DOE/MC/25140 -- 5005
(DE95009740)

Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion

Quarterly Report
April - June 1995

August 1995

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

DISCLAIMER

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August 1995

POWER SYSTEMS DEVELOPMENT FACILITY

QUARTERLY TECHNICAL PROGRESS REPORT
APRIL 1 - JUNE 30, 1995

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1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes the work completed during the first quarter, April 1 through June 30, 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 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 continued at a good pace during the quarter. MWK and FW equipment and the PCDs are being set in the structure. Substantial progress has been made in fabrication and installation of both small and large bore non-refractory lined piping.

The detailed design of the PSDF continued with refinements to the FW, MASB, gas turbine and balance-of-plant P&IDs, preparation of specification bid packages and a move towards freezing the balance-of-plant design. The integration of PCDs and the sampling system in the MWK and FW portions of the process structure continued and detailed civil, electrical, instrumentation and controls, and mechanical design information were exchanged between the design teams. SRI continued with simplifying the design and casting of the particulate sampling system cyclone manifold for the PSDF, working with the engineering design teams to resolve interferences and preparing to issue drawings for construction. The skid mounts for the insertion sampling probes are being fabricated and other parts are being procured for assembly and functional testing.

Construction is progressing well at the site. Most of the construction activities at the beginning of the quarter concentrated on setting up the equipment in the MWK process. The structural steel erection of the MWK bays, PCD bays and the PCD laydown and equipment access bays is essentially complete. Towards the end of quarter, sequence 5 steel erection of the FW bays has started and FW equipment is being rough set-in. The alkali getters were refractory-lined at the site, cured and set in the structure. The lower portion of the CPFBC and part of the solids return loop have also been placed in the structure. Cooling coils have been installed in the FBHE and the construction is proceeding to make arrangements to place the FBHE in the structure. The FBHE is the heaviest equipment at the site, weighing over 250,000 lbs. The MWK and FW motor control center (MCC) buildings have been erected. The I/O cabinets have been placed in the MCC buildings and fiber-optic cable link have been established between the I/O cabinets and the control room.

The MWK transport reactor was trial fitted with the disengager and primary cyclones, combustion heat exchanger, and the vent gas line. Aligning marks were made on various pieces of the reactor and numerous alignment measurements were made from column lines and beams. These measurements are being used in the final fit-up of the reactor loop which is currently in progress. The process structure elevator is being installed incrementally as the structural steel is being erected.. The construction of the control/administrative building was completed and voice and data communications were installed. The project management, operations and maintenance staff moved to the site in April. The existing firewater storage tank and diesel pumps were installed and tested. Field construction of 400,000 gallons service water tank is in progress.

A number of balance-of-plant related equipment bid packages and bids related to bulk procurement was issued during the quarter, and after evaluation, several awards have been made. Vendor drawings are being received and vendor fabrication schedules of critical equipment are being followed closely to ensure timely delivery of equipment.

Procurement of all equipment in the FW train is progressing well. Detailed engineering design of the APFBC system is nearing completion. The design of the MASB is almost complete and an internal Westinghouse design review is scheduled for early July. Design work for the Allison gas turbine and generator skid is also near completion. The MASB and the gas turbine P&IDs were updated, and a Design and Operability Hazard Review (DHR) was conducted. The action items emanating from the DHR are being resolved. FW is preparing/updating a series of document outlining the plant control and operating philosophy, including operating logic and interlocks, and startup and shutdown procedures. These documents along with commissioning instructions and requirements will be used by the operations staff to prepare the detailed operating manuals.

The PCD equipment designs are nearing completion. Purchase orders for equipment fabrication and procurement have been issued. MWK has completed their design and engineering and issued all drawings, databases and other material for construction, and are providing construction support as needed. Comments on the transport train operating instruction manual are being addressed. Many of the 39 MWK train major components were delivered to the site, and procurement activity of the few remaining items is progressing well.

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 (CA) for Budget Period 4 was submitted to DOE in February. The budget was based on an updated schedule of achieving mechanical completion of the MWK train by October 1995. This will be followed by cold and hot shakedown activities and a coal test fire in mid-December. Much of the FW train should be complete mechanically by early 1996. The CA includes risk quantification estimates based on the process development allowance method, but these costs are not included in the budget request. The CA also includes projections for Budget Periods 5-7. Responses to technical comments on the CA for Budget Period 4 were submitted to DOE in April. The CA is undergoing a cost review and final review and negotiations should be completed by July.

As the control room/administration building at the site was nearing completion, project personnel who will be involved with operation of the facility moved into the new building on April 21. The Maintenance Coordinator and remaining two of four Shift Operations Coordinators joined the project during the quarter. A scope of work was finalized and work is progressing in procuring maintenance labor, including instrumentation technicians who will also support precommissioning testing and integration. Negotiations are continuing to secure a labor broker for the bulk of the O&M labor staff. Staffing requirements to address the short-term peak workload period anticipated during the MWK commissioning, continued FW process construction, and planning for the FW commissioning and detailed procedure writeup, are presently being evaluated.

Westinghouse has evaluated the availability of used candles for FL0301 and FL0352 for use during shakedown for the MWK TR and FW APFBC, respectively. Sufficient inventory of used candles appears to be available. Cleanup and inspection costs will be a small fraction of new candle costs. The used candles from AEP-Tidd are being inspected prior to making a decision as to which set of candles to clean for SCS.

On June 29, 1995 there was a meeting at Morgantown to review the design and recent performance of the ceramic filter system developed by Lurgi Lentjes Babcock (LLB). The presentation was given by George von Wedel of LLB with personnel in attendance from DOE/METC, Riley Stoker (Bill Place) and SCS. A copy of a report received from Mr. von Wedel is attached as Appendix A.

2.2 PHASE 1 - CONCEPTUAL DESIGN ACTIVITIES

2.2.1 Task 1.4 Transport Reactor Development Unit

The final report describing all the TRDU operations and test runs was completed by EERC and issued during the quarter.

2.3 PHASE 2 - DETAILED DESIGN ACTIVITIES

2.3.1 Task 2.1 Detailed Design

2.3.1.1 MWK: PSDF Transport Train

The detailed design is essentially complete. The revised P&IDs for the "PCD heat up" were issued during the month of May. A draft of the operating and instruction manual was issued for SCS review. Comments on the draft are being addressed. The draft report of the maintenance and inspection manual is complete and is being reviewed internally. Construction support work involved updating the electrical CARS report. MWK personnel are working closely with the SCS construction engineers in the trial and final assembly of the transport reactor, the combustion heat exchanger and the cyclones.

2.3.1.2 FW Team Activities

The Phase II detailed engineering and Phase III procurement activities continued. The following activities occurred during the second quarter of 1995.

Progress review meeting

A meeting was held in Birmingham between FWUSA, DOE-METC, and SCS to review project progress. The major items arising were as follows:

FWUSA will prepare a document that will outline commissioning instructions and requirements and will be used to assist with the scheduling of activities. The objective is to integrate pre-commissioning and commissioning activities into the construction program and to identify the best sequence for start-up operations.

SCS will prepare a Statement of Work specifying the role of FWUSA during startup and hot shakedown, and early operation. This was expected to cover several periods of residency at the site for the shakedown of separate parts of the plant, each involving

FWUSA's subcontractors; the Westinghouse MASB with the Allison gas turbine; FWEC's circulating PFBC with the larger Westinghouse HTHP filter; and integrated operation of the train with FWDC's carbonizer, IF&P's HTHP filter, and later Westinghouse's smaller HTHP filter. Each of these periods will be separated by downtime for maintenance and repair, when a FWUSA site presence is unlikely to be required.

FWUSA were in the process of preparing, including updating, a series of documents outlining the plant control and operating philosophy, including operating logic and interlocks, and startup and shutdown procedures. These documents will be available at the beginning of July. SCS will review them to determine that they contain all the information necessary for the Operations staff to prepare the operating manuals. FWUSA will provide any additional information required and will review the manuals to ensure that the procedures detailed are consistent with the design intentions.

It was formally agreed that the refractory in the circulating PFBC and associated equipment would be dried in the structure by Hotworks. This will be done as soon as possible after completion of installation, allowing the maximum period of time before startup to effect any necessary refractory repairs.

SCS wish to progress towards Engineering closeout within the next four months, with the objective of completing all work, except for the MASB and gas turbine, by the end of September. FWUSA said that the weekly Needs List meeting should be used to progress this objective.

The P&IDs, omitting those for the MASB and the gas turbine, were to be reviewed by SCS to check that all comments made in previous reviews had been addressed, and were free of major errors. It was accepted that minor errors may still exist and that these should be marked up on a master copy for eventual correction by SCS. This action was completed subsequent to the meeting and FWUSA were informed that the P&IDs had been accepted as complete.

Inspection reports showed that delays were being incurred in the manufacture of the steel portion of the refractory-line pipe. FWUSA and SCS will visit the fabricator and determine how to expedite delivery.

Details of the design for the combustor heat transfer panel and the backup propane burner were discussed and design points clarified.

Alkali getter vessels

The two alkali getter vessels were delivered to site in early April. The refractory was installed by mid-May and cured by a contractor with the vessels on the ground. After passing the inspection the brick supports for the alkali media were installed. This work was completed by the end of May and FW declared them ready for installation. The vessels were installed in mid-June prior to erection of the next layer of steelwork.

FBHE

Refractory lining of the FBHE was completed at the beginning of April and the installation of the cooling coils was completed early in June. The coils were pneumatically tested at 30 psig and no leaks were detected. The FBHE will be installed in the structure at the end of July.

Refractory curing for circulating PFBC system

Foster Wheeler Energy Corporation's (FWEC) proposals to cure the refractory in the Fluid Bed Combustor and associated equipment were evaluated. The equipment includes the Combustor, Cyclone, Fluid Bed Heat Exchanger (FBHE), the J-valve, and the Fluid Bed Ash Cooler. FWEC stated that the refractory is stronger in a green state and curing it in the structure would reduce the chances of cracking while the vessels were being lifted. Curing the equipment in this manner costs significantly less than curing the individual pieces on the ground as less labor and fewer burners are required.

Two alternatives for curing the refractory in the structure were proposed. The first uses the three startup burners to provide the necessary heat and the second involves using a subcontractor to supply burners placed at strategic locations throughout the combustor loop. The first alternative was considered to have two drawbacks. One, it can only be implemented once construction is completed and if refractory problems are discovered at that time their resolution could delay plant commissioning. Two, the internal configuration of the FBHE made it difficult, in certain areas, to achieve the 1200°F gas temperature required for adequate dry out without damaging the heat transfer tubing. To maintain gas temperatures, the tubes are uncooled and have a maximum safe operating temperature of 1300°F. Insufficient curing could result in damage to the refractory when brought to process temperatures. The second alternative can be implemented during the construction phase and so allows more time for any refractory-related problems to be corrected. Further, the burners can be placed such that adequate dry out is achieved without endangering the heat transfer surfaces. For these reasons, although the first alternative was less expensive, the second was selected.

Combustor heat transfer panels

FW issued their revised proposal for installing heat transfer panels in the combustor. The panels were different to those initially proposed in April 1994. Previously, the two panels were each 8 ft x 14 in requiring a water flow rate of 2,000 to 7,000 lbs/hr. Now one panel is 8 ft x 14 in and the other 18 ft x 14in, requiring a water flow rate of 45,000 to 60,000 lbs/hr. Further, previously the probes were to be imbedded within the refractory but are now to stand clear of the refractory surface. These differences raised two main concerns, that were addressed by FWEC.

1. As the panels remove heat from the combustor, will maintaining a constant exit temperature require additional fuel? Will a revised control philosophy be required?

    - The heat removal from the furnace will be accommodated by removing less heat from the FBHE and returning hotter solids to the combustor. Some minor modifications to the controls will be required.

2. Will the panels disrupt solid flow at the wall, influencing combustor performance, and possibly leading to local erosion problems of both the panel and the refractory?

    - The robust design allows for a certain amount of erosion damage. Regular inspections will allow for preventative maintenance and should prevent any damage resulting steam egress.

The basic design and control has been agreed to, although no drawings have yet been issued for approval. Both panels consist of five tubes connected by webbing. Only the center tube is used for data collection to avoid end effects. To determine how heat transfer varies with height, the temperature rise over four sections of the tube are measured by thermocouples attached to the rear of the panel. To obtain better resolution, rather than determining the absolute temperatures and then determining the temperature difference by calculation, the temperature differentials will be measured directly. To achieve this, the resistance of the thermocouples at the inlet and outlet of each measurement section will be balanced within the DCS at ambient temperature. During operation, the thermocouples will then be used to register the temperature difference directly.

When to install the panels and how long to test them still has to be decided. To be in keeping with the rest of the design, the P&ID for the panels will be subjected to a Process Hazard Review.

MASB

The MASB requirements were reviewed and it was agreed to cancel the second MASB which is exactly the same design as the first. If the first MASB fails because of a design fault, then the second one will contain the same fault. Testing at Wilsonville may provide information resulting in future design changes. The decision whether to manufacture a second MASB incorporating these changes will be made based on how satisfactorily the first one performs, from both process and mechanical performance perspectives.

It was also agreed to investigate the purchase a backup propane burner. If the first MASB is irreparably damaged, the backup burner will allow operations to continue while a replacement MASB is fabricated. It is accepted that such an arrangement may only allow the combustor portion of the advanced PFBC plant to be operated for extended periods. For combustor operation, the burner will only be used to effect startup until hot vitiated air is available and the turbine is self sustaining. For carbonizer operation it may be possible, for short periods of time, to flare the fuel gas and gain some operational experience. SCS have proposed that the propane burner receive 600°F air from the compressor, not the 1,600°F vitiated air, but will fire into the vitiated air stream ahead of the gas turbine. FWUSA is evaluating the feasibility of this proposal and expect to respond early in July.

The design of the MASB is almost complete and an internal Westinghouse design review is scheduled for early July. Because of the high flow rate of vitiated air to the dilution zone, the design has been modified to include dilution swirler by-pass holes. The shape of the variable orifice was modified to give a more linear operating flow curve to match the wide range of operating conditions. Certain start-up conditions have been identified in which it is not possible to operate the MASB with a fuel-rich zone. This is an untested operating regime and will probably result in increased NO_x emissions during startup, although probably only for a short duration.

Allison Gas Turbine/Generator Set

Design work for the Allison gas turbine and generator skid was almost complete at the end of June. The machine is on schedule for delivery in December. The base plate was expected to be delivered to U.S. Turbine at the end of June. Fabrication of the gear box and generator has been started and will be delivered to Allison towards the end of August. Procurement of all controls and fluid systems hardware is underway and no delivery problems are anticipated. All unique gas turbine parts are either released for manufacture or on order.

Site activities

Structural steel arrived towards the end of the June for Phase 5 of construction, the second stage of three for the FW side of the plant. Erection work commenced immediately. Most of the steel work will need to be erected before equipment items can be installed towards the end of July.

2.3.1.3 Balance-of-Plant Activities

Significant progress on several on the balance-of-plant systems was made during the last quarter. The P&IDs for all subsystems were completed for the Design Document. A summary of the balance of plant design, engineering and construction support activities arranged by engineering disciplines follows:

BOP Engineering - Mechanical

Coal and Limestone Systems: The mills were awarded to Williams Patent Crusher during late March after performance tests were conducted in early February. The results were forwarded to both MWK and FW for their approvals. FW requested that their grind size distribution closely match their specifications. A mechanical air separator was added to remove fines for the Foster Wheeler limestone grinding system. Currently, SCS received the second issue of the mill system P&IDs. Minimal comments were necessary in response. The mill systems arrangements and a large number of component drawings were also received. A visit to the mill vendors home office was taken to conduct an expediting and inspection meeting. The factory was inspected and it was determined that materials have been procured. The conveyor system vendor drawings were received and reviewed. The bids for the crushed and pulverized limestone and coal silo packages were received, evaluated and awarded.

Ash Handling Systems/Dense Phase Conveying Systems: Post award activities on the dense phase systems have been ongoing with Clyde Pneumatic Conveying. Process building steel drawings and SCS equipment layout drawings were sent to Clyde to aid them in the development of their piping isometrics. The ash silo design and sizing was discussed so that the ash building design can proceed. Further discussions were held with FW and SCS to clarify the routing of conveying piping and other detail design requirements. Currently, piping and instrument diagrams, preliminary layout drawings and some component drawings have been received.

Final Gas Cleanup: The stacks and dilution air fan have been purchased. The drawings were received and reviewed. A change order was made to add the supply of ductwork connecting the sulfator and the MWK stack.

Steam and Condensate Systems: The vendor drawings for the shell and tube heat exchangers for both the MWK and the FW systems were received and approved. Certified pump drawings were received. Control valves for the system were released for procurement. Bids for the auxiliary boiler were received and evaluation was started.

Circulating Water, Cooling Water and Service Water Systems: The cooling tower bids were received, reviewed and awarded. An award for the three plate and frame heat exchangers was completed. The drawings for the plate and frame heat exchangers were received and approved without comment. A bid package was issued for the miscellaneous pumps for the balance-of-plant systems which included the circulating water, cooling water, raw water, service water, and cooling tower makeup pumps. Bids were received, reviewed and a purchase order was issued for the pumps.

An award was made to Tower Tech for the cooling towers. The initial issue of the cooling tower arrangement drawings were received, reviewed and commented. Detail design of the raw water pump to be located at Plant Gaston was begun. The 400,000 gallon service water tank was awarded and construction is near completion.

Service Air/Instrument Air: Inquiry for the compressors, tanks, dryers and aftercoolers were issued during the first quarter. Bids were evaluated and a purchase order for the service/instrument air compressors and related equipment was issued to Hydromatics, Inc. which represents Atlas Copco compressors. Drawings were received during May on the components for the service air compressors. A modification to the service air compressor purchase order was issued to include a high pressure air receiver. Bid package for the high pressure air compressor for the Westinghouse PCD was revised and reissued. Bids were evaluated and an award was made on the high pressure air compressor for the Westinghouse PCD.

Auxiliary Fuel: The propane system bid package was released for bid. A prebid meeting was held in June. Clarification on the propane requirements held up the award, but resolution is near. The 7,000 gallon existing diesel storage tank will be relocated to the utility island. The tank will supply fuel to the auxiliary generator, the fire water pumps and to the rolling stock.

Fire Protection: Engineering provided field support for pumps and piping installation of fire protection pumphouse and provided field support for cleaning, repair, and painting of the existing firewater storage tank. The fire protection system has been checked out and commissioned.

Wastewater: The design and layout of the wastewater treatment basin was finalized. An award was made for the oil/water separator. Drawings were received and are being reviewed.

Nitrogen System: The contract for the nitrogen system was awarded to BOC gases (Airco). Design information on the system foundations and site layout is being exchanged. The low and medium pressure nitrogen will be supplied by October. The high pressure nitrogen compressor bid package was issued. Bids were received on the capacity of the high pressure storage tubes.

Demineralized Water: The small demineralized water pump data sheet was issued with the miscellaneous pump package. The pump suction from the adjacent E.C. Gaston steam plant was field routed by construction. Design of the pump station was started in June.

Detail Designs: Detail design of all the piping located in the pipe trench adjacent to the process structure continued during the quarter. The piping for the saturated and superheated steam to the MWK process were analyzed for the trench layout. Construction in the pipe trench has begun.

BOP Engineering - Civil

Detailed design of the Ash building continued during the quarter. The detailed structural steel drawings of the Ash building were completed and issued for fabrication in June. The drilled pier foundation design for the Ash building was completed, and the drawings were finished and issued for construction. The reinforced concrete base slab detailed drawing is in progress and will be issued for construction in July. The ash building drawings incorporate truck loading requirements. Siding will be used to help reduce the spread of airborne ash during discharge into the trucks.

The preliminary design was started for routing the ash lines through the process structures to the ash handling area. The proposed routing for ash will require two pipe bridges - one between the main process structure and the coal handling structure, and another between the coal handling structure and ash handling area. Another pipe bridge will be required to support the coal and limestone piping between the coal handling structure and the main process structure. The detailed design of these pipe bridges will begin after receipt of drawings from Clyde Pneumatic Conveyors.

The detail design of the coal and limestone silos was completed. Drawings were issued for fabrication. The crushed coal silo fabrication drawings were received, commented and returned to the vendor for fabrication. The limestone silo fabrication drawings were received, and they will be reviewed and returned to the vendor in July. The foundation drawings for the conveyor, crusher, and the reclaim hopper were started in June. They will be completed and issued for construction in July.

Design work for an enclosed area at grade to protect control panels and a motor control center in the Coal and Sorbent preparation structure was started. The architectural drawings and the reinforced concrete slab drawing will be issued for construction in July. Other detailed drawings will also be completed and issued for construction in July. The remaining portion of the Coal preparation area concrete base slab will be completed upon receipt of the final layout of the mills and associated equipment. The foundation design and the detailed drawings were started in June. The detailed drawings will be issued for construction in July.

The foundation design for the MWK stack was completed and the detailed drawings were issued for construction. Miscellaneous steel drawings for equipment supported on the process structure base slab were issued for construction. Details for providing structural steel guides for MWK equipment were issued to the site in June. This was necessary because the guide trunions on the vessel were fabricated on the wrong axis of the vessel.

The reinforced concrete foundations for the Baghouse, Cooling Tower, Sulfator Burner, and the Transport Air Compressor are in progress and will be issued for construction in July. The Dilution Air Fan foundation will be started in July.

The site general arrangement drawing and the final perimeter fence layout was reviewed and revised. The layout now includes changes that were necessary to improve plant daily operations, and to allow for adequate storage and laydown areas.

BOP Engineering - Electrical & Controls

During the quarter, design, drawing, construction support, and bid package preparation and evaluation work continued on several electrical and control system tasks as outlined below:

- The development of DCS wiring diagrams, 4kV switchgear elementary diagrams, and 480V switchgear wiring diagrams continued.
- Design of the 4kV cable bus supports was completed. Support material was purchased.
- The MCC (motor control center) single line diagrams were updated to reflect the latest changes to the motor loads. MCC vendor outline drawings have been received. MCC foundation location and size were finalized for MCC's in the Switchgear and Administration buildings.
- Procurement of the 480V and 240/120V miscellaneous and UPS distribution panels is in progress.
- Thirteen new wiring diagrams and 6 new elementary diagrams were completed. Twenty single line diagrams were revised.
- The field version of the automatic cable routing system was activated and placed on the network. Cable pullcard printing is now available at the site.
- The diesel generator vendor drawings were reviewed again and returned.
- Rotometers and purge assemblies contracts were awarded to Brooks Instruments.
- Specifications were issued for the following BOP (balance of plant) equipment:
  - Nuclear level detector
  - Ultrasonic level transmitters
  - Mechanical level gauges
  - Mechanical level transmitters
  - Magnetic flow transmitter
  - Local flow indicators
- Heat tracing work continued.
- DCS configuration and graphics development continued.
- Development of the BOP loop diagrams continued.
- BOP P&IDs were reviewed.
- Two BOP system design hazard reviews were conducted..
- Met with MWK to discuss cable and raceway input and installation.
- Preliminary design for pipe trench heat tracing was completed.
- Vendor drawings were received and reviewed for the following:
  - 4160V Cable Bus
  - Thermometers and thermowells
  - Pressure and temperature switches
  - Milli-volt switches
  - UPS
  - Battery
  - Battery chargers
- Instrument data sheet compilation continued

- PA system procurement and design for the process structure, MCC/IO building and the electrical switchgear building was completed.
- Preliminary layout of the material handling equipment clean room was begun.

2.3.1.4 Process Hazard Review

Design hazard review of MASB and gas turbine

Draft P&IDs were prepared and the P&IDs were used by SCS and FWUSA to complete a Design Hazard Review (DHR) of the MASB and the gas turbine. A number of suggested modifications were proposed, all of which were minor in nature.

BOP Design Hazard Review

A design hazard review was conducted on the BOP P&IDs on May 22, 24 and 25. The following systems were reviewed: coal and limestone handling and preparation (except for the mills); steam and condensate systems; circulating, cooling, service and waste water systems; service and instrument air systems; propane and nitrogen (except for nitrogen plant) systems; fire protection and pump house systems. BOP action items arising from the FW and MWK design hazard reviews were also addressed. On June 20 and 21, a DHR was carried out on the dense phase conveyors for the coal, limestone, and ash systems. Outstanding BOP items include the nitrogen plant, propane plant, the coal mills, the cooling tower, and the baghouse after the sulfator in MWK transport reactor train. These will be addressed when the vendor P&IDs become available.

2.3.2 Task 2.2 Facility Design Document

The information required to update Volume II of the Design Document (the APFBC system) was determined, written, gathered, and compiled to form the 75% version. The document was sent to duplicating at the end of June to be distributed to project participants prior to the July 25/26 Design Review Meeting to be held in Wilsonville.

Updates to the PSDF design documents for completion of the BOP design were issued in June. Modified information from FW and MWK were also issued.

2.3.3 Task 2.3 Environmental Permitting and Compliance and Safety

During this quarter, routine site inspections were performed for environmental concerns and the results were filed in Monthly Inspection Reports. On April 20, a semi-annual Discharge Monitoring Report (DMR) was sent to the Alabama Department of

Environmental Management (ADEM). The DMR contained analytical results from stormwater runoff samples collected from the construction site. The PSDF National Pollutant Discharge Elimination System (NPDES) application was submitted to ADEM in March. The first draft of the permit was received from ADEM on June 26. ADEM allows a 30 day comment period on the first draft. The first draft will be reviewed and comments will be submitted within the 30 day period.

Work has begun on putting together an Environmental Compliance Document for the Facility. Numerous Federal, State, and Local environmental regulations and procedures are applicable to this facility. A list of these will be compiled and the compliance manual will identify the applicable rules and regulation, the necessary training to comply with the rules, who is responsible, and the necessary reporting that is required for compliance.

Safety Procedures

A significant part of this quarter has been devoted to Safety. One major task has been putting together a Safety manual that summarizes all of the necessary safety procedures and programs that are applicable for the whole plant site. Many of these programs are required by the Occupational Safety and Health Administration (OSHA) and the requirements and preparation for certain programs can become extensive. Some of the major programs that have been worked on and developed include:

Personal Protective Equipment (PPE)
Lockout and Tagout of Energy Systems for Maintenance
Respirator Protection Program
Confined Space Entry Procedures
First Aid/CPR
Hazard Communication Program
Chemical Hygiene Program

These programs are extensive and cannot be covered in the General Safety Manual. The highlights of each program are summarized in the Safety Manual and a reference to the specific document covering the details of each program is made.

Ten employees took a first aid/CPR course on June 6 at SCS. On June 7, seven employees attended a Lockout and Tagout Safety Training Seminar in Birmingham.

2.3.4 Task 2.4 Particle Characterization and Collection

An internal review of the control system outline at SRI has identified the need for several changes, which will be implemented in July. The major changes include:

- Inserting the sampler into the outer casing and removing it from the casing under manual control, rather than under automatic control,
- Adding a procedure for suspending sampling and then restarting sampling to deal with short-term process upsets,
- Adding a procedure for purging the sampler and sampling system with nitrogen at the end of a run, and
- Making safety lockouts active during manual operation as well as automatic operation.

The review of the control program also identified the need for several hardware changes. The major hardware changes are listed below.

- Changing the inner casing purge valve from normally closed to normally open and removing the main nitrogen system solenoid valve, so that a computer failure cannot stop the nitrogen purge,
- Adding analog I/O capabilities to allow the SRI computers to control the probe heatup and cooldown sequences,
- Changing the pause light on the local control panel to a home position indicator light,
- Changing the move-to-home-position button on the local control panel to an auto-start/continue button, and
- Changing the outer-casing-N_2-on button on the local control panel to an outer-casing-pressure-test button that initiates a complete pressure test.

The analog I/O capabilities, fourth control computer, and network are being added to allow all system functions (including preheat and cooldown sequences) to be controlled from SRI's computers. Originally, it was assumed that the distributed control system (DCS) would read the sampler temperature and send signals to Southern Research's computers to indicate when the sampler is preheated for sampling and when it is cooled for retraction. This approach has been abandoned, because it was desirable to separate control of the sampling systems from the main process control.

The changes in control philosophy mentioned above have dictated several changes in the P&IDs and wiring diagrams. These changes are now being implemented, and revised P&IDs and wiring diagrams will be issued next quarter.

2.3.5 Task 2.5 Particle Control Technologies

The following presents a summary of progress made in 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

IF&P continued to work with Oak Ridge National Laboratory (ORNL) for the determination of physical and mechanical properties of improved ceramic tubesheet materials. IF&P also continued working with Mallett Energy Resources Corporation (formally Mallett Technology) as an outside consultant for the physical design of the PCD internals.

The large number of data received from ORNL, a local metallurgical laboratory, and through on-site evaluations have been completed and utilized in the tubesheet/flow block sandwich.

As internal designs are finalized and material physical properties become known, heat transfer and temperature profiling become possible. Outside consultant, Mallett, continues to be retained in this and other regards. The services of Carborundum Corporation have also been utilized for a portion of the task.

2.3.6 Task 2.8 Experimental Test Plan

MWK train test plan: Further iterations of the test plan were prepared in response to suggestions from all participants. The issues, mainly concerning test sequencing and duration, were resolved satisfactorily and to the benefit of the test plan. There will now be six test campaign through to the end of 1997, three each in combustion and gasification modes. Further, the course of hot commissioning was revised to allow for an earlier start to gasification operation.

Cold commissioning activities are ongoing and is projected for completion by November. Hot shakedown and combustion mode characterization testing will follow with the Westinghouse PCD in service. Next, the CPC PCD will be placed in service for characterization testing. When combustion mode characterization testing has been completed, there will be a hot shakedown in the gasification mode, however it will require only a short time since the sulfator will be the only new equipment. There will be gasification mode characterization tests with both the Westinghouse PCD and CPC PCD next.

With systems proven operational and characterized, performance tests will start around mid-June, 1996. Test campaign 1 will be subdivided into ten 80 hour test periods and run in the combustion mode with the Westinghouse PCD in service. Alabama bituminous coal and Plum Run dolomite will be used with a short limestone test at the end of the campaign. The PCD inlet temperature will be around 1300°F with particle loadings from 4,000 to 10,000 ppmw.

Test Campaign 2, divided into ten 100 hour test periods, will be in the gasification mode with the Westinghouse PCD in service. A Powder River Basin subbituminous coal and an Alabama bituminous coal will be tested with both Plum Run dolomite and limestone. Inlet PCD temperatures will be set at 1200°F and 1400°F with particle loadings varying from 4,000 to 12,000 ppmw.

Test Campaign 3, also ten 100 hour test periods, will be in the combustion mode with the CPC PCD. Again, PRB subbituminous coal and Alabama bituminous coal will be used with both dolomite and limestone. The full range of PCD loadings will be tested at 1300°F. Test Campaign 4 will be similar to Test Campaign 3 except it will be in the gasification mode with inlet PCD temperatures around 1600°F.

Test Campaign 5 will be a combustion mode test with the IF&P PCD in service. Testing will be with Alabama bituminous coal and an alternate high sulfur bituminous coal with both dolomite and limestone. Test Campaign 6 will be a gasification mode test with IF&P PCD with conditions similar to Test Campaign 2 and 4.

Major test variables include: reactor temperature, coal and sorbent types, excess air, Ca/S molar ratio, riser gas velocity, reactor pressure, coal feed point (gasification only), staged air split (combustion only), primary air split, coal grind size, steam/coal ratio (gasification only), PCD inlet temperature, face velocity, and PCD inlet gas loadings.

<u>FW train test plan:</u> Discussions were held between members of FWDC, DOE-METC, and SCS to discuss the test plan outline for the advanced PFBC train. A general approach was discussed and SCS will add more details to the plan before it is issued for comment. The DOE-Contractors meeting held in Morgantown provided a lot of relevant information that will influence these details.

MWK and FW train sampling requirements: To assist with test planning and develop a specification for the lab services contract, a sample frequency analysis was developed for the MWK and FW trains. The analysis outlined what tests and methods were to be performed on the solid and gas samples taken from the two trains. Tests on the solid samples included tests for carbon, hydrogen, nitrogen, total sulfur, sulfides, ash, moisture, particle size, metal oxides, chlorine, volatile matter, ash fusion temperatures, carbonate, and particle and bulk densities. Tests for the gas samples included tests for hydrogen sulfide, sulfur dioxide, ammonia, NOx, hydrogen, nitrogen, carbon monoxide, carbon dioxide, methane, and oxygen. The maximum number of samples and the maximum number of analysis to be performed on these samples were determined.

2.4 PHASE 3 - CONSTRUCTION, PROCUREMENT AND INSTALLATION

2.4.1 Task 3.1 Procurement

MWK Advanced Gasifier train

Several pieces of equipment from MWK arrived at the site this quarter. Twenty two pieces of refractory lined pipe, the refractory lined slide valve, the relay control panels and the cyclones (reactor primary cyclone and the disengager) were received. The analyzer shelter and analyzers remain to be shipped.

Combustion Power Company

Schedule: Refractory lined pipe was inspected May 17-18, 1995 and found to be only 70% complete. By the original schedule the refractory lined piping was to be finished by this time. Inspection was repeated on June 30, 1995 at J.T. Thorpe, Houston and found to be 90% complete.

All pressure vessels and refractory lined piping are fabricated. Refractory installation is complete on the larger pressure vessels and these items have been received in Wilsonville. Items that arrived in May and June, 1995 are: water-cooled heat exchanger, cooling air blower, recuperative heat exchanger, gas/air heat exchanger, some instruments and controls, and assembly equipment.

Latest expected shipment dates are as follows:

Refractory Lined Pipe	July 17, 1995
Boost Blower	July 14, 1995
Valves	June 30, 1995

Instruments	July 21, 1995
Piping spools	August 3, 1995

The fabrication schedule will be updated in July 1995.

Electrical & Controls: The panels were ordered from Automation and Control Specialists in April, 1995. Two panels were ordered. One for field mounting the components that collect information from local transmitters and thermocouples; the other for housing the computer control components in the motor control center.

CPC met with the panel supplier in May and June, 1995. The layout of the genius block panel was reviewed. This is one of two panels that were ordered. The genius block panel houses field mounted components that collect information from local transmitters and thermocouples. The other panel houses the computer control components and will be located in the motor control center.

Most of the instruments were ordered in March and April, 1995. Nine different vendors are involved.

Vendor Materials: The filter internals were returned to PMSC of Memphis, TN in early June for rework. A fitup problem was reported on trial installation at SCS.

Three refractory lined vessels from J.T. Thorpe were received at the jobsite: the filter vessel, the de-entrainment vessel, and the media reservoir. A fourth and fifth inspection of refractory occurred May 17-18, 1995 and on June 30, 1995 at Thorpe in Houston, TX. Refractory installation, thermal drying and painting of the remaining piping was scheduled to be complete in mid-May, 1995, but more work needs to be done. In the June 30 inspection, there was one incomplete item and some minor repairs to be made. These items need to be thermally dried, painted, and shipped to Wilsonville for installation.

The recuperative and gas/air heat exchangers, as a unit, were ordered in September, 1994 from Phoenix Metallurgical in Houston, TX. These items have been received at the jobsite. Code documentation is complete.

The baghouse was ordered on October 12, 1994 from Aeropulse Corporation in Pennsylvania. Approval of the remaining details of the baghouse controls occurred in April, 1995. The pressure vessel is in fabrication. Delivery is expected in mid-July, 1995. A procedure for accessing the baghouse timer during operation was approved by SCS.

The boost blower was ordered in December, 1994 from Susquehanna Valley Systems, Inc. (SVS) in Berwick, Pennsylvania. Submittal drawings were received in February, 1995 from the new owners of SVS, Hy-Bon Engineering Company of Midland, TX. Submittal drawings received in mid-February, 1995 included only a general arrangement which was satisfactory. A complete drawing set was received on June 19, 1995, marked up and returned "approved as noted".

The water-cooled heat exchanger, FL0302-HX03, was shipped in late May, 1995. In May 1995, the heat exchanger supplier submitted the allowable forces on the heat exchanger nozzles. These forces, and moments were much lower than expected. Expansion joints had to be added to isolate the heat exchanger.

The cooling air fan, FL0302-FN01, was shipped in late May, 1995. Piping spools were ordered from R.L. Morton & Sons, Taft, CA. Shop details were reviewed and approved in mid-June, 1995.

Industrial Filter and Pump

Fabrication of the pressure vessel is nearing completion and is scheduled to be finished on August 5, 1995. It will then be trucked to IF&P for refractory lining. An alternate refractory liner has been selected to expedite delivery of the filter vessel.

Peripheral materials, including high speed automatic jet pulse valves plus automation components are on-site at IF&P. The majority of materials for the internals are on order.

Westinghouse Filters

FL0301 was delivered to PSDF on March 23 and erected into the structure in early May. The pulse and instrument skids for FL0301 were delivered on June 26 along with two boxes of gaskets for the vessel. The tubesheet, cluster assembly and three boxes of candle holder hardware were delivered on June 27.

The only remaining items for FL0301 are the instrumented flange cover assemblies as well as the ceramic candle filters. Westinghouse is holding these until SCS is ready to install them.

Fabrication is proceeding with FL0352 and completion is expected by 9/30. The delay was caused by vendor fabrication problems and Westinghouse is trying to expedite the delivery if possible. The back pulse and instrument skids have been assembled and tested. They are ready for shipment to the PSDF, but will be held back at the vendor's site for some time, pending availability of appropriate storage at the site. Fabrication is nearly complete for the FL0352 internal metal structures.

Control system database layout on IBase V for Windows was completed and sent to SCS for both FL0301 and FL0352. Pulse control logic specifications for FL0301 were communicated to SCS.

SRI Particulate Sampling

In April, Howmet Corporation received the wax patterns for the cyclone manifold from SiCAM and produced the first ceramic mold for lost-wax casting. The first casting was produced in May and initially appeared to be a good casting. Subsequent removal of the ceramic cores revealed that one of the cores had broken, causing a discontinuity in one of the interconnecting tubes. A second ceramic mold was prepared, and Howmet produced the second casting in June. The core removal for the second casting is scheduled for July, and Howmet has promised to deliver the second casting by July 21.

The parts for the cascade impactor assemblies (precutters, impactor shells, and bauxite cartridges) were received from Alloy Engineering in June. All of the parts appear to conform to the fabrication drawings, but some minor machining will be required to prepare the parts for use. The impactor stages will be produced next quarter.

Procurement of sampling system components continued in April, May, and June. Items ordered this quarter included:

- Orifice plates for measuring flow rates of purge nitrogen and sample gas
- Tubing and fittings for purge nitrogen, instrument air, cooling water, and sample gas
- Pressure gauges for air and water lines
- Thermocouple assemblies for measuring sample gas temperature
- Packing for probe packing glands
- Port sleeves for acoustic detectors and sniffers

Santek Engineering continued to work on the assembly of the sampling system components. Two change orders were issued to Santek in June to cover various design changes that were required to ensure proper alignment of parts. The change orders also covered fit testing and modification of the sampling probes and test cycling of the high-temperature ball valves.

In May, Santek finished work on a prototype version of the control panels for the nitrogen purge systems. The prototype was based on layout drawings supplied by SRI. Following inspection and approval of the prototype, five copies of the prototype panel were produced. In June, SRI delivered layout drawings of the control panels for the sample gas, instrument air, and cooling water systems. Controls for these three systems will be consolidated in a single control panel. These control panels should be completed in July.

In-Control, Inc. completed the assembly and wiring of the control cabinets for the I/O buildings and began work on the control program for the sampling systems. In June, In-Control delivered a preliminary outline of the control program that was based on the operating procedures contained in the Design Document.

During the past quarter, SRI continued to coordinate with SCS on the requirements for equipment delivery and installation. In June, both parties agreed to postpone the delivery of the sampling systems to allow time for construction personnel to finish the installation of the heavy piping before the sampling systems are installed. This change in the delivery schedule was made to minimize the risk of damaging the sampling systems during the construction activities. Current plans call for installing the sampling systems in September.

SRI continued to coordinate with Nolan Multimedia on the training video for the particulate sampling systems. The video will be shot at Santek Engineering on July 27 and 28.

2.4.2 Task 3.3 Construction and Installation

Construction - Civil

The construction civil work at the site continued with support activities associated with Mechanical and Electrical installations. The MWK and FW equipment that were received were unloaded and prepared for short-term storage. The concrete work on the coal storage structure was completed. J.T. Thorpe completed the refractory lining of the FW FBHE vessel and the two alkali getter vessels. Painting of the fire protection water storage and other miscellaneous tanks was completed. Foundation and walls for the electrical building housing the switchgears, starters and circuit breakers were completed. The roof for the coal storage structure was completed. The grading work for additional storage space on the south side of project is continuing. Steel City completed steel erection for Sequence 4 (MWK and common bay to 218 ft) and Sequence 6 except for some hand rail and grating and began erecting Sequence 5 steel (FW side). Process structure equipment continues to be set-in in conjunction with erection of structural steel. All major MWK equipment, including reactor loop, from grade level through Sequence 4 steel is set in the structure. Ring beam foundation for service water tank was completed. The erection of service water tank has begun.

Construction - Electrical

The duct run into the electrical building was completed during the quarter. Telephone, data and cubicle power in the new administration building/control room are essentially complete. Foxboro DCS cabinets were received and set-in the control room and MWK and FW I/O buildings located next to the structure. The fiber optic loops were pulled between the DCS cabinets located in the control room and MWK and FW I/O buildings. The Foxboro DCS cabinets are on temporary power. The conduits from Foxboro cabinets in MWK and FW I/O Buildings to cable trays were installed. The installation of cable tray in the process structure has begun. Telephone and data circuitry was installed in the new warehouse maintenance building. The duct run and grounding to the adjacent E.C. Gaston steam plant was completed. Work on cable tray in the MWK and FW MCC buildings was completed. The distribution panels, pump control panels and transformer were installed in the fire protection pump house. Fire protection pump house transformer and distribution cabinet are on temporary power. Fire protection pump house controls check-out essentially complete, awaiting last total system check-out. The installation of lighting and grounding in coal and limestone storage areas is continuing. The installation of public address system in the process structure has begun. The 4160 volt and 480 volt switchgear and transformers was set in the electrical building and administration building equipment room. Final set and bolting together of 4160 volt switchgear complete. Work on 4160 volt switchgear has begun to cleanup Cutler Hammer's non-compliance to specification. The Alabama Power Company (APCo) is continuing work on the substation.

Construction - Mechanical

Exhaust system for diesel fire pumps was installed. Raw water and Demineralized water lines were installed from railway tracks to E.C. Gaston's intake structure. Potable water system was checked for bacteriological results. Mechanical inspection of administration and warehouse buildings was completed by Shelby County inspection services. Sewage disposal system was completed and checked out. A tracking program for piping materials was established. The fabrication of small bore pipe spools was started. During the quarter, nine pieces of MWK equipment was rough set in the process structure. Piping to the controllers in the fire protection building is complete.

The HTF system piping and the main air compressor piping is in progress. Electric and air tuggers have been installed in the structure to assist in piping and equipment installation. Service air and instrument air piping are in progress. Also, installation of piping in the pipe trench is in progress.

The trial fit-up of the MWK transport reactor loop is complete and the final fit-up has begun. As of 6/30/95, 2,050 feet of pipe has been installed in the process structure. Installation of bottom layer of pipe in the pipe trench is continuing, with 725 feet installed (plus 960 feet fabricated). About 80% of the shop fabricated pipe for MWK has been received and 60% of the pipe supports and hangers are on site. The MWK small bore, field fabricated pipe, and fittings order is 85% complete.

2.4.3 Task 3.6 Preparations for Operations

Wilsonville Interactive Learning System (WILS)

WILS will contain a series of Interactive Video Training (IVT) modules on a variety of tasks. The technology resource modules provide a highly usable, visually-based information on each technology at the Wilsonville facility. Both the technology resource and training modules are being developed concurrently with construction of the facility using 2D and 3D graphics and animation. Training modules will be completed prior to commissioning of each train to allow time for operator training; they will be revised and augmented with video following the shakedown period. WILS is being developed for delivery via a series of Windows-based interactive CD ROMs. As described below, significant progress on the WILS project was made this quarter in a number of key areas.

Based on test frames prepared by ModelVision (Madison, AL), Nolan had the Intergraph model altered to include solid floors so that each level would be visually isolated. Nolan also had various layers of the model turned off so that components could be seen more clearly. These alterations improved the quality and usability of the images considerably.

Near the end of May, SCS and Nolan reviewed the model before visiting ModelVision to obtain the visual material. SCS requested a change in the design of the training module that features these views. The outcome was a new specification for a "Familiarization" Training module. As per the new design, ten 3D views of each level of the Transport Reactor train were created, as well as a set of cross sectional (floor plan) views. These images provide the basis for a series of find-the-component exercises, and a host of other purposes, including: “You Are Here” views in the

Familiarization and Tech Resource modules, and in the Operations modules. They will also be included in the WILS Archive. A total of 123 views were ordered. ModelVision rendered the views and sent them to Nolan on Syquest cartridge.

One of the training modules is the Familiarization (Component Identification) Training module which presents 3D side views (at eye level) of each of the 9 levels of the Transport Reactor train, and asks the user to identify a component in a particular view by clicking on it. The purpose of this module is to familiarize on-site personnel with the relative physical size, shape, and location(s) of key components in the Transport Reactor train. A secondary objective, addressed in the quiz questions, is to promote systems thinking; that is, to assist operators in realizing which components are logically connected into the various systems of the Transport Reactor train -- to make the connection between process flow and physical components. The process descriptions and operations of these systems are addressed in the Technology Resource modules and in the Operations Training (Computer Based Training, CBT) module.

There are a total of 100 such exercises in the Familiarization module. Each time a user accesses the module from the Advance Organizer/Start screen, one of four sets of 25 exercises each are randomly selected by the program for the user to work with. The estimated length of time to complete the session (1 set of 25 exercises) would be 15 minutes for experienced personnel and up to 1 hour (including all the options and features described below) for inexperienced personnel. The Advance Organizer/Start screen provides brief instructions (text) and the module objective.

The Familiarization module will utilize the same graphical user interface, and many of the features and navigational conventions already developed in the Technology Resource modules, and will share certain conventions with the Operations Training (CBT) module as described in this document.

Transport Reactor Train (K-train) graphics development continued on the Gas Cleaning, Solids Handling, Transport Reactor, Recycle Gas and Steam systems. Nolan sent color prints to SCS for review; graphic screens were then corrected and script changes were made.

This quarter, Nolan received the electronic version of MWK's draft Operation instructions manual. This document has provided the basis for developing a preliminary training module under the heading of Operations. Nolan had planned to structure this information in parallel with MWK's own Table of Contents; however, SCS requested a change in the type of access to the information. To this end, the K-train "graphic menus" (i.e., graphics which portray whole systems and provide branch points to information segments on specific components) have been changed (and altered as needed) to become a new graphical front end for the Process Description module. This graphical interface is specifically for new users until they become familiar with the various systems at the PSDF. Experienced users will be able to access the same information more quickly through an alphabetic index.

Development of other modules in the Operations section, such as startup and shutdown procedures, will begin once the information is received from SCS. Other assets that are being developed for the Technology Resource modules, such as stills, engineering drawings, and 3D views, will be made accessible as appropriate from these primarily text-based modules. Delivery of this module is currently expected to be mid-August.

Production moved forward with the processing of HGCU Tech Resource graphics and animation. Computer programming and integration for HGCU then began. SCS received the first draft of the APFBC Train script in June. The script will be reviewed by project team members for completeness, correctness, and overall quality and the comments returned to Nolan.

Nolan finalized the script and made other preparations for the production of 3 short interactive video modules on Sampling Procedures to take place at Santek in Guntersville, AL in July. Earlier in the same week, the on-camera interviews with key executives and engineers will be taped at Alabama Power Company headquarters.

Training/Operation Procedures

A detailed review of the MWK Operating Instructions Manual was completed and comments were forwarded to MWK. Operations personnel are continuing to review system descriptions and drawings, and are developing startup and operating procedures for assigned portions of the MWK train and BOP systems. The detailed procedure for the startup and operation of the MWK Startup Burner was completed. Detailed procedures for startup and operation of the MWK train in the combustion mode, the service/instrument air system and the main air compressor are being developed.

Preparations for instruction of operations personnel continued this quarter. A comprehensive training manual was near completion at the close of the quarter. The manual incorporates technical and system information for both the MWK process and BOP components. Development of the FW process portion will begin after operator training has been conducted on the MWK components. Work has begun on Instructor Guides for Operations Instructors. This will provide information from the training manual in outline form while giving space for the instructor to individualize his/her guide for their teaching style.

Plant and vendor P&IDs were digitally scanned for operations and training use. It is planned to include portions of P&IDs in the text of the training manual. A comprehensive set of P&IDs will be included in the appendix of the manual. Work began on a composite diagram for the MWK system, to provide a ready reference to all plant components, greatly benefiting both operations and training.

Procurement

Plans and P&IDs were developed for chemical injection and chemistry monitoring of the MWK condensate system, closed loop cooling systems, circulating water system (cooling tower), and wastewater treatment system, and an inquiry for specialty water treatment chemicals was issued. Based on a reevaluation of the specific requirements of PSDF water treatment, the decision was made to purchase the chemical feed systems and commodity chemicals and bid the specialty chemicals required. This approach is anticipated to save $10,000 - $15,000 annually because of the short payback period of the vendor supplied equipment as well as eliminating the need for a part-time chemical vendor technician on the job.

Negotiations are continuing to secure a labor broker for the O&M labor staff. Bids were evaluated for the Instrumentation technicians service agreement, and contracts should be awarded in July.

Construction and Installation

As some of the MWK equipment is being assembled in the Process Structure, Operations personnel are observing the assembly for information and to suggest changes to improve maintainability. The trial fit-up of the main reactor vessel has been completed and final assembly of the reactor has begun. The level-up of the process air compressor has been completed, and the alignment of the motor is progressing. The piping installation to the compressor and reactor system is on-going. Several of the operations and maintenance personnel have been involved in the installation of the CPC PCD internals, as much for information as to ascertain the severity of a deviation of roundness and it's impact to operation of the PCD. The Sulfator Fines Screw Cooler was found out of square and was unable to be aligned in present form; the screw cooler is being returned to the manufacturer for inspection and repair. Installation of piping and components is progressing, with much equipment being rough set.

Commissioning Related Activities

Work was completed integrating the MWK start-up activity plan with the Construction and Engineering schedules to identify critical systems and components that require expediting to maintain the overall schedule to commission the MWK reactor this Fall. Present projections indicate completion of commissioning activities and combustion achieved late Fall, barring major problems in component fit and operation. Work is continuing in the development of detailed component and system commissioning action plans for the MWK and related BOP equipment.

Using the blind and spool list provided by MWK as part of the draft copy of the operation instructions manual as a starting point, a preliminary guide has been produced detailing the correct position of each blind and removable spool for both combustion and gasification mode operation.

Work was begun in developing a FW Commissioning schedule, which will then be integrated into the Construction and Engineering schedules to identify critical systems that require expediting. Due to critical FW supplied equipment delivery dates, the FW equipment will not begin commissioning until spring '96.

Pre-installation testing of the 4160V and the 480V switchgear had identified several control relays that were incorrectly installed or failed. These relays were replaced before the switchgear was located in the switchgear house. This early testing allows replacement of the defective devices without impacting the operations schedule. The Distributed Control System was energized in early May and is continuing system testing and configuration updating.

Engineering provided field support for pumps and piping installation of fire protection pumphouse and provided field support for cleaning, repair, and painting of fire water storage tank. The Fire Pump House, its pumps and controllers were tested and pre-commissioned on May 24. These pumps and engines were salvaged from the former PETC Coal Liquefaction project located at Wilsonville, and had been refurbished prior to installation. The diesel engines were tested several months ago, but with the embedded fire header installation complete, as well as the pump house construction being completed, the system controller was energized, the header charged, and the pumps were capacity tested.

Operation and Maintenance

Operations personnel visited FW's pilot plant in Livingston, NJ April 26 and 27 to observe operation of the integrated Carbonizer/Combustor facility. Design hazard review meetings were conducted on the BOP P&IDs, Allison gas turbine, Westinghouse topping combustor, and for the dense phase conveyors for coal, limestone, and ash. Operations, Maintenance, and Safety personnel attended a lockout/tagout seminar in Birmingham to learn about the requirements for implementing OSHA's lockout/tagout program at the PSDF. A draft of the site lockout/tagout procedure was completed. The connected KVA for the entire plant was updated. The electrical loads anticipated during operations with one of the trains operating, both the trains operating simultaneously and both the trains not operating were determined (Appendix B).

Maintenance Shop, Spare Parts, Chemicals

The Maintenance Shop has been used as a storage test shop for the switchgear prior to the switchgear's installation in its various locations; and therefore little has been done in setting up the machine shop tools. There is an on-going evaluation concerning the addition of mezzanine offices in the shop that is also affecting the shop layout.

Work began in selecting a maintenance Work Order Management System for both planning and archiving purposes. The system should interface with the materials management software for cost tracking, and may offer quicker invoicing and payment to the labor brokers. The Work Order Management System, spare parts listing, equipment tagging and database organization have been ear-marked as potential summer student activities requiring nominal supervision.

Maintenance Inspection and Procedures

Summer students have begun collecting, sorting and filing the various vendor and engineering documentation on the project's equipment and systems. This work will progress into the collation of various recommended procedures for maintenance and operation. This work will also include the collating of spare parts lists for evaluation and procurement.

Data Management Development

A set of reports to be used to aid in the writing of the Data Analysis software have been prepared. The program is to be used to perform material and energy balance calculations on the MWK process. The reports detail such item as the needed instrumentation for the calculations, the format of the input data files, the grouping of data for output and archive files, and the organization of the printed reports. Other information, such as heat capacity data for the chemical components involved, that will be needed by the program have also been collected.

The development of data management programs has been in progress since May. This software is completely menu driven and runs in Windows environment. Once completed, the programs will include direct reading of raw and reduced data from DCS and laboratory database, performing system material and energy balances, analyzing operation data, writing reports, and carrying out model computations. By the end of second quarter, the following programs have been completed:

- input and output menus and dialogs
- read raw data from DCS files and calculate averages, flowrates, etc.
- calculate the system material balance.
- calculate physical properties of various streams such as combustion heat of coal and viscosity of gas stream at different temperatures, gas densities and particulate size distributions.

3.0 PLANS FOR FUTURE WORK

1. Complete an orderly closure of the contract with UND/EERC.

2. MWK will continue to provide construction field support. MWK personnel, who put together the reactor erection procedure, will be at the site as needed during the final fitup of the transport reactor, combustion heat exchanger and the startup burner. The work on the operation instructions manual will be completed and a draft copy of the maintenance and inspection manual will be issued. A final report on implementation status of the DHR suggestions on the transport train will be issued.

3. FW will continue towards completing work on the detailed design of piping, electrical and instrumentation systems. The P&IDs for the MASB and gas turbine will be reissued based on implementation of suggestions from the design hazard review. The CPFBC and the FBHE will be installed in the process structure along with the Sequence 5 steel erection. The FW operating instructions procedure writeup and commissioning (cold and hot shakedown) sequence and schedule activities will start in the next quarter. A design closeout punch items is being prepared for the expected finish of the detailed design by August.

4. SCS engineering will continue acquisition and expediting of purchased equipment for the balance-of-plant design. DCS configuration will continue for the MWK and BOP portions. SCS will continue to design steel and foundations for the remaining equipment. Electrical and instrument acquisition will be an on-going activity.

5. Construction at the PSDF site continues. Steel City (steel erectors) will continue work on the FW and common bay steel and set equipment. The process structure elevator is in use. Continuing electrical work will involve work on the lighting, duct runs, grounding and conduits in the process structure and in the coal and limestone storage areas. Mechanical will continue with fit-up of the transport reactor loop and the installation of pipe.

6. Installation of the granular-bed filter equipment has started. This process was slowed by fit-up problems with the filter internals. Alternatives for resolving this problem are being considered. Refractory lined pipe delivery has been delayed the most. Equipment will arrive in Wilsonville through August, 1995. Filter media material may not arrive until October, 1995 since it is not needed until shakedown.

The assembly drawing for the entire granular-bed filter will be issued in July, 1995. This drawing will confirm the details of the installation of all filter items. Some supports details are still being worked out.

7. Outside consultant Mallet Energy Resources Corporation (MERC) continues to assist in internals design. In early July, they will spend three days at IF & P to this end. Another office of MERC is concentrating on thermal profiles and induced stresses and will report shortly.

8. Delivery of the instrument and pulse skids for FL0352 are planned for July. Delivery of the used candles from Tidd should occur during the third quarter. Discussions are underway to decide on the composition of the initial set of virgin filters. The initial set will probably consist of filter elements from Coors, Pall, Dupont, 3M and possibly Schumacher.

9. In the coming quarter, Howmet will deliver the prototype cyclone manifold, and SRI will machine the manifold's receptacles to match the cyclones. The cyclones will then be match lapped to the receptacles. The complete assembly should be ready for testing in the SRI's combustion facility in August or September. Final machining of the cascade impactor parts will be finished, and the impactor stages will be fabricated. Development of the control program for the sampling systems will continue. Final versions of the P&IDs and wiring diagrams will be delivered in August.

10. Nolan will continue with the development of the Wilsonville Interactive Learning System modules along with the instructional design activities. Work will continue towards completing the technology resource modules for the transport reactor train. The transport reactor train training modules are in preparation and a draft version is expected to be completed by early August.

11. O&M personnel will continue integration of the start-up activity plan with the Construction and Engineering schedules to identify critical systems and components that require expediting to maintain the overall schedule to commission the MWK and BOP areas. Also, work will continue in the development of commissioning test plans, monitoring the component installation, updating the MWK start-up plans and initial development of the FW start-up plan. Operations personnel will continue preparing operating manuals and training materials for the MWK and BOP systems.

The Maintenance staff will continue preparing for operation by compiling maintenance procedures, organizing the plant drawing files (both paper and electronic), and preparing the maintenance shop. In addition, activities associated with the Work Order Management System, equipment tagging, and database organization will continue, and preparation of spare parts lists and procurement of warehouse spares and other materials will begin.

The Maintenance support staff will begin instituting the predictive/preventive maintenance programs, beginning with planning for several possible plant modifications that may take place in mid-1996. Also, work required by Maintenance in support of Engineering and Construction activities will be defined.

The remaining Maintenance staff positions (Mechanical Engineer and Designer) should be filled during the next quarter. Negotiations should be completed on a contract for the supply of operators and mechanics, and a labor broker will be selected for providing instrumentation technicians.

The development of the Data Analysis programs will continue. A system energy balance will be developed for the MWK train. As progress is made, the programs will continue to be tested for errors and suitability. Work will begin on similar programs for use with the FW train.

APPENDIX A

LLB FILTER TECHNOLOGY

LLB Filter Technology

LLB Hot Gas Filter Technology

Introduction

In 1987 Deutsche Babcock Energie- und Umwelttechnik AG (DBE) - in parallel to the research on the Pressurized Fluidized Bed Combustion (PFBC) system - began an extensive development program on hot gas filtration. As a result of this work, DBE developed in its 15 MWth PFBC pilot plant a new hot gas filtration technology for temperatures up to 850 to 900 °C. Today this filter technology is available through LLB Lurgi Lentjes Babcock Energietechnik GmbH (LLB). This company now offers all fluidized bed combustion systems earlier marketed by Lurgi AG, Lentjes AG and DBE.

Gas Temperature	up to 850 °C (oxidizing) up to 600 °C (reducing)
Raw Gas Particulate Load	up to 200 g/kg and more
Clean Gas Conditions Dust Content Maximum Particle Size	 < 5 mg/m³ (STP) 5 µm
Allowable Pressure Drop Normal Operation Failure Operation	 up to 0.25 bar as designed (1 bar and more)
Scale-up	200 up to 2000 candles/vessel and more
Failure Supervision and Limitation	
Simple Erection	
Simple Maintenance	

Table 1: Design Goals for the LLB Filter Technology

Table 1 shows LLB's the development goals for applications at elevated pressures and temperatures. This table illustrates the quite different challenges compared to existing filter technologies.

General Description of the LLB Hot Gas Filter System

The LLB hot gas filter concept was developed during the design and operation of the LLB 15 MWth pilot plant. Figure 1 shows a schematic of the LLB hot gas filter concept. An explosion sketch in Figure 2 is showing the details of the arrangement.

In the LLB design the candles are supported from the bottom and seated on a header. The hot gas passes the porous structure of the ceramic filter elements while the dust is kept on the outer surface of the candles. Clean gas within the candles is collected in the clean gas headers supporting the candles. From the horizontal header the clean gas is supplied to the vertical header structure and from there it is leaving into the clean gas duct.

The horizontal headers have a gas tight interface near to their middle. Those parts of the horizontal headers which supply their gas to the same vertical header are forming a group. Headers in different elevations but attached to the same vertical header belong to the same group. Groups are cleaned at the same time.

The material deposited on the surface of the candles increases the pressure drop of the system. As in conventional bag house systems cleaning is necessary using compressed gas(e.g. air, nitrogen, carbon dioxide or clean flue gas) by forcing such gas into the clean gas header. This causes the clean gas in the headers to reverse its flow, increasing slightly the pressure in the clean gas system and subsequently dislodging the dust cake from the candle surface.

The dust removed from the candle surface is falling down into the ash removal area. This is possible through gaps formed between the headers of the filter internals. The ash eventually is removed from the system.

The basic concept of the filter design is a straight forward approach to cocurrent flow conditions inside the filter vessel. This is done by feeding the dust or ash loaden gas from the top of the vessel. Whenever the filter is cleaned and the dust dislodged from the candles falls into the ash removal system this will be in parallel to the raw gas supplied to the process.

LLB's part in supplying such filters is to provide basic and detailed engineering services including procurement, construction and commissioning of such filters.

Major emphasis needs to be put to the choice of candle materials which decide about success or non-success of a filter. The LLB filter technology mostly can easily use the numerous developments of ceramic materials which currently are available or will show up in the future. Detailed discussion is necessary about the choice of a candle and the specific process conditions. LLB is ready to give specific recommendations.

Characteristics of the LLB Hot Gas Filter Technology

The main advantages of the LLB hot gas filter technology are as follows:

- The construction method utilizing multiple levels of candles produces a compact arrangement of a large number of filter candles. The technology allows to install 2,000 or more candles in a single pressure vessel.
- This compact arrangement means that a given number of candles will fit into a pressure vessel of smaller diameter compared to other hot gas filter designs. Therefore, a less expensive workshop fabrication with better quality control is possible and transport is easier.
- The simple and compact arrangement method makes for easy scale-up of the filter vessels to larger sizes. The limiting considerations are cost of shop fabrication and transport of large vessels.
- In the LLB system a tubesheet is not used as a supporting structure. Additionally, usually there is no extra cooling requirement for the support structure.
- Cold medium used as cleaning gas does not directly contact the ceramic candles. In the current design pulse cleaning gas mixes with hot cleaned gas to form a hot cleaning gas for the ceramic candles. This avoids thermal shock on the ceramic.
- Unlike the tubesheet designs, increased pressure drop through the candles actually presses the candles more tightly in their seats.
- The ceramic filter candles are located on support headers with additional weights on top of the candles. The sum of the candle weight and the additional weights produces a compressive stress state in the candles in normal operation. A compressive stress state is favorable for ceramic material. Therefore, forces due to vibrations or the gas flow have less negative effects on the bottom-supported candles than in the case of hanging candles.
- If a candle cracks, the crack will be pressed together and sealed due to the compressive stress state in the candles during normal operation.

- Unlike the tubesheet designs, it is easy to change filter candles because there are not rigid connections between the filter element and its support seat.

History of the Filter Development

LLB began the gas cleaning development program during the operation of the 15 MWth test facility. Initially there was a parallel arrangement of a multicyclone and a hot gas filter. The later one based on 24 ceramic candles held in a tubesheet. Very soon after commissioning the test facility it was found that the multicyclone did not reach the expected levels of dust removal to meet the given emission standards.

In parallel engineering work estimates have shown that with a tubesheet design the number of candles to be arranged in a single pressure vessel is limited. For larger applications like PFBC based power plants therefore several hot gas filter pressure vessel would be needed. As a result of this situation, LLB started to develop its own new design.

In the first step LLB used the original pressure vessel of the multicyclone to install the new concept. The design allowed the installation of two levels of 28 candles each only because of the restrictions of the pressure vessel diameter. Although this led to high surface velocity and high differential pressure across the filter the operation was mostly reliable. At that time LLB operated the PFBC pilot plant with two filters in parallel: one filter was a tubesheet designed and the other was a LLB designed.

In 1991, LLB changed the from bubbling PFBC process to a circulating (PCFB) process. This occasion was use to change the remaining tubesheet-design filter into a LLB-designed new filter with 21 candles.

In 1992, LLB designed a filter with 184 candles in two levels to replace of the filter with the 21 candles.

Operating Experience

LLB has operated several filter configuration in its PFBC/PCFB test facility in Friedrichsfeld near Oberhausen/Germany. Those tests have been done for a total of about 3000 hours. Five different configuration have been tested - more of them different in size to meet the requirements of the specific processes (PFBC or PCFB).

The overview in Table 2 gives details on the range of parameters at which the filters have been tested. HGF stays for Hot Gas Filter. The different configurations tested are those of the bubbling PFBC work (HGF 1 and HGF 2), of a first mode of circulating PCFB operation (HGF 3) and of the final version of the circulating PCFB design (HGF 1/2 and HGF 2/4).

		HGF 1	HGF 2	HGF 3	HGF1/2	HGF 2/4
Type of Filter		Standard	LLB	LLB	LLB	LLB
Number of Candles	(-)	24	56	124	21/56	56/184
Face Velocity	(cm/s)	2-3	5-7	3,5	5-6	1-3
Operating Temperature	(°C)	700-850	700-850	450-750	700-850	700-880
Operating Pressure	(bar)	~ 16	~ 16	~ 10	~ 12	~ 12
Pressure Drop	(mbar)	100-150	500-800	200-450	500-800	50-100
Mean Particle Diameter	(µm)	2-5	2-5	200-300	5-10	5-10
Particulate Load	(g/m3(STP))	~ 5	~ 5	~ 2.500	~ 50	~ 50
Operating Hours		~2.000	~1.500	~ 300	~ 400	~ 400

Table 2: Hot Gas Filter Conditions during LLB PFBC/PCFB Tests

The data show that the development mainly has been done operating the filters in a temperature range between 600 °C and 850 °C. Thus the more difficult development at elevated temperatures has been done first allowing today to design this filter technology also for more moderate conditions like IGCC and others.

The first installation LLB supplied for such process has been designed for the High Temperature Winkler (HTW) gasification process demonstrated by Rheinbraun AG in Berrenrath/Germany.

This unit contains about 600 candles which are arranged following the characteristics of the LLB technology including a full cocurrent flow condition between raw gas and dust cake. The unit is operated at about 300 °C and 10 bar. Figure 3 shows the general arrangement of the system.

The unit has been commissioned midth 1993. All expectations have been met or even exceeded - no failure, stable pressure drop conditions, less cleaning medium consumption, less cleaning medium pressure. It has been decided to use the same concept for the large German HTW demonstration KoBra in the range of about 300 MWe.

Based on the same technology LLB received a contract late 1993 to supply this technology for the Spanish IGCC Project Puertollano. This unit will produce roughly 330 MWe using Krupp Koppers PRENFLO gasification technology. The filter system for that power plant will consist of two filter vessels with about 1000 candles each. The design using a header structure inside the pressure vessel has been customized with single penetrations for all vertical headers including shut off valves - this configuration is shown in Figure 4. The shut off valves allow to shut down groups of candles in the event of any failure and thus to continue operation.

Research and Development

Besides the hot gas filter experience in its own pilot plant and in its first installations, LLB has also been pursuing fundamental and theoretical research and development. The most important activities are described in the following paragraphs:

Four Candle Filter Cold Filter Test Rig. The cold filter test rig with 4 candles is shown in Figure 5. Each candle is cleaned individually by a solenoid valve. With this rig, different dusts, different dust loading, different candles can be tested as well as pressures in different locations during cleaning back pulse can be measured.

Valve Test Rig. The fast acting pulse gas valves in the pulse gas system of a hot gas filter are an important component. The opening time characteristic is one of the most important parameters. The valves have to function in a repeatable and concise manner over their whole operating lifetime to guarantee a consistent and controlled volume flow to clean the candles.

To test the consistency of the opening time characteristic, LLB designed and built a valve test rig which is shown in Figure 6. In this test rig, LLB can get information about the performance characteristics and effective life of a proposed pulse gas valve for a hot gas filter.

Different valves have been tested up to 200,000 pulses each. Figures 7 and 8 show actuation characteristics of two different types. Figure 7 shows that within 30,000 pulses, the pulse time duration of valve 1 changes by a factor of two. Consequently, once placed in a pulse gas system of a hot gas filter, this valve will not function in a repeatable or reliable manner over its whole operating life, and a repeatable and controlled volume flow to clean the candles is not guaranteed. On the other hand, Figure 5 shows that valves are available operating in a repeatable manner over a long service life.

Ceramic Material Tests. In the DBE laboratory several ceramics have been tested in a synthetically-produced coal fuel gas atmosphere. The main parameter of these tests is the gas temperature. The mechanical properties of several samples are being tested after exposure at different temperatures to check corrosion rates.

Together with the Deutsche Fraunhofer Institut, LLB tests the mechanical properties (e.g. fatigue strength) of several candles materials at room temperature and at elevated temperatures up to 850 °C. Additionally, thermal shock susceptibility of different candle materials is tested to determine the reasons for candle failure.

R&D Cooperations. In a cooperation with RWE Energie AG, Schumacher Umwelt- und Trenntechnik GmbH, Rheinbraun AG and LLB, the University of Aachen, funded by the German Government, is pursuing a research program with the following purposes:

- basic research on dust permeability (theoretically and experimental)
- filmed records of the blow-off (cleaning) process
- numeric calculations of the blow-off process (the motion of temperature and pressure fields in the candles)
- the dependence of candle lifetime on gas temperature and number of cleaning cycles
- candles resistance to thermal shock

Since 1986, the Lehrstuhl für Wärmeübertragung und Klimatechnik at the University of Aachen is operating a filtration test facility using six rigid ceramic filter elements as shown in Figure 9. In this test facility the tubesheet supports an array of six ceramic candles. The unit can be operated up to about 850 °C. Several dusts produced in real environments like PCFB, gasification will be tested to the determine basic behavior.

A small unit for testing the permeability of quite of a lot of different ashes/particulate matter was also built at the University of Aachen. The test facility is shown in Figure 10. It consists of a vertical pipe with a circular test filter in its lower section. Dried air, or nitrogen in the case of elevated temperature, in a laminar flow situation disperses the dust onto the test filter. Fly ash permeability can be calculated from the flow and pressure drop measurements. The entire test vessel can be heated to 850 °C to test the effect of temperature on the permeability of different fly ashes.

In another cooperation (Schumacher Umwelttechnik GmbH, Fraunhofer Institute (ceramic research), Technical University of Karlsruhe) LLB is pursuing other fundamentals related to filtration under oxidizing and reducing atmospheres. This program is more related to work on improvement of ceramic filter candle material and is also funded by the German Government.

With this own efforts and the extended cooperation in the field of R&D around filtration at elevated temperatures and pressures LLB has access to outstanding know how in this area.

Scale-up Potential

The scale-up of hot gas filters is a function of a number of factors. These include the following parameters:

- number of candles
- temperature
- pressure
- particle loading
- particle size distribution.

The LLB approach is to limit the size of the filter vessel to diameters that can be shop fabricated. Since in this concept the candles are not supported from a tubesheet, 2,000 or more candles can be installed in a single vessel. Projects requiring a greater number of filter candles would be supplied with multiple modules. This shop fabricated modular approach offers several advantages:

- smaller overall dimensions (vessel, piping, valves)
- improved quality control during fabrication
- thinner walled, lower weight vessels
- shorter overall installation time.

Summary

LLB has continued the effort of DBE to develop a reliable filter technology which is suited for high temperature applications like pressurized fluidized bed combustion (bubbling and circulating) as well as for gasification application which operate under reducing atmospheres and moderate temperature. LLB today is able to supply large filter systems for such processes.

Further LLB is prepared to enter other areas where filtration at elevated temperatures and pressures might help to redesign processes which today are designed as they are because the task of filtration couldn't be done so far.

LLB offers complete supply including of such unit including - but not limited to - all necessary engineering work, procurement, construction and commissioning.

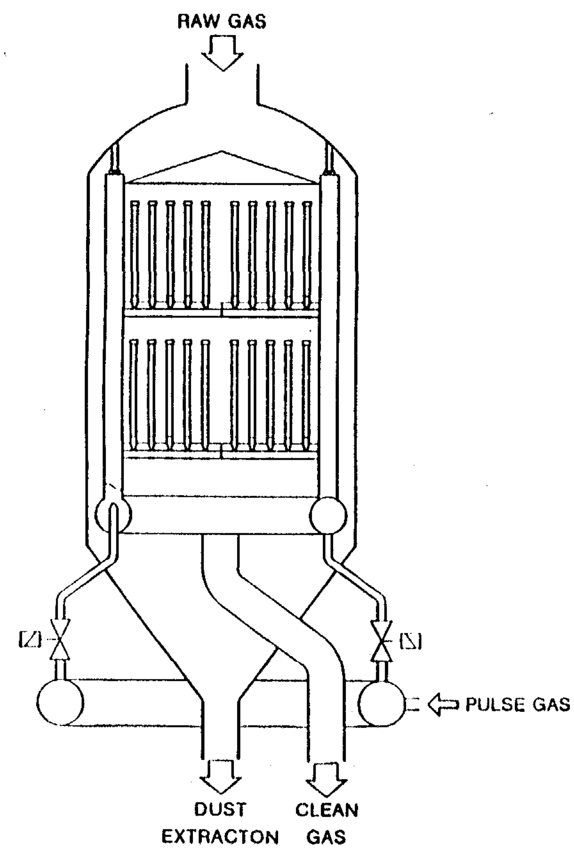

Figure 1: Basic Concept of LLB Filter Technology

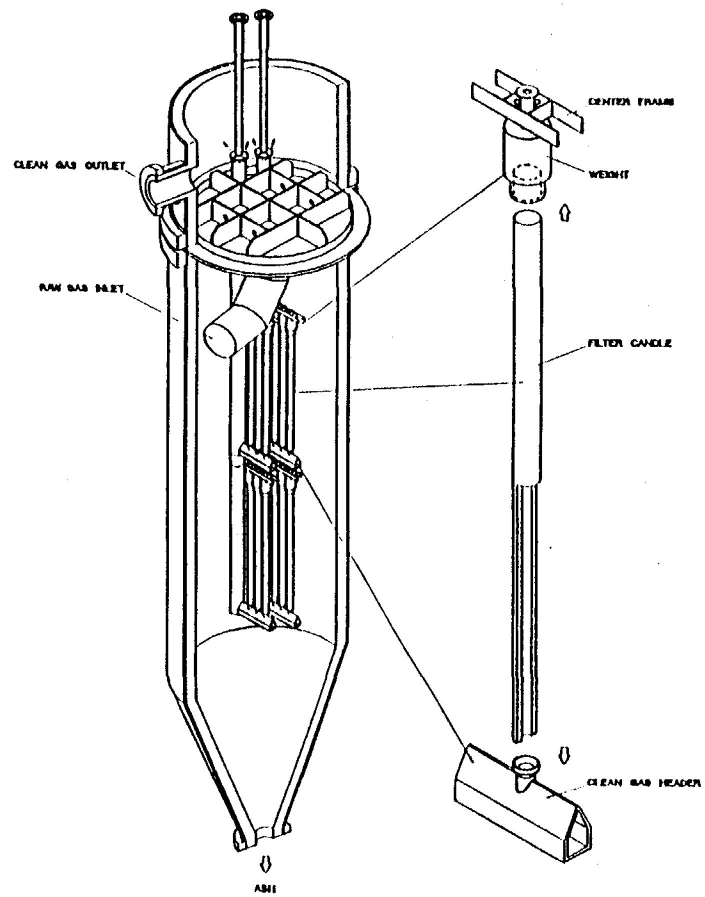

Figure 2: Single Candle Arrangement

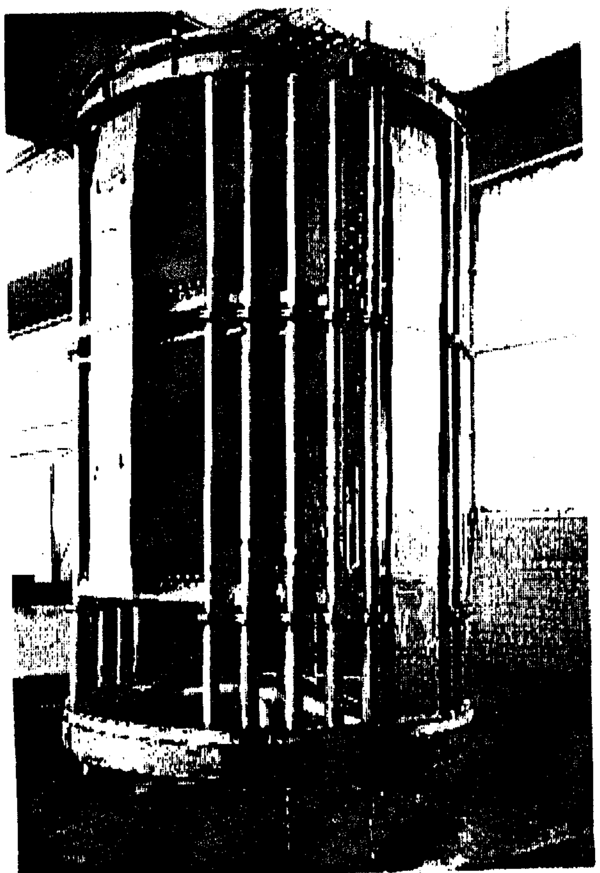

Figure 3: LLB Filter at HTW Gasification Test Facility of Rheinbraun AG in Berrenrath, /FRG

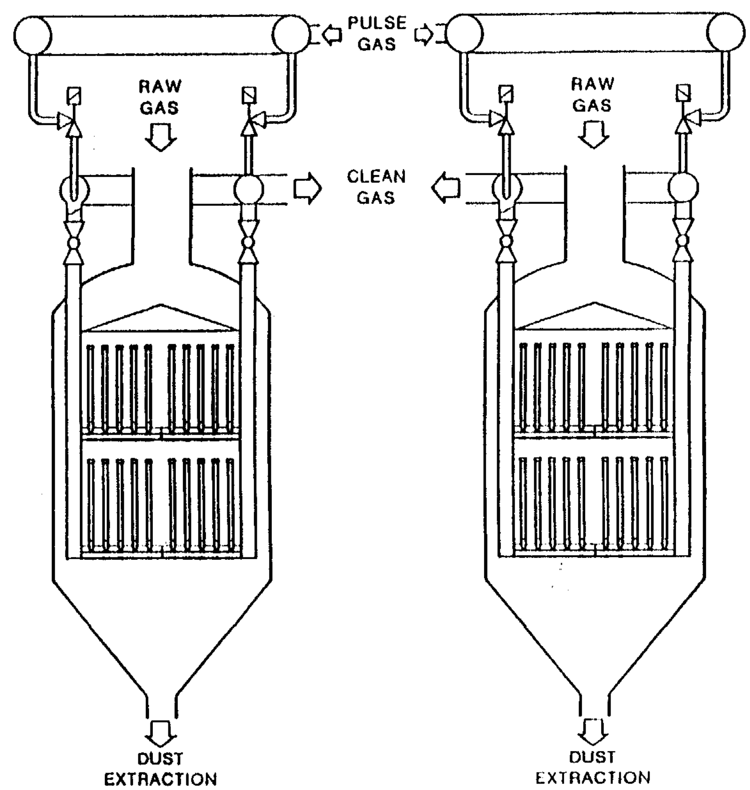

Figure 4: LLB Filter for Krupp Koppers 330 MWe Puertollano Project

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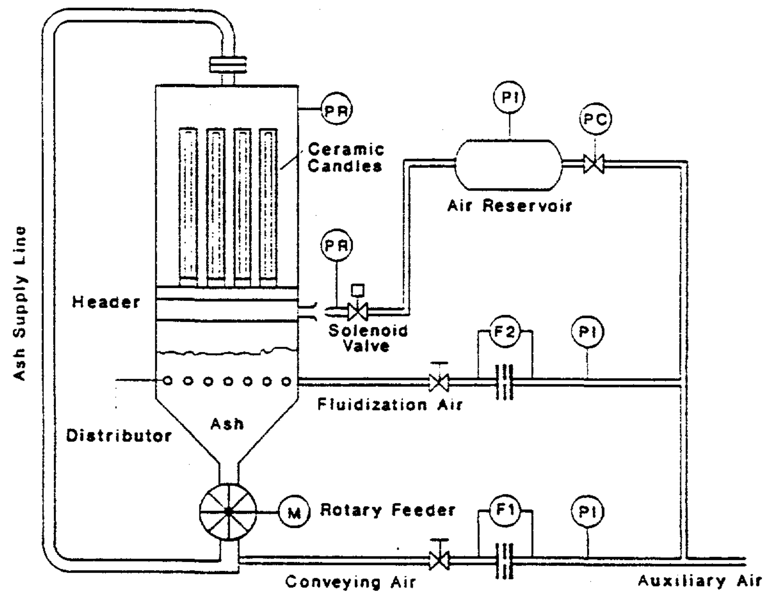

Figure 5: Four Candle Test Rig

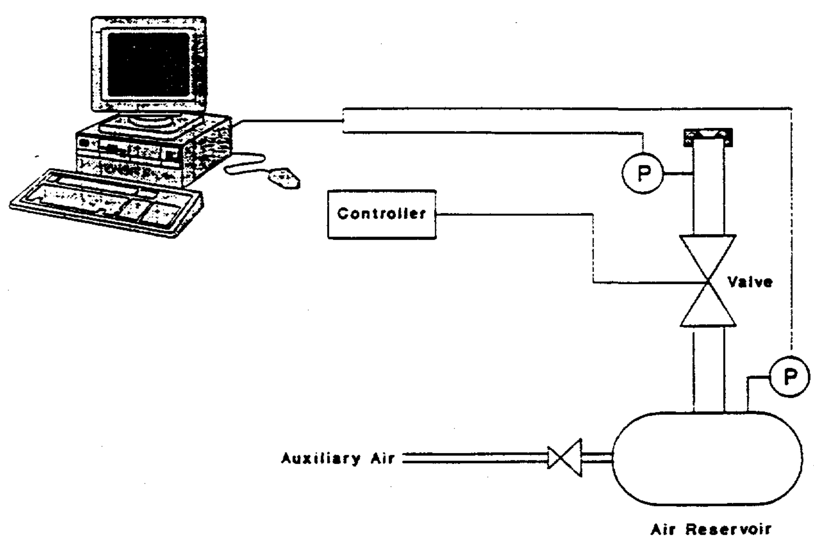

Figure 6: Valve Test Rig

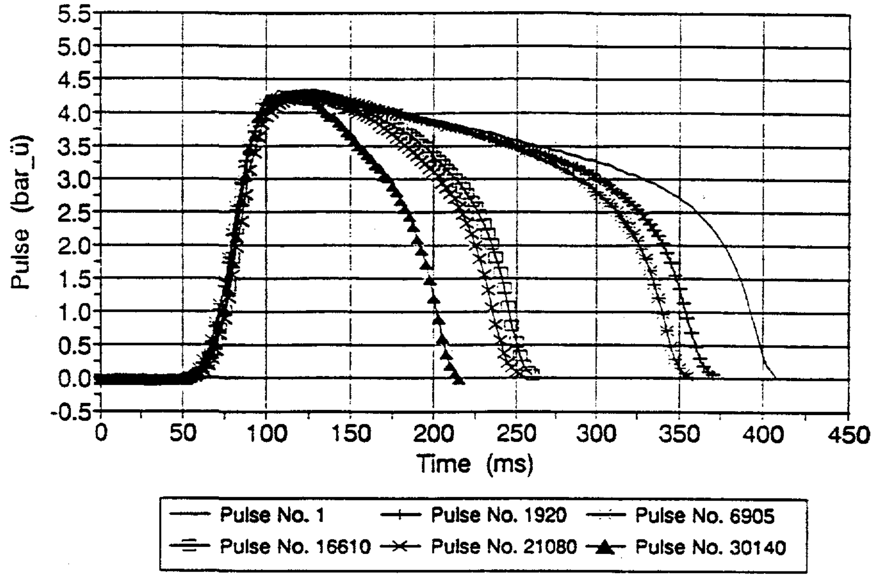

Figure 7: Valve Characteristic of Valve not suited

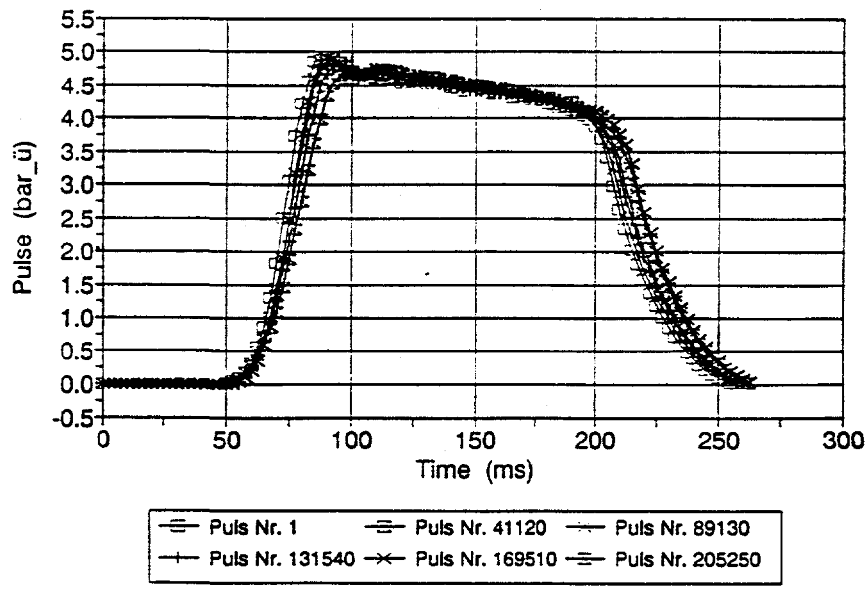

Figure 8: Valve Characteristic of Valve suited

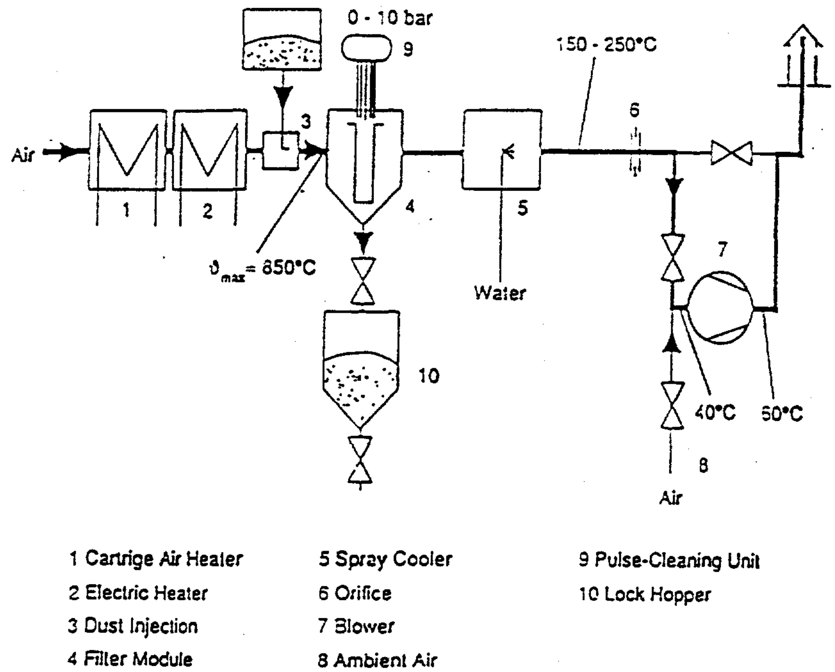

Figure 9. Six Candle Test Rig at Aachen Technical University

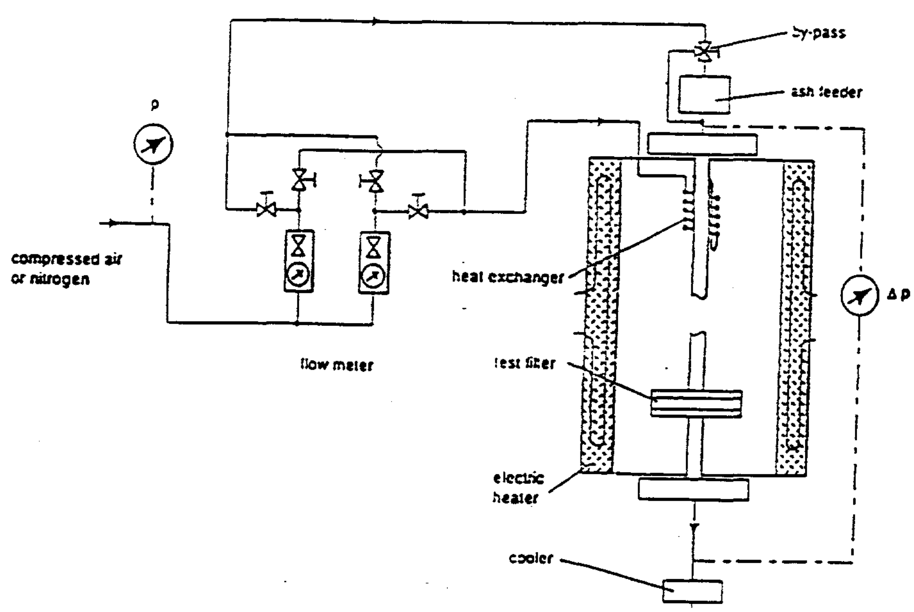

Figure 10: Permeability Test Rig at Aachen Technical University

APPENDIX B

ELECTRICAL LOADS DURING OPERATIONS

DESCRIP	FUR	HP	KW	KVA	CONN KVA		FW		MWK		BOTH ON		BOTH DOWN
120/208V MISC POWER XFMR A	FW	0.0	0.0	15.0	15.0	0.6	9.0	0.6	9.0	0.6	9.0	0.3	4.5
120/208V MISC POWER XFMR B	FW	0.0	0.0	15.0	15.0	0.6	9.0	0.6	9.0	0.6	9.0	0.3	4.5
AIR/OIL SEPARATOR MOTOR	FW	0.8	0.0	0.0	0.8	0.1	0.1	0.1	0.1	0.1	0.1	0	0.0
BOOSTER AIR COMPR LUBE OIL SYSTEM	FW	9.0	0.0	0.0	8.8	0.1	0.9	0.1	0.9	0.1	0.9	0.1	0.9
BOOSTER AIR COMPRESSOR	FW	700.0	0.0	0.0	682.6	1	682.6	0	0.0	1	682.6	0	0.0
CARB. COAL FEEDER	FW	2.0	0.0	0.0	2.0	1	2.0	0	0.0	1	2.0	0	0.0
CHAR COOLER FAN	FW	5.0	0.0	0.0	4.9	0.6	2.9	0.1	0.5	0.6	2.9	0.1	0.5
COMBUSTOR COAL FEEDER	FW	2.0	0.0	0.0	2.0	0.4	0.8	0	0.0	0.4	0.8	0	0.0
FINES COOL SCREW FEEDER	FW	5.0	0.0	0.0	4.9	1	4.9	0	0.0	1	4.9	0	0.0
GAS TURBINE/GENERATOR	FW	0.0	0.0	4375.0	4375.0	0	0.0	0	0.0	0	0.0	0	0.0
GEN COOLING FAN #1	FW	5.0	0.0	0.0	4.9	1	4.9	0.1	0.5	1	4.9	0.1	0.5
GEN COOLING FAN #2	FW	5.0	0.0	0.0	4.9	1	4.9	0.1	0.5	1	4.9	0.1	0.5
HEAT TRACE POWER XFMR A	FW	0.0	0.0	45.0	45.0	0.4	18.0	0.4	18.0	0.4	18.0	0.4	18.0
HEAT TRACE POWER XFMR B	FW	0.0	0.0	45.0	45.0	0.4	18.0	0.4	18.0	0.4	18.0	0.4	18.0
LUBE OIL TANK IMMER HEATER	FW	0.0	3.0	0.0	3.5	0.1	0.4	0.3	1.1	0.1	0.4	0.3	1.1
PRE/POST LUBE PUMP	FW	5.0	0.0	0.0	4.9	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5
QUENCH PUMP A	FW	20.0	0.0	0.0	19.5	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
QUENCH PUMP B	FW	20.0	0.0	0.0	19.5	0.1	2.0	0.1	2.0	0.1	2.0	0.1	2.0
SORBENT FEEDER	FW	2.0	0.0	0.0	2.0	0.1	0.2	0	0.0	0.1	0.2	0	0.0
TRANSPORT AIR COMPRESSOR	FW	50.0	0.0	0.0	48.8	1	48.8	0.1	4.9	1	48.8	0.1	4.9
TURBINE LUBE OIL COOLING FAN	FW	5.0	0.0	0.0	4.9	1	4.9	0.1	0.5	1	4.9	0.1	0.5
TURBINE/GEN AUX POWER XFMR	FW	0.0	0.0	15.0	15.0	0.6	9.0	0.1	1.5	0.6	9.0	0.1	1.5
TURBINE/GEN STARTING MOTOR	FW	200.0	0.0	0.0	195.0	0.1	19.5	0	0.0	0.1	19.5	0	0.0
ANALYZER HOUSE	MWK	0.0	0.0	45.0	45.0	0.8	36.0	0.8	36.0	0.8	36.0	0.8	36.0
COAL FEEDER SYS DISCHARGE FEEDER	MWK	1.5	0.0	0.0	1.5	0	0.0	1	1.5	1	1.5	0	0.0
FINES SCREW COOLER	MWK	3.0	0.0	0.0	2.9	0	0.0	1	2.9	1	2.9	0	0.0
HEAT XFER FLUID SYSTEM COOLING FAN	MWK	3.0	0.0	0.0	2.9	0	0.0	1	2.9	1	2.9	0	0.0
HEAT XFER FLUID SYSTEM HEATER #1	MWK	0.0	30.0	0.0	35.3	0.6	21.2	0.3	10.6	0.3	10.6	0.6	21.2
HEAT XFER FLUID SYSTEM HEATER #2	MWK	0.0	30.0	0.0	35.3	0.6	21.2	0.3	10.6	0.3	10.6	0.6	21.2
HEAT XFER FLUID SYSTEM PUMP NO.1	MWK	25.0	0.0	0.0	24.4	0.7	17.1	1	24.4	1	24.4	0.7	17.1
HEAT XFER FLUID SYSTEM PUMP NO.2	MWK	25.0	0.0	0.0	24.4	0.1	2.4	0.1	2.4	0.1	2.4	0.1	2.4
LIMESTONE FDR SYS DISCH FEEDER	MWK	1.5	0.0	0.0	1.5	0	0.0	1	1.5	1	1.5	0	0.0
MAIN AIR COMP AUX L.O. HEATER A	MWK	0.0	4.5	0.0	5.3	0.7	3.7	0.1	0.5	0.1	0.5	0.7	3.7
MAIN AIR COMP AUX L.O. HEATER B	MWK	0.0	4.5	0.0	5.3	0.7	3.7	0.1	0.5	0.1	0.5	0.7	3.7
MAIN AIR COMPRESSOR	MWK	1750.0	0.0	0.0	1706.5	0.1	170.7	1	1706.5	1	1706.5	0.1	85.3
MAIN AIR COMPRESSOR AUX L.O.P.	MWK	5.0	0.0	0.0	4.9	0.5	2.4	0.1	0.5	0.1	0.5	0.5	2.4
MAIN AIR COMPRESSOR MIST ELIMINATOR	MWK	0.3	0.0	0.0	0.3	0.5	0.1	1	0.3	1	0.3	0.5	0.1
RECYCLE GAS BOOSTER COMP L.O.P.	MWK	1.5	0.0	0.0	1.5	0.7	1.0	1	1.5	1	1.5	0.7	1.0
RECYLE GAS BOOSTER COMPRESSOR	MWK	200.0	0.0	0.0	195.0	0	0.0	1	195.0	1	195.0	0	0.0
SPENT SOLIDS FDR SYS DISCH FEEDER	MWK	1.5	0.0	0.0	1.5	0.1	0.1	1	1.5	1	1.5	0.1	0.1
SPENT SOLIDS SCREW COOLER	MWK	5.0	0.0	0.0	4.9	0.1	0.5	1	4.9	1	4.9	0.1	0.5
SULFATOR AIR COMPRESSOR	MWK	200.0	0.0	0.0	195.0	0.1	9.8	0.9	175.5	0.9	175.5	0.1	19.5
SULFATOR COMP ENCL EXHAUST FAN	MWK	0.3	0.0	0.0	0.3	0.3	0.1	0.9	0.3	0.9	0.3	0.3	0.1
SULFATOR LIMESTONE SYS SCREW FDR	MWK	0.8	0.0	0.0	0.8	0	0.0	0.9	0.7	0.9	0.7	0	0.0
SULFATOR SOLIDS SCREW COOLER	MWK	5.0	0.0	0.0	4.9	0.1	0.5	0.9	4.4	0.9	4.4	0.1	0.5
THERMAL OXIDIZER BLOWER	MWK	125.0	0.0	0.0	121.9	0.1	12.2	1	121.9	1	121.9	0.1	12.2
120/208V MISC POWER TRANSFORMER	SCS	0.0	0.0	30.0	30.0	0.9	27.0	0.2	6.0	0.9	27.0	0.6	18.0
120/208V MISC POWER TRANSFORMER	SCS	0.0	0.0	30.0	30.0	0.2	6.0	0.9	27.0	0.9	27.0	0.6	18.0
120/208V MISC POWER TRANSFORMER	SCS	0.0	0.0	30.0	30.0	0.9	27.0	0.9	27.0	0.9	27.0	0.6	18.0
480V TRANSFORMER NO. 1	SCS	0.0	0.0	1333.0	1333.0	0.0	13.3	0.0	13.3	0.0	26.7	0.0	13.3
480V TRANSFORMER NO. 2	SCS	0.0	0.0	1333.0	1333.0	0.0	13.3	0.0	13.3	0.0	26.7	0.0	13.3
480V TRANSFORMER NO. 3	SCS	0.0	0.0	1333.0	1333.0	0.0	13.3	0.0	13.3	0.0	26.7	0.0	13.3
480V TRANSFORMER NO. 4	SCS	0.0	0.0	1333.0	1333.0	0.0	13.3	0.0	13.3	0.0	26.7	0.0	13.3
480V TRANSFORMER NO. 5	SCS	0.0	0.0	1333.0	1333.0	0.0	13.3	0.0	13.3	0.0	26.7	0.0	13.3
60 TON CRANE	SCS	50.0	0.0	0.0	48.8	0	0.0	0	0.0	0	0.0	0	0.0
ADMIN BLDG 480V PANEL 1	SCS	0.0	0.0	300.0	300.0	0.8	240.0	0.8	240.0	0.8	240.0	0.8	240.0
AIR COMPRESSOR 1A	SCS	200.0	0.0	0.0	195.0	1	195.0	1	195.0	1	195.0	1	195.0
AIR COMPRESSOR 1B	SCS	200.0	0.0	0.0	195.0	0.9	175.5	0.3	58.5	1	195.0	0	0.0
AIR COMPRESSOR 1C	SCS	200.0	0.0	0.0	195.0	0.3	58.5	0.3	58.5	0.3	58.5	0	0.0
AIR COMPRESSOR 1D	SCS	200.0	0.0	0.0	195.0	0.1	19.5	0.1	19.5	0.1	19.5	0	0.0
AIR COMPRESSOR 2A	SCS	75.0	0.0	0.0	73.1	0.1	7.3	0.1	7.3	0.1	7.3	0.1	7.3
AIR COMPRESSOR 3	SCS	100.0	0.0	0.0	97.5	0.2	19.5	0.2	19.5	0.2	19.5	0.2	19.5
AIR DRYER 1A	SCS	0.0	12.5	0.0	14.7	0.2	2.9	0.2	2.9	0.2	2.9	0.2	2.9
AIR DRYER 1B	SCS	0.0	12.5	0.0	14.7	0.2	2.9	0.2	2.9	0.2	2.9	0.2	2.9
AIR DRYER 1C	SCS	0.0	12.5	0.0	14.7	0.2	2.9	0.2	2.9	0.2	2.9	0.2	2.9
AIR DRYER 1D	SCS	0.0	12.5	0.0	14.7	0.2	2.9	0.2	2.9	0.2	2.9	0.2	2.9
AIR DRYER 2	SCS	0.0	5.0	0.0	5.9	0.1	0.6	0.1	0.6	0.1	0.6	0.1	0.6
AIR DRYER 3	SCS	0.0	5.0	0.0	5.9	0.2	1.2	0	0.0	0.2	1.2	0	0.0
ASH SCREW COOLER	SCS	5.0	0.0	0.0	4.9	0.6	2.9	0.3	1.5	0.6	2.9	0.3	1.5

DESCRIP	FUR	HP	KW	KVA	CONN KVA		FW		MWK		BOTH ON		BOTH DOWN
ASH UNLOADER VENT FAN A	SCS	2.0	0.0	0.0	2.0	0.2	0.4	0.2	0.4	0.2	0.4	0.2	0.4
ASH UNLOADER VENT FAN B	SCS	2.0	0.0	0.0	2.0	0	0.0	0.1	0.2	0.1	0.2	0	0.0
AUX BOILER FD FAN	SCS	30.0	0.0	0.0	29.3	1	29.3	0.1	2.9	1	29.3	0.1	2.9
AUX BOILER FEEDWATER PUMP A	SCS	10.0	0.0	0.0	9.8	1	9.8	0.1	1.0	1	9.8	0.1	1.0
AUX BOILER FEEDWATER PUMP B	SCS	10.0	0.0	0.0	9.8	0	0.0	0	0.0	0	0.0	0	0.0
BAGHOUSE OUTLET SCREW COOLER	SCS	5.0	0.0	0.0	4.9	0	0.0	0.3	1.5	0.3	1.5	0	0.0
BATTERY CHARGER NO. 1	SCS	0.0	0.0	20.0	20.0	0.3	5.0	0.3	5.0	0.5	10.0	0.1	2.0
BATTERY CHARGER NO. 2	SCS	0.0	0.0	20.0	20.0	0.3	5.0	0.3	5.0	0.5	10.0	0.1	2.0
CHEMICAL INJECTION PUMP A	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.0
CHEMICAL INJECTION PUMP B	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.0
CHEMICAL INJECTION PUMP C	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.0
CIRC WATER PUMP A	SCS	150.0	0.0	0.0	146.3	1	146.3	1	146.3	1	146.3	0.6	87.8
CIRC WATER PUMP B	SCS	150.0	0.0	0.0	146.3	1	146.3	1	146.3	1	146.3	0	0.0
CIRC WATER PUMP C	SCS	150.0	0.0	0.0	146.3	0	0.0	0	0.0	1	146.3	0	0.0
CIRC WATER PUMP D	SCS	150.0	0.0	0.0	146.3	0	0.0	0	0.0	0	0.0	0	0.0
COAL HANDLING MISC POWER XFMR	SCS	0.0	0.0	30.0	30.0	0.6	18.0	0.6	18.0	0.6	18.0	0.6	18.0
COAL & LIMESTONE CRUSHER	SCS	75.0	0.0	0.0	73.1	0.2	14.6	0.1	7.3	0.3	21.9	0	0.0
COAL & LIMESTONE RUN-OFF SUMP PUMP	SCS	5.0	0.0	0.0	4.9	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5
COOLING TOWER FAN NO. 1	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0.9	52.7	0.9	52.7	0.5	29.3
COOLING TOWER FAN NO. 2	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0.9	52.7	0.9	52.7	0	0.0
COOLING TOWER FAN NO. 3	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0.9	52.7	0.9	52.7	0	0.0
COOLING TOWER FAN NO. 4	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0	0.0	0.9	52.7	0	0.0
COOLING TOWER FAN NO. 5	SCS	60.0	0.0	0.0	58.5	0	0.0	0	0.0	0.9	52.7	0	0.0
COOLING TOWER FAN NO. 6	SCS	60.0	0.0	0.0	58.5	0	0.0	0	0.0	0.9	52.7	0	0.0
COOLING TOWER MAKEUP PUMP A	SCS	5.0	0.0	0.0	4.9	0.7	3.4	0	0.0	0.7	3.4	0.3	1.5
COOLING TOWER MAKEUP PUMP B	SCS	5.0	0.0	0.0	4.9	0	0.0	0.7	3.4	0.7	3.4	0	0.0
COOLING TOWER MISC POWER XFMR	SCS	0.0	0.0	30.0	30.0	0.6	18.0	0.6	18.0	0.6	18.0	0.4	12.0
CPC GRANULAR BED FILTER BLOWER NO.1	SCS	15.0	0.0	0.0	14.6	0.1	1.5	0.9	13.2	0.9	13.2	0.1	1.5
CPC GRANULAR BED FILTER BLOWER NO.2	SCS	15.0	0.0	0.0	14.6	0	0.0	0.5	7.3	0.5	7.3	0	0.0
CPC GRANULAR BED FILTER COOLING FAN	SCS	20.0	0.0	0.0	19.5	0.1	2.0	0.9	17.6	0.9	17.6	0.1	2.0
CRUSHED LIMESTONE SILO DISCH ACT	SCS	1.5	0.0	0.0	1.5	0.2	0.3	0.1	0.1	0.3	0.4	0	0.0
CRUSHED MATERIAL CONVEYOR	SCS	15.0	0.0	0.0	14.6	0.2	2.9	0.1	1.5	0.3	4.4	0	0.0
CRUSHER FEED CONVEYOR	SCS	7.5	0.0	0.0	7.3	0.2	1.5	0.1	0.7	0.3	2.2	0	0.0
DEMIN WATER MAKEUP PUMP A	SCS	10.0	0.0	0.0	9.8	0.7	6.8	0	0.0	0.7	6.8	0.3	2.9
DEMIN WATER MAKEUP PUMP B	SCS	10.0	0.0	0.0	9.8	0	0.0	0.7	6.8	0.7	6.8	0	0.0
DIESEL ROLLING FILL PUMP	SCS	5.0	0.0	0.0	4.9	0.1	0.5	0.1	0.5	0.1	0.5	0	0.0
DIESEL GEN FUEL TRANSFER PUMP	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.1	0.1	0	0.0
DILUTION AIR BLOWER	SCS	50.0	0.0	0.0	48.8	0	0.0	1	48.8	1	48.8	0	0.0
DRAG CHAIN CONVEYOR (COAL)	SCS	7.5	0.0	0.0	7.3	0	0.0	0.1	0.7	0.1	0.7	0	0.0
DRAG CHAIN CONVEYOR (LIMESTONE)	SCS	7.5	0.0	0.0	7.3	0.1	0.7	0.1	0.7	0.1	0.7	0	0.0
DRY ASH UNLOADER A	SCS	0.5	0.0	0.0	0.5	0.1	0.0	0	0.0	0.1	0.0	0	0.0
DRY ASH UNLOADER B	SCS	0.5	0.0	0.0	0.5	0	0.0	0.1	0.0	0.1	0.0	0	0.0
ELEVATOR	SCS	30.0	0.0	0.0	29.3	0.3	8.8	0.3	8.8	0.3	8.8	0.3	8.8
ENGINE GENERATOR	SCS	0.0	1800.0	0.0	2117.6	0	0.0	0	0.0	0	0.0	0	0.0
ESSENTIAL 120/208V POWER XFMR	SCS	0.0	0.0	30.0	30.0	0.6	18.0	0.6	18.0	0.6	18.0	0.5	15.0
FW COAL CYCLONE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0.7	0.7	0	0.0	0.7	0.7	0	0.0
FW COAL MILL	SCS	30.0	0.0	0.0	29.3	0.9	26.3	0	0.0	0.9	26.3	0	0.0
FW COAL MILL BAGHOUSE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0.7	0.7	0	0.0	0.7	0.7	0	0.0
FW COAL MILL COMBUSTION BLOWER	SCS	5.0	0.0	0.0	4.9	0.9	4.4	0	0.0	0.9	4.4	0	0.0
FW COAL MILL DUST EXH FAN	SCS	25.0	0.0	0.0	24.4	0.9	21.9	0	0.0	0.9	21.9	0	0.0
FW COAL MILL FAN	SCS	75.0	0.0	0.0	73.1	0.9	65.8	0	0.0	0.9	65.8	0	0.0
FW COAL MILL FEEDER	SCS	1.0	0.0	0.0	1.0	0.9	0.9	0	0.0	0.9	0.9	0	0.0
FW COAL MILL SPINNER SEPARATOR	SCS	3.0	0.0	0.0	2.9	0.9	2.6	0	0.0	0.9	2.6	0	0.0
FW COAL SCREW COOLER FEEDER	SCS	7.5	0.0	0.0	7.3	0.9	6.6	0	0.0	0.9	6.6	0	0.0
FW CONDENSATE PUMP A	SCS	200.0	0.0	0.0	195.0	0.9	175.5	0.1	19.5	0.9	175.5	0.1	19.5
FW CONDENSATE PUMP B	SCS	200.0	0.0	0.0	195.0	0	0.0	0	0.0	0	0.0	0	0.0
FW COOLING WATER PUMP A	SCS	25.0	0.0	0.0	24.4	1	24.4	0	0.0	1	24.4	0	0.0
FW COOLING WATER PUMP B	SCS	25.0	0.0	0.0	24.4	0	0.0	0.1	2.4	0	0.0	0.1	2.4
FW LIMESTONE AIR SEP COARSE ROT VLV	SCS	0.8	0.0	0.0	0.8	0.2	0.2	0	0.0	0.2	0.2	0	0.0
FW LIMESTONE AIR SEP FINES ROT VLV	SCS	0.8	0.0	0.0	0.8	0.2	0.2	0	0.0	0.2	0.2	0	0.0
FW LIMESTONE CYCLONE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0.2	0.2	0	0.0	0.2	0.2	0	0.0
FW OVERSIZE COAL SCREEN	SCS	0.5	0.0	0.0	0.5	0.9	0.4	0	0.0	0.9	0.4	0	0.0
FW OVERSIZE LIMESTONE SCREEN	SCS	0.5	0.0	0.0	0.5	0.2	0.1	0	0.0	0.2	0.1	0	0.0
HOIST	SCS	20.0	0.0	0.0	19.5	0.1	2.0	1	19.5	0.1	2.0	0.1	2.0
JOCKEY PUMP	SCS	15.0	0.0	0.0	14.6	0.4	5.9	0.4	5.9	0.4	5.9	0.4	5.9
LIMESTONE MILL	SCS	30.0	0.0	0.0	29.3	0.1	2.9	0.1	2.9	0.2	5.9	0	0.0
LIMESTONE MILL BAGHOUSE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.2	0.2	0	0.0
LIMESTONE MILL COMBUSTION BLOWER	SCS	3.0	0.0	0.0	2.9	0.1	0.3	0.1	0.3	0.2	0.6	0	0.0
LIMESTONE MILL DUST EXH FAN	SCS	15.0	0.0	0.0	14.6	0.1	1.5	0.1	1.5	0.2	2.9	0	0.0

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DESCRIP	FUR	HP	KW	KVA	CONN KVA		FW		MWK		BOTH ON		BOTH DOWN
LIMESTONE MILL FAN	SCS	75.0	0.0	0.0	73.1	0.1	7.3	0.1	7.3	0.2	14.6	0	0.0
LIMESTONE MILL FEEDER	SCS	1.0	0.0	0.0	1.0	0.1	0.1	0.1	0.1	0.2	0.2	0	0.0
LIMESTONE MILL MECH AIR SEPARATOR	SCS	15.0	0.0	0.0	14.6	0.1	1.5	0.1	1.5	0.2	2.9	0	0.0
LIMESTONE MILL SPINNER SEPARATOR	SCS	3.0	0.0	0.0	2.9	0.1	0.3	0.1	0.3	0.2	0.6	0	0.0
LP GAS TRANSFER PUMP	SCS	25.0	0.0	0.0	24.4	0.9	21.9	0.9	21.9	0.9	21.9	0	0.0
MWK COAL CYCLONE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0	0.0	0.9	0.9	0.9	0.9	0	0.0
MWK COAL MILL	SCS	30.0	0.0	0.0	29.3	0	0.0	0.9	26.3	0.9	26.3	0	0.0
MWK COAL MILL BAGHOUSE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0	0.0	0.9	0.9	0.9	0.9	0	0.0
MWK COAL MILL COMBUSTION BLOWER	SCS	5.0	0.0	0.0	4.9	0	0.0	0.9	4.4	0.9	4.4	0	0.0
MWK COAL MILL DUST EXH FAN	SCS	15.0	0.0	0.0	14.6	0	0.0	0.9	13.2	0.9	13.2	0	0.0
MWK COAL MILL FAN	SCS	75.0	0.0	0.0	73.1	0	0.0	0.9	65.8	0.9	65.8	0	0.0
MWK COAL MILL FEEDER	SCS	1.0	0.0	0.0	1.0	0	0.0	0.9	0.9	0.9	0.9	0	0.0
MWK COAL MILL SPINNER SEPARATOR	SCS	3.0	0.0	0.0	2.9	0	0.0	0.9	2.6	0.9	2.6	0	0.0
MWK COAL OVERSIZE SCREEN	SCS	0.5	0.0	0.0	0.5	0	0.0	0.9	0.4	0.9	0.4	0	0.0
MWK COAL SCREW COOLER FEEDER	SCS	5.0	0.0	0.0	4.9	0	0.0	0.9	4.4	0.9	4.4	0	0.0
MWK CONDENSATE FEEDWATER PUMP A	SCS	50.0	0.0	0.0	48.8	0.1	4.9	0.9	43.9	0.9	43.9	0.1	4.9
MWK CONDENSATE FEEDWATER PUMP B	SCS	50.0	0.0	0.0	48.8	0	0.0	0	0.0	0	0.0	0	0.0
MWK COOLING WATER PUMP A	SCS	30.0	0.0	0.0	29.3	0.1	2.9	0.9	26.3	0.9	26.3	0.1	2.9
MWK COOLING WATER PUMP B	SCS	30.0	0.0	0.0	29.3	0	0.0	0	0.0	0	0.0	0	0.0
MWK LIMESTONE CYCLONE ROTARY VLV	SCS	1.0	0.0	0.0	1.0	0	0.0	0.1	0.1	0.1	0.1	0	0.0
MWK LIMESTONE OVERSIZE SCREEN	SCS	2.0	0.0	0.0	2.0	0	0.0	0.1	0.2	0.1	0.2	0	0.0
NITROGEN PUMP	SCS	60.0	0.0	0.0	58.5	0	0.0	0	0.0	0	0.0	0	0.0
NITROGEN SYS HP AIR COMPRESSOR A	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0.9	52.7	0.9	52.7	0.3	17.6
NITROGEN SYS HP AIR COMPRESSOR B	SCS	60.0	0.0	0.0	58.5	0.9	52.7	0.9	52.7	0.9	52.7	0.3	17.6
NITROGEN SYS HP AIR COMPRESSOR C	SCS	60.0	0.0	0.0	58.5	0	0.0	0	0.0	0	0.0	0	0.0
NITROGEN SYSTEM	SCS	0.0	1000.0	0.0	1176.5	0.9	1058.8	0.9	1058.8	0.9	1058.8	0.3	352.9
POTABLE WATER BOOSTER PUMP	SCS	2.0	0.0	0.0	2.0	0.9	1.8	0.9	1.8	0.9	1.8	0.9	1.8
RAW WATER PUMP A	SCS	25.0	0.0	0.0	24.4	0.5	12.2	0	0.0	0.5	12.2	0.5	12.2
RAW WATER PUMP B	SCS	25.0	0.0	0.0	24.4	0	0.0	0.5	12.2	0.5	12.2		0.0
SCS COOLING WATER PUMP A	SCS	75.0	0.0	0.0	73.1	0.5	36.6	0.5	36.6	1	73.1	0.3	21.9
SCS COOLING WATER PUMP B	SCS	75.0	0.0	0.0	73.1	0	0.0	0	0.0	0	0.0	0	0.0
SERVICE WATER PUMP A	SCS	50.0	0.0	0.0	48.8	0.5	24.4	0.5	24.4	1	48.8	0.5	24.4
SERVICE WATER PUMP B	SCS	50.0	0.0	0.0	48.8	0	0.0	0	0.0	0	0.0	0	0.0
TRENCH SUMP PUMP PUMP	SCS	2.0	0.0	0.0	2.0	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
UPS	SCS	0.0	0.0	37.5	37.5	0.5	18.8	0.5	18.8	0.8	30.0	0.6	22.5
UPS ISOLATION TRANSFORMER	SCS	0.0	0.0	40.0	40.0	0	0.0	0	0.0	0	0.0	0	0.0
WAREHOUSE 480V PANEL	SCS	0.0	0.0	300.0	300.0	0.8	240.0	0.8	240.0	0.8	240.0	0.8	240.0
WASTE WATER OIL SEPARATOR HEATERS	SCS	0.0	4.5	0.0	5.3	0.1	0.5	0.1	0.5	0.1	0.5	0.1	0.5
WASTE WATER SUMP PUMP A	SCS	2.0	0.0	0.0	2.0	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.2
WASTE WATER SUMP PUMP B	SCS	2.0	0.0	0.0	2.0	0	0.0	0	0.0	0	0.0	0	0.0
Total					9611		4538		5525		7297		1820
TURBINE/GENERATOR OUTPUT							4375		0		4375		0
NET POWER USAGE							163		5525		2922		1820