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Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion Project

Quarterly Report
October - December 1995

February 1996

Work Performed Under Contract No.: DE-FC21-90MC25140

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Southern Company Services, Inc.
Birmingham, Alabama

MASTER

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February 1996

POWER SYSTEMS DEVELOPMENT FACILITY

QUARTERLY TECHNICAL PROGRESS REPORT
OCTOBER 1 - DECEMBER 31, 1995

TABLE OF CONTENTS

1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes the work completed during the third quarter, October 1 through December 31, 1995, under the Department of Energy (DOE) Cooperative Agreement No. DE-FC21-90MC25140 entitled "Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion." The objective of this project is to evaluate hot gas particle control technologies using coal-derived gas streams. This will entail the design, construction, installation, and use of a flexible test facility which can operate under realistic gasification and combustion conditions. The major particulate control device issues to be addressed include the integration of the particulate control devices into coal utilization systems, on-line cleaning techniques, chemical and thermal degradation of components, fatigue or structural failures, blinding, collection efficiency as a function of particle size, and scale-up of particulate control systems to commercial size.

The conceptual design of the facility was extended to include a within scope, phased expansion of the existing Hot Gas Cleanup Test Facility Cooperative Agreement to also address systems integration issues of hot particulate removal in advanced coal-based power generation systems. This expansion included the consideration of the following modules at the test facility in addition to the original Transport Reactor gas source and Hot Gas Cleanup Units:

1. Carbonizer/Pressurized Circulating Fluidized Bed Gas Source.
2. Hot Gas Cleanup Units to mate to all gas streams.
3. Combustion Gas Turbine.
4. Fuel Cell and associated gas treatment.

This expansion to the Hot Gas Cleanup Test Facility is herein referred to as the Power Systems Development Facility (PSDF).

The major emphasis during this reporting period was continuing the detailed design of the facility towards completion and integrating the balance-of-plant processes and particulate control devices (PCDs) into the structural and process designs. Substantial progress in construction activities was achieved during the quarter. Delivery and construction of the process structural steel is complete and the construction of steel for the coal preparation structure is nearing completion. All MWK equipment are set in its place and the FW equipment and the PCDs are being set in the structure. Substantial progress has been made in the fabrication and installation of both small and large bore non-refractory lined piping.

It should be noted that this report includes accounts of progress made by Foster Wheeler (FW), M. W. Kellogg (MWK), Combustion Power Company (CPC), Industrial Filter & Pump (IF&P), Westinghouse, Southern Research Institute (SRI), Nolan MultiMedia, and Southern Company Services (SCS).

2.0 REVIEW OF TECHNICAL PROGRESS

2.1 PROJECT MANAGEMENT

Budget and Schedule: The PSDF budget and schedules were updated and based on the updates various options for completion of construction of both trains and operation are being addressed. An updated budget estimate for all costs required for Operations and Maintenance, including labor, fuels and other consumables, spare parts and materials, and other miscellaneous operating costs is being prepared.

Laboratory Services: SCS evaluated the options for performing laboratory analyses and decided that certain analyses would be performed at the PSDF on-site lab while other analyses were more suitable to being performed by an outside laboratory. SRI was selected under a competitive solicitation to provide personnel for the on-site lab. SRI's lab personnel are working under a Letter Agreement while the service agreement contract is being negotiated. A draft service agreement was provided to SRI, and SRI's comments and subsequent SCS responses were made in late November. A revised draft service agreement was submitted from SCS to SRI on December 20, 1995, for review. Alabama Power's laboratory was selected based on low cost as the outside laboratory to provide analysis for all the coal, flyash, sorbent, lube oil, and corrosion coupon analyses.

Data Analysis and Management: A variety of computer software has been considered for assisting in data management. After investigations, negotiations were initiated for a trial evaluation for a specific software to provide access on the LAN to the data from the control system. A draft Evaluation Agreement and License Agreement were transmitted in early October for review and comment. Based on discussions through October, a revised License Agreement and Evaluation Agreement were transmitted on November 13 and 16, 1995, respectively. After further discussions, a revised Evaluation Agreement was provided by SCS on December 21, 1995, and the vendor is still reviewing. The software should be delivered within one month of completing the negotiations and having a signed agreement. SCS also pursued the upgrade on Laboratory Information Management System software which would be used to manage the PSDF analytical data and has the capability of electronically transferring data from the outside laboratory to the PSDF lab once the data passes QA/QC. The software, LABWORKS, has been procured and shipped to the project site. Preparations are underway for installation and training of PSDF personnel on each of these software items.

Nolan Multimedia: Due to budget considerations, it was decided that the Wilsonville Interactive Learning System being developed for the PSDF by Nolan could not proceed to its original conclusion. Analysis was conducted on how best to proceed with a timely closeout of Nolan's work. A prioritized list was developed of the modules which should be finished and the order in which they should be finished to guide production. All of this work will be completed by April 1996. Modules to be completed are as follows:

- MWK Transport Reactor Technology Resource Module
- Finalization and debugging of the Hot Gas Cleanup Technology Resource Module
- Finalization and debugging of the Operations and Familiarization Modules
- SRI sampling system video training module
- Archive module (P&ID, still photographs, and 3D views library)
- Upgrading of menus and finalization of navigation mechanism
- Promotional Video
- Real Time Monitoring/Sampling Technology Resource Module

2.2 PHASE 2 - DETAILED DESIGN ACTIVITIES

2.2.1 Task 2.1 Detailed Design

2.2.1.1 MWK: PSDF Transport Train

The detailed design is complete. Comments were received from SCS on the maintenance and inspection manual. The operating and maintenance manual revision from Clyde Pneumatics Conveying will be issued early next quarter. Personnel assignment for the operations advisor during start-up is finalized. Engineering support continues on an as required basis with most of the activities focused around gas analyzer probes, cabinets and analyzers, drawing and design intent clarifications and alternative materials for some procurement items.

2.2.1.2 FW Team Activities

The Phase 2 detailed engineering and Phase 3 procurement activities continued. The following activities occurred during the fourth quarter of 1995.

Site construction

In October, all vessels were lifted into the structure and rough set in position. The combustor cyclone interfered with a hanger and some minor redesign was required.

Preparations were made for installing the refractory lined pipe. From the MWK construction experience two tasks were identified: (1) determine that all the materials required, gaskets, studs, washers, bolts, etc., are available; and (2) grind off excess refractory at the pipe ends to ensure that the excess did not prevent seating of the flanges. Some damage to the flat faces of the flanges was also observed that will require repair to ensure a leak-tight joint.

Work was started on developing an integrated construction and startup schedule based on the following construction sequence: simple cycle; circulating PFBC; then carbonizer for integrated operation. As part of this exercise, discussions have been scheduled to better understand the work involved in installing the MASB and gas turbine.

Operating procedures

PSDF technical staff commenced the task of writing the operating procedures. The Project identified the need for additional support and two FWUSA staff were nominated to provide assistance. One was on-site permanently and one was on-site on alternate weeks. Draft versions of the following procedures were prepared: carbonizer coal feed; combustor coal feed; carbonizer startup burner; booster compressor; the vent and flare system; circulating PFBC; fluidized bed heat exchanger; bed ash cooler; fine ash system; carbonizer; transport air compressor; and sorbent feed system. These have been issued for comment and most are ready for final issuance.

In writing the procedures some design questions were raised that required clarification either from FWUSA or one of their vendors. All such issues were resolved satisfactorily.

- An adiabatic head analysis was performed to confirm the guaranteed performance of the booster compressor. Some deviation was shown to exist between the results of the analysis and experimental data, but the operating ranges, anti-surge limit, and stonewalling conditions are consistent. A Moore Products representative visited the site to evaluate status of configuration for the booster compressor. As the suction head is positive compared to the negative head normally experienced, a non-standard, specialized control strategy is required.

- The need for additional safety interlocks between the coal feed systems and the booster compressor were identified. In one instance, after a booster compressor trip, the control strategy decreased the coal feed rate as the booster air flow rate decreased. Hence, coal and sorbent could be fed without being conveyed away and so the line would eventually block. In the other, if the carbonizer air supply stopped and the bed slumped, the conveying air flow continued to prevent hot solids from falling back into the line. The incoming air would have produced localized hot spots with possible ash fusion occurring, resulting in fluidization problems upon restarting the carbonizer. One proposed means of avoiding this is to use existing valving to switch over to conveying nitrogen in the event of the carbonizer bed slumping.

Winterization of equipment

Some items of equipment were expected to be installed before November, 1995, and the vendors had not prepared them for long-term storage. Some items such as fans, vessels, screw coolers and control skids were covered. The coal diverter valves were coated with a rust inhibitor. Grease was applied to bearings and shafts and provisions made to turn them regularly to prevent flat spots. The booster and transport air compressors required a more rigorous procedure and it was elected to install them in their final locations. The centrifugal booster compressor was installed in October and this allowed the control panel heater to be activated and the prelube pump made available to circulate lubricating oil. The reciprocating transport air compressor was installed in November. Certain items were identified to be placed in covered storage once it becomes available early in 1996.

Revised cost estimate for construction

The isometrics were reviewed to determine the following for the different diameters and types of pipe: the total footage; the number of field welds; the number and type of fittings; and the number and type of valves. The P&IDs were also reviewed to determine the number of different types of instrumentation and their installation requirements. These data were then used to provide an installation cost estimate based on the productivity rates achieved during construction of the MWK reactor.

Alkali probes

FWUSA had obtained a quote for four alkali probes from Westinghouse to be installed before and after the combustor and carbonizer alkali getters. The probes before the alkali getters would be in a similar location to the SRI dust probes which can also determine alkali. Hence, there would be a cross check on the determined values, although it is still unclear how any differences in measured values between the two probes would be resolved. On this basis it was considered that the SRI probe was as likely to yield reliable data as the Westinghouse probe.

As alkali is present in low concentrations and its measurement is prone to error, it had previously been decided to use Westinghouse probes before and after the alkali getters to eliminate errors arising from different probe designs. Such errors would arise when using an SRI probe upstream and comparing it to a downstream measurement made with a Westinghouse probe. Upon reflection, it was realized that the downstream alkali concentration would be zero if the getter was working as expected. Hence, such between probe variances would be of no consequence and the upstream probe would be the one of greatest importance.

On balance it was decided not to proceed with the Westinghouse probe and to use the SRI probe in the location upstream of the alkali getters. In addition to this technical decision, not proceeding with the Westinghouse probes and using the already fabricated SRI probes, results in a significant cost saving to the Project. Further cost savings were made by deleting ports that were no longer required. To allow alkali measurements to be made with the SRI probe, FWUSA were asked to provide suitable ports in the refractory pipe. If the SRI probe proves unequal to the task of measuring alkali, the decision not to purchase the Westinghouse probes will be revisited.

Traversing temperature probe for the MASB

To allow the temperature profile at the exit of the MASB to be determined, the need for a traversing probe has been identified. The original idea was to use a grid of cooled thermocouples, but this was considered by the Design Hazard Review Team to place the turbine in jeopardy if the thermocouples broke free. In the current design there are three thermocouples penetrating the pressure shell at the interface of the MASB and the entry pipe to the turbine. These are set at 120° to one another and are directed towards the MASB. If each of the three can be traversed, a radial and circumferential profile could be determined with a slight axial component. If the measurements were made at the end of a test period and for a restricted period then they would pose little risk of damage to the turbine.

Several inquiries were made but only one proved fruitful. The proposed method was very simple and inexpensive, the thermocouple being driven through a gland by a handwheel mechanism. A ball valve is located upstream of the gland to provide a positive seal should the gland fail. There are some questions to be answered before the acceptability of the device can be determined.

Gas analysis equipment

Three vendors were invited to site for discussions prior to final selection of the gas analysis equipment. The company selected provide an infrared optical head device capable of operating at 600°F, which eliminates the need for sample conditioning systems in both the combustor and carbonizer streams. An added advantage is that the technique can also provide a continuous measurement of ammonia and H_2S so eliminating the need for batchwise, wet chemical determinations of these species. Although the capital cost of the analyzers themselves was slightly higher than the second choice, the elimination of the sample conditioners and the batch samplers was considered to essentially eliminate the cost difference. Although selected, the purchase of the equipment has been delayed pending budget and schedule resolutions.

FW detailed engineering design

Meetings were held in Birmingham on Friday, November 17 and on Thursday, December 6, between SCS Engineering and FWUSA to identify outstanding work items to be completed. The following Table outlines the items discussed and the schedule for completion.

Topic	Completion date
I/O list, FW to SCS	11/20/95
DCS assignments, SCS to FW	12/11/95
IRS	1/15/96
P&IDs	11/27/95
SAMAs	1/1/96
Sequence drawings	12/11/95
Point-to-points	1/10/96
Interlocks, Hard wired	12/11/95
Software	12/11/95
Instrument installation & support	1/31/96
Instrument location plans	1/31/96
Raceway and circuit schedules	2/13/96
Raceway plans	2/6/96
Wiring diagram	1/25/96
Electric diagrams	1/25/96
Line list for trace heating	11/27/95

SCS considered that some topics did not contain sufficient detail for construction purposes, in particular the Instrument Reference Schedule. The range and scope of all the work was discussed. It is expected that this work will be completed by the end of February, after which the FWUSA design can be closed out. Following this, the final electrical design by SCS will commence using information provided by FWUSA. The schedule for completing this work remains to be determined.

Defining DCS Screens

The screen mimics were based on the P&ID sheets, and for each screen key process and control data were identified for display. This information will be used for configuration of the operator display screens and controls.

MASB and gas turbine

Pending resolution of budget and schedule, it was necessary to suspend work by Allison on the gas turbine. But for the suspension, delivery was expected in January, 1996. Discussions are still being held to determine how best to accommodate the delay. Allison said that the bearings for the machine still had to be assembled and that the inlet scroll remained to be manufactured. These were both long lead items, and to avoid future delays, Allison said that they would try and complete these work items before discontinuing work.

Fabrication has commenced for the MASB burner assembly and its spool piece. These will both be competed in January, after which the thermal barrier coating will be applied to the inside surface of the burner. Assembly of the burner in the spool piece and attachment of all the protective thermocouples will commence in February. The assembly is expected to be delivered to site before the end of March.

Staffing

The six Operators to be allocated to the FW advanced PFBC train completed their training and start work on equipment preservation and locating those materials needed for installing the refractory-lined pipe. They also completed a variety of drawing cross-checks in support of the FWUSA design close out schedule. These included checking the P&IDs against the Instrument Reference Schedule for all instruments, pneumatic and electric valves, manual valves, and pressure relief valves. Instrument locations, and installation details were also checked. The Operators also participated in the material take off from the isometrics in support of preparing the revised construction cost estimate.

2.2.1.3 Balance-of-Plant Activities

A summary of the balance of plant design, engineering engineering, procurement and construction support activities arranged by engineering disciplines follows.

BOP Engineering - Mechanical

Coal and Limestone Systems: Engineering continued to receive and comment on vendor drawings for the mill systems. Engineering has received and reviewed ductwork layouts submitted by the vendor and prepared supports for the ductwork systems. Visits continued to be made during October to the conveyor supplier in Ohio along with their suppliers to expedite and observe their efforts. The latest issue of the P&ID's from the mill vendor were received and a minimal number of comments were provided. Instruction manuals for the mill systems and the screw coolers were received and reviewed. Design efforts on the coal and limestone preparation systems during December consisted primarily of answering questions from Construction personnel. The final P&ID's for the pneumatic conveying systems for the coal, limestone and bed materials (coke, alumina and LASH) were completed for transmittal.

Ash Handling Systems/Dense Phase Conveying Systems: The design of the ash handling systems continues at Clyde Pneumatics Conveying, Inc. Engineering continues to communicate with Clyde in order to obtain design information and resolve interface issues. Layout drawings for the instrument air and cooling water were begun. The final P&ID's for the ash handling systems were completed for transmittal.

Steam and Condensate Systems: The design of the MWK portion of this system is complete. Awaiting final designs from FW in the condensate area before completing the FW condensate system drawings.

Circulating Water, Cooling Water and Service Water Systems: Design completed the routing of the cooling water to the coal and limestone mills and to FW ash screw cooler in the ash storage building. Design is waiting for final designs from FW in the condensate area before completing the FW condensate system drawings.

Service Air/Instrument Air: Design completed the layout drawings of the service/instrument air to the equipment in the mill structure. The layout drawings to the equipment in the ash storage building continues.

Auxiliary Fuel: Detail design of the piping from the propane supplier's equipment to the various consumers on the site continued and was completed on the portion to the mill system. Completion of the propane line to the auxiliary boiler will be complete upon receipt of detail drawings for the auxiliary boiler. Drawings for the diesel fuel tank pump were received during October. Layout drawings of the propane piping in the mill structure were completed.

Fire Protection: Detail design of the riser system within the process structure was started and completed.

Nitrogen System: Vendor drawings from BOC Gases for the liquid nitrogen supply system and the nitrogen generator continue to be received. Design completed the routing of the low pressure and medium pressure lines from the nitrogen vendors interface point to the trench and to the high pressure air compressor. Layout drawings for the nitrogen piping in the mill structure were completed.

Demineralized Water: Design of the demineralized water pump station was completed.

Auxiliary Steam: Design is awaiting additional information from the boiler supplier before drawings are begun on the ancillary lines to and from the auxiliary boiler.

Miscellaneous Materials: Valves for the balance of plant systems continued to be identified and placed on order. Additional valves on the M.W. Kellogg process continued to be identified and procured as needed.

BOP Engineering - Civil

The final design drawings for the structural steel Coal Building were issued to the site. These drawings include the modifications necessary to support the equipment provided by the mill and ash vendors.

The dilution air fan concrete foundation was revised to match the as-built location of electrical pull box #2. The concrete supports for the MWK piping from the Thermal Oxidizer to the dilution air fan were designed, and drawings issued for construction. The duct from the MWK thermal oxidizer to the baghouse and stack, the duct support steel, the duct supports, and the associated duct support foundations were designed, detailed, issued for bids, and issued for fabrication and construction. Several miscellaneous structural steel pipe supports and the platform for the MWK main air compressor air inlet were designed and issued for construction.

The structural steel pipe bridge between the coal and ash structures was issued to the site for procurement and erection. The final detailed drawings of the north and south pipe bridges between the process structure and the coal structure, and the access platform over the headers at the cooling tower were issued for construction. The pipe support drawing for the headers at the cooling towers was completed and issued for site fabrication and erection.

The maintenance platforms for the Westinghouse PCDs were designed, detailed and issued to the site for procurement and construction. Also in the process structure, the maintenance platform for the west side of the overhead crane was detailed and issued for construction.

In the coal building, the final detailed drawings for the MCC enclosure and HVAC were issued for procurement and construction. Also issued were the final detailed drawings for the coal mill foundations and base slab.

The high pressure air compressor, dryer, and air accumulator foundations were issued to the site. Also issued for construction were the foundations for the steam and condensate piping and heat exchangers. The detailed drawings for the structural steel cover over the coal and limestone reclaim hopper were completed and issued for construction.

Modifications to the coal building structural steel were detailed and issued for construction. The design for the diesel fuel storage tank and retaining wall foundation was completed in December. The detailed drawings are 95% complete and will be issued for construction in January. The Ash Building structural steel was revised to match the support frames for screw coolers. The detailed drawings just received were different than what was expected during the original design and layout of the steel.

The detailed design of the structural steel platforms and steel for FW pipe supports was started. This steel will support the topping combustor and provide access and support platforms for SRI probes. Since one platform still extend over the proposed control building for the turbine, the supports for one end of the platform will be supported by the roof of the control building. The design for the steel will be completed in January.

The design for the reinforced concrete foundation for the tube bundle was started, and will be completed in January. The design drawing for the Baghouse foundations was revised to incorporate the foundations for the duct support steel. This was done to avoid interferences with future electrical ducts, and to eliminate the problem of undercutting an existing foundation.

The PCD maintenance platforms were revised to allow them to be stored in the maintenance bay. This will reduce the open area of the common bay, but it will eliminate the need to lower the platforms to grade, and having to move them to the laydown area for storage.

Some structural steel was modified in the field to aid the installation of CPC equipment. The modified steel was re-evaluated and was found to be adequate for the anticipated loads. These modifications are necessary to eliminate interferences with ducts and coal handling equipment layouts just received by SCS. SCS engineering has been assisting construction in making the detailed drawings for the steel modifications.

A review of the site paving requirements was completed with plant operations, and a new cost estimate was completed for the current site layout. The design for the diesel fuel storage tank and retaining wall foundation was completed in December. The detailed drawings are 95% complete and will be issued for construction in January.

BOP Engineering - Electrical & Controls

Development of wiring, elementary, and loop diagrams for the balance of plant equipment continued. Work on the MWK and BOP cable routing continued. Wiring diagrams, elementary diagrams, and electrical physical drawings were issued for the baghouse, baghouse screw conveyor, stack lighting feed, liquid nitrogen backup system, dilution air fan, high pressure air compressor, coal and limestone runoff sump, balance of wastewater. Wiring and elementary diagrams were issued for the MWK ash system (Areas 500 and 800), the crusher/conveyor system, FD0140, FD0154, and FD0104. Wiring and elementary diagrams were begun for the Clyde Pneumatics Conveying, Inc systems associated with MWK. SRI circuits were routed and conduit sketches were prepared for the MWK areas. Circuits were routed for FD0206. Circuits were written for FL0301. Work continued on the heat tracing for the MWK piping and BOP piping. Heat tracing material procurement began and continued. Physical design of coal and ash handling lighting, receptacles, and communications, ash handling conduit and grounding continued. Review of vendor drawings and procurement of bulk materials continued.

Instrument installation details and loop drawings were issued for the baghouse, baghouse screw conveyor, MWK ash system (Areas 500 and 800), liquid nitrogen backup system, dilution air fan, FD0140, crusher/ conveyor system, FD0154, coal and limestone runoff sump, balance of wastewater, FD0104, and all of the Clyde Pneumatics Conveying, Inc systems associated with MWK. Loop drawings were prepared for FL0301.

Work on recommending a vendor for the APFBC Gas Analysis equipment continued. The FW Instrument Reference Schedule was reviewed by verifying I/O which already had terminations assigned and assigning terminations to those I/O which had not previously been assigned. Meeting was held with FW to determine the remaining scope of their responsibility. Balance of Plant P&IDs were reviewed and updated. I&C provided construction support for the installation of instruments. Work continued on the DCS configuration, graphics development, instrument data sheets, and database development. Add-on instruments for the BOP were ordered. Proposals for the multipoint temperature indicators were received. Review of vendor drawings continued.

2.2.1.4 Process Hazard Review

The final MWK design hazard review report was prepared. All design items were closed with 22 remaining open items pertaining to maintenance and operating procedure writing. These items will be closed as they are completed.

Responses to some of the BOP design hazard review action items were completed. The remaining action items and responsible parties were assembled as a report to be updated as the action items are completed. The remaining action items mainly deal with material that needs to be incorporated in operating procedures.

2.2.2 Task 2.2 Facility Design Document

The information required to update Volume II (the APFBC system) and III (Balance-of-plant) of the Design Document is being gathered to form the 100% version.

2.2.3 Task 2.3 Environmental Permitting and Compliance and Safety Issues

Environmental Issues: The first National Pollutant Discharge Elimination System (NPDES) Discharge Monitoring Report (DMR) for the PSDF was submitted to the Alabama Department of Environmental Management (ADEM) on October 25,1995. The only discharge reported for the month of September was treated sanitary wastewater. Similar reports were also submitted in November and December with again the only discharge being treated sanitary wastewater. An annual DMR was also submitted on October 25 which covered stormwater runoff under the NPDES Stormwater Construction Permit. These reports are submitted biannually. Draft contracts for disposal of waste products generated during operations were reviewed and changes were incorporated into a revised draft contract.

On October 17, a request was submitted to the Air Division of ADEM for an amendment to the PSDF Air Permit. Minor changes in the emission rates for SO_2, No_x, CO, and Volatile Organic Compounds(VOC's) from the Transport Reactor operating in the combustion mode were requested. A phone conversation on December 12 with ADEM officials verified that the amendment would be approved as requested.

On December 14, the PSDF received from ADEM a Notification of Operating Permit Application Requirements. This application is for an operating permit for the PSDF facility and is in accordance with Title V of the 1990 Clean Air Act. All existing operating facilities are required to obtain federally mandated operating permit within a period of five years of enactment of clean air act amendment. ADEM categorized the existing industrial facilities in Alabama through a lottery for submission of the application and the application for PSDF is due December 16, 1996.

On November 22 four nuclear level detection devices were received from TN Technologies. The devices were inspected and placed in isolated storage under lock and key. As required, a notification of the presence of these devices at the PSDF was submitted to the Alabama Department of Public Health- Bureau of Radiological Health, on November 27, 1995.

Safety Issues: For this quarter, a significant amount of time was devoted to preparing safety procedures, programs, methods, and a Health and Safety Manual to be used for operations at the PSDF. These procedures and methods compliment those already in place for construction activities and include Lockout and Tagout, Confined Spaces, Bloodborne Pathogens, Personal Protective Equipment, Hazard Communications, Respiratory Protection, Hearing Protection and Construction Safety Orientation. All of the above programs were taught to new, incoming operators beginning in September and ending in December in conjunction with anticipated startup of the Transport Reactor. Some of the same courses were also taught to the technical staff as awareness-type programs. The Health and Safety Manual for operations was completed in October and submitted for internal review. After comments were received from several sources, these changes were incorporated and the final version was ready in mid-December and distributed to technical and operating personnel at the end of December.

2.2.4 Task 2.4 Particle Characterization and Collection

Impactor Parts and Modifications: Particle size cutpoints, jet momentum, and Reynolds numbers were calculated for various impactor stage configurations. Based on these calculations, the configuration given below was selected for the initial impactor runs at the PSDF.

Stage Number	Stage Description
Precutter	SRI custom
1	University of Washington S1
2 to 7	Graesby/Andersen S3 to S8
Backup filter	SRI custom

Commercially-available stages were selected so that an initial assessment of impactor performance could be made without investing in specially-fabricated stages. Transition pieces will be fabricated to allow the use of these stages in the existing impactor shells. The design of the transition pieces was completed in November, and drawings were submitted to four machine shops. Quotes have been received from three of the shops.

To ensure that the precutter and the selected impactor stages generate appropriate particle size cuts, it will be necessary to install larger nozzles in the precutters. The nozzle openings will be expanded from 0.073 in. to 0.25 in. When this modification is made, some additional machining will also be done to the impactor shell to provide a better surface for a gasket between the top stage and the shell and it will also be necessary to remove the thermocouple bosses from the bauxite cartridges to simplify the design of the ceramic liners.

Ceramic Liners For Bauxite Cartridges: SRI completed a preliminary design of the ceramic liners for the bauxite cartridges. The preliminary design was based on the use of a cylindrical alumina liner containing a longitudinal notch for the thermocouple boss. The design also included perforated ceramic disks on both ends of the liner to contain the bauxite and distribute the gas flow through the cartridge. One disk will be permanently affixed to the liner, and the other disk will be removable. The design was reviewed by two ceramic fabricators, Coors Ceramics and Applied Ceramics. Both companies expressed concerns about the difficulty of producing the notched geometry. After further discussions with these companies, it was decided to change the design to a simple cylinder with a separate ceramic tube for the thermocouple feedthrough. The ceramic tube will be glued to the attached perforated disk at one end of the liner and will protrude through a hole in the removable disk at the other end of the liner. Quotes on the fabrication of these liners have been received from the two fabricators mentioned above, and a quote from a third supplier is expected in January.

Evaluation of Impactor Substrate Materials. To help select the impactor substrate materials to be used at the PSDF, SRI performed preliminary lab tests on several candidate materials: 316 stainless steel, quartz fiber, Kaowool Ultrafelt, Inconel 600a foil, 316 stainless steel with HI26 ceramic coating, and two types of Zircar alumina paper (APA-2 and APA-3). The stainless steel, quartz, and glass fiber materials are available in the form of precut substrates for the selected stage configuration. The other materials would have to be cut or punched to produce substrates in the desired configuration.

Table 1 shows the results of the tests conducted to date. The first four tests consisted of repeated 5-hr exposures to temperatures of 1200°F in air at ambient pressure. The last seven tests were done in the same manner, but with repeated 2-hr exposures to temperatures of either 1200°F or 1800°F. The filters were cooled and desiccated after each exposure and before weighing. A mass change during the first exposure to high temperature is acceptable and simply indicates that pretreatment will be required. Continuing changes in mass during subsequent heatings may indicate a potential problem with substrate stability.

The 316 stainless steel substrate gained mass in the two exposures to high temperature. Although the mass gained during the second test was less than the first, even the lower mass change is far too large. (Weight changes below 0.1 mg are desirable, although higher values can be tolerated if they are predictable.) Subsequent examination of the substrate indicated that not only had the stainless steel turned blue, indicating oxidation of the steel, but that there were several fingerprints on the substrate that had undergone reactions as well. The relative contributions of the steel oxidation and the baked fingerprint oils to the mass increases are unknown. SRI has conducted tests in the past which indicated that handling substrates with bare hands did not add sufficient mass to affect the particle mass measurement. However, the validity of this conclusion should be verified for high temperature operation. In any case, it seems probable that 316 stainless steel will not make the ideal substrate material, especially at higher temperatures. The possibility of having Graesby/Andersen cut substrates from a high-temperature alloy (e.g., 310 SS or Inconel) is being explored.

Table 1. Results of Impactor Substrate Materials Evaluations

Substrate Material	Pretreatment Time/Temp	Exposure Time/Temp	Weight Change, mg 1st Exposure	2nd Exposure	3rd Exposure
Andersen 316SS	None	5 hrs/1200°F	+2.308	+0.902	Not Done
Quartz Fiber Filter	None	5 hrs/1200°F	-3.102	-0.270	-0.135
Andersen Quartz Fiber	None	5 hrs/1200°F	-1.414	-0.171	-0.177
Kaowool Ultrafelt	None	5 hrs/1200°F	-0.624	-0.589	-0.193
Kaowool Ultrafelt	2 hrs/1800°F	2 hrs/1200°F	-0.221	Not Done	Not Done
Inconel 600a foil	None	2 hrs/1200°F	+0.935	+0.999	Not Done
316 SS/ HI26 coating	None	2 hrs/1200°F	+0.400	-0.100	0.000
Zircar APA-2 alumina	None	2 hrs/1200°F	-0.876	-0.310	-0.488
Zircar APA-3 alumina	None	2 hrs/1800°F	-8.484	-0.151	-11.167
Kaowool Ultrafelt	2 hrs/1800°F	2 hrs/1200°F	-0.018	Not Done	Not Done
Zircar Felt 2yF	2 hrs/1800°F	2 hrs/1200°F	+1.170	Not Done	Not Done

Before these tests were conducted, it was believed that quartz fiber mat was likely to be the best fibrous substrate material. However, the behavior of the tested quartz filter was far from ideal. Even after a large initial weight loss, the filter continued to lose mass at a rate that could equal the mass collected in the small particle sizes. Further confusing the matter, the loss in mass was also not constant but was still decreasing even after 15 hours of exposure. More disturbing was the almost constant shrinkage that occurred with the quartz filter. With the radial slot substrate configuration anticipated for these impactors, this much shrinkage could cause the substrate to occlude some of the jets for the next stage of the impactor, invalidating the size distribution test. This test was made on a 47-mm disk filter rather than on an Anderson style substrate. Additional tests will be made with actual quartz substrates to see if jet blockage is a problem. Because of the high shrinkage rate, heat-treating this material at higher temperature to speed up stabilization of its weight does not seem to be an option.

After a large initial mass loss, the glass fiber lost mass at a rather high, but fairly repeatable rate. If the change is repeatable and predictable, it can be compensated for. The shrinkage of the outside diameter of this substrate was not measured after each test because the frilly structure of the substrate makes the accuracy of such measurements questionable. However, estimates of diameters before and after the series of tests suggest that the shrinkage of the glass fiber was significantly less than for the quartz material. However, the shrinkage that did occur was sufficient to block some of the jets of the next stage, which is not acceptable. Additional tests will be made with this material to determine if acceptable shrinkage occurs and if mass losses are repeatable after the equivalent of a size distribution test (two heatings, one for pretreatment and one to simulate a sample run).

The Kaowool Ultrafelt filter had the lowest initial mass loss of all the fibrous materials, but subsequently lost mass at an inconsistent rate. Pretreatment at 1800°F produced a kaowool material that lost only 0.018 mg after two hours at 1200°F. The Kaowool also appeared to be dimensionally stable at 1200°F with no detectable shrinkage measured over three exposures. Unfortunately, this material is too thick (~0.125 in.) to use on an impactor stage, where the jet-to-plate spacing is only 0.1 in. A thinner version of this material has not been located.

The results obtained thus far suggest that a two-hour pretreatment at 1800°F may be adequate to allow use of the kaowool material at temperatures up to 1200°F. However, the thickness of the kaowool prevents its use on all stages, except for the backup filter. The ceramic-coated stainless steel appears to be usable at 1200°F after a single two-hour exposure at that temperature, but it may be difficult to apply the ceramic coating to the impactor substrates without altering the size of the holes. The samples of ceramic-coated stainless steel that were used for these tests were also too thick to serve as substrates. The other materials do not appear to be acceptable with pretreatment at 1200°F, but it is possible that pretreatment at a higher temperature may improve their performance. The evaluations planned for next quarter will focus on the behavior of these materials after pretreatment at 1800°F.

2.2.5 Task 2.5 Particle Control Technologies

The following presents a summary of progress made during the last quarter in the design and engineering of the Particulate Control Devices (PCDs) for the PSDF.

Combustion Power Company

During the quarter the decision was made to perform the initial operation of the filter system with a deeper bed of smaller diameter media. This change required the modification of the filter internals and the refractory lining of the filter vessel. The design work is completed, and the construction modifications should occur in the first quarter of 1996.

Industrial Filter & Pump PCD for the FW Carbonizer

Three separate meetings involving non-IF&P personnel were held at IF&P. Mr. J.Bitner of Mallett Technology spent three days working with the IF&P design group. A second meeting was conducted involving personnel from SCS, DOE/METC, Mallett and IF&P. The proposed internal design was discussed in detail and two sets of internals drawings were delivered as was a copy of Mallett's report on structural evaluations. A third meeting involving personnel from Mallett Technology, IF&P's ceramic internals (but not candles) supplier and IF&P's gas team was conducted. Specifications for dimensional, degree of parallel and flatness tolerances were agreed upon. Ceramic nut and bolt systems using CFCC materials were selected as were newly designed bolting plates and hold down plates for the safety candles which would also allow use of a "right side up" tubesheet in the safety area of the TS/FB sandwich. Work continued on the detailed design of the balance of the internals and completion is anticipated in mid-January, 1996.

2.3 PHASE 3 - CONSTRUCTION, PROCUREMENT AND INSTALLATION

2.3.1 Task 3.1 Procurement

MWK Advanced Gasifier train

All of the refractory lined pipe has been delivered to the site. The analyzer shelter and analyzers have been shipped to the site with a punch list of items to be corrected in the field by the vendor after procuring the missing parts. The refractory lined orifice holders were shipped to the site.

Combustion Power Company

CPC specified that the Genius Block Panel be purged and pressurized for the Class I, Division II location. This is in accordance with NFPA 496. CPC utilized a supplier of standard packaged systems to perform the pressurization. The purge panel is supplied by CPC for mounting by SCS in the field. The location of the purge panel was confirmed by SCS.

Materials delivered to the jobsite this quarter include the baghouse and boost blower.

The piping spools and auxiliary piping and supports have been purchased and delivered. The piping supports and spring hangers have been ordered. Work is progressing on the Installation and Operation Manual.

During the month of December, the installation of the CPC refractory lined pipe began. Work completed to date includes:

- All lift pipe segments have been installed up to the elevation of the granular bed filter.
- All de-entrainment vessel internals have been installed.
- The regenerative heat exchangers have been lifted into the structure. The sections have not been welded together.
- The granular bed filter internals have been modified.

<u>Industrial Filter and Pump</u>

A sample of CFCC material was tested in R&D for use as the jet pulse conduit. It was placed in a kiln, ramped up to 1800°F and held there. Once at temperature, about 16 liters of room temperature nitrogen were pulsed through the tubular sample in 2 seconds every 5 minutes. After about 100 such pulses, the sample was cooled down, removed and inspected. Its appearance was unaltered. Therefore, this material is the leading candidate for the jet pulse conduit.

The pressure vessel for the PCD incurred some ring warpage during relocation of the dirty gas inlet nozzle. The cylindrical portion was machined square at a separate location and returned to the fabricator where the entire PCD was assembled, tested and ASME stamped.

The PCD external pulse measuring tank, high speed jet pulse valves, manual isolation valves and jet pulse piping were all assembled and final welds were made to assure proper fit. The inside surfaces were coated with mastic and the system moved to Chicago Metal Fabricators where refractory lining with 7.125 inches of Resco 3A was applied. After lining, reassembly was begun in anticipation of curing the refractory. It was decided to cure the refractory 100% and leave 0% moisture in it to avoid cracks due to freezing prior to installation and use.

Westinghouse Filters

During the quarter, SCS received the used, clean filter elements from Westinghouse. These were the filter elements used previously at Tidd. It is anticipated that the filter elements will be installed during March or April.

The vessel was pressure tested during December, and the manway covers leaked. The reason for the leakage was insufficient torquing of the manway bolts. The gaskets have been replaced and the manways torqued to the designed load.

SRI Particulate Sampling

Prototype Cyclone Manifold: Southern Research continued to work with EDM Technologies on the machining of the cyclone manifold. Machining of the interconnecting tubes took much longer than anticipated because of the ceramic core material that was left in the casting. Machining of the cyclone receptacles revealed unanticipated voids in the casting, which made the machining more difficult and required a substantial amount of welding to repair. The initial machining and weld repairs were completed in November. In December, additional machining was done to clear weld material from the interconnecting tubes and receptacles. Following the additional machining, the openings in the interconnecting tubes will be plugged. A final machining step will then be performed to remove the portions of the plugs that protrude inside the tubes and to smooth the inside surfaces of the tubes. EDM Technologies expects to be finished with this work in February.

A firm, fixed-price quote was obtained from Howmet Corporation for casting a second cyclone manifold. For the second manifold, Howmet has agreed to make as many attempts as necessary to produce a good casting that is free of voids and trapped core material. Howmet will use casting waxes produced from the existing mold, which will be obtained from SiCAM Corporation.

Probes, Insertion Mechanisms, and Control Panels: SRI continued to evaluate the need for additional machining to flatten the probe end flanges. The flanges were distorted when they were welded on the probes and may require additional machining to provide a good sealing surface for the gasket between the probe end flange and the skid flange. These requirements were discussed with the SCS shop supervisor, and it was determined that this machining cannot be done on site at the PSDF. SCS is also checking on whether this work can be done in the shop at Plant Gaston or should be sent to an outside shop.

In November, Santek Engineering completed the remaining control panels and brackets for mounting components on the insertion mechanisms. Two sets of the control panels and insertion mechanisms will be shipped to the PSDF in January. The remaining two sets will be stored at Santek until April.

2.3.2 Task 3.3 Construction and Installation

Construction - Civil

Civil support activities associated with Mechanical and Electrical installations have continued. FW and MWK equipment was unloaded as received. Installation of the coal, limestone and ash silos continued. Installation of the coal and limestone conveyor system was completed except for electrical work. Work on miscellaneous concrete foundations that were completed include the nitrogen system, baghouse ductwork, dilution air fan, coal and limestone structure base slab and BOP cooling water system. Erection of the ash structure except for the leave out steel for equipment installation was completed. Work on sequence 10 steel (additional structural steel in the coal and limestone structure) was started.

Construction - Electrical

Electrical continued with installation of cable tray and conduit in the process structure, in the compressor island and in the coal handling structure. All MCC's except those in the coal handling and ash handling were energized. Battery chargers and miscellaneous power panels in the Electrical Building and MWK I/O Building were energized on permanent power. The 480 volt distribution panel and motor controls for equipment at river intake structure were energized. Demineralizer pumps located at river intake structure were operated. Service water and MWK condensate pumps were operated from local stations. HTF skid mounted equipment was turned over to operations for flush. Work on MWK stack lighting was completed. SRI probe equipment was set and cable installation was started.

Duct run from PB # 8 to the cooling tower and circulating water pumps was completed. Installation of control panels and conduit for cooling tower equipment was started. Setting MCCs and building racks for control equipment in coal handling MCC building was started as well as installation of conduits for conveyor equipment and installation of cable tray for air compressor island. Installed control panel and completed installation of process structure waste water pumps. Support for grounding in various equipment pads and site grounding was continued. Parts of the Clyde Pneumatic Conveying systems were completed and turned over to Operations for initial phases of check out. The MWK main air compressors was turned over to operations for a pressure test. The UPS was turned over to I&C for check-out. The check out was completed and the UPS distribution panels will be energized in January so as to move the DCS equipment feeds to the UPS. Power supply to the propane equipment is complete.

Construction - Mechanical

CPC specified that the Genius Block Panel be purged and pressurized for the Class I, Division II location. This is in accordance with NFPA 496. CPC ordered a standard package to be mounted in the field by SCS. The installation manual for FL0301 filter vessel was written by Westinghouse and sent to the PSDF along with a general assembly drawing and suggested support design and location for blowback pipes.

SRI personnel coordinated with SCS construction personnel on plumbing and wiring between sampling system control panels and the probe insertion mechanisms. Additional wiring was necessary because the wiring was not done in the shop as planned.

The installation of the plant air compressors was started in October. The five service air compressors were mounted as well as the matched dryers, aftercoolers and receivers. The FW transport and booster compressors were also installed. The Sullair instrument air compressor that was transferred from the PETC Coal Liquefaction project in Wilsonville had been inspected and serviced over the summer prior to installation. Because this compressor is not water cooled, it was wired temporarily to begin check-out of the instrument air piping and controls themselves; while the other compressors that require water cooling to operate are having the piping and electrical connections being made later, after the roof trusses are in place. These roof trusses were placed in late December and work on cooling water headers and electrical cables began.

The Demineralized Water system that pumps demineralized water from the power plant adjacent to the PSDF was completed in October, and the automatic control system was completed in November. The MWK condensate and steam system installation was completed. The Boiler Feed Pumps were installed, started and commissioned. The Steam/Condensate piping in the Process Structure, the heat exchangers, and the thermal oxidizer heat recovery boiler were Hydrostatically tested and prepared for a caustic wash to remove any deposits in the heat exchangers and piping that might cause hotspots and tubing failures in operation. The temporary piping for the chemical cleaning was also connected into the heat exchanger loops and readied for the wash.

Most of the Dense-phase solids transport systems for the MWK process installation were completed and are being readied for check-out and testing. The vessels, densairveyors, and screw coolers are now permanently installed, and the electrical installation proceeding to an early January turn-over for testing. The installation of BOP dense phase systems in the Coal and Sorbent Mill structure is underway. Most of the BOP systems' materials are on-site and installation proceeding as structure and equipment allows. The conveyor system vendor started and completed his mechanical installation during the Fall. The site personnel will complete the electrical installation using the provided materials and plans.

The propane storage equipment vendor began installation of his equipment in October, and was mechanically complete with his system of tanks, pumps, and steam- and air-heated vaporizers by early December. The electrical control system was installed in late December, as was the connecting piping from the vaporizer station to the pipe trench that carries most of the piping from the utility island to the process structure and on to the cooling/condensate pump stations. Installation of the propane piping in the MWK side of the process structure was completed in mid-December, and passed pressure testing before Christmas. Heat tracing and insulation of the propane piping, necessary due to the higher pressures and saturation temperatures required by both MWK and FW process, was begun in late December.

Installation of process piping and instrumentation continued throughout the Fall, with work being prioritized by systems and startup requirements. The refractory lined piping installation was completed by the end of November. Some fit-up and alignment work used temporary spool pieces in place of the regulating orifice spools, which did not arrive until late in October. The Transport Reactor piping was readied for a pneumatic pressure test of all connections, from the main process air compressor to the pressure regulating valves, which took place just before Christmas. The Sulfator piping was also completed and instrumentation is being installed on all equipment as space and priorities allow.

The installation of the equipment for the cooling water systems continued with the Cooling Tower erection, and the installation and piping of the MWK process closed loop cooling system pumps and heat exchangers. The Circulating Water Pumps were installed and plumbed, the MWK cooling loop and condensate heat exchangers were installed and piped in, and the Cooling Tower Make-up pumps were installed and the motors run-in. The Service Water system was completed, flushed and used to support flushing of other piping systems and the operation of other equipment as a temporary source of cooling water.

Installation of the coal and sorbent pulverizer systems began in November, with the foundation erection and the initial placement of the mills and mill air heater packages. This work will continue over the next several months, due to the extra complexity of the systems over standard pulverized coal fired boiler mill installations. Installation of ducts from the thermal oxidizer to the stack along with the baghouse and dilution air fan is underway.

The Ash Cooler Heat Transfer Fluid system was readied for check-out and flushing. This system distributes hot fluid to the ash coolers to cool the ash to 200^{o}F, and has piping throughout the Process Structure.

2.3.3 Task 3.6 Preparations for Operations

Commissioning Related Activities

Late this fall a significant effort in identifying specific components and construction activities required to be ready for major Startup tests was started. This effort grew out of a need for an integrated engineering/construction/operations detailed project schedule and from the need of the Equipment Startup Team personnel to better identify required predecessors and successors and to more clearly match activities to final BOP design. This work, together with an in-depth re-estimate of the remaining construction work based on actual construction drawings, bills of material, and historical productivity rates, has provided a tool to measure impacts of extra construction labor and better allow construction to project completion dates. This data will be incorporated into the integrated MWK startup schedule that is used to identify critical path activities. An engineering close-out punch list based on scheduled need dates is also derived from this schedule. A similar integrated startup schedule for FW is currently under development, with the operational activities being identified and loaded into the schedule. Construction, Procurement, and Engineering activities will be associated with specific operations activities, and priorities assigned to that work as well. Both the MWK and FW startup schedules, as well as the test plan schedules for both trains, will be integrated into a master project schedule to identify conflicts and to match operational resources to daily requirements.

Preparations for equipment testing and commissioning are nearly finished; teams assigned to particular equipment for testing and evaluation have compiled information for inclusion into commissioning procedures, and are monitoring construction progress closely. Several of the design engineers are participating on the teams, as well as extra technical resources being assigned to facilitate the turn-around of each startup team's deliverables. These teams are acting as both design and construction quality assurance cross checks, as well as supplying the scheduling personnel with additional information and identifying any overlooked activities.

Some early startup and commissioning activities began in October. Energization of various electrical systems, such as the DC battery charger, the UPS, and more of the 480V Motor Control Centers continued. Several piping systems were flushed, and more pump motors were run. Most of the work done in this area was the construction quality inspections and walk-downs of systems to gauge completeness. These walk-downs are to focus work on systems and areas needed in the earlier stages of start-up testing. By finishing parts of systems needed for early commissioning testing first, commissioning can start earlier, giving time to correct problems identified by testing without impacting when the entire system would be ready for operation.

The Service Water pumps were run in, and flushing of the service water piping began in November. The service water system supplied water (the service water tank has been filled with city water for the last two months) to leak test and flush the Heat Transfer Fluid (HTF) system that regulates the ash temperature in the screw coolers. The HTF leak test and flush were started in November. The HTF piping was leak tested, flushed and filled with the heat transfer fluid (UCON 500). The fluid heaters, coolers and controls were all tested and integrated. The pumps and cooler fan were also commissioned during this time.

The UPS for the DCS is in the final stages of check-out. There was an outage in early November, on the permanent power substation to correct problems with the transformer oil tank and with the lightning arrestors, and missing switcher position circuits were pulled to the DCS. The Maintenance Shop/Warehouse building was tied to permanent power.

To support the Hydrostatic test of the MWK steam and condensate system, several other systems were commissioned in November. In the Demineralized Water system, which was flushed in October, the pumps were operated and the demineralized water tank filled for use during the Hydrostatic test of the MWK steam and condensate system, and the automatic control system was checked out. The MWK feedwater pumps were checked out, run in and used. The hydrotesting was passed with an exceptionally small number of leaks, all of them were fittings, doors, and plugs. No welds and only two flanges were leaking, an indication of the high quality of the construction work. There were several P-11 steam line welds that required stress-relieving after chemical cleaning, but there was no impact on any following activities.

Several systems were mechanically finished and ready for check-out, including all of the MWK supply side dense phase transporters, the Sulfator, recycle gas compressor, filters, coolers and piping, the Sulfator compressor, the flare system, the raw water system, and the overhead building crane. The BOP propane storage system was completed and pressure checked, and propane placed in the tanks. Instruments and control panels were wired and checked where possible.

Preparations for chemical cleaning of the MWK steam generation system were completed in November, and the vendor started work on December first week. The Chemical Cleaning was required to minimize any corrosion that may have initiated during construction, as well as, to assure that all heat transfer surfaces are wetted and clean, preventing areas of local overheating and possible tube failures. The Vendor supplied the chemicals, temporary circulating pumps and heat sources, waste material storage and disposal, and oversight of the cleaning process.

With the refractory lined pipe installation complete, a pressure boundary established, and the main process air compressor ready for operation; preparations for the initial pressure test of the entire transport reactor system were finished in mid-December. The main MWK air compressor was commissioned, and its controls tuned and readied to provide the air volume and pressure for the pressure test. This air-test of the transport reactor included the PCD's and adjoining ductwork as well. The reactor only air-test, that was done in August, used two cubic foot capacity high pressure nitrogen bottles that were available on-site; and could not find any leaks, while holding 135 PSI pressure for several hours with no measurable loss.

On Friday December 22, the initial pressure test of the Transport Reactor loop was undertaken. The reactor pressure was ramped up to 35 Psig, where packing leaks on both ash discharge screw coolers, and a leaking union on the start-up burner were discovered. After these leaks were tightened, the reactor pressure was raised to 70 Psig, and the screw cooler packings found to be leaking again. After further tightening the packing glands, the reactor pressure was returned to 70 Psig and an orifice loaded union on the fines screw cooler nitrogen purge line was leaking. The craft personnel were unable to tighten the union, requiring the pressure to be zeroed in order to break and remake the union. After the union was reconnected, the reactor pressure was returned to 70 Psig, and raised further to 105 Psig. At 105 Psig, operators found both manways on FL0301 leaking badly. Due to safe practice, Construction personnel did not want to try and torque the manway bolts at this pressure. The decision was made to end the test at this point due to the lateness of the day, and the extra hazards of inspections after dark. The reactor was depressurized, and the Main Air compressor was taken out of service. Although the design pressure was not achieved during the pressure check, the test was a success in many ways. Operations personnel learned how to control the main air compressor, and no leaks were found on large piping joints. Several small leaks were identified, as was a reversed check valve in the combustion air piping to the Transport Reactor.

Wilsonville Interactive Learning System (WILS)

The Wilsonville Interactive Learning System (WILS) project is an extremely innovative interactive multimedia application for documenting the technologies being tested at the PSDF through a storehouse of highly organized visual, audio, and text-based information. WILS is being delivered on CD ROM discs playable on any Windows-based multimedia-capable PC. Two versions of the program will be available: a proprietary version that will include access to all the materials, the non-proprietary version that will restrict access to P&IDs and other materials. It is expected that the proprietary version will be used at the PSDF only; the non-proprietary version can be sent off-site. SCS will determine the appropriate distribution.

When completed, WILS will contain a series of Technology Resource Modules to provide highly usable, visually-based information on the Transport Reactor Train and related HGCU technologies. WILS will also contain a number of Training Modules. All modules are being developed concurrently with design and construction of the facility using 2D and 3D graphics, animation, stills, video and text. The third and final component of WILS is an Archive which will provide direct access to the visual resources used frequently throughout the program, namely the P&IDs, stills and 3D views.

Significant progress on the WILS project was made this quarter in a number of areas:

- The K-Train Operations Training (OPS) module was brought from a prototype stage to working alpha and beta releases. The module includes two levels of text (summary and detail), 3D views of the plant with component highlights, P&IDs,

still photos, and additional "unlinked" references. Users can choose to access information through either a graphical or list-based (index) menu.

- Effort was concentrated on integration and coding activities for the K-Train Technology Resource module. This module represents the largest module of the WILS Project; it consists of an Overview, and nine systems in both Gasification and Combustion modes, a section on eyewash station locations, access to all related P&IDs, text-based status bar messages for each scene and event, plus a system of menus and index for each mode. Thousands of graphic images and components and hundreds of pieces of audio have been developed for this module alone, and each component has been integrated into the program and tested. A framework for the object-oriented programming code was developed for scene-to-scene navigation, index, pulldown menus, interactive tables and other branching options. The K-Train module uses some code already developed for the OPS and FAM modules. Debugging began in December with the delivery of the first K-train module and will continue into the new year as bugs are fixed and new versions are tested.

- Nolan implemented changes to the Familiarization Training (FAM) module as requested by SCS. Many of these changes involve making corrections to quiz question art and 3D exercise graphics. There are a few remaining open bugs in FAM, which will be resolved in tandem with K-train Technology Resource debugging cycles.

- Nolan completed storyboard development for the APFBC (A-train) Technology Resource module. A new super-storyboard format includes the script, colored storyboard flow lines and information about all the assets in a particular scene. Graphics development on this module began in November. In addition, the A-Train process flow diagram was updated, an asset management structure was developed, a Bill of Materials was created, and P&ID assignments were made.

- Nolan completed graphics production and processing for the Balance of Plant (BOP) Technology Resource module. Flowcharts, the glossary and menus were created; audio was recorded and edited; and P&IDs were scanned and assigned asset names and scene numbers in the P&ID database. Asset lists to be imported into the programming code were also developed.

- Progress was made in analyzing assets for the Realtime Monitors and Sampling (RM&S) Technology Resource module. The video requires some rebuilding to conform to the current interface and functionality specifications. Twenty-four-Bit RM&S artwork was located and analyzed and a glossary was created. A list-based Bill of Materials was started so asset data can be easily imported into programming scripts.

- The WILS Introduction was completed and integrated into the program, including the digital video interviews. Nine different speakers take turns giving an overview of the history, purpose and technology at the PSDF. There is one scene for Executive Interviews and another for Engineering Interviews.

- P&IDs were scanned and assembled. These will replace existing P&IDs that are illegible throughout the program. Integration was also started on the P&ID Library (WILS Archive).

Part of the plan for the WILS Project included a stills shoot to augment and replace stills that show Transport Reactor train components in the yard prior to installation in the process structure. A 3-day stills shoot took place in mid-December and approximately 240 images were taken. The pictures included the Feed Preparation and surrounding areas as well as various angles of each component in the MWK half of the process structure as seen from each level. Each frame shot was logged into Nolan's stills database during the production process. This procedure streamlined the image processing and integration processes considerably. The film rolls were processed and transferred to Photo CD. Each image was then copied, sized, entered into the stills template, and the appropriate title and text was added. The art was then processed from 24 bit to 8 bit and imported into the "shared cast" of the authoring software for immediate use.

Scene assignments for the K-train Technology Resource module were also made. In some cases, Nolan opted to include the old stills as well as the new stills, but in all cases, the new stills will appear first. For those components that were not yet installed in the process structure at the time of the December shoot, previous stills will be used, if available. New stills will be added to the OPS module early next year. In addition to the stills, some video was also shot. Most of this video features the engineers who were previously interviewed on camera. The new video will appear in the promotional video on the PSDF and will not be used in WILS. At the time of the shoot, the process structure and surrounding areas were obviously under construction, so little additional footage of exterior locations could be obtained.

Training/Operation Procedures

Training of operational personnel continued this quarter. Mechanics and Assistant Plant Control Operators received a week-long course in BOP auxiliary components together with an overview of the MWK Transport Reactor system. An operator training course for newly arrived operators began on November 6 and continued for four weeks. It was decided to also send the Assistant Plant Control Operators to this course since they would be also be working in a variety of functions in the MWK Transport Reactor system. Also, training on Transport Reactor components and operations was given to the Electrical & Instrumentation Journeymen.

Development of training materials proceeded on a continual basis. Some materials used in the first operator course in August, 1995 were updated with lessons learned in that first class. Training manuals were replicated and distributed to students and other personnel needing a compilation of system and plant information.

Operations personnel continued to develop and review procedures and startup packages on assigned systems with the main emphasis on preparing the MWK Train for refractory cure out and combustion mode of operation.

Procurement

Bid packages were issued for the supply of an Alabama bituminous coal, as well as for coke breeze. An award was made for the supply of propane. Draft agreements were prepared and are being reviewed for the transportation and disposal of ash and other waste products, hazardous waste disposal, and a parts cleaner service. Orders for many miscellaneous items required for plant operations continue to be placed.

Operation and Maintenance

The O&M labor staffing is nearly complete; most of the plant's Operators, half of the plant's mechanics, and all of the Electrical and Instrumentation personnel have participated in Project familiarization training. All of the operating and maintenance personnel have had at least five days of training and familiarization with the PSDF processes and equipment. Most personnel have been involved, in some capacity, in the inspection, testing or installation of process equipment as preparation for long term operation.

The Electrical and Instrumentation personnel worked on several projects during the quarter, most of them related to the start-up testing of the controls, transmitters and motors that were completed and needed for equipment testing. The addition of one permanent and two part-time E&I journeymen, during October, helped with the workloading during commissioning as instruments are readied for testing. The E&I personnel began stroking most of the MWK pneumatic operated control valves (80% complete), began check-out and calibration of instrumentation on the MWK start-up burner (BR0201), continued work on the PLC to DCS interfaces, continued clean-up work on the MWK DCS configuration, and continued testing the input and output signals to and from the Foxboro Control System, as well as procuring needed test equipment for their electrical maintenance responsibilities.

The Mechanics and Welder spent most of the quarter setting up the Maintenance shop tools and the Operations Warehouse equipment, installing needed services, and planning work to be done during the later stages of Startup. Several of the mechanics and operators are supporting the construction effort by identifying, finding, and locating equipment and materials in the storage yards, reducing the time and effort needed by craft labor in collecting the components to finish the work assignments. The crew designed and are constructing a lifting basket to safely transport the ceramic filter candles to elevations needed to load the plenum when it is in the temporary PCD maintenance bay, which is now under construction.

Operators continued to walk down systems in preparation for startup, identifying those areas on which construction should concentrate to meet the startup plan schedule, and prioritizing a punch list to assist in the effort. P&IDs and piping isometrics are being marked up during the process to allow updating of appropriate drawings upon completion of each system.

Maintenance Shop, Spare Parts, Chemicals

The Work Order Management System (WOMS) has been tested and installed and is awaiting resolution of licensing issues within the company. The system will provide the maintenance procedures with the work-order, including dispatching periodic inspection requests and maintaining a historical database.

Work continues in filing equipment maintenance information for reference, procedures and spare parts requirements. Some spare parts were recently transferred from other SCS/DOE Clean Coal projects where the testing phase has been completed. Other spare parts for PSDF that have been identified as possibly having poor availability, high usage, or lower fabrication costs are being procured. A database of recommended spares is being assembled and orders are being generated from the database using commonality, experience and judgment as guides.

Maintenance Inspection and Procedures

Tools and equipment are being procured, and training conducted on the equipment, to prepare a preventive maintenance program of vibrational analysis, borescopic inspections, oil analysis, motor current analysis, and thermographic analysis. This preventive maintenance program has two goals, minimize outages due to equipment failure and minimize the cost of repairing equipment by avoiding unneeded repairs and by preventing catastrophic failures. Similar programs have reduced failures and cost at other plants.

The Inspectorscope (borescope) was received and PSDF personnel trained in its use. This instrument allows viewing of vessel and pipe internals, recording of the images, and takes length and depth measurements of flaws and disparities for use in analyses. An ultrasonics thickness gage transferred from the PETC Coal Liquefaction project was verified for accuracy. This will be used to monitor vessel and pipe wall thickness during operations. The project also have access to an infrared camera from within SCS to be used for maintenance and operations activities, saving the project about $60,000 which would have been spent on a new camera. Other preparations for predictive maintenance included basic training on the importance of lube oil analysis and the various types of evaluations available.

As pumps and compressors were started during the quarter, vibration readings were taken to define the initial operational state of the machines and provide a baseline set of data for future comparisons. This has already paid dividends in that misalignment was detected in Service Water Pump B using vibrational analyses. Further inspection of the pump discovered that the foundation had been disturbed and this had affected the alignment. In addition, vibration testing on the MWK main air compressor revealed high readings on the motor. These vibration problems are currently being corrected. Using this type of vibrational analysis the PSDF can be certain that all machines are in excellent running condition.

Miscellaneous

The Maintenance staff assembled safety relief valve technical information as recommended (but not required) by OSHA 29 CFR 1910.119; and was involved in designing several retrofits and modifications including a fill line for the MWK reactor to allow alumina to be transported into the reactor standpipe prior to start-up, and completed design of a start-up/warming loop for MWK's primary and secondary heat exchangers. Members of the Start-up support team are collecting the information on all the projects pressure vessel for inclusion in the summary.

A numbering convention for all MWK manual valves was developed and is being implemented. These numbers are being used in detailed procedure writeup, field identification and tagging. There are about 1,750 manual valves specified by MWK and these are grouped into approximately 50 different commodity numbers. Valve sizes need to be specified with each commodity number. The conventions used by CPC and Westinghouse and MWK vendors will be used as such for procedure writeup and tagging as necessary.

Data Management Development

Laboratory Services: SCS evaluated the options for performing laboratory analyses and decided that certain analyses would be performed at the PSDF on-site lab while other analyses were more suitable to being performed by an outside laboratory. SRI was selected to provide personnel for the on-site lab. The on-site lab staff will be responsible for sample collection, sample tracking, sample preparation, sample storage, coordination of outside laboratory services, quality assurance/quality control (QA/QC) procedures, and the following on-site analyses: water treatment chemistry, particle sizing, ash characterization, and gas analysis. Two SRI personnel are already involved in setting up the lab which includes evaluating the condition of existing equipment, advising SCS on new equipment procurement, installing selected equipment, establishing safety procedures, and establishing QA/QC procedures for both on-site and outside lab services.

Data Analysis and Management: The effort to provide a mathematical model of the pressure and temperature regimes of transport reactor began to focus on providing predictions of operational data. The model was used to provide expected values for instrumentation and the changes that would be expected during differing operating conditions. The models were also used to provide insight into the control and monitoring of the transport reactor. Other performance calculations that were carried out in support of operations include initial operation of startup heater, refractory temperature profiles, and aeration and fluidization gas flowrates. Programming on the material and energy balance program for the FW train has begun. Similar programs for the MWK train is in a draft form, ready for testing.

3.0 PLANS FOR FUTURE WORK

1. MWK will continue to provide construction field support and expediting completion of gas sampling related punch list items.

2. FW will continue towards completing work on the detailed design activities identified during meetings with SCS. The FW operating procedure writeup and commissioning (cold and hot shakedown) sequence and schedule activities will continue into the next quarter.

3. SCS engineering will continue acquisition and expediting of purchased equipment for the balance-of-plant. DCS configuration, graphics development, instrument data sheets and database development will continue for both MWK and BOP portions. Electrical, instrument, and heat tracing acquisitions will continue. SCS started the design of the structural steel support system from the FW alkali getters to the combustion turbine. SCS design of all MWK support systems should be completed.

4. Construction at the PSDF site continues. Work on the coal, limestone and ash silos continues. Continuing electrical work will involve work on installation of cable trays in the structure, and in the coal and limestone storage areas, installation of SRI probes, and associated conduits and grounding in the process structure. Mechanical will continue with the installation of process, utility pipe, instrument piping, circulating water systems, baghouse ducting and PCD. Heat tracing and insulation are continuing.

5. During the upcoming quarter it is anticipated that the internals will be installed into the granular bed filter system and the refractory will be modified. At that point the head will be installed, and the refractory lined pipe completed. The current plans are to perform the refractory cure-out through the CPC filter vessel. Some portions of the Operation and Maintenance procedures have been issued. The remaining information on auxiliary equipment, instruments and valves is being prepared.

6. The fabrication of IF&P pressure vessel is essentially complete and will be shipped to the jobsite during next quarter. The design of the internals will be completed in February and reviewed at the PSDF.

7. Construction activities around the Westinghouse FL0301 filter vessel and the backpulse skid will continue to progress.

8. In the coming quarter, EDM Technologies will finish work on the prototype cyclone manifold. Southern Research will then develop and test methods of holding the cyclones in the manifold receptacles. SRI will continue to coordinate with SCS Construction on various construction-related issues and will coordinate with SCS Operations and Maintenance on operational concerns.

9. During Winter and Spring, as equipment installation is completed, Startup and Commissioning testing will continue, culminating with a coal fire in the MWK Transport Reactor. The Operations Startup activity plan will continue to be integrated with Construction and Engineering schedules to identify critical systems and components that require expediting to maintain the overall schedule to commission the MWK process and related BOP areas for operation in Combustion mode. As equipment is commissioned, system loops will be calibrated, tested, tuned and commissioned before integrating into a larger matrix, allowing problems to be solved at a manageable scale before introducing too many variables.

   Work will continue in the development of commissioning test plans and procedures, monitoring component installation, updating the MWK Startup plans, and developing safety, operating, and maintenance procedures. Maintenance support staff will continue preparations for operation by instituting predictive/preventive maintenance programs, beginning planning for some plant modifications, and organizing the plant drawing files, both paper and electronic.

   By the end of the next quarter all of the Cooling Water Systems (Circulating, Service, Closed Loop) should be completed, the plant's service and instrument air compressors should be ready for long-term operation, the propane and nitrogen systems (storage and distribution) should be proven, checkout of the dense phase systems should be completed, and the start-up burners should be sparking. The MWK Transport Reactor process piping will be completed in the Spring, at which time the auxiliary equipment should be completed and ready for integration into an operating process, culminating in the milestone of preheating the reactor with propane to dry and cure the refractory piping and seal chalking.

Nolan should complete development of the Wilsonville Interactive Learning System per the prioritized list of modules. Orders will be placed and initial shipments received for remaining raw materials, including coal, sorbent, coke breeze, and startup bed material. Also, waste disposal agreements should be in place.

10. Secure service agreement contract with SRI for lab services and continue efforts to setup the laboratory. Begin establishing the QA/QC and safety/chemical hygiene procedures. Install and begin setting up the Laboratory Information Management System software and obtain necessary training. Negotiate the Evaluation Agreement for the software to provide access on the LAN to the data from the control system. Secure needed training, have the software installed, and continue setting up the data analysis and management system with this software.