream to the formate reactor

- Batch and continuous mode of formate reactor operations

- Filtration and cake washing of the formate reactor product and/or slag leaching product mix

- Oxidation of formate to carbonate

- Evaporation of formate containing solution

Also, the bench scale and large scale testing to select a suitable dryer for drying the formate solution to dry powder/flakes was carried out at the sites of two prospective vendors.

Results obtained from the bench scale tests and those carried out at the vendor sites were evaluated and utilized in developing/updating the plant design and cost estimate for a 300 MW_t plant. The Phase I results were also utilized in designing each major component of the proposed proof-of-concept (POC) scale plant to develop reliable cost estimates and meaningful design data base for the subsequent large scale/commercial plants.

The following major advantages and experimental results for a formate based seed reprocessing system were confirmed and verified:

- More than 96% of the total potassium coming out from the MHD power plant as spent seed material and slag is recovered and returned to the MHD combustor in a >97% sulfur-free form.

- Either option of recycling regenerated seed as formate or carbonate is available.

- Major chemical reaction steps (i.e. potassium extraction from insoluble aluminosilicates and formate reaction) can be carried out in one reactor (235°C, CO pressure 30 atm, <20 minutes residence time) and with less processing steps than the other processes currently being evaluated.

- Flocculant reduces settler size ten fold

- Slag leaching products precoat enhance formate product filtration

- The estimated budget capital cost* of the 300_t plant based on various optional configurations ranged from $21.7 to 25.8 million

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* Includes escalation and allowance for funds during construction, royalty allowance, cost of training personnel, lost income during start-up, initial chemicals and catalyst cost, etc. as per EPRI guidelines.

with the corresponding yearly operating expense ranging from \$6.34 to 6.85 million. In comparison, the similar costs for the SO_2-control option based on wet limestone scrubbing is \$50.5 million and \$7.10 million respectively. The effect of impurities and process economics for three different options (i.e. base case, without slag leaching and without formate oxidizer) was evaluated.

Base upon this study and the process history of commercial operations, the formate-based concept is an excellent candidate and has a high potential with a low risk for successful adaptation to an MHD seed reprocessing option. As such, the process requires only minimum development resulting in a savings of both time and cost.

4. PLANNED ACTIVITIES

The Phase I final report and Phase II revised proposal (with separate plans and cost estimate for the DOE-requested regenerated seed tests) have been submitted to DOE/PETC for review and selection. The Phase II efforts will begin as soon as DOE completes their selection and evaluation of the Phase II seed regeneration contractor.

5. SCHEDULE

Except for writing appropriate technical papers in the near future, no further activities are planned, funded or outstanding under the Phase I contract.

CONTRACT TITLE AND NUMBER:	Date
Conceptual Design of the Scholz MHD Retrofit Plant DE-AC-87PC79668	1/24/89
CONTRACTOR:	Reporting Period
Westinghouse Electric Corporation Advanced Energy Systems Division P.O. Box 10864 Pittsburgh, PA 15236	6/23/88 to 12/31/88
PROJECT MANAGER:	Period of Performance
Lawrence E. Van Bibber (412) 382-5158	9/87 to 4/30/89

1. Contract Objective

The objective of this project is to develop major portions of a conceptual design of a coal-fired MHD retrofit of the SCHOLZ Generating Plant owned and operated by the Gulf Power Company, a subsidiary of Southern Company.

2. Technical Approach

The initial tasks for the conceptual design included the collection of technical data for the existing plant and preparation of the Retrofit Plant Requirements. MHD System Trade-off Studies were performed to determine operating state points that minimize the plant cost of electricity. Design descriptions and sizing of the MHD systems were developed and layouts were prepared of the buildings and overall plant. Plant performance and estimates of economic value were calculated. The final tasks will include preparation of a design and construction schedule and an estimate of cost for building the retrofit systems.

3. Progress Summary

During this reporting period conceptual drawings were completed for the MHD retrofit systems and interfaces with the existing facilities. Layout drawings were developed for the buildings and site. Process flow diagrams and electrical one-line diagrams were also developed.

Figures 1 and 2 are photographs of the SCHOLZ Plant. Figure 1 is a view of the rear of the plant highlighting the boiler building and the electrostatic precipitators. Figure 2 shows the land available for installing the MHD facilities. The SCHOLZ plant contains two 46 MWe Steam Turbine Generator Units with separate boilers and control systems. Turbine inlet conditions are 425,000 lbs/hr of steam at 900°F and 850 psia. The plant operates with Illinois No. 6 coal and has coal access by railroad and barge via the Apalachicola River.

During the previous reporting period MHD system trade studies and generator analyses were completed resulting in the definition of system state points and performance requirements. Key parameters are presented in Figure 3.

A conceptual design study of an integrated generator concept was developed based on the use of demonstrated AVCO electrode hardware. In developing this concept, emphasis was given to including features that would enhance fabrication, assembly and removal; increase magnet warm bore utilization; and increase reliability. A channel design concept was developed with bore dimensions of 5.5 m in length and a 0.4 m square inlet configuration. This channel contains 190 anodes and 209 cathodes.

A conceptual design of an "active" power conditioning system was developed which is based on the use of solid state current collection converters to control current at each individual electrode. Individual currents are consolidated into eight terminals that form four complete frames at relative uniform voltages and two terminals at the channel ends. Potential Defining Converters are used to control voltage of the consolidated terminals for optimizing performance. The power conditioning system design also includes transformers, filters, capacitors, a bulk inverter and protection equipment.

Design concepts were developed for the combustor, magnet and diffuser. The combustor design is based on the TRW two-stage combustor scaled to the specified operating conditions. The magnet design concept is a circular saddle field coil design similar to the six Tesla long Argonne National Laboratory magnet. Scaled dimensions for the retrofit application approximate those of the existing magnet. The diffuser design is based on the concept used at the UTSI facility. Design concepts have also been developed for the boiler, coal handling equipment, oxidant supply and other support systems.

Layout drawings have been developed for the buildings housing the power train, boiler, and power conditioning and support systems. Figure 4 is a layout of the MHD System building including the power train and the heat recovery boiler.

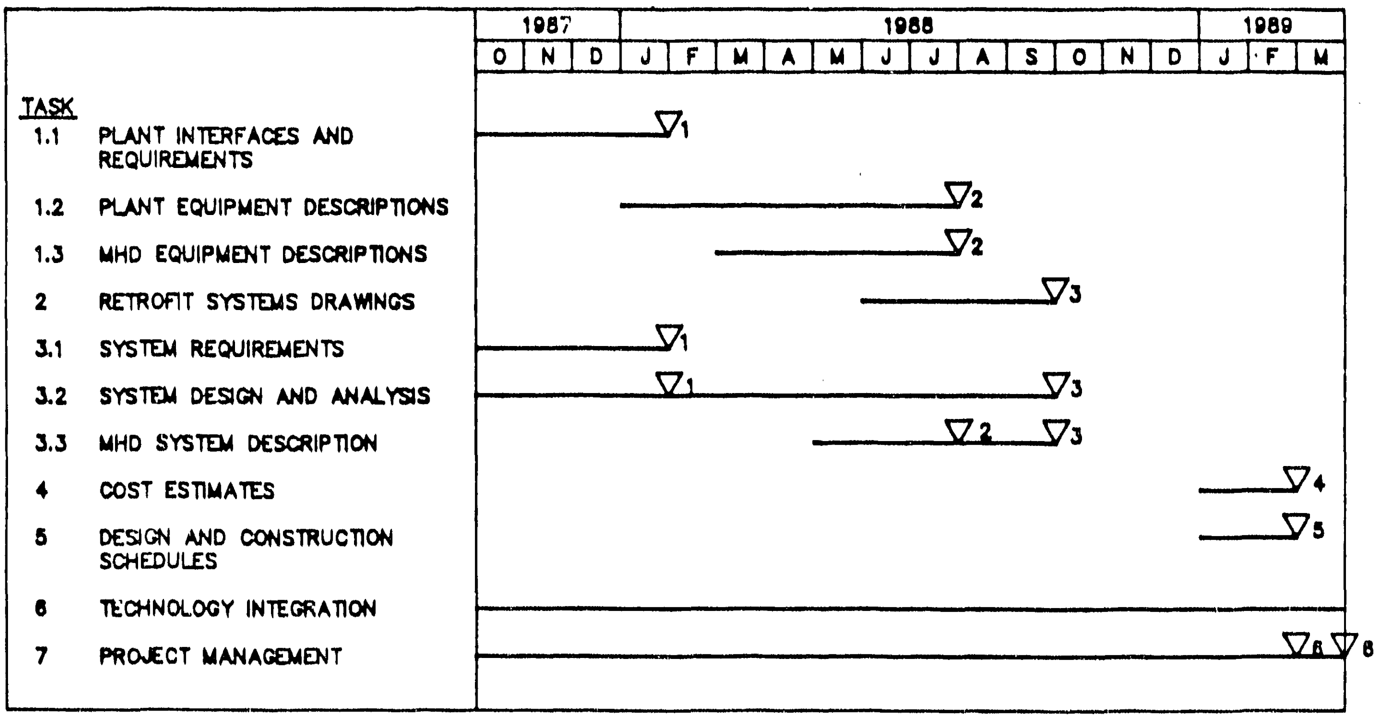
Plant layout drawings, process flow diagrams and electrical one-line schematics have also been developed. Figure 5 highlights the location of the MHD systems relative to the existing facilities. Existing plant drawings have been modified to highlight the coal, steam, water, process gas and electrical interfaces.

4. Planned Activities

Near term activities include completion of Task 4 - Engineering and Construction Cost Estimate and Task 5 - Engineering and Construction Schedules. In parallel with these activities, the draft final report will be prepared. These activities will be completed by May 1989.

5. Schedule

SCHEDULE



1. PLANT REQUIREMENTS AND INITIAL DESIGN
2. PRELIMINARY SYSTEM DESCRIPTIONS
3. CONCEPTUAL DESIGN
4. COST ESTIMATES
5. SCHEDULES
6. FINAL REPORT

MHD881018-1A

FIGURE 1

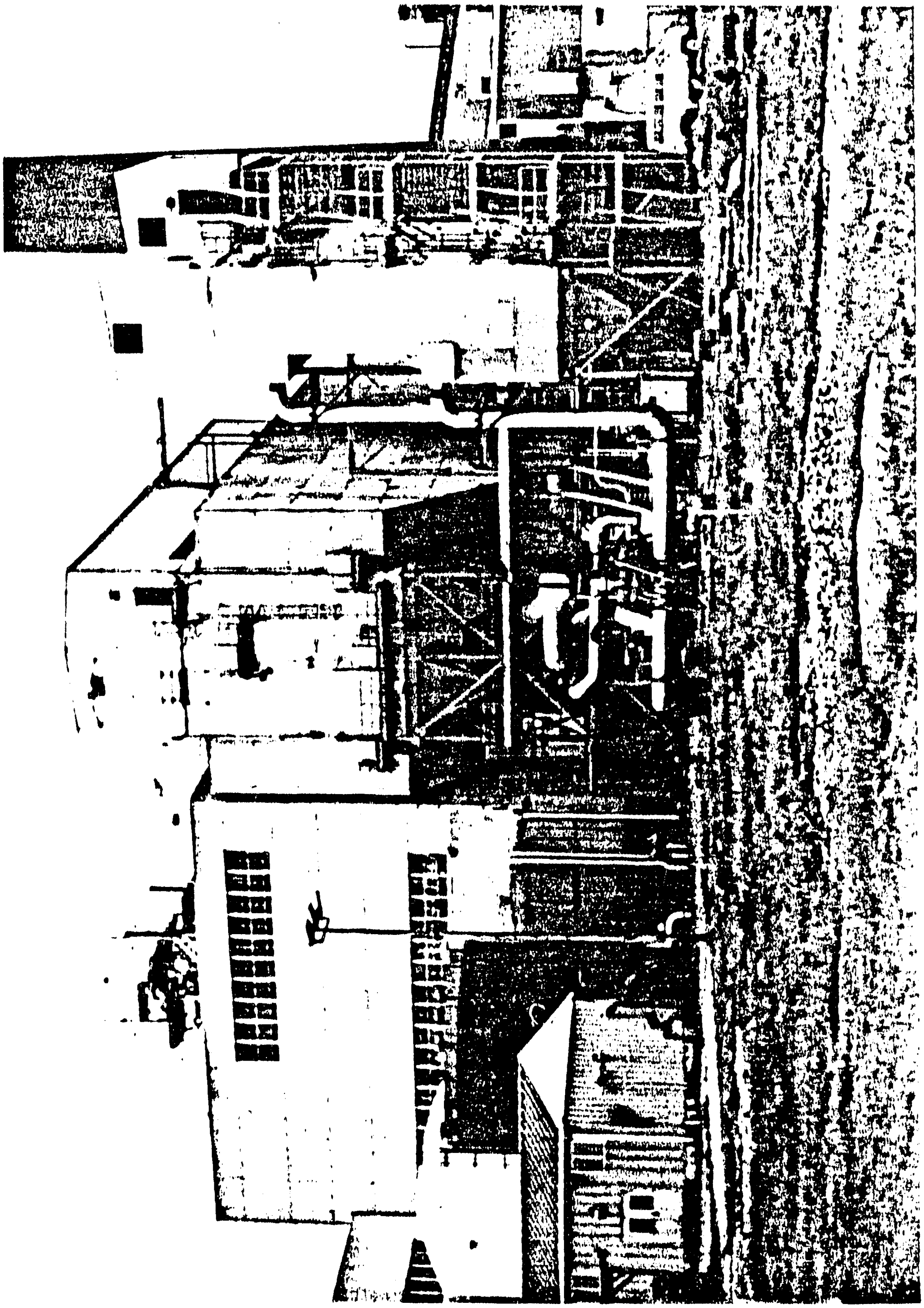


FIGURE 2

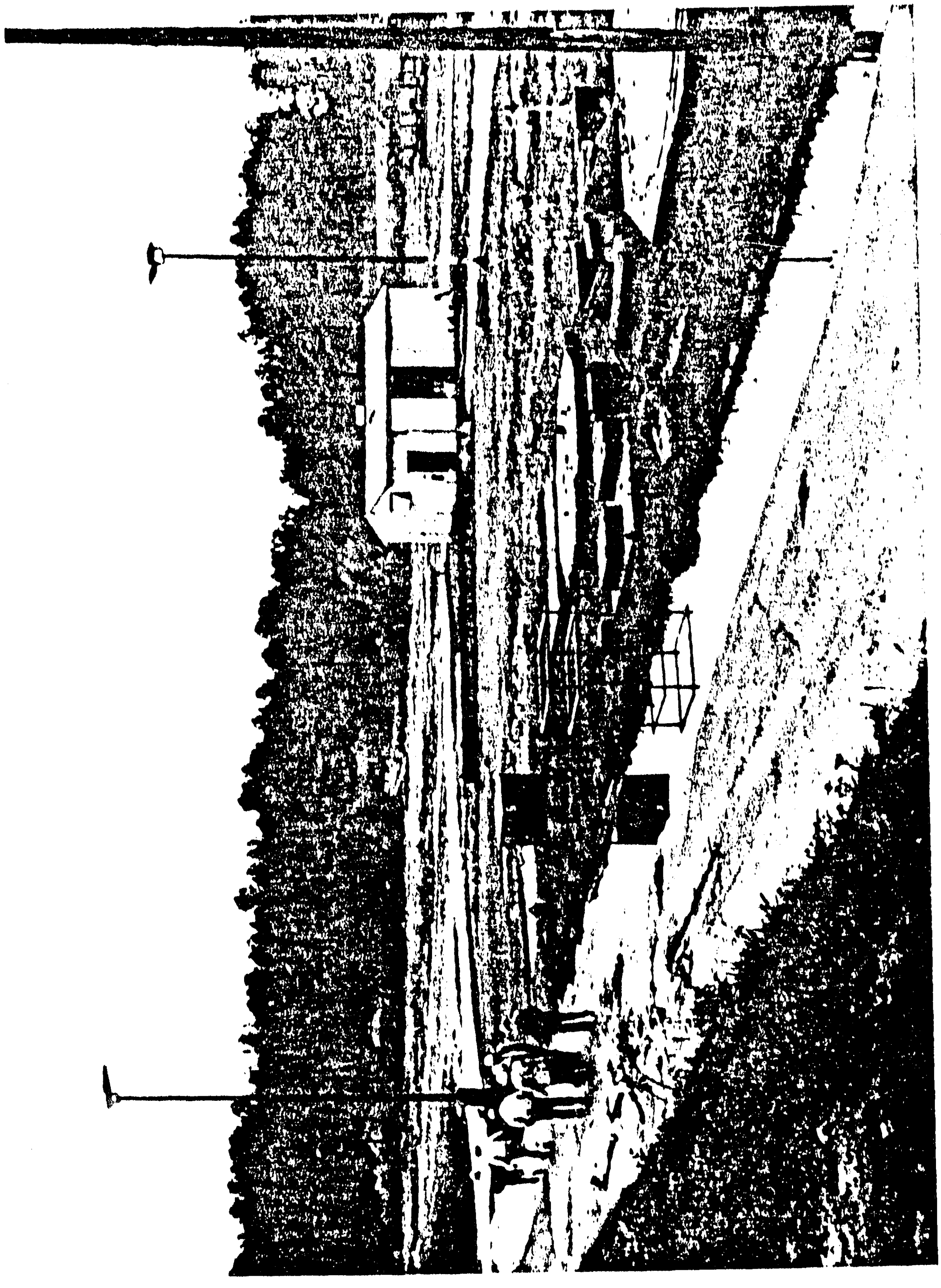


FIGURE 3

OPERATING SUMMARY

Coal Thermal Input (MW_t)	192
Power Generated (MW_e)	74.4
MHD Generator (MW_e)	24.4
Turbine	50.0
Power Consumed (MW_e)	14.8
Net System Power Output (MW_e)	59.6
Plant Heat Rate Btu/kWh	10995
Plant Efficiency %	32.4

STATEPOINTS

	Flow lb/Hr	Temp. °F	Pressure PSIA
Coal	52,293	80	88
Seed	9,364	80	88
Oxidant	231,438	1,450	88
Nozzle Inlet	289,311	4,815	85
Diffuser Outlet	288,311	4,106	14.6
To ESP	373,176	415	14.3

CONTRACT TITLE AND NUMBER:

Conceptual Design of a Coal-Fired Retrofit of the J. E. Corette Plant
DE-AC22-87PC79669

DATE:

January 17, 1989

CONTRACTOR:

MHD Development Corporation
P.O. Box 3809
Butte, MT 59702

REPORTING PERIOD:

January 28, 1988 to January 26, 1989

PROJECT MANAGER:

Neal S. Egan
406/723-8213

PERIOD OF PERFORMANCE:

September 25, 1987 to January 1, 1993

1. CONTRACT OBJECTIVE

It is the objective of this contract to perform a conceptual design of a coal-fired MHD retrofit of the J. E. Corette plant in Billings, Montana. The retrofit design project must demonstrate constructability, operability, reliability, and maintainability, while providing performance and cost data for MHD systems operating within the environment of an electric utility.

2. TECHNICAL APPROACH

The contracting entity for this project is the MHD Development Corporation (MDC), a consortium of the major companies developing MHD in this country. The project team was formed by MDC and consists of AVCO Research Laboratory, Babcock and Wilcox (B&W), General Dynamics, Montana Power Company (MPC), MSE, TRW, UTSI, and Westinghouse.

Key features of the Corette are that it is fired by subbituminous Montana Rosebud coal and that it uses a reheat cycle. The reheat cycle is typical of larger steam plants, so it was a key factor in selecting the Corette for a meaningful demonstration design. Another key point is that the retrofit design will utilize a steam connection between the existing plant and the Corette, i.e., steam generated in the HRSR will be piped to the Corette turbine. The Corette has a turbine capacity of 185.0 MW_e (nominal), although environmental constraints presently restrict the output to approximately 166 MW_e. During MHD operation approximately 107 MW_e will come from the Corette boiler and the remainder (approximately 78 MW_e) from the MHD steam. The MHD channel will produce 28 MW_e.

The overall design effort is divided into six tasks:

Task 1 - Component Identification and Description

Both existing plant and new components constituting the design are being identified by type, size, and quantity. The following guidelines have been used during this conceptual design effort:

- 65% plant capacity factor
- 85% plant operational availability
- Plant operational considerations in the range of 75-100% of design
- Each of the MHD components is to be designed for a continuous operation of 4000 hours
- Rosebud coal is the reference fuel
- Dry potassium carbonate is the seed material
- Component descriptions include appropriate sections for inspection, maintenance, and operation considerations.

Task 2 - Plant Layout and Integration

The plant layout and integration consists of the existing J. E. Corette plant layout showing the integration of the MHD system. In addition, schematic and general arrangement drawings for major components and major piping are being prepared to depict the method of integration with those of the existing facility. Heat and mass balance diagrams for 75% and 100% of design are being prepared.

Task 3 - Reporting and Design Review

Reporting requirements are on a monthly basis. Formal design evaluations are accomplished by several reviews: preliminary design definition, preliminary design review meeting, design status, and two final design reviews prior to report finalization.

Task 4 - Preparation of Cost Estimates

An estimate of the capital costs for the MHD plant in 1988 dollars is being accomplished and will be presented in the conceptual design report in accordance with the DOE/NASA Code of Accounts. For operational cost considerations, an estimate of consumable costs along with credit for power delivered to the grid will be furnished. In addition, costs are being estimated for preliminary and detailed design as well as for construction. Cost sharing possibilities for the construction of the project are being included, identifying sources, types, and amounts.

Task 5 - Preparation of Design and Construction Schedules

The conceptual design report will include a schedule for accomplishing the design and construction efforts required to achieve the MHD plant addition.

Task 6 - Interfacing with the National MHD Program

MDC has been and will continue to participate in the MHD Technology Transfer Integration and Review Committee as requested.

3. PROGRESS SUMMARY

Task 1 - Component Identification and Description

The first portion of this task has been to define MHD operating parameters, their interrelation with Corette systems (boiler performance at part load, achievable turbine capacity, feedwater availability, coal handling, switchyard capacity, etc.) and develop a plant heat and mass balance diagram. Final heat and mass balance diagrams (100% and 75% of design) are being revised on the basis of analytical results provided by AVCO and MSE, and component design requirements defined by the project team. Magnetic field maps have been provided by General Dynamics to assist in determining materials of construction and water purity requirements.

Efficient interface of the Corette feedwater system and the MHD cooling water loops continues to require attention as the component designs are finalized. Continual vigilance is necessary to maximize heat utilization from the various sources.

Besides system integration efforts, Task 1 has included the design of the individual components. Each of the team members have specific hardware design responsibilities, and furnish this design information to MSE, the technical integrator/coordinator. Component designs have been completed and additional information on various operational aspects - part load, reliability, maintainability - are nearing completion.

Task 2 - Plant Layout and Integration

Initial estimates of component size were made and several placements evaluated. The Corette plant site has sufficient area to allow the MHD retrofit to be placed in close proximity to key systems and to minimize steam and feedwater line lengths; however, placement is a challenge as the site is restricted by natural and man-made features (river, highway, park, residences). An initial placement of the MHD system was selected on the east side of the existing Corette plant between the Yellowstone River and track for the incoming railroad. Final layout diagrams reflecting component designs are now being prepared; however, information to date confirms the initial placement.

Integration of the two plants will include these systems:

Plant Services:

- Building heating system
- Fire protection
- Communication
- Sanitary/storm sewers
- Service and instrument air
- Service water
- Potable water
- Service electrical
- Raw coal supply
- Electrical
- Control room
- Steam
- Feedwater

Task 3 - Reporting and Design Reviews

A project team kick-off meeting was held in Billings to orient the team to their project responsibilities and to tour the Corette plant. A November meeting in Pittsburgh was held by DOE-PETC to insure that MDC understood the objectives of the design effort and to request formal submittal of a Design Definition Document. This document was submitted for advisory committee and DOE review in mid-December 1987, discussed at DOE in mid-January 1988, and formally issued in February 1988. Preliminary design review meetings were held with the project team on April 21, 1988 and with DOE on April 28, 1988. A design status meeting was held at PETC on December 15, 1988. Comments from team members and DOE were incorporated into the designs. Initial report inputs have been sent to team members, consultants, and advisory committees for review. Comments will be reflected in the rough draft of the final report now being prepared for issuance this month.

Task 4 - Preparation of Cost Estimates

A standard format and form was prepared for the project team to use in submitting cost estimates. The estimates required component and system definition so this effort is now underway.

Task 5 - Preparation of Design and Construction Schedules

As with the costing, scheduling requires component and system definition prior to completion, so this activity is also currently being done.

Task 6 - Interfacing with the National MHD Program

This task is primarily to support MDC's participation in the TTIRC, e.g., the June 22 meeting in Nashville. Other interface opportunities have been the meeting with DOE-PETC in November 1987, the Contractor's Review Meeting in January 1988 and the SEAM Conference in Nashville in June 1988.

MDC is also participating in the January 24-26, 1989 TTIRC and Contractor's Review Meeting.

Future participation is expected to be at the next TTIRC semi-annual meeting and the Contractor's Review Meeting in June 1989.

4. PLANNED ACTIVITIES

A draft of the final design report will be issued in January 1989 and review meetings will be held in late February and early March. The approved report was issued in August 1989.

TTIRC SEMI-ANNUAL REPORT
Prepared by G. D. Funk
January 10, 1989

CONTRACT TITLE AND NUMBER:

Operation of the Department of Energy's Component Development and Integration Facility.

Contract No. DE-AC07-78ID01745

CONTRACTOR:

MSE, Inc.
P.O. Box 3767
Butte, MT 59701

REPORTING PERIOD:

June 21, 1988
December 31, 1988

PROJECT MANAGER:

J. M. Sherick
(406) 494-7300 or FTS 587-7300

PERIOD OF PERFORMANCE:

June 21, 1988 to
December 31, 1988

CONTRACT OBJECTIVE:

The Component Development and Integration Facility (CDIF) is an engineering scale, development test facility for magnetohydrodynamic (MHD) topping cycle components operated for the U.S. Department of Energy by MSE, Inc. The major objective of the CDIF is to obtain MHD test results that will provide the design basis for larger scale MHD components, which is in support of DOE's commitment to MHD development and proof-of-concept program. Included is support for the National MHD Environmental Program that provides research on environmental issues specific to MHD, evaluation of environmental test data from the CDIF and the Coal-Fired Flow Facility (CFFF), support for the development of an MHD technical data base, and ambient air quality monitoring at the CDIF.

TECHNICAL APPROACH:

MSE, Inc. has been under contract to the U.S. Department of Energy since October 1, 1978 to perform MHD component testing. The first system turnover from construction was December 1979 and initial turnover of the facility by the construction contractor occurred in February 1980.

MHD component testing began in December 1980 with initial power generation being achieved in April 1981. Maximum power to date, 2.3 MWe, was achieved in September 1982. In December 1983, 3.3 MWhrs of electricity were transmitted to the commercial power grid using the EPRI-supplied inverter.

From December 1983 through July 1984 preparations for and installation of the TRW-designed coal-fired combustor (CFC) occurred. CFC first-stage characterization testing was completed January 30, 1985. Installation of the second stage and an upgraded channel/diffuser was completed on May 17, 1985. The first checkout firing was accomplished on July 17, 1985 and coal-fired power generation tests on the workhorse components were initiated. On October 2, 1986 an 8-hour duration test was completed. In May and July of 1988 record peak power levels (coal generated) were attained in the diagonal and Faraday modes, respectively. From October 12, 1988 through the present, instrumentation and plant systems were modified, and the TRW coal-fired precombustor (CFPC) was installed. Checkout testing of this new hardware is scheduled beginning in February 1989. Tests on this hardware will continue until delivery of the next generation (prototypic) components.

Specific tasks to support the above include:

1.0 Test Support

- Channel refurbishment and repair
- Design, installation and checkout of plant modifications to support the testing program
- Plant maintenance

2.0 Major Plant Modifications

- Design, installation, and checkout of major plant modifications required to support the Integrated Topping Cycle (ITC) and DOE Five-Year Program Plan

3.0 Upgrade Plant Systems in Support of ITC and DOE Five-Year Plan in the Areas of:

- Reliability
- Availability
- Maintainability
- Operability

PROGRESS SUMMARY:

During the reporting period, testing at CDIF continued with checkout of modifications to second-stage oxygen injection (improved second-stage oxygen mixing and additional injection ports), Faraday steady-state operation, and diagonal 100% slag carryover testing. Testing to support calibration of the inverter and verify the new split coal feed configuration for the CFPC was accomplished. Successful preliminary diagnostic measurements were performed by Mississippi State University. Test time for the past twelve months includes a total of 66:29 hours on coal and 36:18 hours of power generation. Testing at CDIF was shutdown during this reporting period to initiate installation of the new oil-fired vitiator (OFV) and CFPC. During the shutdown the coal-fired combustor was disassembled and inspected for wear and damage. Reassembly of the CFC incorporated several new components and extensive refurbishment to the second-stage. Considerable progress was made on channel refurbishment including fabrication and assembly of several new wall sections. Work in progress includes procurement of newly designed cathode end blocks for the forward peg sidewalls and newly designed cathode sidebars. A comprehensive review of the CDIF channel design, fabrication, assembly, installation, and operation was conducted by the ITC Team and MSE.

PLANNED ACTIVITIES:

Test plans for the next reporting period include checkout of the newly installed OFV and CFPC. A new post-nozzle test section for optical measurements will be fabricated, installed and tested during CFPC checkout. Installation and checkout of on-line coal flow rate and moisture measurement devices are scheduled. Hardware activities for the period include fabrication of new supersonic diffuser sections, complete assembly of new aft diagonal sidewalls, and assembly of new aft peg sidewalls.

Late CY89 activities include completion of pegwall refurbishment, checkout of the improved iron oxide/slurry injection system, and power testing using the CFPC. An all new "confirmation" channel and a full compliment of prototypic current controls will be installed and the Confirmation Test Series initiated.

CDIF TESTING AND MILESTONE SCHEDULE

O TEST DATE SCHEDULE

● MILESTONE SCHEDULE

DESCRIPTION	JAN	FEB	MAR	APR	MAY (1989)	JUN	JUL	AUG	SEP	OCT	NOV	DEC
INSTALL CFPC	●											
INTERFACE AND FLOW VERIFICATION TEST/PLANT STARTUP		●										
CFPC CHECKOUT TESTING		O	O	O								
INSTALL REFURBISHED CHANNEL				O								
INTEGRATED SYSTEM TEST					O							
FINE COAL TEST					O							
FINE SEED TEST					O							
LOW ASH COAL					O							
OPTIMIZATION TEST SERIES					O	O						
100% CARRYOVER (WITH WATER)						O						
STEADY STATE DEGRADATION							O					
PLATINUM ANODE EVALUATION							O					
INSTALL CONFIRMATION CHANNEL								O				
INSTALL AVCO CURRENT CONTROLS								●				
CONFIRMATION TEST SERIES									●	O	O	O

SUMMARY OF THE TECHNOLOGY TRANSFER, INTEGRATION AND REVIEW
EXECUTIVE COMMITTEE MEETING
(October 26, 1988)
Boston, MA

The format inputs to the semi-annual reports were discussed along with the total report format and distribution. In addition to the TTIRC Charter members, the National Technical Information Center (NTIC) will receive copies such that abstracts would be available to a wide distribution.

The MHD Power newsletter, published by the MHD Industrial Forum, was handed out to about 200 representatives of the Joint Power Conference by Bill Irving along with copies of his presented paper on MHD. The Forum said that another 200 copies were mailed to the CEO's of utilities ranging in size from 500 MW_e to 1000 MW_e.

Bill Owens presented a Clean Coal Technology III schedule overlaid on the current FY'89 MHD schedule as it might apply to the MHD Retrofit of the Scholz Generating Plant or the Corette Plant. You will hear more about that in the Pittsburgh Committee meeting in January because it closely relates to Article - 5 of the Committee's Charter.

A motion was passed to add to the Missing Link Subcommittee a task to "provide the TTIRC with a listing of corporations or consortiums that are engaged in building power generation plants and selling power to utilities. Where are they and how does one approach them."

Additional discussions were held concerning the schedule of the January TTIRC meeting and the one following the SEAM in June.

The balance of the Executive Committee meeting was spent in defining the technical interface issues that the POC program may face. Not solving the issues; just defining them, was the aim, of the Committee.

For instance:

1. Sulfur/sulfate addition to the topping cycle;
2. Acceptability of alternate seeding material i.e., potassium formate;
3. How compatible are topping/bottoming cycle and seed regeneration design conditions with the requirements of the two retrofit conceptual design studies with respect to:

    a) oxidant make-up, preheat temperature and pressure
    b) water coolant temperature, pressure and integration with steam cycle
    c) coal specs
    d) diffuser/radiant boiler interface
    e) NO_x, $Ø_2$ and ASP limitations
    f) start-up, part load and shutdowns
    g) handling electrical faults

Finn Hals has been retained as a consultant, to Marty Bauer on the TRW Integrated Topping Cycle TTIRC, to put his arms around these issues. You will all be hearing from him in Session - 2 of this Committees meeting on Thursday, 26 January, 1989 in Pittsburgh, PA.

TECHNOLOGY TRANSFER, INTEGRATION & REVIEW
COMMITTEE (TTIRC)

Second Semi-Annual Meeting
Session 1
24 January 1989
Allegheny Room, William Penn Hotel, Pittsburgh, PA

1:00pm	Welcome and Introduction	R. Cunningham - TRW
1:05	Call Meeting to Order and Acceptance of Last Semi-Annual Meeting Minutes	W. Irving - WMI G. Staats - DOE
1:10	Brief discussion of the October 1988 Executive Committee Meeting in Boston & Agenda for Session 2 (Technical) on Thursday	G.Staats R. Cunningham M. Bauer - TRW®
2:00	Break	
2:15	Clean Coal Technology III & IV vs. MHD Activities Related to Charter Article - 5	J. Sherick - MSE
3:00	Clean Coal Technology III & IV vs. MHD Activities Related to Charter Article - 5	J. Cuchins - So.Services Company
3:30	DOE Requirements to Respond to any Clean Coal Technology	R. Cunningham
3:45	Open discussion All TTIR Committee Members	Leaders W. Irving, G. Staats
4:30	Adjournment	

TECHNOLOGY TRANSFER, INTEGRATION AND REVIEW
COMMITTEE (TTIRC)

Second Semi-Annual Meeting
Session 1
24 January 1989
Allegheny Room, William Penn Hotel, Pittsburgh, PA

The minutes for this meeting have not yet been approved by the general committee for distribution and are being revised.

TECHNOLOGY TRANSFER, INTEGRATION & REVIEW COMMITTEE (TTIRC)

Second Semi-Annual Meeting
Session - 2
26 January 1989
Allegheny Room, William Penn Hotel, Pittsburgh, PA

1:00pm	Welcome and Introduction	W. Irving - WMI
1:15	Technical Issues - Objectives	M. Bauer - TRW
1:30	Definition of Technical Issues: "How compatible are Topping/Bottoming cycle and seed regeneration design conditions for the POC Program with the requirements & assumptions used for the two retrofit conceptual studies."	M. Bauer
	1. Carbonate/Sulfate addition to the topping cycle because of bottoming cycle needs	P. Probert - B&W
	2. Acceptability of alternate seeding material (i.e. potassium formate)	G. Ogle - TRW
	3. Magnetic Field strength/channel Mach no.	R. Kessler - AVCO
	4. Oxidant composition & preheat temperature for the topping cycle.	F. Hals - Consultant
	5. Topping cycle water coolant temperature/ pressure.	F. Hals
	6. Coal Specifications	G. Ogle
	7. Diffuser/Radiant boiler interface	P. Probert
	8. Use of additives in the topping cycle	R. Kessler
	9. NO_x and O_2 differences between topping & bottoming cycle (POC)	W. Owens - G/C
	10. Start-up, shutdown, part load & their effects on downstream	P. Probert
	11. Channel loading	R. Kessler
4:00	Open Discussion - Identify other technical issues that may need investigation - all TTIR Committee Members	Leaders: W. Irving, G. Staats
5:00	Adjournment	

TECHNOLOGY TRANSFER, INTEGRATION AND REVIEW
COMMITTEE (TTIRC)

Second Semi-Annual Meeting
Session 2
26 January 1989
Allegheny Room, William Penn Hotel, Pittsburgh, PA

The minutes for this meeting have not yet been approved by the general committee for distribution and are being revised.

15. MHD TTIRC DISTRIBUTION LIST

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