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Power Systems Development Facility

Quarterly Report
January - March 1996

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For
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DISCLAIMER

POWER SYSTEMS DEVELOPMENT FACILITY

QUARTERLY TECHNICAL PROGRESS REPORT
JANUARY 1 - MARCH 31, 1996

TABLE OF CONTENTS

1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes the work completed during the first quarter, January 1 through March 31, 1996, 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 FW portion 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 complete. All Balance-of-plant equipment, MWK equipment and the PCDs in the MWK process are set in its place. Substantial progress

has been made in the fabrication and installation of small bore piping. Several MWK and balance-of-plant systems have been checked and commissioned.

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

The Continuation Application for Budget Period 5 was submitted in February. Discussions were held with DOE in January concerning the preparation of a complete re-estimate and rescheduling of the work remaining on the PSDF that would be submitted to DOE in the June-July 1996 time frame.

Plans that were developed to closeout SCS Engineering as well as to transfer Construction responsibilities either to Operations personnel or reallocate them to remaining Construction personnel are being implemented.

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. 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

Erection schedule: At a meeting with the DOE at the beginning of January, it was determined that there were insufficient funds to support much of FW construction activities prior to October, 1996. Work would proceed with completing the FW design by the end of June and then preparing an RFQ to put plant construction out to bid. The plant would be ready for simple cycle operation in April 1997, for PFBC operation in August, and for integrated operation in October.

Design completion: FWUSA completed the remaining design tasks, electrical, I&C, and mechanical. In March, SCS staff conducted various drawing and document reviews and communicated any discrepancies to FWUSA for resolution. All comments were restricted to those requiring process clarification by FWUSA, lesser corrections were retained for correction by SCS once the electronic files for the InterGraph model become available. This measure was previously adopted for the P&IDs, and is expected

to save both time and money. Drawings reviewed included: the isometrics (in comparison to the P&IDs), Instrument Reference Schedule, SAMA, sequencing, emergency trip systems, hard wired and software interlocks, point-to-point wiring, instrument installation and supports details, instrument locations, electrical drawings, raceway plans, wiring diagrams, and electrical diagrams.

Many design documents from FW to SCS were on hold within the document control system until all comments were addressed. Most of these comments were addressed as part of the design review, allowing the hold on the drawings to be released. Plans were finalized to move the design files, for MWK and FW, to the PSDF site on April 15.

The detailed design, including stress calculations, for the refractory-lined pipe between the alkali getters and the gas turbine was completed. The refractory is covered with a metal liner to hold it in place and prevent pieces coming free and damaging the gas turbine. The end of the metal liner for one pipe has to overlap that of the adjoining pipe. The designers did not think that the pipework could be fabricated as specified and meetings were held with the fabricator to revise the design. An aspect of this close-fitting design is that the pipework cannot be field fitted to take up any misalignment or slack. The strategy to be adopted is that the gas turbine will be set, the pipework connected, and the alkali getter vessels allowed to float. The vertical run between the alkali getters and the exit of the PCD vessels allows alignment in the three planes, and this run will be used to take the slack existing between the PCD vessels and the gas turbine.

Winterization of equipment: Now that the bulk of construction activities has been delayed until late 1996, effort has been renewed to preserve equipment that is stored outside. Electronic components have been brought inside, tarps have been secured over all skids, and lined pipe has been sealed to prevent water ingress. The raised metal faces of the flanges have been coated in a light oil to prevent corrosion. Some small amounts of damage have been noted for repair and refurbishment prior to construction. The reactor vessels were supported on chain pulls and as these were only temporary measures, more permanent supports were installed. At the same time all grating and handrails were made safe.

MASB: Fabrication of the MASB spool piece and the burner itself were completed by the end of February after which the burner was ready for application of the thermal barrier coating. The coatings were applied to two of the three sections, the quench and exhaust sections. Two fabrication issues were identified on the third section, the main burner assembly; two welds were not ground sufficiently smooth and the cone cooling

air annulus exit width was not as specified. Consequently, the assembly was returned to the manufacturer for rework delaying coating until April. The spool piece is due to be hydro-tested at the beginning of April. All parts, spool piece and burner, are expected to be delivered to UTSI for assembly in early May and be ready to deliver to site by the end of the month. A meeting will be scheduled for early May between SCS, FWUSA, DOE-METC, and Westinghouse at UTSI to view the parts prior to assembly and to discuss construction and commissioning details.

Gas turbine: A meeting was held on February 20 between SCS, FW, US Turbine and Allison to discuss various gas turbine issues. SCS had requested the meeting to help define the remaining tasks to complete the installation and commissioning of the CT. Other issues discussed included, O&M manuals, installation instructions, and operator training. The status of the project and a preliminary construction schedule were also discussed.

US Turbine said that the gearbox, generator, and a large amount of auxiliary components are currently mounted on the skid, with a dummy engine being used to check fit-ups. They requested a final design status report and a list of unresolved issues from FW to ensure that fill-in work, that is proceeding on the equipment, is performed correctly.

All material is in-house at US Turbine except the turbine, which is at Allison. Although work is on hold, US Turbine expect to complete the fabrication of the CT assembly in May, except for design, manufacture, and installation of the enclosure, and the PLC programming, which is currently 50 percent complete. The time required to complete this remaining work is around 8 weeks.

Operating procedures: Draft versions of the procedures for the circulating PFBC, the fluidized bed heat exchanger; and the bed ash cooler were prepared and issued for comment. Most draft versions of procedures prepared previously were finalized, although some issues still need to be resolved. Three procedures still require finalization, the carbonizer, coarse ash handling, and one outlining integrated plant operation. Procedures still have to be written for the MASB and gas turbine, but this work cannot start until the O&M manuals have been received from Westinghouse and Allison, respectively.

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. The design is now complete with site personnel handling any miscellaneous items except electrical.

BOP Engineering - Mechanical

Coal and Limestone Systems: Design efforts on the coal and limestone preparation systems consisted primarily of support to Construction personnel. Instruction manuals on the mill systems and the dense phase systems were received and review was started.

Ash Handling Systems/Dense Phase Conveying Systems: Mechanical design efforts in this area are essentially complete.

Steam and Condensate Systems: The design of the MWK portion of this system is complete.

Circulating Water, Cooling Water and Service Water Systems: The design of the MWK and BOP portions of the system are complete.

Service Air/Instrument Air: Design completed the layout drawings of the service/instrument air to the ash storage building and the baghouse area.

Auxiliary Fuel: Detail design of the piping from the propane supplier's equipment to the various consumers on the site was complete. This includes completion of layout drawings of the propane piping in the mill structure. Drawings for the diesel fuel tank pump were received during October. Detailed drawings for the diesel fuel storage tank and retaining wall was issued for construction.

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

Nitrogen System: Vendor drawings from BOC Gases for the liquid nitrogen supply system and the nitrogen generator were received.

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

Auxiliary Steam: The design of the auxiliary boiler was restarted and a review of the vendor's instruction manuals was completed. Vendor was contacted to resolve incomplete and deficient items on the purchase.

Miscellaneous Materials: Valves for the balance of plant systems continued to be identified and placed on order.

BOP Engineering - Civil

The detailed drawings for the diesel fuel storage tank and retaining wall foundation was completed and issued for construction in January. The Nitrogen Compressor and Tube Bank reinforced concrete foundation drawings were completed and issued for construction in March. Modifications to the Coal Building structural steel were incorporated on the drawings and issued for construction. These revisions modified 3 column gusset plates.

The detailed design of the structural steel for the FW platforms and pipe supports at the Topping Combustor were completed in February. Revised piping loads from FW necessitated the structural steel to be re-analyzed. The increased loads caused some of the steel members to increase in size. The detail drawings were not revised yet to reflect the latest changes. These drawings will be checked and revised to reflect the final member sizes. The structural steel drawings for the MASB / SRI Probe supports were completed and issued for construction in March. Steel detail drawings were completed but not issued. The design for the foundations for the MASB / SRI Probe support columns was completed, and marked prints were given to site personnel. Also included on this marked print was the concrete slab for the Combustion Turbine (CT) Control Room. The foundation drawing for the CT was revised to allow two MASB support columns to be supported by this foundation.

The following is a list of remaining civil related design activities:

- Prepare detailed foundations drawings for SRI Probe/MASB support steel
- Prepare detailed drawings for the CT Control Room slab
- Prepare detailed design and drawings for the CT Control Room (walls & roof)
- Design support system for the CT silencer & exhaust duct to FW stack
- Prepare detailed structural drawings for the Auxiliary Boiler & associated equipment
- Prepare detailed foundation drawings for FW condensate pumps
- Any engineering associated with the Fuel Cells

BOP Engineering - Electrical & Controls

Development of wiring, elementary, and loop diagrams for the balance of plant equipment continued. Physical design of coal and ash handling lighting, receptacles, and communications, ash handling conduit and grounding was completed. Wiring and physical electrical design of gas detection system and material handling conveyor system were completed. Electrical design of the CPC system was completed. MWK's "As-Built" drawings were completed and returned to the site for review. Physical electrical design of nitrogen and high pressure nitrogen pump areas was started. Work continued on the MWK and BOP cable routing. Work on the BOP and MWK heat tracing design continued. Procurement for heat tracing material continue. Review of vendor drawings and procurement of bulk materials 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. FW SAMA logic, hard interlock logic for the emergency trip system, software interlock logic, instrument location and installation drawings, sequence logic, emergency trip system ladder diagrams, overall plant control philosophy document, char transfer system process description, and the startup process description reviews continued. Balance of Plant P&IDs review and update were continued. Support for the installation of instruments was provided to construction. Work on the DCS configuration, graphics development, instrument data sheets, and database development continued. A review of DCS termination drawings was started. BOP and MWK instruments were ordered as required. The order for FW instruments added to the process after the original order was released. Review of vendor drawings continued.

The Clyde system PLCs programs and logic for the coal and sorbent feed systems and other solid handling systems in the MWK process have been reviewed and checked. All software and diagram errors detected in the process have been compiled and transmitted to the vendor.

2.2.1.4 Process Hazard Review

All design items on the MWK design 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

Information from all vendors is being accumulated.

2.2.3 Task 2.3 Environmental Permitting and Compliance and Safety Issues

Environmental Issues: Work continues on completing the wastewater treatment system. This is the primary treatment unit for the facility and it collects runoff from the coal and limestone piles and stormwater from the main process sump. Cooling tower blowdown discharges through a separate point and work also continues on this portion of the wastewater discharge system. The sanitary wastewater treatment unit has been the only active discharge point on the NPDES permit for the first quarter of 1996. Work continues on final site preparation and includes grassing, leveling, and placing stones in specific areas to prevent silt runoff and erosion.

Safety Issues: A plant-wide safety meeting schedule was established. Safety meetings are to be held the third Wednesday of each month. Departmental safety meetings were also initiated and these occur at no specific time and more often than once per month. On March 5, a delegation from the PSDF attended a Construction Safety Conference in Birmingham. The one day meeting included speakers from OSHA, the National Safety Council, and local industries. Some topics covered included Confined Space, electrical safety, scaffolding, and fall protection.

2.2.4 Task 2.4 Particle Characterization and Collection

The first quarter included continued work from SRI and EDM Technologies on the machining of the prototype cyclone manifold. EDM repaired welds to fill in voids in the manifold casting and removed excess weld material that had partially obstructed the interconnecting tubes. On February 22, SRI and SCS personnel met with a sales engineer from Haynes International and metallurgical and casting experts from Howmet Corporation to discuss the problems which occurred with the casting of the prototype manifold. Howmet believes the voids were caused by an adverse interaction between the casting alloy (H556) and the ceramic core material. No ceramic cores will be used for the second casting, and EDM machining will create all internal passages.

In February, SRI continued design work on the internals for the cascade inpactors. The design is based on the assumption that fabrication will occur in two steps: (i) adapter parts will be fabricated to use existing SRI low-temperature (<1200°F) stages to allow the evaluation of the impactor performance during the initial runs and (ii) the high-temperature internals design would be based on the results of the low temperature tests. The high temperature internals may need to be fabricated and installed from the start due to the scheduled early switch to gasification mode.

Fabrication of the impactor shells is complete, but due to problems with the impactor internals and cyclone system, a simpler sampling system for collection of a bulk particulate sample on a single collection filter will be implemented for use with the shells. This would allow for calculation of the total particulate mass loading, possibly ex-situ particle size analysis, some solids chemical analysis, and the measurement of alkali with the bauxite cartridges. The system could be used at either the inlet or outlet of the PCD to verify the total particulate loadings reported by the more complex impactor and cyclone systems.

Impactor substrate material evaluations continued in January and February, focusing on thin foils of 310 stainless steel, Haynes 230 alloy, and Havar. Based on the tests, SRI concluded that the Haynes 230 alloy is suitable up to 1600°F provided it is pretreated at 1800°F. Preliminary tests on Havar indicate that it may be acceptable up to 1200°F if it is pretreated at 1600°F. The 310 stainless appeared to be adequate up to 1200°F but distorted at 1600°F and above and, therefore, does not appear to be a suitable substrate material. Further pretreatment tests are necessary for the Haynes 230 and Havar to determine if they are suitable for temperatures of 1800°F and 1600°F, respectively.

It is important to remember that the testing to date only evaluates the effect of high-temperature oxidation on the materials. The effects of sulfidation, carburization, etc. are not being considered. Therefore the continued evaluation of new materials is important, and for this reason SRI will design a device for testing multiple samples at a time. Based on DOE/METC's recommendation, SRI has solicited the assistance of Dr. Rod Judkins at Oak Ridge National Laboratory for selection of materials. Dr. Judkins will be reviewing the process conditions and the design of the cascade impactor to recommend materials for the substrates and internals.

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.

Industrial Filter & Pump PCD for the FW Carbonizer

The fabrication contractor for IF&P cured the refractory lining in the pressure vessel (FL0351) to 100% and primed all externals with temperature-sensitive paint. They also designed a special cradle for transport of the vessel and reprimed and painted certain rings and brackets that had not been properly primed. IF&P shipped the vessel to the PSDF in March where it has been placed in the equipment yard still on its cradle awaiting installation. Mallet Technology and IF&P agreed upon several drawing revisions based on the fabrication process. These revisions and some new drawings have been started, and IF&P will distribute them with applicable substitution instructions. IF&P also continued to supervise the fabrication of previously ordered ceramic components and submitted a price request for an alternate inlet component design using CFCC alloy instead of 800HT.

2.3 PHASE 3 - CONSTRUCTION, PROCUREMENT AND INSTALLATION

2.3.1 Task 3.1 Procurement

MWK Advanced Gasifier train

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 fabrication and inspection of probe boxes for the analyzer house is complete and will be shipped to the site in March.

Combustion Power Company

SCS Construction installed the filter vessel, seal leg, media valve, lift pipe, and disengagement vessel during the quarter, and CPC reviewed the internal installation procedure prior to installation by SCS Construction.

All major items are at the jobsite for installation. Spares and filter material are not yet ordered. New head gaskets were ordered to prepare for the refractory cureout and have been received at the PSDF site.

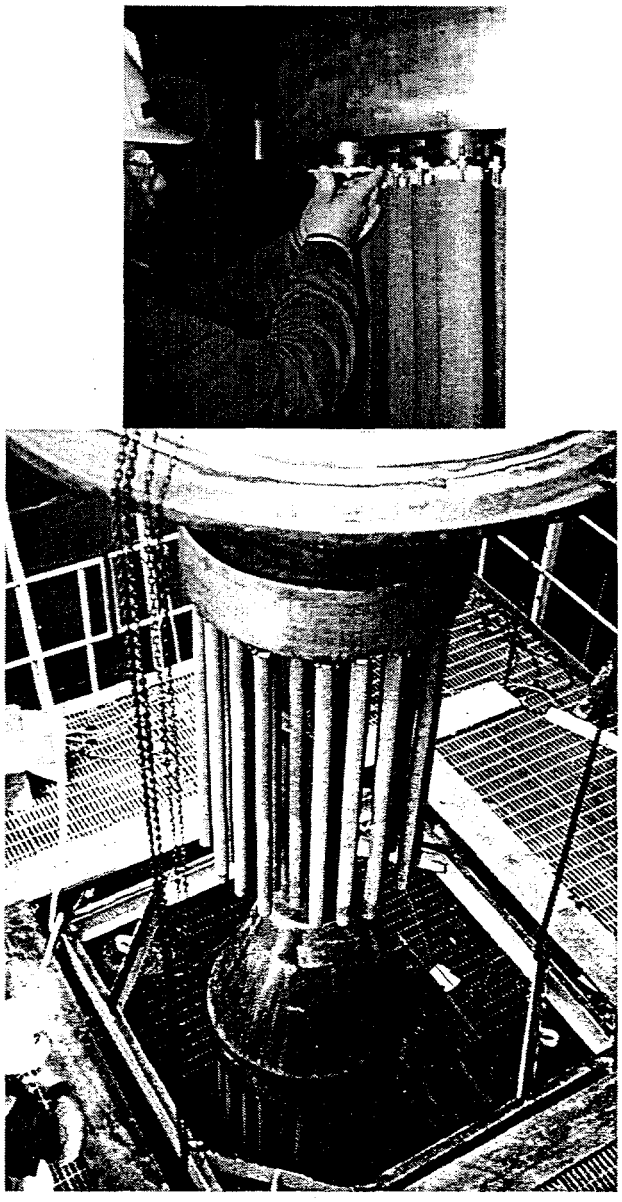
All on-site modifications to the granular bed internals were completed in February. A row of refractory brick was removed from the filter to accommodate the use of 3 mm filter medium.

Westinghouse Filters

Westinghouse, SCS and DOE have been discussing what mix of new candles to purchase for FL0301. This decision should be finalized during March/April and the first set of new candles purchased. The only items remaining for shipment to the PSDF are the instrument nozzle flange assemblies for FL0352 and these will be shipped when required.

Westinghouse personnel were at the PSDF the week of March 25 to provide guidance to SCS personnel in the installation of the cluster into the tubesheet, installation of used candles from Westinghouse and the Tidd project to be used for startup, and installation of the entire assembly into the vessel for FL0301. Westinghouse's Zal Sanjana, project engineer, and John Meyer, project technician arrived on site March 25 to provide technical supervision of the installation process. Prior to candling of the cluster by SCS maintenance personnel, Construction boilermakers prepared the tubesheet by welding necessary attachments in place and welding the bi-plenum cluster into place in the tubesheet. Due to impending inclement weather, Construction carpenters fabricated a tent structure over the three specially prepared PCD maintenance levels that allowed for the installation of candles to proceed unhindered by the constant downpour on March 27 and 28.

Candling of the cluster began on Wednesday, March 27, using candles from the Tidd project and from Westinghouse's supply of other used candles. These candles will be used for cold and hot shakedowns and initial startup runs since they are dispensable. In preparation for candling, SCS technical, maintenance, and operations personnel participated in hands-on training in the candle installation procedures. Due to this training and the care exercised by the maintenance personnel, the installation was completed in less than two days with no broken candles, which is a rare accomplishment for this type of work. The picture below shows SCS personnel installing candles.



The above picture shows the cluster being lifted from the specially designed levels of the maintenance bay. The weather cleared on Friday, March 29, long enough for SCS maintenance personnel to successfully complete the mechanical installation by lifting the cluster and tubesheet into the pressure vessel, packing the flange of the vessel with insulation, and aligning the flanged head onto the vessel. These final steps occurred with no problems.

SRI Particulate Sampling

In January, SRI received the third bid for machining and modifying the existing impactor parts. SRI submitted the bids to SCS on January 16 with the recommendation that ThermaFab Alloy, the low bidder, complete the work. SRI also received three bids on the six ceramic liners for the bauxite cartridges. Each liner is composed of an alumina cylinder, two perforated alumina end plates, and an alumina thermocouple feedthrough tube. Accuratus Ceramic Corporation of Washington, New Jersey, was the low bidder and SRI recommended them for the fabrication.

SRI is now in the process of collecting information about possible gasket materials for the impactor components. Among the materials that are being evaluated are grafoil, grafoil with metal inserts, metal-clad grafoil, laminated graphite, and several kinds of fibrous ceramic materials. The grafoil gasket encountered material degradation problems in a high temperature exposure test, so the ceramic materials were subsequently tested in a similar test in March. Thermal Ceramics kaowool and Zircar alumina-silica paper appeared to be more resilient than the other materials and are being considered for use within the impactor to hold the stages in place. IEP Nu-Board 1800, a rigid material, is being considered for the sampler/probe flange.

2.3.2 Task 3.3 Construction and Installation

Construction - Civil

Civil support activities associated with Mechanical and Electrical installations have continued. Installation of the coal, limestone and ash silos is complete. Work on miscellaneous concrete foundations, including the diesel generator foundation, chemical feed building foundations, the nitrogen system foundation, and the ash building base slab are complete. Work on sequence 10 steel (additional structural steel in the coal and limestone structure) was completed. Work on the ash building structural steel and miscellaneous stairs and platforms continued.

Construction - Electrical

Installation of conduit and cable in the process structure and the coal-limestone structure continued. Installation of conduits/equipment for conveyor equipment continued. Cable tray and conduit for air compressor island was completed. Installation of controls and power for cooling tower water pumps was completed. Three service air compressors and cooling tower fans and pumps were partially turned over to Operations for check-

out. The Simons Air System was turned over to Operations. Installation of conduits for instrumentation on MWK demineralizer and cooling water pumps was completed. Coal-handling, ash-handling and conveyor MCC feeds were pulled. The Control room building is now on permanent power feed. UPS panel in the Control room building was energized and part of Foxboro System is now on UPS power. PLC and speed drive setting for the Clyde dense phase equipment in the coal handling MCC room was completed. Installation of cables between the PLC cabinets, speed drives and MCCs in the coal handling equipment room continued. Installation of conduits to high pressure air compressors and high pressure nitrogen compressors were completed. Start-up burner terminations were completed and turned over to I/C for check out. Cable to the baghouse dilution air fan and associated equipment was completed. Cable for Clyde system FD0820 was installed. Emergency diesel generator was set and power feed to the 4160 volt switchgear was completed. Installation of associated control cabinets and equipment for emergency generator was started. Installation of conduits/cable tray for the thermal oxidizer continued. Heat tracing efforts in the process structure are continuing. Support for grounding and embeds in various equipment pads and site grounding were continued.

Construction - Mechanical

The installation of the instrument air compressors cooling water piping and cable tray was completed in February. In the meantime, with the completion of air piping in the structure, the air-cooled compressor was tied into the construction air headers to replace a rental air compressor that was returned. This air compressor is run most of the day supplying the needs of construction and start-up activities. A muffled vent is kept open to maintain some loading on the compressor so that it would not excessively cycle and overheat. Check-out of the water-cooled Atlas Copco air compressors was postponed to March due to the continuing work preparing the BOP closed loop cooling water system. The compressors were needed in March to support check-out of other systems; and two were commissioned using a temporary water supply at that time. The vendor rep inspected the installation in February and discovered several missing parts in the compressor cabinets, and he is trying to expedite their replacement. The Sequencer, which controls the four water-cooled air compressors, was checked out and set up for operation.

The equipment cooling water systems are nearing completion; with the Raw and Service Water Systems turned over for testing in January, and the Circulating and MWK cooling water systems turned over in February. Both the Raw and Service Water pumps were run, and testing of the control systems underway, finding some problems in the Foxboro

configuration that is being corrected. The Cooling Tower erection, the installation and piping of the MWK process closed loop cooling system pumps and heat exchangers was physically completed as were the installation and wiring of the instrumentation. The Circulating Water Pumps, the Cooling Tower and the MWK Cooling Pumps were turned over for testing in February. The BOP cooling water system installation is continuing, with the only remaining section being the piping to the Mill and Ash structures. The BOP cooling loop heat exchangers were installed and piping begun in February.

The controls for the Demineralized Water System were tested in January and the storage tank was refilled under automatic operation. All stress relieving required on the Steam piping was completed. Steam and Condensate piping was heat-traced and insulated after completing another hydro of the steam piping that was not included in the original hydrostatic test. This system was then laid up under a nitrogen blanket to prevent any corrosion. A jumper will be installed to bleed some saturated steam to the high pressure propane vaporizer, allowing operations without using the auxiliary boiler to raise propane vapor.

Mechanical installation of the Thermal Oxidizer and the final gas baghouse was completed in February; and work begun in pulling the electrical connections into place. The use of the Thermal Oxidizer to raise steam for the propane vaporizer puts emphasis on early completion of this system in order to complete check-out of the propane supply system.

Most of the Dense-phase solids transport systems for the MWK process are now undergoing check-out and testing. The vessels have been pressure tested, valves operated, and instruments calibrated and loop tested. Work on the Process Loop Controller (PLC) check-out is under way. Due to the fact one PLC controls five densairveyors and two screw coolers, this check-out is quite involved to prevent unexpected operations occurring due to interactions; therefore this check-out will be one of the most difficult of this start-up. The BOP dense phase systems installation in the Coal and Sorbent Mill structure is progressing.

Installation of the fuel and sorbent pulverizer systems continued, with the installation of the mills and air heater ductwork, and the installation of the sizing and feed equipment above the silos. These mills are equipped with individual propane fired, partially recirculating transport air heaters to transport the ground material to the sizing equipment, fans, cyclones, screen-sizers, and baghouses for the vented gases. To these

systems storage silos are being connected into the circuits, the dense phase transporters are also being connected, to provide the pulverized feedstocks to the process structure.

The propane piping in the structure and in the trench has been tested and heat tracing and insulation is complete. Installation of the bag house in the hot gas cleanup system is complete. Propane, cooling water, air and nitrogen lines are being run to the coal and limestone structure. The hangers have been fabricated and installed for these lines and approximately 25% of the lines have been installed. The balance of MWK structure piping has been prioritized and is 93% complete. Approximately 600 feet of pipe remains to be installed in the process structure. Work is complete on the BOP high pressure air compressors and piping. In the coming month work will concentrate on the wastewater treatment, fire protection, safety eyewash and showers, diesel fuel, instrumentation, utility lines to coal and limestone and BOP nitrogen systems.

2.3.3 Task 3.6 Preparations for Operations

Commissioning Related Activities

By the end of March, the PSDF Start-up efforts have focused on: Station Service, Raw and Demin Water supplies to the plant, the MWK steam/condensate system including chemical cleaning, Service and Cooling Tower Make-up Water systems, the Circulating Water systems including flushes, Instrument Air compressors and piping, proof testing of the propane and nitrogen supply piping, the Heat Transfer System for Ash screw coolers, operating the main process air compressor for pressure testing the transport reactor, operating the dense phase transport system to circulate solids between feeders, the reactor standpipe, and the spent solids transporters. The Propane system has been pressure tested, and the storage tanks have been filled waiting for some steam and some need to complete the commissioning. The Instruments, PLC's and the Controlling DCS are under an on-going check-out effort. Testing of these systems will continue, primarily as part of integration tests of larger processes. By assuring that each piece operates satisfactorily alone, and building/ testing small packages of equipment before testing the operation of larger processes, the troubleshooting required to resolve the process problems will be minimized and be focused at process variables as opposed to equipment failures.

The Station Service (electrical power) was energized last September, by powering up the Main transformer and the 4160V switchgear. After the 4160V bus was energized, the 4160V/480V transformers were each tested and energized, powering the five 480V buses. Each of these buses then supply various Motor Control Centers, the last of which

was energized in late February '96 (not counting the BOC Gases supplied and controlled MCC for the Nitrogen Separation Plant). All of the Switchgear is controlled by DC power supplied by batteries; these batteries were initially charged using temporary equipment which has been replaced with our permanent equipment, and have been connected to the UPS that supplies power to the DCS equipment and all the PLC's and control circuits to the plant's equipment.

The PSDF is buying their Potable Water from the City of Wilsonville, and has been using parts of the permanent piping system since the administration building was occupied. This city water was also used to fill the fire water and raw water tanks until the permanent Raw Water system to pump river water to the plant from E.C. Gaston's Intake on Yellowleaf Creek to both of these tanks were in place. E.C. Gaston also supplies PSDF with high purity water for use in our steam generation and process cooling systems; these pumps were first tested in early November '95 in preparation for the MWK Steam/Condensate system chemical cleaning. This cleaning was a recommended higher temperature caustic wash using the industrial equivalent to laundry powders. The actual cleaning was completed to better than specified results, in two days less than estimated.

The Raw Water Pumps and strainers were tested in December, and some needed control modifications were completed before the system was declared operational in March '96. The raw water system flush was completed in late January. The fill lines to the raw water and fire tank were flushed for approximately 30 minutes each, until the water was its natural "Yellow" color (pumping river water). Both pumps were ran individually and simultaneously with no problems. Vibration data on the motor and pump of both pumps registered in the precision range. There were only a few minor leaks, all of which except one were corrected during the flush. All pump and valve operation was done manually. The timers/solenoids on the filters operated as expected. In March, the automatic operation of the pumps and valves was demonstrated; at which point the Raw Water system was declared operational.

The Raw Water Tank supplies water to the Service Water and the Cooling Tower Make-up Systems. Both of these systems were tested, flushed and commissioned in January and February '96. The service water is used as wash water, seal water on the Flare, and as a source of temporary water to replace other systems. The cooling tower make-up water has been used during the fills and flushes of the Cooling Tower and Circulating Water system. One of the Make-up pump motors is under observation due to moisture in the bearings; the motor was to be supplied with grease fittings and was not, which prevents flushing the bearing easily; the vendor is evaluating this.

The service water pump run-in/test/flush was completed in early February. Both pumps were run and the flare seal drum and utility stations were flushed. Also, the minimum flow/recirculation valve was checked and the setpoint adjusted. Pump vibration was within the acceptable tolerance. The level control valve on the flare seal drum was also checked out to ensure that it would respond to tank level. Adjustments were made to this valve to ensure a minimum opening at all times as required.

The Cooling Tower and the Circulating Water System has been flushed, tested and commissioned. The Circulating Water system was tested first, the pumps operated, and the three loops flushed in March '96. During the flush several items were captured and removed from the screens. Tuning of the pump's discharge pressure controls was completed at the time; but not before a water hammer, caused by a valve to operate too quickly, dislocated some piping on the Foster Wheeler loop. The Cooling Tower was then commissioning and the fans tested. The Tower's distribution was found adequate for two circulation pump operation, and the fans were satisfactory. Like all PSDF rotating equipment, the vibration levels during early operation are recorded and evaluated. Several pieces of equipment, including several of the Cooling Tower Fans, have been realigned, rebalanced or modified as a result of this testing to further improve the reliability of the equipment.

Since the completion of the Instrument Air Headers to and into the Process Structure, and of the installation of the air-cooled Air Compressor, the air headers have been charged by the air-cooled compressor (the Sullaire). This compressor was transferred from the previous Liquefaction project that was next door, it was refurbished prior to installation on the air compressor island, and has been running since December supplying air to the instruments and valves, to expedite testing of the same, and for use by Construction to allow the return of a rented compressor. In March '96, the Sullaire was joined by two of the four Atlas-Copco water-cooled air compressors. Until completion of the BOP closed loop cooling system in late April, the Copco compressors are using temporary water supplies, when they are needed to meet the demands, caused by testing, that the smaller Sullaire cannot.

Some of the testing these air compressors are used for is low pressure proof testing of several piping systems. The use of air is much easier and cheaper than bottled Nitrogen for the initial fill and low pressure testing of the several completed piping systems including the propane, dense phase, and the nitrogen piping. The higher test pressure are achieved using bottled nitrogen added after reaching the highest pressures possible with air. Because of the nature of the piping, most of the piping had to be tested

pneumatically, rather than the preferred hydrostatic means because of the damage water could cause if not completely removed. So far, none of these proof tests have found a failed weld.

The pressure test of the Kellogg Transport Reactor was one test that the instrument air compressors would not meet the demand; so the main process air compressor was commissioned to pressure test the transport reactor. The process air compressor has an on-board PLC monitoring the protective systems and controlling the compressors operation. The communication between the PLC and the DCS was first established and served as the test of the communication gateway of the DCS. The compressor was then started, and tuned to support the pressure test. The actual pressure test was run in December '95; reaching 110 psi before loose gaskets were blown out. The test was halted at that point to allow construction to continue making connections to the reactor and will be restarted in May '96.

One of the earliest systems to start testing was the Heat Transfer System for Ash screw coolers. The system was charged and flushed at temperature before being connected to the screw coolers and flushing continued. This system is still being reviewed, and the computational model tested, because of concerns raised in assuring adequate flows to three parallel loops at different elevations. Operation of this system was required for the commissioning trials of the dense phase transport system to proceed, and further helped familiarize the plant operators in the use of the DCS.

The single most time consuming system start-up to date has been on the Kellogg supplied dense phase system. Unfortunately, this package was bought with one PLC controlling all five MWK supplied feeder/transport systems, this complication made it difficult to put many people on the check-out of the separate feeders because of the inability to time-share the programming interface to the PLC. All the inputs, outputs and communication with the DCS were tested and calibrated; the vessels have been pressure tested, equipment function tested on all valves, screw coolers and rotofeeder variable speed drive sand motors, valve and seals; and the systems were dry-run before circulating start-up bed material between feeders, the reactor standpipe, and the spent solids transporters. These were completed in the first week of April.

The Propane Storage and Supply system has been pressure tested, and the storage tanks have been filled waiting for some steam and some need to complete the commissioning. The steam heated vaporizer installation has been completed, including the condensate return and the condensate subcooler. A cross-over in the steam lines ties the MWK drum to the vaporizer steam supply piping to reduce the need to operate the Auxiliary

Boiler until gasification is tested this fall. All of the structure piping, including the flare, the reactor start-up burner and the Sulfator start-up burners have been pressure tested; the low pressure supply to the Thermal Oxidizer was ready for testing by the end of March.

The process gas analyzer house was powered-up and checkout of the controllers has begun. The sample conditioning equipment will require modification due to failures of equipment while operating at 75% of final temperature. The remote sample conditioning boxes have yet to be mounted, and the design for the sample draw-off system is still being finalized.

The plant's instrumentation has been undergoing testing and check-out since last fall when the E&I Journeymen completed their PSDF familiarization training. This instrumentation continues to be tested as soon as is practical, as this area is potentially the pinch point of the start-up program. The check-outs include stroking all control valves, calibration testing of all transmitters, loop and function testing of all PLC and DCS inputs and outputs, and supporting the operational testing of equipment and systems. The function of both the hard-wired and software interlocks and control logic is tested and verified before systems are declared operationally ready.

During commissioning, due to concerns and philosophies of particular systems, enhancement to the designs for safe and reliable operation were made. Several of these changes have been made including: modifications to supply steam to the propane vaporizer, extension of the raw water pump shafts, nitrogen purging of the propane supply header from the tank to the structure, temporary piping rerouting for start-up bed material charging and warm-up, and safe ash sampling systems.

Solid Transport Systems: Major progress has been made during the quarter in construction and preparations for operation in areas which include the transport reactor, startup burner, and solid transport systems, FD0210, FD0220 FD0510, FD0520 and FD0530. The construction of these systems is nearly complete. The PLC softwares and hardwares have been checked thoroughly and a set of functional checklists for these systems are in progress. The functional checklists and tests will ensure that the control system logics are functioning as designed. The functional check is a physical realization of step by step control logic including all alarms and sequential controller actions. The loop and functional checks for the solid transport systems and startup burner have been completed and are underway for the transport reactor loop. The commissioning tests for the solid transport systems have been done under vendor's supervision.

In March, the engineers from Clyde came to the site to commission the solid feed systems. The PLC software was revised and tested. Errors in the software were corrected and the systems were functionally checked according to the intended logic operation. All of the systems were operated dry at low pressure to check program sequence and valve operation for each transporter. Many of the contacts were forced via the PLC to be true so the sequencing could be tested. The motors on each of the rotofeeders, FD0210, FD0220 and FD0530, were operated without solids. The commissioning tests were performed using alumina as conveying material. Alumina will also be used as the reactor startup bed material. The test material has a bulk density of 100 lbs/ft^3 and mean particle size of 170 μm. Instrument air was used as the transport medium with a supply pressure of about 100 psig. A temporary pipeline connected the feed systems to the reactor standpipe. As part of the commissioning tests, the solids were transported to the reactor standpipe. The screw cooler FD0206 was used to feed the solid from the standpipe to FD0510, from which the alumina was pneumatically conveyed to FD0530. Alumina was conveyed from FD0210 at a rate of about 70 ft^3/hr or 7000 lbs/hr.

The commissioning tests are quite successful although there are some problems that needs to be resolved. The major problem was with rotofeed motors which were difficult to start and often tripped due to high current draw. Parameters on the adjustable frequency drives were changed to try to keep the motors running. For FD0210 and FD0220, the motors would continue to function. However for the FD0530 system, the motor would not run above 15% of speed. Clyde Pneumatics Conveying thought the problem was due to the density of the alumina that was being transported (about 100 lbs/cu ft). Clyde said they will take a closer look at the design. Latter in April the FD0530 system was again tried but the FD0530 rotofeed motor would not operate. The rotofeeder was removed for inspection. The metal surfaces between the rotating feeder hub and the plate that keeps the solids from going directly to the outlet pipe had couple of deep scratches. The galled metal was causing the motor to stop.

Baghouse (FL0700):Mechanical construction was completed during the quarter, and insulation and E&I construction are nearing completion. PSDF E&I personnel will proceed with loop checks for instrumentation directly following installation by Construction E&I personnel. Pre-refractory cure functional checks are being developed and this includes functionally checking the dilution air fan and the temperature-controlled interlock that operates the fan inlet vanes and the bypass dampers. The system will be operated in bypass for cure-out of the thermal oxidizer in early May and will again be set in bypass for refractory cure of the MWK process. Prior to full system

operation, functional checks for the differential pressure controlled backpulse cleaning system and the screw conveyor ash removal device will be written and implemented, both of which are to be part of an integrated ash removal control scheme which is currently being developed.

Baghouse Ash Removal and Storage (FD0820 and SI0814): The densephase pump FD0820 is installed and awaiting functional checks, which will be conducted by SCS and Clyde Pneumatic Company (CPC) personnel when CPC returns closer to start-up. The construction of MWK ash silo, SI0814, is partially complete. Construction E&I personnel are currently installing and wiring instrumentation for the silo, and it will be functionally checked along with FD0820. After dry functional checks on the baghouse screw conveyor and CPC ash removal and storage, SCS and CPC will introduce an ash substitute for a wet check of the removal process from the baghouse to the silo.

High Pressure Air/Nitrogen Systems: High pressure air will be fed into the high pressure nitrogen feed header for backpulsing the Westinghouse PCD during combustion mode. The high pressure air system is nearing completion and will soon be ready for functional and commissioning checks. A crossover connection between the H.P. air and H.P. nitrogen systems was added. The H.P. nitrogen system is currently under construction for use during gasification mode for backpulsing the Westinghouse PCD. The three nitrogen compressors have been installed and the heated storage tube bank will be installed next quarter.

Procurement

Bid were received 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 project's feedstock system operators joined the project in January, and the project lost an operator to a promotion as well. In February, the temporary E&I journeymen were given permanent assignments to the project after reevaluation of the manpower requirements to support expected modifications and troubleshooting during the project operation. In March, one of the Operations Shift Supervisors left the project for another position in the Southern Company. All of the operations personnel have been involved

in equipment inspections, design reviews, and procedure reviews. Several groups of operators have been preparing safety procedures, Foster-Wheeler design tabulation, equipment preservation, and equipment testing. As construction completion nears, the operations personnel are preparing for shifts which are slated to begin in spring with 24 hour operation to cure the refractory lined process piping, and beginning to operate equipment from the DCS control consoles thereby gaining confidence in the system operation.

The Electrical and Instrumentation personnel attended a class on the project's specified PLC, its operation and programming; and worked on several projects this 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 E&I personnel stroked most of the MWK pneumatic operated control valves, continued work on the PLC to DCS interfaces, continued clean-up work on the MWK DCS configuration, and 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 January working on long term preservation of the Foster Wheeler piping and equipment, while supporting construction in fabrication of minor gaskets and components, and preparing for work to be done during the later stages of Start-up. Several of the mechanics, and operators are supporting the construction effort by retrieving equipment and materials in the storage yards, reducing the time and effort needed by the construction 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.

The maintenance engineering staff continued designing future modifications and assisting in several design evaluations including: (a) helping SRI in a review of the appropriate materials to use in future construction of the sampling cyclone and impactors, (b) adding and sizing a safety relief valve for the nitrogen storage tubes, and (c) comparing the Foster Wheeler and MWK potable water systems to determine if there is a possible cost savings by combining the two.

Maintenance Shop, Spare Parts, Chemicals

Work continues in preparing a work order system, filing equipment maintenance information for reference, procedures and spare parts requirements. The growing database of recommended spares is being added to as vendor documentation arrives and

orders are being generated from that database. We expect to have a satisfactory inventory of spares that would be needed to keep a process on-line while spending less than a third of the budget for spares.

WOMS, an electronic maintenance work order system was approved for use by PSDF as a donation of Mississippi Power's licensing rights. This system will allow us to create, transmit, complete, and track work orders electronically and in an orderly fashion. WOMS allows on the spot batch analyses of work orders (i.e. the number of work orders placed against a certain piece of equipment; the number of work orders issued this month; the number of work orders completed; the number of open work orders; etc.). WOMS also acts as an equipment database in that it can store equipment information such as an assembly breakdown, parts list, referenced procedures, etc.

Maintenance Inspection and Procedures

Tools for our applications for preventive maintenance program of vibrational analysis, borescopic inspections, oil analysis, motor current analysis, and thermographic analysis have been procured. 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. We have begun development of a safety valve testing program. This investigation includes the required frequency, test method (on-site or off-site), costs, and possible vendors.

As pumps/compressors were started, we began taking vibration readings to define the initial operational state of the machine 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. This was corrected, and the pump has since run with low vibration. Vibration levels on the Cooling Tower fans, while being accepted by the vendor's representative, was unacceptable by the plant's standards; and is being corrected by shuffling the fan blades to achieve a better static balance and by assuring the blade pitch is constant. Using this type of vibrational analysis we can be certain that all of our machines are in excellent running condition.

In January, the project's maintenance engineer attended several days of training on the vibration equipment's extra features and on the successes of other Southern Company Power Plant's predictive maintenance programs.

Miscellaneous

Two maintenance personnel completed Intergraph PDS training in January. Once the workstation is at the site we can begin updating the model(s) with the "as-built" information and designing modifications with the help of the on-site engineering staff. On-site personnel also have access to AutoCad Light, to handle most of the CAD requirements that don't require use of the Intergraph model. O&M personnel are starting to discover the value of the PDS model. Several times last quarter, the model was used to generate prints of specific piping/equipment systems. These prints were used for technical discussions and training.

Data Management Development

Laboratory Services: Two SRI personnel continued in setting up the on-site lab that will handle water treatment chemistry, particle sizing, ash characterization, and gas analyses. Needed equipment continued to be procured and installed. Preparation of the draft chemical hygiene plan was completed and the draft is undergoing review. Work on the QA/QC plan and the Operating Procedures was initiated. The service agreement contract between SCS and SRI for laboratory services was executed. Work is underway to secure a laboratory service agreement with Alabama Power's laboratory to provide analysis for all the coal, flyash, sorbent, lube oil, and corrosion coupon analyses.

Data Analysis and Management: An Evaluation Agreement was signed with Oil Systems for a trial evaluation of PI software to provide access on the LAN to the data from the control system. The server and other hardware for the PI system were purchased and both the hardware and software were installed. The configuration of the PI system is underway. The configuration continued for the Laboratory Information Management System software, LABWORKS (used to manage the PSDF analytical data and with the capability of electronically transferring data from the outside laboratory to the PSDF lab once the data passes QA/QC).

3.0 PLANS FOR FUTURE WORK

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

2. The FW team at the site will continue with the review of the FW drawings and other information in order to prepare for construction of the system. Preservation of FW equipment that are on site will continue.

3. Balance-of-Plant mechanical design and engineering is complete. Electrical engineering is completing the heat tracing, the nitrogen and high pressure nitrogen pump areas, and the BOP cable routing. Civil engineering has several remaining items primarily associated with the FW process.

4. Construction at the PSDF site continues. Civil will continue to complete the remaining ash building structural steel and miscellaneous stairs and platforms. Installation of the conduit and cable in the coal, limestone and ash structures, the thermal oxidizer, and emergency generator will continue for the electrical group. Mechanical work continues in the wastewater treatment, fire protection, safety eyewash and showers, diesel fuel, instrumentation, utility lines to the coal and limestone and the BOP nitrogen.

5. The refractory cure-out will use the CPC vessel, instead of the Westinghouse vessel, as the flowpath. This allowed for candling of the Westinghouse vessel prior to cure-out to minimize the activities which must occur between the cureout and the first coal fire. A piece of the refractory-lined media circulation piping at the media outlet nozzle will be removed and a blind flange installed. A blind flange will also be installed on the media inlet nozzle. Certain sections of the granular bed filter O&M procedures have been issued, and the remaining information is being prepared for future release.

6. At some point during the summer, SCS would like to meet with IF&P, Mallett technology, DOE and EPRI to review the drawings of the filter internals. At that time, any final changes will be recommended. SCS has asked IF&P not to fabricate the internals until the design review meeting and until the issues regarding the FW schedule are resolved. IF&P has already purchased some materials for the internals, but has agreed not to purchase additional materials until a later date.

7. John Meyer of Westinghouse has discussed installation of the internal instrumentation for FL0301 with SCS maintenance personnel, and maintenance will perform this installation, which includes connection of the pulse cleaning skid to the vessel, early next quarter. Meyer will return to the site prior to startup to inspect and approve the installation.

8. SRI will continue work on the prototype cyclone manifold and will continue to solicit bids on the remaining sampling system components. Purchase requests for next quarter will include cyclone modifications, ceramic liners, Haynes bolts, impactor internals and substrates, and gaskets. SRI will continue to evaluate the Haynes 230, Havar, and other alloys as substrate materials. Ongoing interface between SCS Construction, Technical, and O&M and SRI on construction and operations issues will also occur.

9. By the end of April, commissioning of the rest of the cooling water systems should be completed. In early April, the MWK and BOP closed loop systems will be started and flushed. The pumps will be run-in, the minimum flow values tuned, and the system inventory controls tested and set-up. After the headers are flushed, separate flushes to each cooler will take place, and testing to assure required flow to each cooler is achieved. Once the closed loop systems are operational, several temporary cooling arrangements can be returned to normal, allowing normal operation of several different air compressors and testing of more integrated packages in long term configuration.

   Commissioning will also soon begin on the Recycle Gas Compressor, the Thermal Oxidizer system components, the Reactor Start-up burner, the Sulfator Start-up burner and compressor, the Baghouse and Dilution fan, the Conveyor system, and (in early May) both feedstock preparation Pulverizers. As each component is turned over, the E&I Journeymen begin testing the instrumentation, the breaker controls and the functional control from the DCS or PLC; after which the start-up teams begin to test the operation of the components and the function of the system.