DOE/MC/25140 -- 5131
(DE96004354)

Power Systems Developemnt Facility

Quarterly Report
July - September 1995

November 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.
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POWER SYSTEMS DEVELOPMENT FACILITY

QUARTERLY TECHNICAL PROGRESS REPORT
JULY 1 - SEPTEMBER 30, 1995

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1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes the work completed during the third quarter, July 1 through September 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 balance-of-plant processes and particulate control devices (PCDs) into the structural and process designs. Substantial progress in construction activities was achieved during the quarter. Delivery and construction of the process structural steel is nearing completion. Nearly all MWK equipment are set in its place and the FW equipment and the PCDs are being set in the structure. Substantial progress has been made in the fabrication and installation of both small and large bore non-refractory lined piping.

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

2.0 REVIEW OF TECHNICAL PROGRESS

2.1 PROJECT MANAGEMENT

A design and construction review meeting was held on July 25 and 26 at the PSDF site in Wilsonville. The FW system, balance-of-plant and SRI's batch probe design, procurement and fabrication status were reviewed. Proposed test plans for the MWK train, including the two PCDs, and the FW APFBC system were presented. Nolan Multimedia reviewed the status of development of the Wilsonville Interactive Learning System (WILS) and demonstrated various portions of the WILS project. Various aspects of the operations and maintenance preparations that are ongoing for commissioning and operation of the two trains were reviewed at the meeting. Some presentations from the review meeting are included in Appendix B.

SCS signed a labor broker agreement with Alabama Power Company to furnish operations and maintenance craft labor for the PSDF. Also, SCS signed a contract with Alabama Power Company for the PSDF electric power supply.

The maintenance engineer, maintenance designer, and I&C engineer positions have all been filled. Staffing requirements to address the peak manpower requirements during the MWK commissioning, continued FW process construction and planning for the FW commissioning, were evaluated, and will be handled by using engineers and operators at the site. The first group of Plant Control Operators (fourteen) and Electrical & Instrumentation Journeymen (three) arrived on site August 28. The first group of Mechanics (five) and Assistant Plant Control Operators (four) reported to the site on September 11 and 25.

SCS has initiated discussions with SRI regarding the characterization of the filter cake. This includes running a variety of tests on ash samples taken from the SRI probe, from hopper ash samples and from the filter elements during shutdowns. The purpose of the testing is to determine the impact of changing process variables such as fuel source, sorbent, reactor operating conditions, cyclone spoiling and PCD inlet temperature on filter cake permeability, cohesiveness, and tensile strength. SRI has developed a proposed test matrix based on the SCS test plan and an initial cost estimate. This proposal is currently under review.

Discussions were also initiated with the materials testing group of SRI to lay the groundwork for candle testing in their labs. One of the major issues discussed included deciding which tests should be performed at different exposure intervals. It was tentatively decided that a complete array of testing would be performed at "milestone" intervals (1000 hr, 2500 hr, etc.) and a smaller group of tests would be performed on elements which were removed between these intervals. Also discussed was which tests were appropriate for each type (monolithic, fiber wound, Fibrosic) of candle. For example, it would probably not make sense to perform creep tests on a Fibrosic candle due to the nature of its construction.

The first set of candles for FL0301 have arrived on the jobsite. These are used candles from the Tidd filter system. During the next quarter, the first set of new candles are expected to be ordered.

Combustion Power and SCS have had several discussions regarding the initial configuration of the granular bed filter. SCS would prefer a more conservative approach than that proposed in the CPC test plan. CPC is preparing drawings for the changes required to operate the filter vessel initially with a deeper bed, a lower velocity through the bed and with smaller media. A decision should be made in October to set the start-up parameters on the granular bed filter.

2.2 PHASE 2 - DETAILED DESIGN ACTIVITIES

2.2.1 Task 2.1 Detailed Design

2.2.1.1 MWK: PSDF Transport Train

The detailed design is complete. The Operating Instruction Manual was issued. Comments were provided to Clyde Pneumatics on the operating and maintenance instructions for their system. A report with settings for all of the process parameters during initial transport reactor test activities is being prepared. A draft report of the Maintenance/Inspection Manual was submitted to SCS for review. The report on Design Hazard Review resolutions will be completed in October. Engineering support continues on an as required basis with most of the activities focused around refractory pipe installation.

A brief materials test program for the MWK train has been drafted for further discussions.

2.2.1.2 FW Team Activities

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

MASB

A design review meeting was held at FWUSA's offices in Perryville at the beginning of August to discuss various MASB design issues. The highlights of the meeting were as follows:

- Although Westinghouse had not received firm dates for all stages of fabrication, they believe that the MASB and spool piece will be delivered to the PSDF site as early as the end of February and certainly before the end of March 1996. Delays could be caused by non-availability of materials but alternatives had been identified if the need arose.

- The design of a backup propane burner to replace the MASB in case of catastrophic failure was discussed. Such a burner would allow for continued operation of the plant only in first generation. FWUSA had provided a preliminary design, with a budget price of around $400k, which is similar to that of the second MASB. Because of a number of factors, the wisdom of proceeding with purchase of the backup burner was brought into question.

- Westinghouse said that the MASB design had been subjected to several internal design reviews. Its integrity had been rigorously scrutinized and was considered to be more than adequately designed to withstand the arduous conditions. At certain locations on the casing, the metal of the MASB had been designed for working temperatures in excess of 1700°F and the design included normal safety margins. These margins had been increased by the application of a thermal barrier coating (hard ceramic insulation) which was calculated to lower the metal temperature by 150°F. Westinghouse said that this was normal burner design practice. Spalling, or delamination of this coating could result in damage to the turbine but such flaking had not been seen either in commercial burner applications or at UTSI.

- Westinghouse described the various stages involved in the development of a burner. These included design studies, cold model studies, laboratory testing, field trials, and commercial demonstration. The MASB had gone through the first three stages, with UTSI testing constituted the laboratory studies, and now the PSDF was the field trial. Once a burner reaches the field trial stage it may still experience problems but it is unlikely to suffer a catastrophic failure. In Westinghouse's opinion, the MASB had benefited from more preparatory work than did most conventional burners and so was in a good position to succeed.

They added that most of the components incorporated into the design had already been proven commercially.

- Westinghouse thought that the key to testing the MASB was to proceed cautiously and fully characterize burner performance before moving onto full load operation. The burner included 36 surface thermocouples which would assist in identifying hotspots. If an alarm was raised the appropriate action would be to cut back on the firing rate. Westinghouse said that they would prepare operating criteria, including the maximum allowable temperature difference between adjacent thermocouples. Pressure taps had been provided to measure dynamic pressure and determine whether resonance was likely to occur. A means of obtaining temperature profile data was to be pursued to ensure that the burner was operating as designed and to assist modeling work in support of future design effort. Inspection periods would be specified after so many operating hours to monitor the condition of the MASB and, allow for corrective action and/or maintenance. Once the nature of mechanical performance was characterized, the interval between inspections could be extended. It had to be accepted that all burners suffer metal stress cracking to some degree because of thermal cycling.

- Following Westinghouse's presentation, it was agreed that the MASB was unlikely to fail catastrophically.

The design and stress analysis of the pipework connecting the alkali getters to the MASB, and the MASB to the gas turbine, is still to be completed. Allison have specified a very low allowable deflection for the turbine. The design process is sufficiently advanced for the hot isolation valves in the flue gas and fuel gas lines to be released for manufacture.

The process design of the transition piece between the MASB and the gas turbine has been completed. The mean temperature of the gas exiting the MASB is over 2200°F, comfortably above the 1977°F working temperature of the gas turbine. Attemporating air to reduce the gas temperature is introduced through the transition piece between the MASB and the gas turbine. The cooling air is fed to a ring main around the center of the transition piece which passes, via holes drilled through the metal shell and the refractory, to the annular space between the refractory and the protective metal liner. The air passes to both ends of the annular space and enters the gas flow through a series of holes. In addition to attemporating the gas, the air flow also cools the metal liner. Based on the results of mathematical modeling studies, DOE-METC wanted these jets to have sufficient momentum to break up the flow pattern from the burner and achieve a more even temperature distribution. The pressure driving force available for the cooling air flow is limited by the pressure drop across the thrust bearing so it may not be possible to achieve greater jet penetration.

Site construction

Installation of the structural steel is essentially complete, with some steel to be added after the last vessels are installed. The FBHE was set in place during the first week of August. As its weight approached the capacity of the crane, the on-site crane required an extension and an additional crane was needed as a trailer. All major vessels have been delivered and installation will commence in mid-October as installation of MWK and BOP equipment approaches completion. Delivery of minor equipment continues.

Operations and Test planning support

SCS visited FWDC offices in Livingston at the beginning of August to discuss various aspects of the testing on the advanced PFBC pilot plant. Among the items discussed were the following:

- Gas analysis experience
- Alkali vapor concentrations in fuel and flue gas streams
- Selection of alkali getter bed materials
- Filter operating experience
- Agglomeration problems
- Carbonizer startup
- Circulating PFBC operating problems

Information gathered during the visit on the above subjects was very useful and will help greatly with the selection of equipment and specification of operating conditions for the PSDF.

Operating procedures

The detailed operating procedure writeup for the FW train by the site personnel began in this quarter. The task was divided up into the following major plant areas:

Feed systems
Solids removal
Compressors
Startup burners

HTHP filters
MASB and gas turbine
Carbonizer
Circulating PFBC

The first six tasks were allocated to PSDF staff members. The need for additional effort was identified to complete the last two tasks, and FWUSA was asked to provide assistance from two people for three months. Two people acceptable to the Project were identified, and both will commence work on the tasks in mid-October. One will work full time at the PSDF and the other will allocate 80 percent of his time to the tasks and spend alternate weeks at the site. The Procedures are planned to be completed by the end of December, in keeping with the time-scale for Operator training.

Gas analyzers

The bid for gas analyzers was released and quotations were received back from six vendors. To understand how the MASB performs, gas analyzers are required for the vitiated air stream, the fuel gas stream and the stack gas stream. These same analyzers will characterize the performance of the carbonizer and the circulating PFBC, and monitor environmental emissions. The following continuous analyzers were required.

Species	Vitiated air	Stack gas	Fuel gas
CO	X	X	X
CO_2	X	X	
H_2O	X		X
SO_2	X	X	
NO_x	X	X	

In addition, a chromatograph was required to determine the hydrocarbon and hydrogen content. A particular problem with the fuel gas is the deposition of ammonia salts at temperatures below 420°F. If there is SO_3 present in the vitiated air and stack gas, this will condense out at temperatures around 280°F. The deposition/condensation problems can be catered for by allowing these processes to occur in part of the sample conditioning train specially designed to tolerate them. However, this also removes the water which is needed primarily to allow the meters to determine the gas flow rates.

Two systems were identified for further discussion prior to making the final selection. One uses conventional meters designed to operate at ambient temperatures and so will require a specially designed sample conditioning system. The other uses an infrared optical head capable of operating at around 600°F which would eliminate the need for sample conditioning as described above. It would, however, require a means of controlling the gas temperature below 600°F but above 420°F. An added advantage of this technique is that it can give a continuous measurement of ammonia and H_2S which will greatly assist understanding MASB performance. Nevertheless, both these species could be determined by wet chemical methods. Further, the H_2S could be calculated from a mass balance around the MASB and turbine as it will burn to SO_2. A decision on which system to select will be made in October.

Fuel gas cooler

Following the test requirement to operate the fuel gas HTHP filters initially at temperatures around 1350°F, cost estimates were obtained for two types of cooler. One is an evaporative cooler in which water is sprayed, and the other is a conventional shell-and-tube type cooler.

The equipment cost for the evaporative cooler was estimated at $14,000. It gives potentially better control than the shell-and-tube, simply by altering the water flow rate, and is more easily installed. Although widely mentioned in studies, it is an untried technology. It also carries the risk that it might result in water hitting the filter candles and cause them to fail by thermal shock.

The equipment cost for the shell-and-tube cooler was estimated at $142,000. This requires a by-pass line around the cooler to effect temperature control, and will require a large space to be installed. It is, however, a proven technology and measures can be taken to guard against potential tube erosion and corrosion problems.

Heat loss calculations were carried out for the pipe work between the carbonizer and the filter vessel and it was demonstrated that by operating at a part-load condition with the carbonizer at 1500°F, the fuel gas entering the HTHP filter will be around 1350°F. Based on FWDC pilot plant experience, operating the carbonizer at this temperature with bituminous coal will result in excessive agglomeration with subsequent fluidization problems. However, operation at this temperature with sub-bituminous coal would be readily achievable. The project personnel are currently reviewing which approach is the more appropriate, a cooler or a change in coal type.

2.2.1.3 <u>Balance-of-Plant Activities</u>

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

<u>BOP Engineering - Mechanical</u>

<u>Coal and Limestone Systems</u>: Engineering received and reviewed the second issue of the mill systems arrangements from the vendor. Engineering continued to receive vendor drawings for the components of the mill system. Engineering has begun the design of the ductwork supports for the mill systems.

A visit was made to the conveyor supplier in Ohio along with a number of their suppliers to determine the progress of their efforts. A meeting was also held at the site between Construction, Engineering and a representative from the conveyor supplier to discuss various issues.

<u>Ash Handling Systems/Dense Phase Conveying Systems</u>: Piping and instrumentation diagrams and layout drawings were reviewed and commented. The design of the ash handling systems continues at Clyde Pneumatics. Engineering continues to communicate with Clyde in order to obtain design information and resolve interface issues. All of the dense phase systems arrived on September 18, 1995.

<u>Final Gas Cleanup</u>: 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. The stack for the MWK process was erected during the quarter.

<u>Steam and Condensate Systems</u>: The detail design drawings for the MWK steam and condensate systems were completed and the valves in the systems were specified for procurement.

<u>Circulating Water, Cooling Water and Service Water Systems</u>: Engineering completed the detail design drawings for the circulating water system. Detail design of the raw water pump station located at Plant Gaston were completed. The design of these systems are essentially complete and the valves in these systems were specified for procurement.

Service Air/Instrument Air: Vendor drawings for the service/instrument air systems were received and returned with no comments. Detail design of the systems along with the high pressure air and the FW transport compressor are complete.

Auxiliary Fuel: Design of the diesel fuel system was revisited during July and the tank was relocated in order to meet the new location of the diesel electric generator. Vendor drawings for the propane system were received and approved. Detail design of the piping from the propane supplier's equipment to the various consumers on the site has begun.

Fire Protection: The fire protection system has been checked out and commissioned. Detail design of the riser system within the process structure has begun.

Wastewater: Design of the water treatment and chemical feed systems is nearing completion. Procurement of many of the small components of these systems is also nearing completion. The site water treatment systems consist of cooling tower treatment, MWK condensate treatment, closed loop cooling for FW, MWK, and BOP, and waste water treatment. The specialty chemical supply contract has been awarded. Chemical pumps and accessories have been ordered; and some of the analyzers have been received. Modifications of several waste water sumps are on-going, as is the fabrication of required chemical freeze protection sheds.

Nitrogen System: Drawings for the liquid nitrogen supply system and the nitrogen generator continue to be received. Engineering is also continuing to communicate with BOC Gases in order to define the interfaces. Detail design of the nitrogen piping has begun.

Demineralized Water: Design of the demineralized water pump station is complete.

Auxiliary Steam: A few vendor drawings have been received on the boiler. Design is awaiting additional information before drawings are begun.

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

HVAC: The design for the mill control room is nearing completion. Equipment has been specified and the drawings have begun.

BOP Engineering - Civil

Modifications to the coal building structural steel was required due to differences in equipment layout information received from vendors. The structure will be approximately 30 feet taller to provide the required support points for this equipment. The analysis of the structural steel in the coal building was completed in September, and sketches were issued to the field for material procurement. The finalized structural drawings will be issued in October. These modifications are necessary to support screw coolers, baghouses, and other equipment supplied by the mill vendor. Details are being prepared for the support/access platforms for dense phase feeders in the coal building. These details and drawings will be completed in early October. The reinforced concrete foundation and slab drawings were issued for the coal building. One additional concrete pad at grade was added to the drawings to support the feeder FD0140.

The final detail drawings for the coal/limestone conveyor, reclaim hopper, and crusher foundations were issued for construction in August. The reinforced concrete foundation drawings for the diesel generator, cooling tower and pumps, sulfator burner, crossover duct, and the gas turbine were issued for construction in August. Also issued for information and comments was the layout drawing for the personnel platform over the piping headers at the cooling tower. The dilution air fan foundation was issued to the site for construction. The layout and design of the duct from the thermal oxidizer to the dilution air fan, baghouse and the stack was started in September and will be issued for fabrication and erection in October.

SCS contracted Virginia Crane to provide the overhead crane in the process structure. Physical drawings and electrical information have been received, approved, and returned to the vendor.

Several pump and heat exchanger foundations were completed and drawings issued to the field for construction. All foundation design for pumps and heat exchangers necessary for the MWK startup are complete.

The reinforced concrete foundations for the service air compressors were completed and issued for construction. The design of the canopy over the service air compressors was completed, and drawings were issued to construction for fabrication and erection. The design was changed to a structural steel frame rather than a bar joist type of construction to reduce the lead time for purchasing materials.

The structural steel pipe bridge between the coal and ash buildings was completed and sketches were issued to the site for procurement. The finalized drawings will be issued in October. The structural steel frame and the concrete foundation for the BOP heat exchanger was completed and issued to the field.

The foundation drawings for the liquid Nitrogen area were completed and issued to the site.

BOP Engineering - Electrical & Controls

Development of electrical wiring, elementary, and loop diagrams for balance of plant equipment continued. Work on the MWK cable routing continued. Wiring diagrams and electrical physical drawings were issued for the demineralized water, raw water, instrument and service air systems, MWK feedwater system, miscellaneous AC power distribution system, cooling tower, cooling tower makeup system, cooling tower chemical feed system, circulating water system, MWK and SCS cooling water system, wastewater system, propane system, engine generator, and the overhead crane power feed. The contract for heat tracing was awarded to Thermon. Physical drawings for the air compressor shed and the administration building equipment room were issued. The plant dc system wiring and electrical physical drawings were completed. Electrical embed drawings, exposed raceway drawings, and circuit routing were completed for the diesel generator. The process structure lighting, air compressor cable tray, and river water equipment were purchased.

Instrument installation details and loop diagrams were issued for the demineralized water, raw water, instrument and service air systems, MWK feedwater system, cooling tower, cooling tower makeup system, circulating water system, chemical feed system, MWK and SCS cooling water loops, wastewater and propane systems and the engine generator. Work continued on the DCS configuration, graphics development, instrument data sheets, and database development and design and procurement of the PLCs to DCS interface.

2.2.1.4 Process Hazard Review

A final MWK report on the DHR suggestions and implementations is being prepared. Several vendor systems (Williams coal mills, liquid nitrogen, propane, MWK PCD heatup changes, and the SRI samplers) in the BOP were reviewed. This completes the review of BOP sections of the plant. DHR responses are being prepared.

2.2.2 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 distributed to project participants prior to the July 25/26 Design Review Meeting 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.

2.2.3 Task 2.3 Environmental Permitting and Compliance and Safety Issues

The first draft of the National Pollutant Discharge Elimination System (NPDES) Permit was received from the Alabama Department of Environmental Management (ADEM) in late June. After internal discussions, a response to the first draft was sent to ADEM on July 18. Permit issues were then resolved by a phone conversation with the ADEM regulator who works in this district. The final permit was issued by ADEM and it became effective on September 1, 1995. The first Discharge Monitoring Report will be due to ADEM by October 28, 1995. The site also remains under the Stormwater Construction NPDES Permit. For annual reporting, stormwater samples were collected on September 14 and submitted to a laboratory for analysis. The results from the samples will be submitted with the DMR in October.

After discussions and reevaluation, a decision was made to request from ADEM an amendment to the Air Permit in order to raise the emission factors (pounds/hour) for SOx, NOx, CO, and VOC's on the Kellogg Transport Reactor operating in the combustion mode. The increase requested still keeps the total facility emissions for each of these pollutants below the 250 ton per year limit and therefore does not impact the type of permit issued to PSDF.

Work continues on developing specific site safety procedures to be used in operations. Completed programs include Clearance Procedure for electrical energy, Hazard Communications, Bloodborne Pathogens, Hearing Conservation and Respirator Programs. The general Safety and Health Manual for operations has been reviewed and revisions are in the process of being completed. Safety training has begun for the new operators and mechanics.

2.2.4 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.

Combustion Power Company

An inspection in July, 1995, revealed that piping inside the boost blower pressure vessel enclosure was inadequate. A redesign resulted in some rework of the pressure vessels.

Industrial Filter & Pump PCD for the FW Carbonizer

Coordination between Oak Ridge National Laboratory, Mallet Technology, Inc., Kawin Laboratories, and the University of Illinois - Chicago was further utilized to determine the physical properties of the ceramic tube sheet material. These data allowed for confirmation and revision of the design parameters for the tubesheet sandwich.

Mallet Technology and IF&P spent three days in Birmingham and Wilsonville, the first of which was spent with SCS, DOE, and EPRI personnel reviewing the then current internal design and deciding upon areas of redesign. This initial meeting resulted in numerous design revisions, the most significant of which was the relocation of the dirty gas inlet. These revisions resulted in a second meeting of DOE and SCS personnel at IF&P in Chicago in September. At this second meeting, certain areas of design were deemed to require improvement and an additional meeting, also at IF&P, was proposed for October. It is anticipated that all design revisions will be completed by early December.

New fabrication and design drawings were prepared for the PCD with its inlet below the tubesheet. Moving the inlet resulted in the elimination of the inlet expansion joint, the tubesheet to inlet pipe seal and the inlet vertical pipe. The new location will be at the point of an unused nozzle which was removed and replaced with a 26 inch nozzle.

2.2.5 Task 2.8 Experimental Test Plan

MWK train test plan: Writing of the test plan report for the advanced gasifier train is in progress. The report format was developed, and the cold shakedown section of the report was completed. Based on discussions with the DOE and EPRI and the test plans submitted by the participants, an integrated test plan detailing the schedule, operating conditions of each test period, and the purpose of each test was developed and presented at the Design status and construction review meeting held at the PSDF site in July.

Suggestions made at the meeting are being included in the report. Writing of the characterization and performance testing sections of the advanced gasifier test plan report was completed. An evaluation plan for data analysis was developed and incorporated into the test plan report.

FW train test plan: A draft outline test plan for the APFBC system was prepared for presentation at the Project Review meeting held at the PSDF on the 25th July. Testing is proposed to proceed in the following stages.

(i) Hot shakedown test for first generation: Simple cycle operation with the MASB fired on propane.

(ii) Hot shakedown tests for first generation: Plant operation expanding the flue gas through the gas turbine without topping.

(iii) Test Campaign 1: Plant operating in first generation mode.

(iv) Hot shakedown for second generation: Fully integrated plant operation, topping gas turbine inlet temperature with fuel gas from the carbonizer.

(v) Test Campaigns 2, 3, 4, and 5: To be completed with plant operating in second generation mode.

To more accurately determine the effects of temperature upon filter and alkali getter performance, it is proposed that a single coal and sorbent (Alabama low sulfur bituminous coal and dolomite) be used throughout the test program. This eliminates variations related to feedstock properties. In the follow-on program, commencing in 1998, the effects of different feedstocks, and alkali getters, upon process and equipment performance will be investigated.

The initial program includes a number of different candles and a candle replacement schedule. A concern was expressed about the filter exposure temperatures. Filter testing at the Tidd PFBC Demonstration Plant had achieved acceptable candle lives with inlet gas temperatures in the range 1450 to 1500°F. The PSDF should build on this experience and commence testing just beyond this range with a filter inlet temperature of 1550°F. Once this is established as being acceptable, the inlet temperature would be increased progressively towards 1625°F. An initial reaction was that the initial temperature should be similar to that at Tidd to qualify the PSDF system and establish that there were no rig-specific factors that would reduce candle life.

A factor influencing candle material strength is the alkali content of the filtered gas. As fuel gas will have a higher alkali content than flue gas, and candles may have a shorter life in the carbonizer stream than the combustor stream at the same temperature. In addition, compared to an oxidizing environment, how a reducing atmosphere will affect candle strength is unknown. On this basis, it has been suggested that the fuel gas be cooled to allow the filters to operate at temperatures as low as 1350°F. Temperatures below this are to be investigated on the Kellogg train, which does have a cooler. Alternatives to the cooler include: using a sub-bituminous coal which allows the carbonizer to operate at a lower temperature, 1500°F compared to 1650°F for a bituminous coal; and operating at part load allowing natural heat loss to produce a greater flue gas temperature loss. All three options are to be assessed further before any decisions are made.

2.3 PHASE 3 - CONSTRUCTION, PROCUREMENT AND INSTALLATION

2.3.1 Task 3.1 Procurement

<u>MWK Advanced Gasifier train</u>

All of the refractory lined pipe has been delivered to the site. The analyzer shelter has been received. The Haynes alloy orifices and orifice holders will be shipped in October.

Repair of equipment transit damage was completed for the screw cooler and relay panels. Both pieces were returned to the site. The following problems detected during field installation of equipment were corrected either in the field or at the original fabrication facilities:

- flange mismatches between the spent solids receiver bin (FD0530) and the bin vent filter,
- the sorbent feeder (FD0220) vent filter access door is 12" longer and projects thorough the deck floor, and
- misalignment of the refractory lined pipe from the primary cyclone.

<u>Combustion Power Company</u>

The control panels ordered from Automation and Control Specialists were inspected by CPC on July 26, 1995, and again in the first week of August by a consultant employed by CPC, and the genius block was programmed. CPC has specified that the genius block panel be purged and pressurized for the Class I, Division II location in accordance with NFPA 496. A supplier of standard packaged systems for pressurization performance was proposed. The purge panel would be supplied by CPC for mounting by SCS in the field. SCS confirmed the location of the purge panel. The transmitters were ordered in July, but last minute changes in the panel could affect the ranges specified.

Quotes for nuclear type level detectors were reviewed for SCS, and a summary was issued on August 11. Both Berthold and TN Technologies were adequate and appeared to accommodate a general license, but TN Technologies appeared to be less costly in the CPC analysis. Mounting brackets are attached to the CPC pressure vessels based on the TN Technologies detectors.

The filter internals that had been returned to PMSC of Memphis, TN, for rework were returned to SCS in July, 1995. A fifth inspection of refractory-lined piping occurred on June 30, 1995, at Thorpe in Houston, TX. After one incomplete item was completed and minor repairs were made, the piping was thermally dried, painted, and shipped to the PSDF site for installation.

Final assembly of the pulse manifold and valves on the baghouse and completion of the electrical work occurred in July, 1995. Delivery of the baghouse was not until the end of September because shipment of the filter bags was late. Rework of the boost blower was scheduled to be completed in September for shipment in October. Fabrication of the piping spools was completed and the spools were shipped to the PSDF site in September. A list of materials for auxiliary piping and supports was issued in late August, 1995. Quotes have been received, but items have not yet been purchased.

The following is a schedule of anticipated upcoming shipping dates:

Boost Blowers	10/9/95
Transmitters	10/11/95
Filter Material	Nov/Dec 95 (not ordered yet)
Spares	Nov/Dec 95 (not ordered yet)

<u>Industrial Filter and Pump</u>

As previously mentioned, the PCD was redesigned with its gas inlet below the tubesheet. IF&P purchased the new nozzle and reworked the vessel according to the new design. Forms needed for refractory lining were built and will be welded into place at the fabricator prior to hydrostatic testing. After hydro testing and cleanup, the vessel will be primed on the exterior and mastic will be applied to the interior. It will then be delivered to IF&P in early November for installation of the refractory and dry out. Shipment to the PSDF site is anticipated towards end of November.

Fabrication of new PCD internals based on design revisions will commence in January.

Westinghouse Filters

Fabrication of FL0352 was completed and the vessel was scheduled to ship in mid-October. The backpulse and instrument skids for FL0352 were assembled, tested, and shipped to the PSDF site in July. Fabrication of the internal metal structures (tubesheet, plenums, etc.) was completed and they are being held at the vendor's shop pending approval to ship.

Because of the delay in the delivery of FL0352, the vessel was scheduled to be lifted into the structure on October 28 using the overhead crane. Clearances were checked during August and it was determined that lifting the vessel with the overhead crane was possible, but it would be safer if the lift were made with a larger crane.

SRI Particulate Sampling

Work on the production of the prototype cyclone manifold continued in July. Howmet removed the ceramic cores from the second casting and found several minor problems with the casting. Thin films of metal had penetrated into two of the interconnecting tubes, and the dome of the bauxite cartridge was not completely filled out. In August, Howmet removed the thin metal film and placed the manifold in a salt bath to dissolve the remaining ceramic core material inside the tube. Following the removal of the remaining core material, another thin layer of metal blockage was discovered. Howmet drilled through this metal layer at the end of August, and after eight such drillings the last section of ceramic core material was removed in the salt bath. Because of the time required to clear the interconnecting tube, delivery of the manifold to SRI was delayed until September 20. Southern Research is now making arrangements to have the cyclone receptacles machined to accept the cyclones. The finished assembly should be ready for testing in SRI's combustor in mid-November.

The insertion mechanisms for the particulate sampling systems are now complete, except for the installation of junction boxes, position sensors, and flow-control components. In July, Santek Engineering completed the control panels for the nitrogen purge systems and began work on the control panels for the sample gas, instrument air, and water. Santek has finished the two sets of panels needed for the Kellogg train. The two sets of control panels will be delivered to the PSDF in early October, along with the two push-button control boxes and the control cabinet to be located in the Kellogg I/O building.

The operating procedures for the particulate sampling systems were revised to incorporate comments received from SCS operations and maintenance personnel. In July, In-Control, Inc. developed an outline of the sampling system control logic based on operating procedures supplied by SRI. In August, In-Control began implementing the control logic in a Visual Basic program.

The wiring diagrams for the particulate sampling systems and sniffers were finished in July and submitted to SCS on August 3. The diagrams were returned to SRI for revision, and the construction issue was submitted to SCS on September 22. The construction issue of SRI's P&ID's was submitted to SCS on September 3.

Procurement of sampling system components continued in July, August, and September. Items ordered this quarter included:

- Solenoid valves and fittings for control panels
- Position sensors for insertion and rotation mechanisms
- RA330 alloy for fabrication of impactor stages
- Labels for control panels
- Machining services for cyclone manifold

The following equipment has been delivered to the PSDF:

- Port sleeves, ball valves, and outer casings for both sampling systems in the Kellogg structure

- Insertion mechanisms and beds for both systems (without probes, motors, or bed-mounted instruments)

- Local motion control panels, nitrogen purge control panels, and sampling control panels for both systems

- Control cabinet for Kellogg I/O building

The probes will be shipped after a modification is made to correct the alignment of the thermocouple feedthrough. The motors and bed-mounted components will be shipped after the insertion mechanisms are placed in the process structure. (The bed-mounted components include the probe rotation mechanisms, flexible hoses, cooling coils, condensate tanks, tubing, and fittings.)

2.3.2 Task 3.3 Construction and Installation

Construction - Civil

Civil support activities continued with mechanical and electrical installations. FW and MWK equipment were unloaded as received. Steel City completed erection of Sequence 5 steel and started erection of Sequence 7 steel. Process structure equipment continues to be set in conjunction with steel erection. Construction and painting of the service water tank is complete. On site construction of the coal and limestone silos is complete. The silos will be set in the structure next month. Work on miscellaneous concrete foundations including the coal and limestone conveyor foundations continued. Plans for next month include erection of structural steel for the ash structure and installation of the coal and limestone conveyor system.

Construction - Electrical

Installation of cable tray and conduit in the process structure continued. Process structure P.A. system is operational and satellite stations for P.A. system will be added later. Conduits from cable tray to equipment (Switchgear, MCC's, Transformers and Foxboro) were installed in the electrical building. Permanent cables were pulled for the 4160/480 volt transformers. Installation of cable bus and enclosure to substation was completed. MCC supply feeds are pulled except for coal handling and ash handling. Installation of site ground grid and grounding in various pump and compressor equipment pads continued.

The Electrical Station Service installation is nearly finished, with final preparations being completed for the testing and energizing of the 4160V switchgear. These preparations included: cable being pulled between switchgear and transformers, the protective relaying and cabling being tested for integrity and function, DCS configuration and operator interface screens being designed and installed, and the substation installation complete. Check-out of the 4160 volt bus system (hi-pot tests on bus, breakers and contactors, protective relay trip checks, and cable hi-pot tests) was carried out and the switchgear was energized on September 17, 1995 as well as one 480V bus; the other 480V busses were energized by the end of the month. This progressed smoothly, with only minor problems with transmitters and relaying that was not previously identified. With the advent of permanent station service, equipment start-ups will begin.

Coal and limestone storage area lightning protection is complete. Batteries, chargers, and DC distribution panel installed with one charger on temporary power. Installation of various miscellaneous power and essential power transformers, distribution panels and associated conduits was started. Yard lighting essentially complete except for a couple of light poles unable to set due to interference with ongoing construction activities. Work on the demineralizer and raw water pumps and controls at the adjacent E.C. Gaston power plant intake structure continued. UPS system was set and conduits are being installed between UPS, MCC and distribution panel.

Construction - Mechanical

The final fit-up of the MWK transport reactor loop and air pressure test was completed. The reactor assembly, less the Combustion Heat Exchanger was pressure tested with nitrogen to 135 psi; which the reactor held with no measurable loss in pressure for over 3 hours. Installation of the MWK refractory lined pipe is continuing. The refractory-lined piping for the PCD inlet was installed in September, and the maintenance bay was designed to hold the tubesheet for candle insertion and is scheduled for installation in early November. Two refractory spool pieces have not been received from the fabricator. Shipment is due in mid-October. The CO4 refractory lined pipe piece was cut and reworked to correct for alignment problems. Installation of the dense phase system is underway. Priority systems being worked are the steam, condensate and feedwater, and the service and instrument air systems. Approximately 20% of instrumentation installation is complete.

Detailed engineering design drawings was received for various balance of plant mechanical systems and installation is in progress. The deminerlizer water supply pumps have been set at the intake structure and will be grouted next month. The raw water supply pumps have been set at the intake structure and the motors mounted. Fabrication of the pipe to these pumps has started. The installation of the Sullair compressor (leftover from a previous project) is in progress. Trench piping is now 90% complete. The MWK condensate tank (also leftover from the previous project) has been set and additional nozzles installed. The MWK boiler feed pumps have been set on their foundations and piping from the tank to the pumps is being fabricated. The MWK closed loop cooling water heat exchanger is on its foundation and fabrication of the circulating water to and from the cooling tower is underway. The frame for mounting the MWK condensate heat exchangers is installed. Pipe fabrication for the heat exchangers is underway. The underground piping for the cooling tower has been installed. Work on the underground line from the cooling tower to the trench will begin next month. The propane system vendor has completed his work. The cooling tower make-up pumps and service water pumps have been set and grouted. Pipe fabrication is underway from the tank to these pumps.

Piping installation is continuing on the MWK process; with piping for steam and condensate, various pressures of air, nitrogen, propane, and venting being installed simultaneously. About 11,200 feet of pipe has been installed in the MWK side of the structure to date. Several equipment fit problems are being identified during construction, most only require modification onsite to correct. Several pieces of equipment that were returned to the manufacturer for repair, are back onsite and being re-installed at this time:

- Two pieces of refractory lined piping were found not to fit: a spool piece on the disengager was cut and refabricated on-site before being sent back to reinstall refractory; the primary cyclone outlet spool also did not fit and was cut and corrected on-site, requiring minor refractory filling that was done during the fit-up and weld-out.

- One of the 480V Motor Control Centers was returned after being damaged in transport.

- The sulfator fines screw cooler was returned after inspection of the hollow flight screw and corrective repair of the motor mounting supports. This cooler has been reinstalled in the process structure.

Work is accelerating in the installation of the BOP and MWK equipment now that the majority of equipment and design drawings are on-site. The construction labor staff numbers over 200 people, and is working two shifts to allow access for instrumentation installation during the off hours.

2.3.3 Task 3.6 Preparations for Operations

Commissioning Related Activities

The integrated MWK start-up schedule is being used to identify critical path activities, which are then focused on; it is also being used to generate the engineering close-out punchlist based on scheduled need dates. This schedule is being adjusted by the Equipment Start-Up Team personnel to better identify required predecessors and successors and to more clearly match activities to final BOP design. A similar integrated start-up schedule for FW is currently under development, with the operational activities identified and being loaded into the schedule. Construction, Procurement, and

Engineering activities will be associated with specific operations activities, and priorities assigned to that work as well. Both the MWK and FW start-up schedules, as well as the test plan schedules for both trains are integrated into a master project schedule to identify conflicts and to match operational resources to daily requirements.

Preparations for equipment testing and commissioning are continuing. Teams have been assigned to particular equipment for testing and evaluation, information is being gathered for inclusion into commissioning procedures, and construction progress is being monitored closely. Several of the SCS design engineers are on-site to participate in the teams, as well as additional personnel assigned to facilitate the turn-around of each start-up team's deliverables. Generic commissioning procedures have been collected from previous Power Plant Start-ups and are available to each of the teams as a basis for specific PSDF equipment commissioning plans. The teams are conducting design and construction quality assurance cross checks, supplying the scheduling personnel with more detailed breakdowns of assigned areas, and identifying any overlooked activities.

The Chemical Cleaning contract for the MWK steam/condensate system has been awarded, and design of the temporary piping has been included into Construction's planning. The Vendor will supply the chemicals, temporary circulating pumps and heat sources, waste material storage and disposal, and consulting oversight of the cleaning process. This is required to minimize any corrosion that may have initiated during construction, as well as, assure that all heat transfer surfaces are wetted and clean, preventing areas of local overheating and possible tube failures.

Planning for another MWK milestone, the air-test of the transport reactor, was forced to change due to the unavailability of rental air compressors that could build enough pressure. This will take place with the main process air compressor later in November and include the PCD's and adjoining refractyory-lined pipe as well. The reactor-only air-test was conducted using two cubic foot capacity high pressure nitrogen bottles that were available on-site. No leaks were found, with the reactor holding 135 psi pressure for several hours with no measurable decrease in pressure.

The Control System configuration is continuing, with the designers having to recheck designs against conceptual philosophies and operational experience. The Operator interface screen developmental effort is closely following the configuration development. Early check-out of the actual DCS inputs and outputs has begun using the same technicians who will be maintaining the system during PSDF operation. The gas analyzer technician was involved in the factory acceptance test of MWK's gas analysis equipment in preparation of the package shipping to the site.

Wilsonville Interactive Learning System (WILS)

The WILS project is an innovative interactive multimedia application for documenting the experience and knowledge gained at the PSDF through a storehouse of visual, audio, and text-based information. WILS is to be delivered on a series of CD ROM discs playable on any Windows-based multimedia-capable PC. When completed, WILS will contain a series of Technology Resource Modules to provide highly usable, visually-based information on each technology at the PSDF. WILS will also contain a series of Training Modules to promote readiness for on-the-job training. All modules are being developed concurrently with design and construction of the facility using 2D and 3D graphics, animation, stills, video and text. Beta 1 versions on CD ROM will be completed prior to or around the time of commissioning of each train at the PSDF; modules will be revised and augmented as needed following the shakedown period. The third and final component of WILS is an interactive, flexible archive designed to document equipment modifications and design changes, primarily through still photographs and text.

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

- The Technology Resource Modules have many "special" features, such as individual graphic events timed to narration, interactive graphic menus for most of the systems, animation, and interactive tables. On analysis, Nolan determined that the handcrafted programming of these elements was overly time-consuming. It became clear that these elements should be "modularized" whenever possible by dealing with similar features as a group within the architecture of the programming code.

  Since WILS program features and functions were not fully defined at the onset of production, the WILS Project has evolved as materials became available and new ideas for dealing with them surfaced. In addition to its being a training application, WILS can also be used now as an engineering application with a number of enhanced learning aids. As a result of making changes and augmenting the program, existing programming code was found to be inadequate or resulted in poor CD ROM performance. The project is now well defined; each different type of module has been produced, and the specification as well as the programming code can be applied to future modules.

- Production, testing and debugging of the Hot Gas Cleanup (HGCU) Technology Resource Modules was a major effort this quarter. These modules include the

HGCU Introduction, and two PCD modules for the Transport Reactor Train, one on the Westinghouse PCD and one on the Combustion Power Company PCD. Each of these modules includes a graphical user interface, navigation and menu systems, integration of graphics and audio, animation, access to 3D views, stills, and P&IDs and engineering diagrams. A glossary was implemented which links terms used in the narration with glossary definitions. Additional glossary functionality will be added which allows random access to an alphabetic list of glossary entries. A "bugs" database was also developed to aid programmers and staff personnel in making corrections to the modules.

In the Beta 1 versions of these HGCU modules, all P&IDs (including general arrangement and other drawings) can be accessed. Some of these assets are proprietary and will be restricted if distribution outside the PSDF is required. Once final Beta 1 versions of these modules are completed, Nolan will submit a Bill of Materials, which can be used by SCS and appropriate participants for review purposes. SCS will submit any changes to Nolan prior to finalization of the Beta 2 version of each module.

- Production, testing and debugging of the Familiarization Training Module (FAM) was also a major effort this quarter. FAM consists of 80 functionally identical exercises which are accessed randomly. The incorporation of a "test mode" for linear review was developed for testing.

- About 90% of the graphics processing on the Transport Reactor (K-train) Technology Resource module was completed this quarter. The K-train separates gasification mode from combustion mode, and is the largest module in the program. Processing tasks included breaking down and renaming hundreds of 24-bit graphics into approximately three thousand separate 8-bit elements using the custom color pallet created for the WILS project earlier this year. Processing will conclude shortly and integration tasks will begin using the new, streamlined programming code.

- During this quarter, production got well underway on the Operations Training (K-train/Process Descriptions) module. The Operations Training module represents a different style of program content. It is primarily text-based which allows for easy editing. It also includes branches to many of the rich visual assets used in other parts of WILS. Many of the remaining WILS modules will follow this same format. A total of 36 sub-modules were prepared by Nolan, reviewed by SCS and revised accordingly. Graphics were completed, and streamlined programming code was mostly completed.

- Design has been completed on the BOP Technology Resource module. Because the content is more familiar, interactive tables and audio will be used to supply information instead of graphical process descriptions. Graphics production for this module will begin in October.

- This quarter progress was made in script development for the APFBC (A-train) Technology Resource Module. About half of Nolan's second draft has been reviewed by SCS and returned. Nolan is now ready to begin storyboards on the completed sections, and will start graphics production in November. Unlike the K-train Tech Resource module which is being processed and integrated as a whole, the A-train module will be integrated system by system, pending approval of graphics by SCS.

- User performance data tracking is now functional. When users first log on to access a training module, a new user file is automatically written to the individual's hard drive. As a user completes a section of a training module, performance data is written to their personal user file. Then, in subsequent sessions, their user file is augmented with the new performance data. Performance data files remain in a folder on the user's hard drive. If trainees log on to more than one computer, there will be more than one data file. Eventually, when systems at SCS are in place and linked to a server, user files can be automatically linked to a server.

Nolan demonstrated a working demo of HGCU and FAM at the 75% Design Review meeting in Wilsonville on Wednesday, July 26th.

Nolan conducted and videotaped a total of nine interviews by various project management personnel. Nolan also shot construction footage at the PSDF to be integrated into a promotional video that will be produced later this year or early next year. Additional videotaping of the PSDF facility during operation will be necessary before the video is assembled.

Videotaping of three training modules on SRI sampler installation and retrieval was conducted in Guntersville, Alabama at the fabricator's facilities. Based on notes taken during the shoot, script revisions on the Sampling Procedures modules were prepared. To expedite the production process, Nolan edited the video to help identify what discrepancies, if any, may be present between the revised script and the actual images that were obtained. A rough cut was sent to the PSDF for review by SCS and SRI.

Training/Operation Procedures

Training for safe plant operations at the PSDF entails the development of materials suitable for training from available vendor technical documentation, the WILS interactive video training/archiving system· as well as the development and implementation of a training plan for operational personnel. This Third Quarter period saw the development of training materials and the commencement of operator training. The training documents, at present, includes only MWK and BOP materials. FW materials will be added upon their preparation. This manual includes a complete set of piping and instrumentation diagrams and a glossary of terms and definitions.

Training for the first group of Plant Control Operators was conducted on the MWK and BOP areas required to support the MWK process. In addition, training for the first group of Electrical and Instrumentation Journeymen and Mechanics was conducted during the quarter, and training was begun for the first group of Assistant Plant Control Operators. Training for all arriving Operations and Maintenance craft personnel was conducted on Plant Safety, Hazard Communication, and the PSDF Lockout/Tagout Program.

Operations personnel continued to develop and review startup and operating procedures for the MWK train and BOP systems, and began reviewing the revised FW documents addressing startup procedures, operating philosophy, and operating logic descriptions. A PSDF Procedure Status Log is included in Appendix A. A meeting was held with SRI on August 21 to review operating procedures for the SRI sample probes.

Procurement

A maintenance contract for Atlas-Copco air compressors (CO-2201-A to D) was acquired, and spare parts purchased for some equipment. Operations began placing orders for miscellaneous tools, oils and lubricants, and other common warehouse stock items needed for day to day operation. An order was placed for the initial sorbent to be used, Plum Run Greenfield formation dolomitic stone. Also, UCON 500 heat transfer fluid for the MWK process was ordered, and bids were issued for the supply of propane. Initial contacts identifying coke breeze suppliers were made.

Operation and Maintenance

The O&M labor staff are beginning to join the project, two-thirds of the plant's Operators, half of the plant's mechanics, and all of the Electrical and Instrumentation personnel are on-site participating in familiarization training. All of the operating and maintenance personnel have been to at least five days of training and familiarization with the PSDF processes and equipment. Craft personnel are involved in the inspection, testing or installation of process equipment as preparation for long-term operations continues.

Work in identifying predictive maintenance tools and services is continuing. Procuring these items and services will continue into the fall. Several other items needed by Construction, presently, are being bought with use by Maintenance over the course of the project in mind.

Instrumentation personnel participated in the FW/Allison/U.S. Turbine design interface meeting at FW's offices in Perryville, NJ on August 29.

Maintenance Shop, Spare Parts, Chemicals

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

The Work Order Management System (WOMS) is nearing installation, as the project is using equipment surpluses by another Southern Company Plant as they upgrade their system to a local-area network. Work continues in filing and collating equipment maintenance information for reference, development of maintenance procedures, and spare parts requirements. The procedures will be included in the WOMS database, and printed with work orders written on their specific equipment. The equipment database for use by WOMS and the property management program are being completed by SCS engineering as the design is completed.

Work has begun in setting up the Instrumentation shop, with areas for information storage, transmitter repair and calibration, and sensing element testing. Much of the equipment for the instrumentation shop has been transferred from other projects and is presently being checked out and calibrated, while other necessary equipment is also being identified. Also, tools transferred from other research projects are being allocated to the journeymen. Shop tool orders of the large and high precision tools and indicators have been made and shop machinery is being set and repaired.

Maintenance Inspection and Procedures

A borescope and equipment for vibration monitoring/maintenance was procured for use during operations. Summer students collected, sorted and filed 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, and will include the collating of spare parts lists for evaluation and procurement. The Mechanics and E&I Journeymen are reviewing and commenting on several procedures provided by the equipment vendors, based on experience with similar equipment.

Data Management Development

Progress has been made in setting up the computer networks to allow both SCS and representatives of other participants and organizations access to the data produced at the facility. All onsite participants will be given accounts on the local network server. The data that will be available from the network server will be organized into a hierarchy of main directories based on the participants with subdirectories under each main heading to provide a logical organization of the data.

When the participants access their accounts on the network, they will be able to access data that relates to their responsibilities in the project. Areas will also be setup to house nonproprietary information, balance of plant information, data analysis software, and other needed information. The accounts have been tested to insure that the data is secure, and that no one can access data other than the intended parties.

These accounts will also allow the user access to the display screens of the control system. This will allow real-time monoritoring of plant and equipment by onsite personnel. These accounts will also restrict the information that is available to a user. The privileges will be based on the users network login ID.

Programming of the heat and material balance programs has continued. These are modular C++ programs written for the Windows environment that will collate data from the DCS, lab analysis and other sources and will perform heat and material balances. The programs also calculate various process and equipment performances. Draft versions of the programs for the MWK train and for the balance of plant equipment are ready for testing. Work is beginning on similar programs for the FW train.

In preparation for operation of the transport reactor train, a series of modeling calculations to predict the behavior of the circulating solids in the transport reactor was carried out. Much of the work has centered on estimating the pressure and temperature profiles for the reactor. This includes calculations of various standpipe nozzle aeration rates for a given solid circulation rate, relationship between the standpipe pressure differentials and dipleg solid heights, flow regimes in the standpipe corresponding to different solid circulation rates, and separation efficiencies of primary cyclone and disengager. In addition, correlations have been either found or derived to calculate the pressure drop for the the mixing zone, riser, cyclones, and j-leg. These models are being used to provide estimates of readings of the differential pressure instruments around the reactor loop. While the normal scatter connected with these types of correlations makes it unlikely to obtain accurate values, the models can be used to predict trends in instrument readings associated with a change in operating condition. This type of information should be useful for the operation of the reactor.

3.0 PLANS FOR FUTURE WORK

1. MWK will continue to provide construction field support. The work on the maintenance and inspection manual will be completed during the next quarter.

2. FW will continue towards completing work on the detailed design of piping, electrical and instrumentation systems. The FW operating procedure writeup and commissioning (cold and hot shakedown) sequence and schedule activities will continue into the next quarter. A design closeout punch items is being prepared for the expected finish of the detailed design.

3. SCS engineering will continue acquisition and expediting of purchased equipment for the balance-of-plant. DCS configuration will continue for the MWK and balance-of-plant portions. SCS will continue to design steel and foundations for the remaining equipment. Electrical, instrument and other bulk acquisitions will be on-going.

4. Construction at the PSDF site continues. Steel City (steel erectors) will continue with erection of remaining steel on the coal and ash buildings and set equipment. Continuing electrical work will involve work on power transformers, distribution panels, associated conduits and grounding in the process structure and in the coal and limestone storage areas. Mechanical will continue with fit-up of the transport reactor refractory lined pipe and the installation of process and utility pipe.

5. For the granular bed filter, Combustion Power will ship the boost blowers, transmitters and filter material in the next quarter. Any changes to the GBF filter internals will take place prior to the installation of the internals in December. Once the internals are installed, construction will begin with the installation of the de-entrainment vessel and the refractory lined piping.

6. A meeting is scheduled for early October with IF&P, DOE and SCS personnel. During the meeting, the final configuration of the vessel internals should be decided. At that point IF&P will begin producing the fabrication drawings for the internals. The current plan is for the internal drawings to be completed by the end of 1995. There will be a final review meeting prior to release of the drawings for fabrication. The fabrication of the pressure vessel is currently scheduled to be completed on November 3. The vessel will then be shipped to IF & P for the installation of the refractory before shipping to SCS on November 20.

7. Construction activities around the Westinghouse FL0301 vessel continue to progress rapidly after the commencement of the refractory-lined piping installation. The outlet pipe installation will begin in late October. Candle installation is scheduled to occur in mid-November. The FL0352 is scheduled to arrive on the jobsite in November. Construction plans to install the vessel in the structure by the end of October.

8. In the coming quarter, the prototype cyclone manifold will be machined to accept the cyclones and tested at the SRI's combustion test facility. The receptacles will be finished using die-sinker EDM (electrical discharge machining). This work is already underway at EDM Technologies in Atlanta. The remaining control panels for the FW structure will be finished, and the control panels that are already onsite will be installed. At least one of the insertion mechanisms will be fitted with all bed-mounted components to ensure that the brackets fit properly. The insertion mechanisms that are now on site will be installed, and shakedown of the sampling systems will begin immediately after the completion of installation.

   Current plans call for setting the control panels in the process structure and setting the control cabinet in the I/O building in October. Wiring between the control panels and the I/O building will also begin in October. The sleeves and ball valves will be mounted after the refractory-lined piping is in place at the sampling locations. The insertion mechanisms will then be set in place, supported, and attached to the ball valves.

9. 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.

10. With the journeymen on-site, and construction nearing completion of selected sub-systems and components, testing and commissioning is about to begin. Over the next month, Station Service (permanent) electrical power will be energized, orders will be placed for feed materials (coal, sorbent, propane, coke breeze, startup bed

material, heat transfer fluid, etc.), several water supply systems will be completed, and early component check-out of various other systems will begin. Instrumentation technicians will continue transmitter loop calibrations and functional testing of the control devices prior to powering equipment up.

11. During the Fall, as equipment installation is completed, start-up and commissioning testing will continue, culminating with a coal fire in the MWK Transport Reactor. As equipment is commissioned, system loops will be tested, tuned and commissioned before integrating into a larger matrix. As the individual parts are proven, problems are solved at a manageable scale before introducing too many variables. This process of building and proving systems that function stablely separately minimizes the risk of process upsets having an unknown cause.

12. A few areas of modeling the solids circulation in the Transport Reactor need to be investigated. Most important are items dealing with the operation of the standpipe, dipleg, and j-leg and their dependence on one another. The results will continue to be adapted for use in operation of the reactor. The MWK and BOP heat and material balance programs will be tested and the programs for the FW train will be put into a draft form. Softwares to transfer and manage data from the DCS and to record and retrieve laboratory analysis data are currently being evaluated.

APPENDIX A

PSDF PROCEDURES STATUS LOG

PSDF Procedure Status Log

Procedure Number	Procedure	Author	Revision	Comments/Status
PSFD-GEN-AP-01	Development, Review, and Approval of Plant Procedures	MH	Rev. 0	Issued as approved
PSDF-GEN-AP-02	Documentation of Design Deviations	BW	Rev. 0	Issued for cross-disciplinarty review 9/29/95. Placed on hold while site Mangement of Change policies are considered.
PSDF-GEN-SHP-01	Lockout/Tagout	WB	Rev. 0	Issued for cross-disciplinary review 9/15/95
PSDF-GEN-SHP-02	Hazardous Energy Control	WB	Rev. 0	Issued for cross-disciplinary review 9/15/95
PSDF-GEN-SOP-2000	Station Service	CP	Rev. 0	Issued for cross-disciplinary review.
PSDF-AUX-SOP-100	Coal Receiving	RL	Rev. 0	Issued for cross-disciplinary review 9/13/95
PSDF-AUX-SOP-101	Sorbent Receiving	RL	Rev. 0	Issued for cross-disciplinary review 9/13/95
PSDF-AUX-SOP-102	Coal and Sorbent Reclaiming	RL		
PSDF-AUX-SOP-103	MWK Coal Preparation	RL		
PSDF-AUX-SOP-104	Sorbent Preparation	RL		
PSDF-AUX-SOP-105	MWK Coal Transportation System FD0104	RL		
PSDF-AUX-SOP-106	FW Coal Transportation System FD0105	RL		
PSDF-AUX-SOP-107	Coke Breeze/Bed Material Transportation System FD0140	RL		
PSDF-AUX-SOP-108	FW Coal Preparation	RL		
PSDF-AUX-SOP-108	MWK Sorbent Transportation System FD0154	RL		
PSDF-AUX-SOP-110	FW Sorbent Transportation System FD0155	RL		
PSDF-AUX-SOP-200	Propane Receiving	RL		
PSDF-AUX-SOP-201	No. 2 Diesel Fuel Receiving	RL		
PSDF-AUX-SOP-202	Propane System Operation	RL		
PSDF-AUX-SOP-300	Service and Instrumetn Air System Operating Procedure	MH		

PSDF-AUX-SOP-500	Cooling Water System - MWK Loop	WB	Rev. 0	Issued for cross-disciplinary review 9/13/95, and returned with comments 10/5/95.
PSDF-AUX-SOP-501	Cooling Water System - FW Loop	WB	Rev. 0	Issued for cross-disciplinary review 10/13/95, and returned with comments 10/5/95.
PSDF-AUX-SOP-502	Cooling Water System - SCS Loop	WB	Rev. 0	Issued for cross-disciplinary review 9/13/95, and returned with comments 10/5/95.
PSDF-AUX-SOP-600	Circulating Water System	WB	Rev. 0	Issued for cross-disciplinary review 9/20/95, returned with comments 10/5/95.
PSDF-AUX-SOP-700	Service Water System	WB	Rev. 0	Issued for cross-disciplinary review 9/15/95, returned with commetns 10/5/95.
PSDF-AUX-SOP-900	Fire Protection System	WB	Rev. 0	Issued for cross-disciplinary review 9/15/95.
PSDF-AUX-SOP-1200	Ash Transport System FD0810	RL		
PSDF-AUX-SOP-1201	Ash Transport System FD0820	RL		
PSDF-AUX-SOP-1202	Ash Silo and Unloading System SI0814	RL		
PSDF- MWK-SOP-100	MWK Coal Feed System FD0210	RL	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.
PSDF- MWK-SOP-101	MWK Coke Breeze Feed System FD0210	RL		
PSDF- MWK-SOP-102	MWK Sorbent Feed System FD0220	RL	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.
PSDF- MWK-SOP-103	MWK Bed Material Feed System FD0220	RL		
PSDF-MWK-SOP-200	MWK Startup Burner	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95
PSDF-MWK-SOP-201	MWK Transport Reactor - Combustion Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95
PSDF-MWK-SOP-202	MWK Transport Reactor - Gasification Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95
PSDF-MWK-SOP-400	Spent Solids Transporter System FD0510 - Combustion Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.
PSDF-MWK-SOP-401	Spent Solids Transporter System FD0510 - Gasification Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.

PSDF-MWK-SOP-402	Spent Fines Transporter System FD0520 - Combustion Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.
PSDF-MWK-SOP-403	Spent Fines Transporter System FD0520 - Gasification Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/2/95.
PSDF-MWK-SOP-404	Spent Solids Feeder System FD0530 - Combustion Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments on 10/5/95.
PSDF-MWK-SOP-405	Spent Solids Feeder System FD0530 - Gasification Mode	CT	Rev. 0	Issued for cross-disciplinary review 9/15/95, returned with comments on 10/5/95.
PSDF-MWK-SOP-600	Sulfator Sorbent Feed System FD0610	RL	Rev. 0	Issued for cross-disciplinary review 9/13/95, returned with comments 10/5/95.
PSDF-MWK-SOP-701	Heat Transfer Fluid System	WB		
PSDF-MWK-SOP-702	Steam Generation and Distribution	WB		

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

1. FW APFBC SYSTEM
2. PARTICULATE SAMPLING AND MONITORING
3. CONSTRUCTION PROGRESS
4. TEST PLAN FOR THE MWK TRAIN
5. TEST PLAN FOR THE PCDS IN MWK TRAIN
6. DRAFT TEST PLAN FOR THE FW TRAIN
7. OUTYEAR PLANS

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

1. FW APFBC SYSTEM

FOSTER WHEELER APFBC SYSTEM

- P&ID STATUS
- IMPACT OF HAZOP REVIEW
- DELETION OF SPARE MASB
  - COST IMPLICATIONS
- PROPANE BURNING COMBUSTOR
  - TECHNICAL ISSUES
  - COST AND SCHEDULE
- FW CLOSE OUT PLAN

P&ID STATUS

- REV0 ISSUED 04/07/95
  ALL EXCEPT:
  - TOPPING COMBUSTOR
  - GAS TURBINE

- REV1 ISSUED 06/16/95
  - TOPPING COMBUSTOR
  - GAS TURBINE

- NOW COMPLETE

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

REASONS FOR CHANGES:

- CONTRACTUAL
- VENDOR DETAILS
- INCOMPLETE DESIGN
- OPTIMIZATION
- CLIENT REQUEST
- HAZOP

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

CHANGES DUE TO VENDOR DETAIL DEVELOPMENT

- BOOSTER CONTROLS
- QUENCH PACKAGE
- POSITION OF SAMPLE POINTS
- J-VALVE AIR SIGHT GLASSES
- 8 MINOR CHANGES

FOSTER WHEELER APFBC SYSTEM

P&ID CHANGES SINCE 75%

CHANGES DUE TO DESIGN COMPLETION

- CHAR DRUM LOADING DETAILS
- HARD PIPE AERATION POINTS
- ADD WATER PSV FD0256
- 9 OTHER MINOR CHANGES

FOSTER WHEELER APFBC SYSTEM

P&ID CHANGES SINCE 75%

CHANGES DUE TO DESIGN OPTIMISATION

- DELETE REDUNDANT ANALYSER
- REDUCE MP N2 TO 250PSI
- HX0253 PIPED FOR BATCH
- 2 OTHER MINOR CHANGES

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

CHANGES DUE TO SCS REQUEST

- EXTRA TI ON LP0613
- 2 OUT OF 3 VOTING COMBUSTOR TSHH

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

CHANGES DUE TO HAZOP

- 25 MINOR HARDWARE CHANGES
- 16 MINOR SOFTWARE CHANGES
- NO MAJOR CHANGES

FOSTER WHEELER APFBC SYSTEM

P&ID CHANGES SINCE 75%

TOPPING COMBUSTOR P&ID

- CONTRACT WAS FINALISED AFTER 75% REVIEW
- SCOPE WAS NOT CLEAR UNTIL CONTRACT WAS SIGNED

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

TOPPING COMBUSTOR P&ID

- WESTINGHOUSE SCOPE:
  - BURNER
  - SPOOL PIECE
  - SLIDE PLATE
  - METAL THERMOCOUPLES
  - IGNITORS

- SCS SCOPE:
  - VITIATED AIR ANALYSER
  - SYNGAS ANALYSER

FOSTER WHEELER APFBC SYSTEI
P&ID CHANGES SINCE 75%

TOPPING COMBUSTOR P&ID

- ALLISON SCOPE
  - PROPANE SKID

- FOSTER WHEELER SCOPE
  - INTEGRATION ENGINEERIN(
  - UPSTREAM SPOOLPIECE
  - DOWNSTREAM SPOOLPIECI
  - BURNER MANAGEMENT SYSTEM

FOSTER WHEELER APFBC SYSTEM
P&ID CHANGES SINCE 75%

TOPPING COMBUSTOR P&ID SIGNIFICANT CHANGES

- SPLIT INTO TWO FLOWSHEETS
- SIMPLIFIED PIPING
- SWEEP GAS LINES ADDED
- INSTRUMENTS RATIONALISED
- PROCESS RATIONALISED

FOSTER WHEELER APFBC SYSTEM

P&ID CHANGES SINCE 75%

GAS TURBINE P&ID SIGNIFICANT CHANGES

- REDRAFTED
- SIMPLIFIED

FOSTER WHEELER APFBC SYSTEM

CHANGES FROM HAZOP

- HAZOP OF ISBL P&IDS AND VENDOR DRAWINGS

- 348 ISSUES IDENTIFIED:
  205 REQUIRING NO ACTION
  54 BOP ISSUES
  31 CANDLE FILTER ISSUES
  25 MINOR HARDWARE CHANGES
  16 MINOR SOFTWARE CHANGES
  17 OPERATING PROCEDURES

- NO MAJOR CHANGES

FOSTER WHEELER APFBC SYSTEI

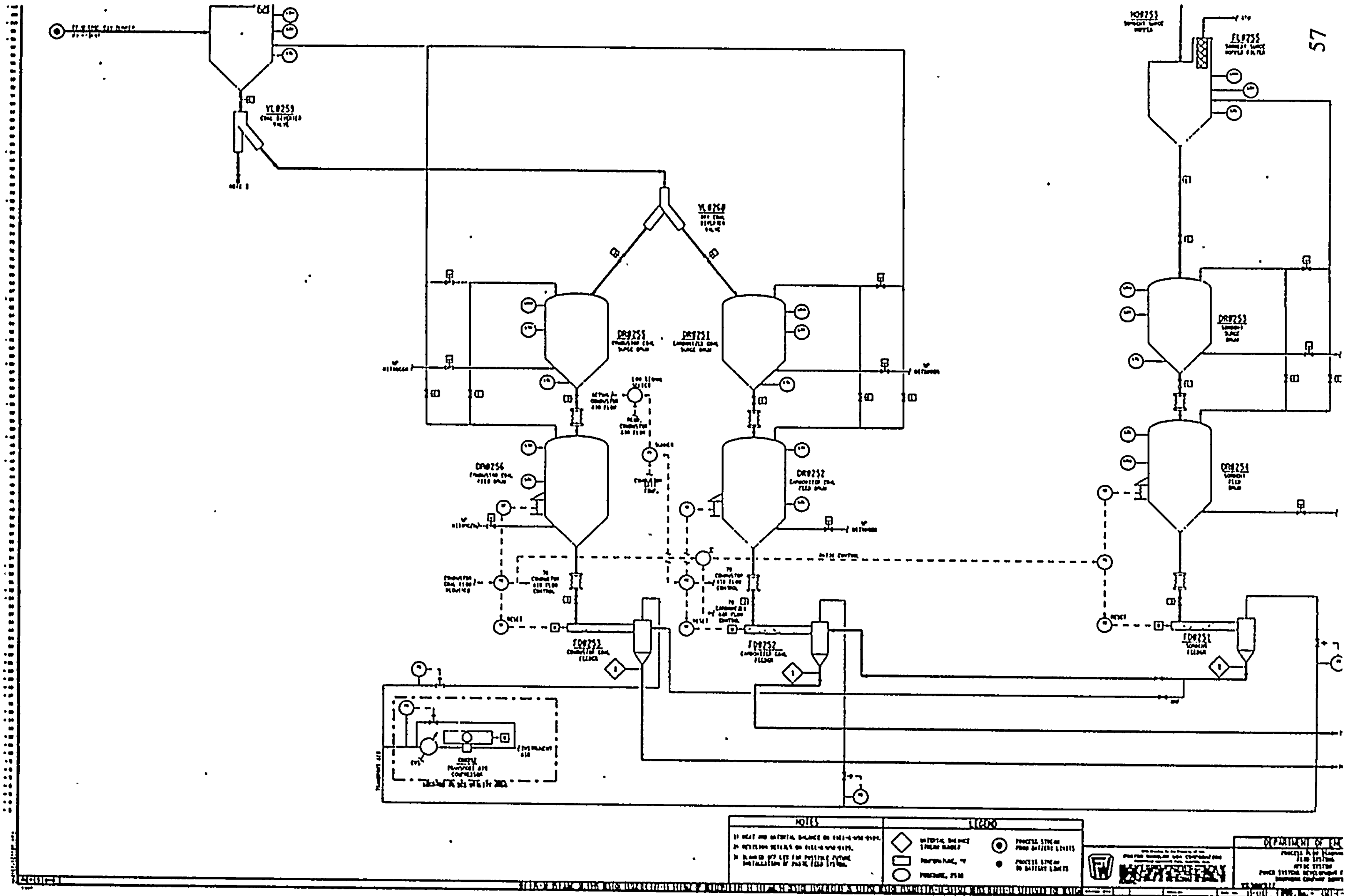
PROPANE BURNER

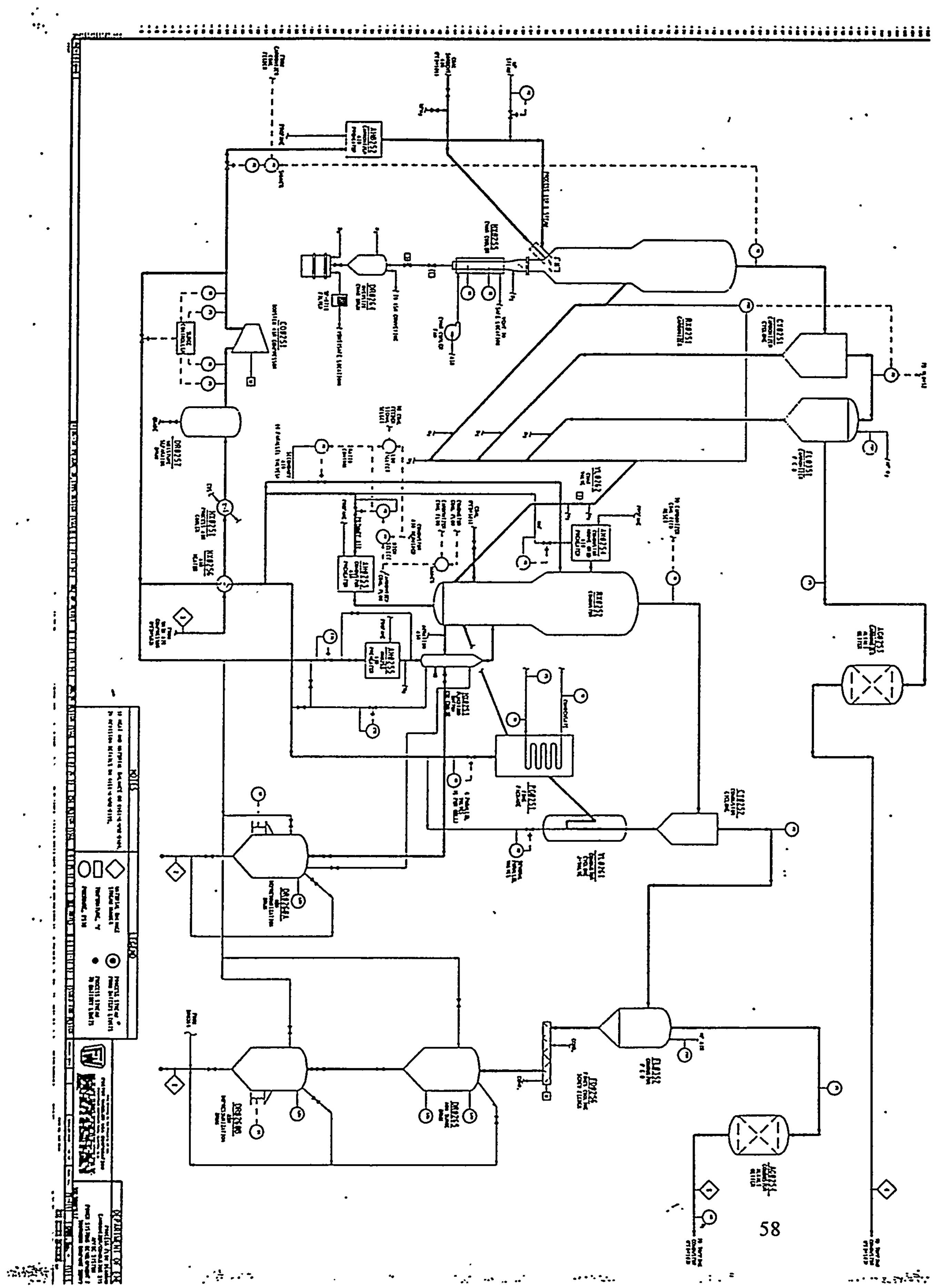
- ENABLE FIRST GENERATION OPERATION WITHOUT MASB
- CONTINGENCY DEVICE IF MASB FAILS MECHANICALLY
- MAY HELP SCHEDULE

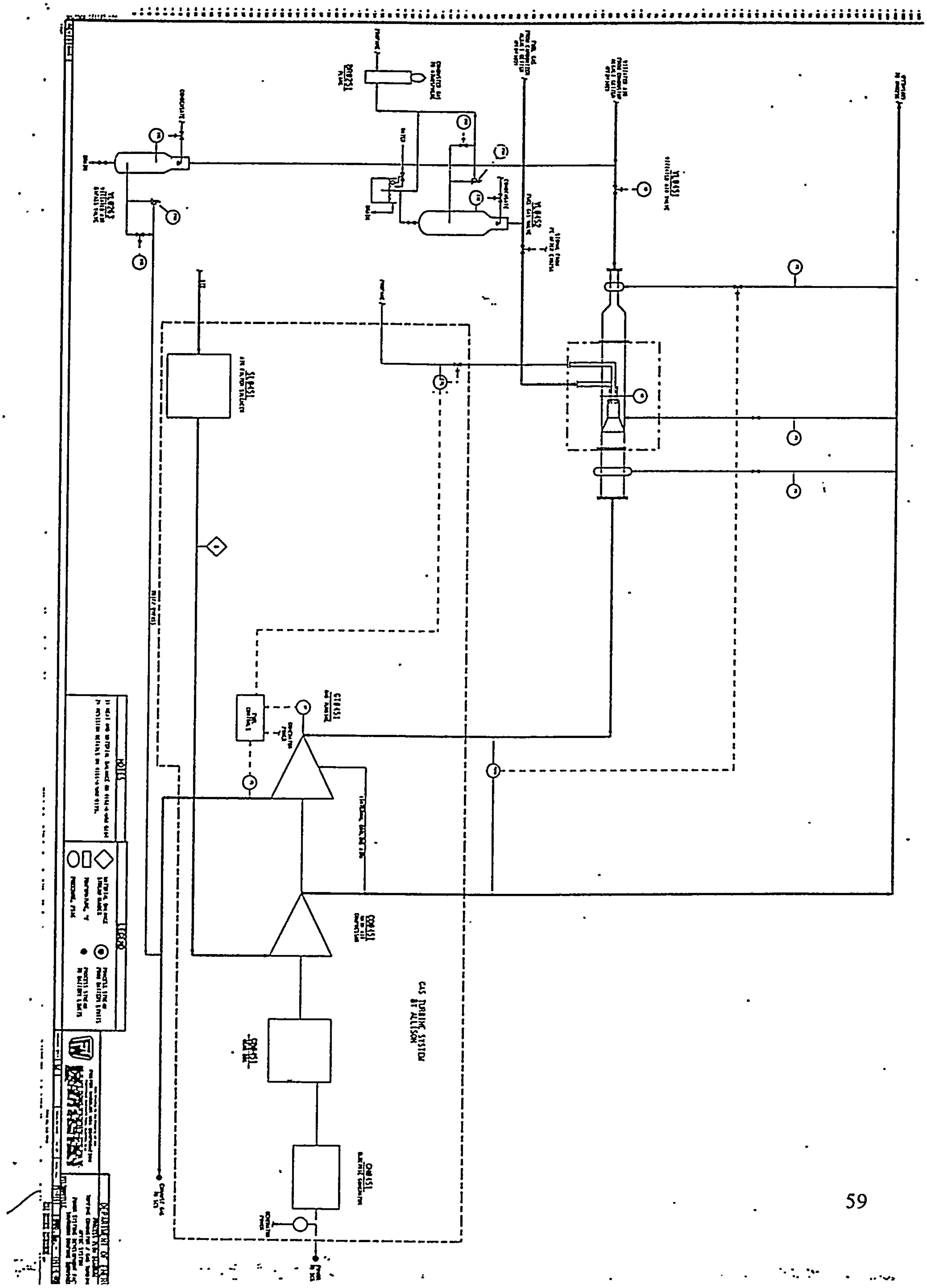
FOSTER WHEELER APFBC SYSTEM

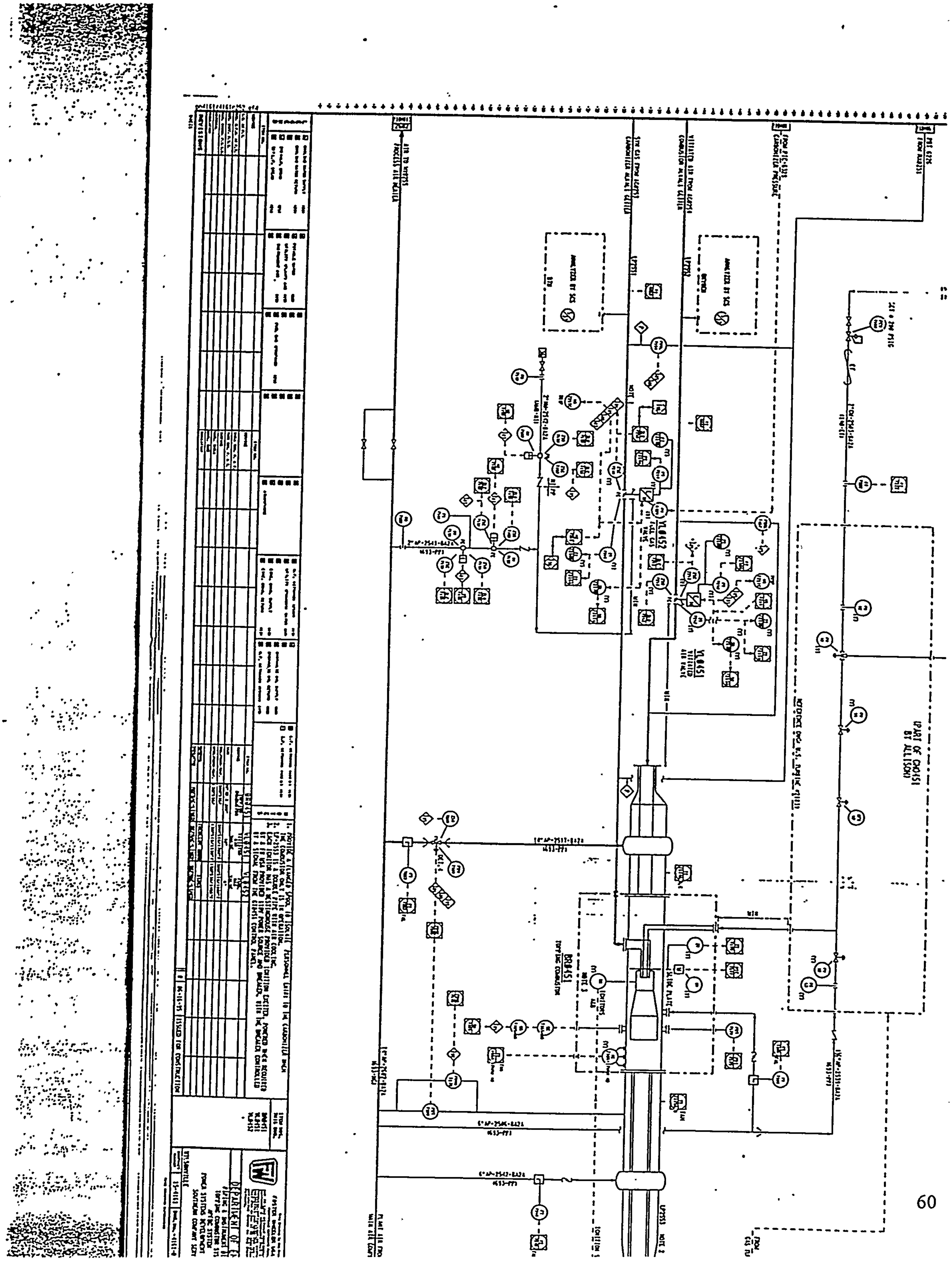
PILOT PLANT STATUS

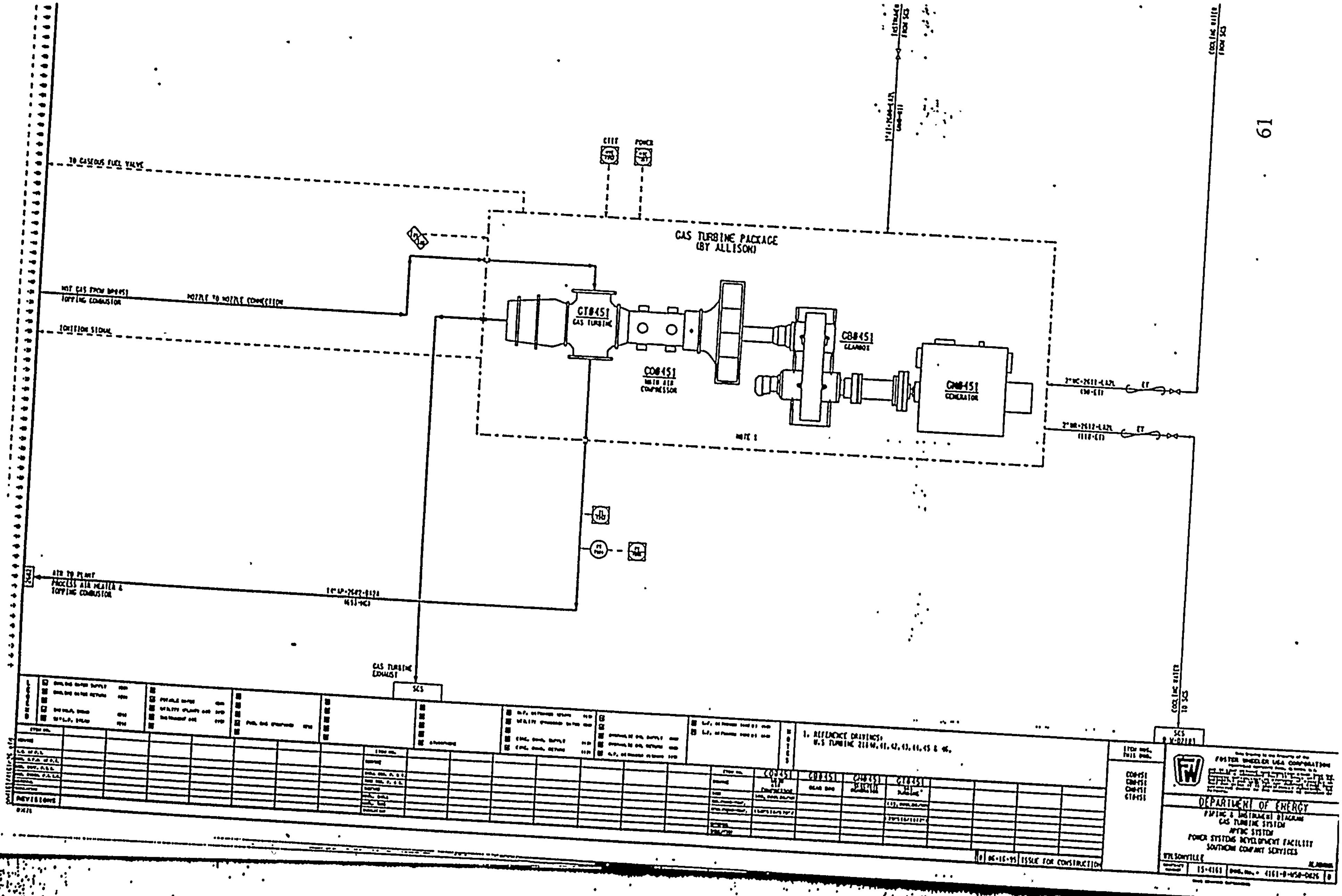
- 5 SHAKEDOWN RUNS SO FAR
- 2 EXPERIENCED EQUIPMENT PROBLEMS
- 3 ACHIEVED INTEGRATED OPERATION FOR 1 - 3 HRS
- EFFORT UNDERWAY TO RESOLVE PROBLEMS
- LESSONS FOR WILSONVILLE

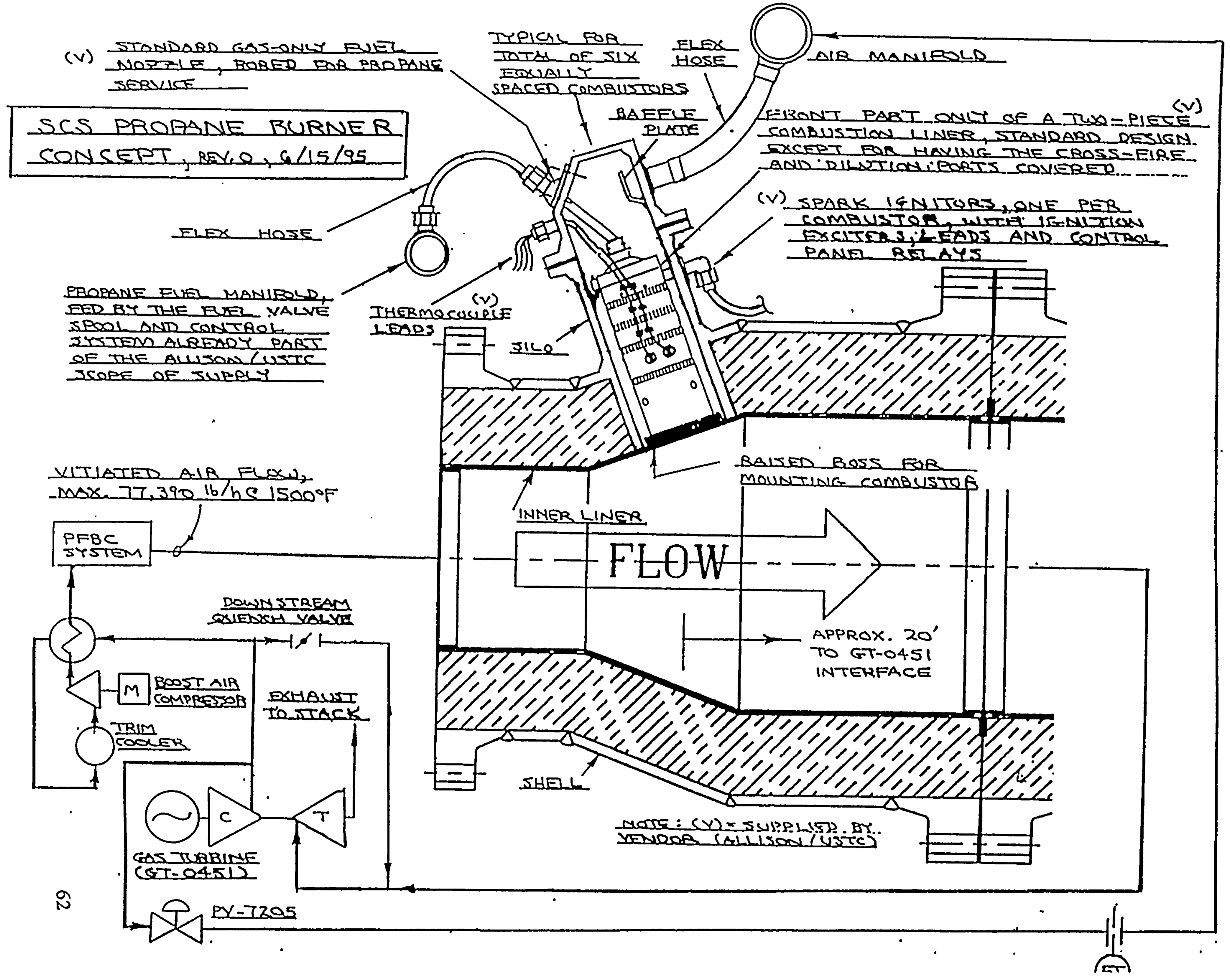

YL0259
YL0258
DR0255
DR0251
DR0256
DR0252
DR0253
FD0253
FD0252
FD0251
FL0255
HO0253
NOTES
LEGEND

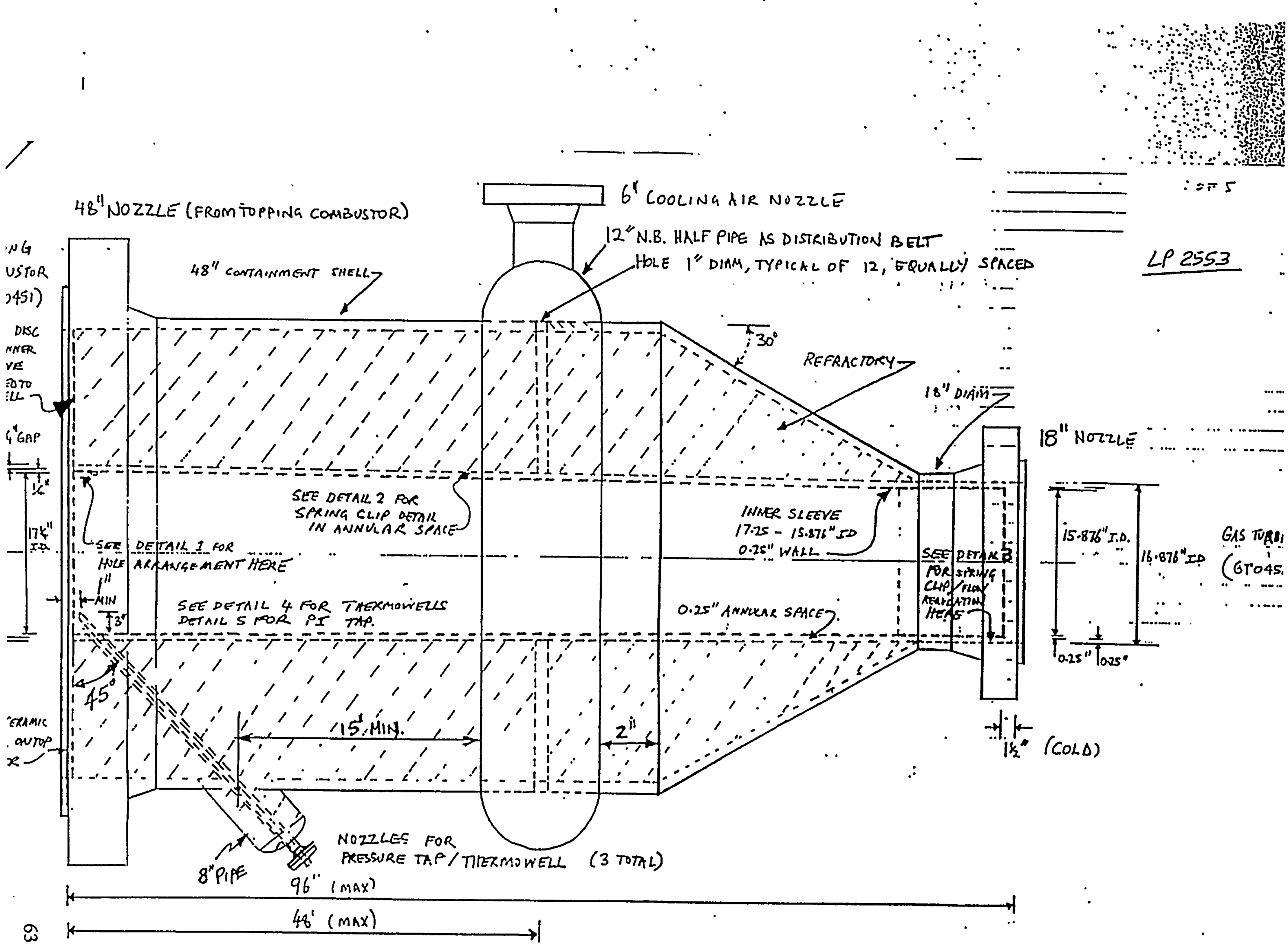







GAS TURBINE PACKAGE
(BY ALLISON)
GT#451
GAS TURBINE
CO#451
MAIN AIR COMPRESSOR
GB#451
GEARBOX
GN#451
GENERATOR
TO GASEOUS FUEL VALVE
HOT GAS FROM BP#451
TOPPING COMBUSTOR
NOZZLE TO NOZZLE CONNECTION
IGNITION SIGNAL
AIR TO PLANT
PROCESS AIR HEATER &
TOPPING COMBUSTOR
GAS TURBINE
EXHAUST
SCS
COOLING WATER
FROM SCS
COOLING WATER
TO SCS
INSTR AIR
FROM SCS
NOTE 1
1. REFERENCE DRAWINGS:
REVISIONS
ISSUE FOR CONSTRUCTION
FOSTER WHEELER USA CORPORATION
DEPARTMENT OF ENERGY
PIPING & INSTRUMENT DIAGRAM
GAS TURBINE SYSTEM
APFBC SYSTEM
POWER SYSTEMS DEVELOPMENT FACILITY
SOUTHERN COMPANY SERVICES
WILSONVILLE
ALABAMA


SCS PROPANE BURNER
CONCEPT, REV. 0, 6/15/95
(V) STANDARD GAS-ONLY FUEL NOZZLE, BORED FOR PROPANE SERVICE
TYPICAL FOR TOTAL OF SIX EQUALLY SPACED COMBUSTORS
FLEX HOSE
AIR MANIFOLD
BAFFLE PLATE
(V) FRONT PART ONLY OF A TWO-PIECE COMBUSTION LINER, STANDARD DESIGN, EXCEPT FOR HAVING THE CROSS-FIRE AND DILUTION PORTS COVERED
(V) SPARK IGNITORS, ONE PER COMBUSTOR, WITH IGNITION EXCITERS, LEADS AND CONTROL PANEL RELAYS
FLEX HOSE
PROPANE FUEL MANIFOLD, FED BY THE FUEL VALVE SPOOL AND CONTROL SYSTEM ALREADY PART OF THE ALLISON/USTC SCOPE OF SUPPLY
(V) THERMOCOUPLE LEADS
SILO
RAISED BOSS FOR MOUNTING COMBUSTOR
VITIATED AIR FLOW, MAX. 77,390 lb/hr @ 1500°F
PFBC SYSTEM
INNER LINER
FLOW
APPROX. 20' TO GT-0451 INTERFACE
DOWNSTREAM QUENCH VALVE
M
BOOST AIR COMPRESSOR
EXHAUST TO STACK
TRIM COOLER
SHELL
C
T
GAS TURBINE (GT-0451)
NOTE: (V) = SUPPLIED BY VENDOR (ALLISON/USTC)
PY-7205


LP 2553
48" NOZZLE (FROM TOPPING COMBUSTOR)
6" COOLING AIR NOZZLE
12" N.B. HALF PIPE AS DISTRIBUTION BELT
HOLE 1" DIAM, TYPICAL OF 12, EQUALLY SPACED
48" CONTAINMENT SHELL
30°
REFRACTORY
18" DIAM
18" NOZZLE
SEE DETAIL 2 FOR SPRING CLIP DETAIL IN ANNULAR SPACE
INNER SLEEVE 17.25 - 15.876" ID 0.25" WALL
SEE DETAIL 1 FOR HOLE ARRANGEMENT HERE
SEE DETAIL 4 FOR THERMOWELLS DETAIL 5 FOR PI TAP.
0.25" ANNULAR SPACE
SEE DETAIL 3 FOR SPRING CLIP/FLOW REALIGNATION HERE
15.876" I.D.
16.876" ID
0.25"
0.25"
GAS TURBI
(GT045
1" MIN
3"
45°
15" MIN.
2"
1½" (COLD)
¼" GAP
¼"
17¼" I.D.
NOZZLES FOR PRESSURE TAP/THERMOWELL (3 TOTAL)
8" PIPE
96" (MAX)
48' (MAX)

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

2. PARTICULATE SAMPLING AND MONITORING

Particulate Sampling and Monitoring

by
SOUTHERN RESEARCH INSTITUTE
Birmingham, Alabama

Project Review Meeting
Power Systems Development Facility
July 25, 1995

d:JUL951B.IMA

Scope of Work

DESIGN, PROCUREMENT, AND INSTALLATION

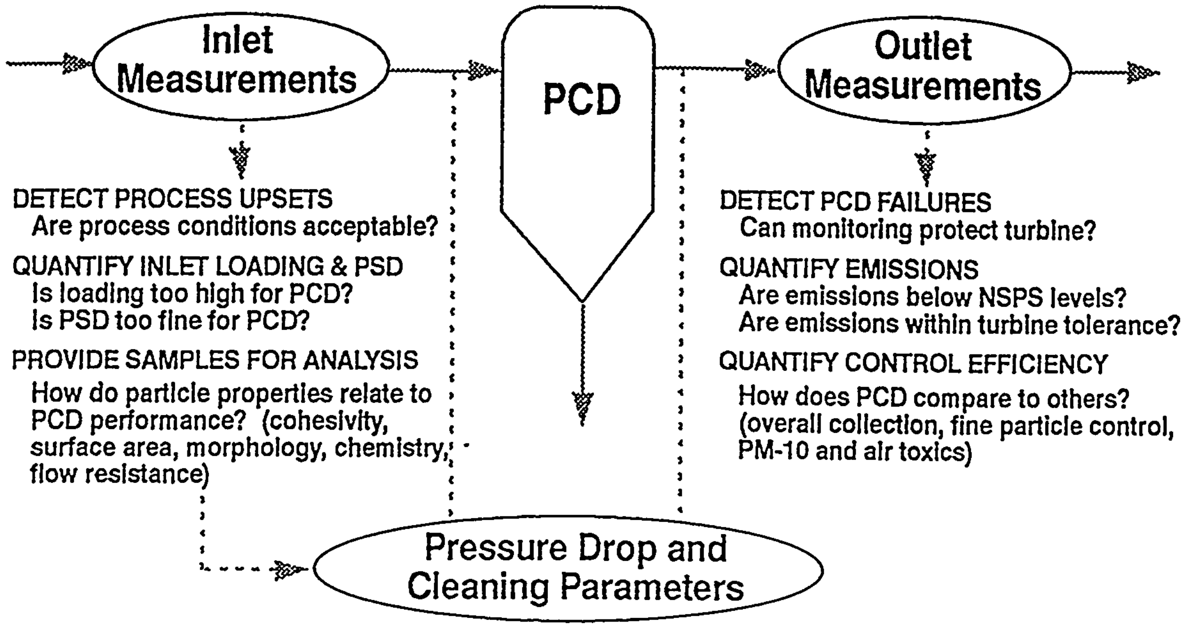
- Design and build particulate sampling systems
- Specify and purchase particulate monitors
- Assist SCS in procurement of PCDs

OPERATIONS AND TESTING

- Conduct particulate sampling and monitoring
- Assist SCS in evaluating PCD performance
- Assist SCS in developing test plans

d:JUL951C.IMA

Why Make Particulate Measurements?



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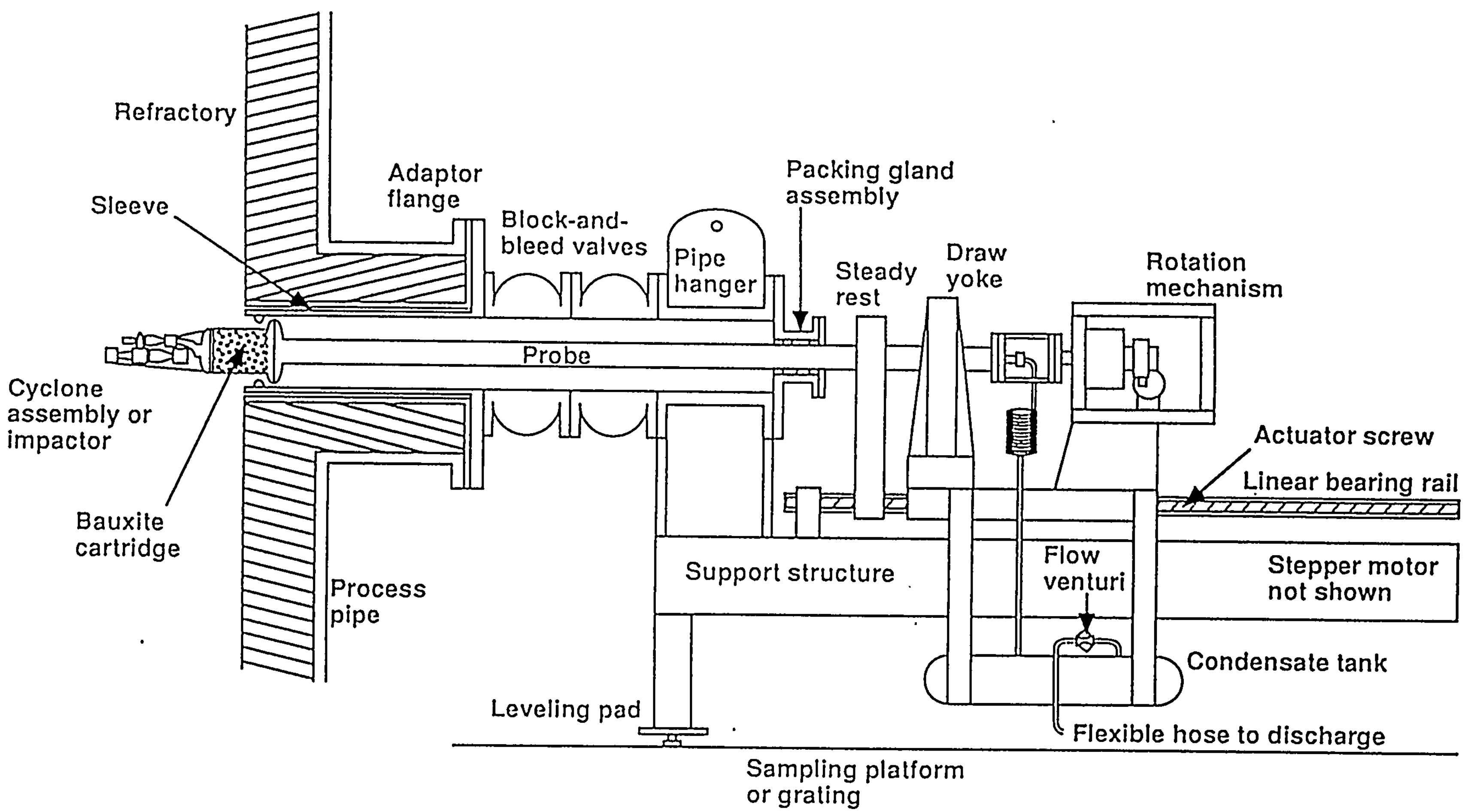
Particulate Sampling System

DESIGN GUIDELINES

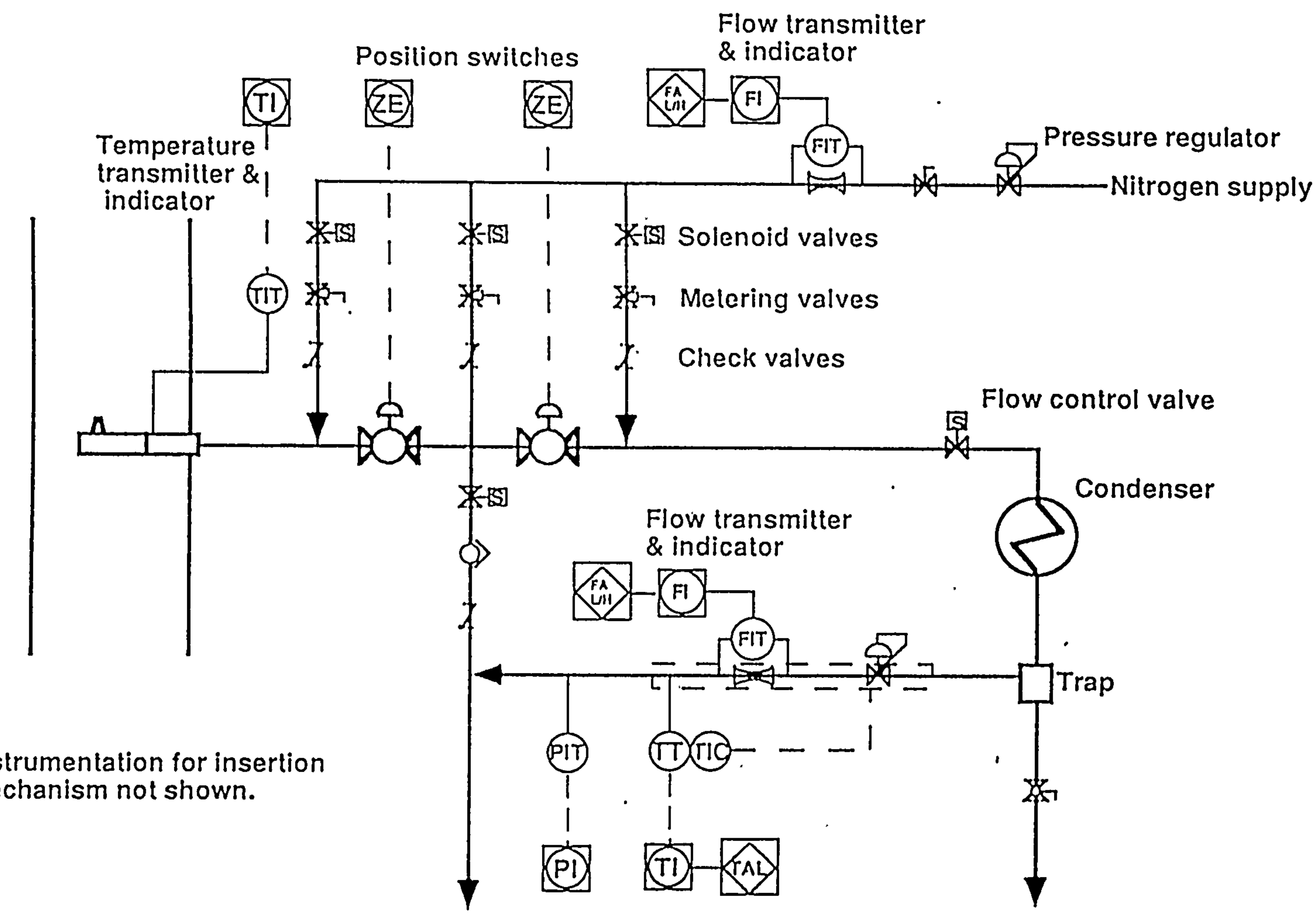
- Minimize particle loss and alteration
- Minimize alkali vapor condensation
- Make samplers interchangeable
- Provide on-line access to process gas stream
- Provide large (>50-g) samples for characterization
- Match inlet and outlet run times
- Minimize exposure of personnel to hazards

d:JUL951D.IMA

Particulate Sampling System



Sampling System Instrumentation



Note: Instrumentation for insertion mechanism not shown.

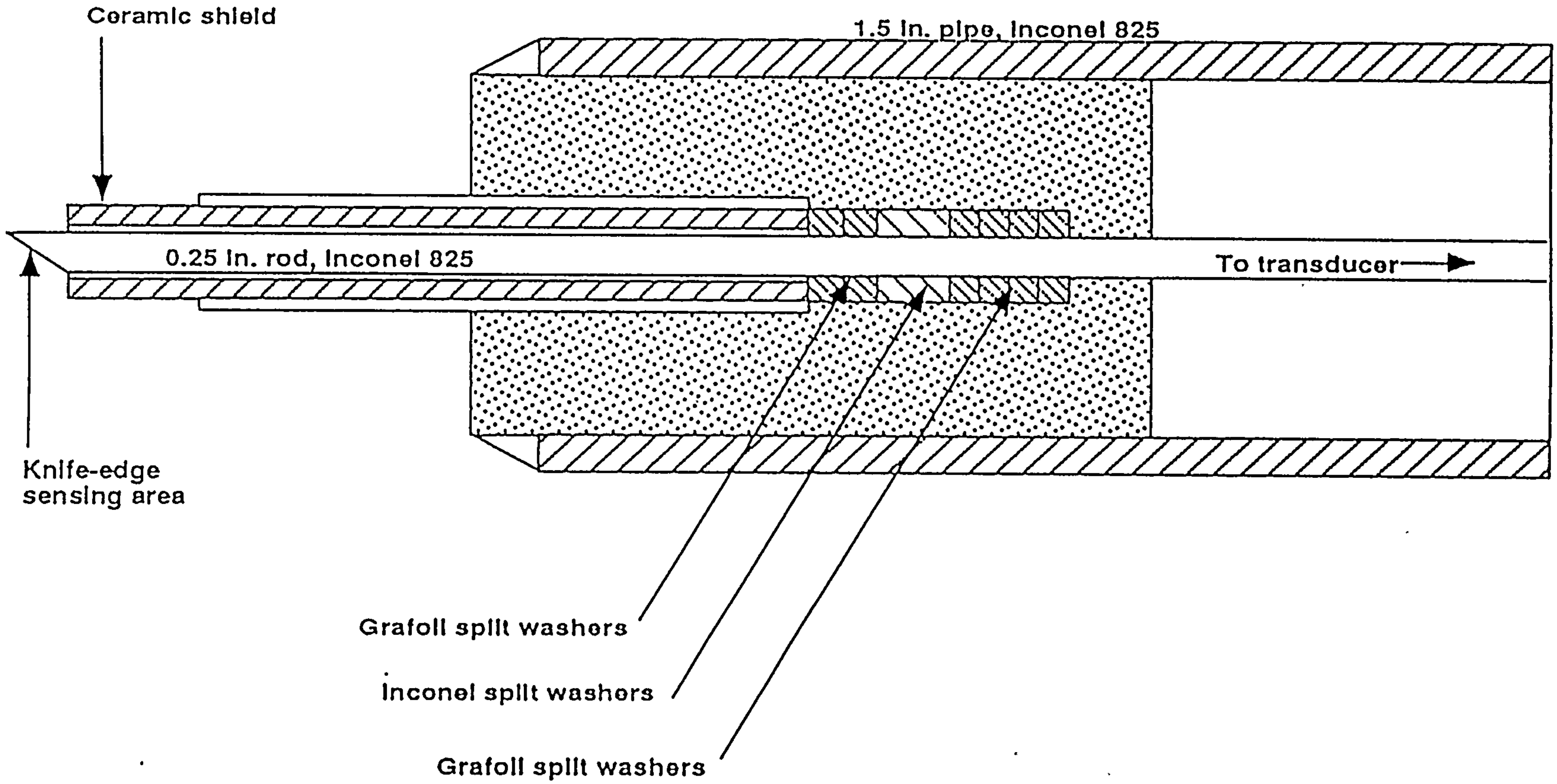
Particulate Sampling System

CONTROL PHILOSOPHY

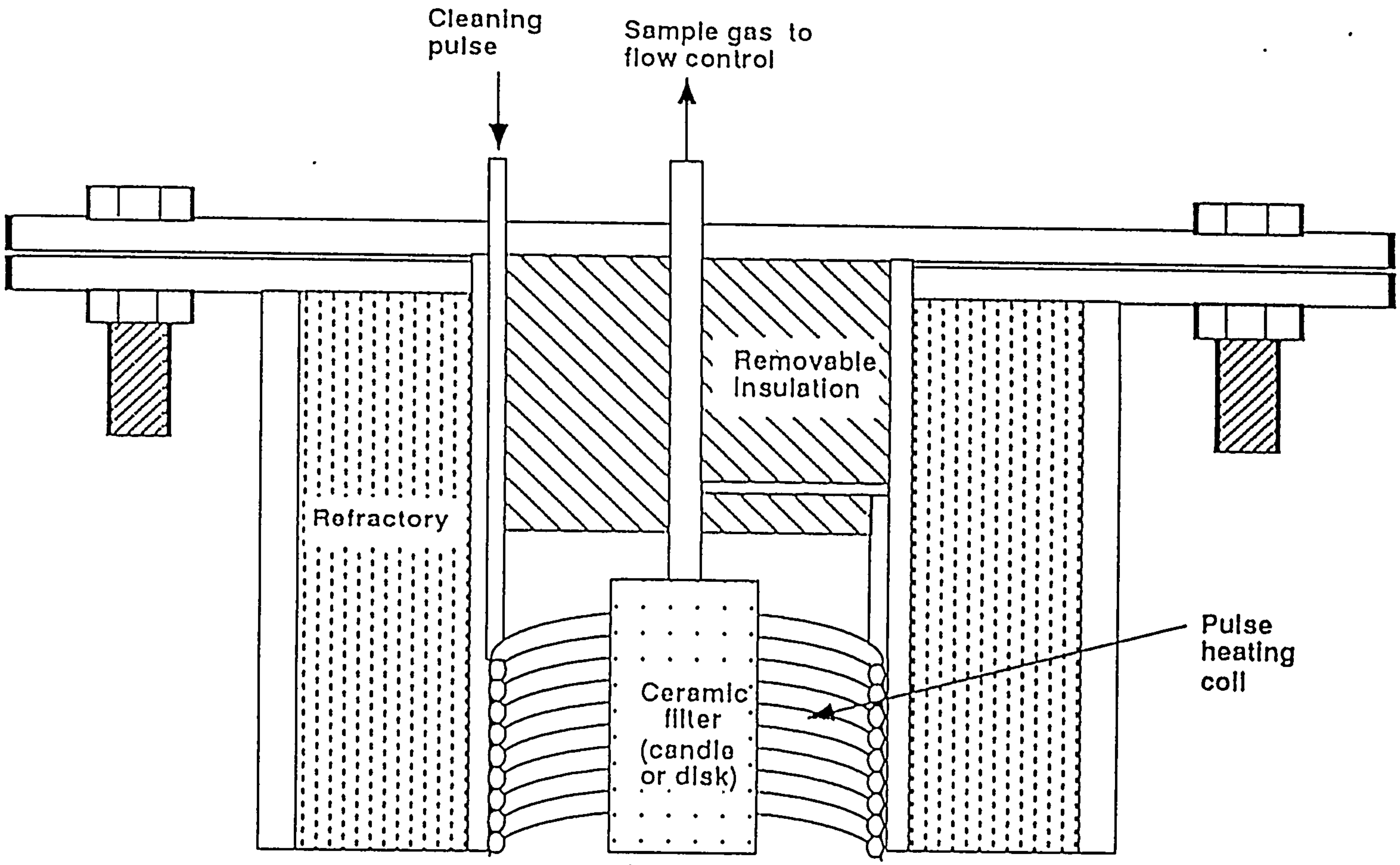
- Manual control during sampler installation
- Automatic control during probe movement
- Authorization required at critical junctures
- Gradual insertion to limit thermal stresses
- Sampler cool down to protect ball valves
- Safety lock-outs built into control system
- Operator lock-out from DCS

d:jul951e.IMA

Acoustic Detector



Sniffer


Cleaning pulse
Sample gas to flow control
Removable Insulation
Refractory
Ceramic filter (candle or disk)
Pulse heating coil

Particulate Monitors

ACOUSTIC DETECTORS

- Simple installation and operation
- Could lose sensitivity as knife edge is eroded
- Not proven at high temperatures and pressures

SNIFFERS™

- Based on IF&P concept
- Flow metering and control complicates design
- Slow response to changes in dust loading
- Not proven at high temperatures and pressures

d:JUL951F.IMA

Current Status

DESIGN

- P&IDs and DCS data base have been delivered
- Wiring and assembly drawings delivered by 7/28/95

EQUIPMENT

- Fabrication is now about 95% complete
- Insertion mechanisms ready for delivery
- Cascade impactor complete except for stages
- Cyclone manifold in second casting
- Monitors to be delivered in September

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APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

3. CONSTRUCTION PROGRESS

POWER SYSTEMS DEVELOPMENT FACILITY

CONSTRUCTION PROGRESS

AS OF 07/25/95

ELECTRICAL BUILDING	- Began Foundation Excavation On 04-10-95. - Completed Floor On 04-17-95. - Walls Completed on 05-03-95. - Equipment Pad Construction Completed On 05-26-95. - Roof Installation Completed On 06-07-95. - 480 Volt Switchgear # 1, 2, & 4 Set. - Cable Tray Installation Is Complete. - 4160 Volt Switchgear Set. - Began Conduit Installation. - MCC Foundations Are Complete. - Began Wiring Changes and Interconnections Between 4160V Switchgear and 4160V MCC Frames. - Set BOP MCC's 1 And 3. - Began Wire Checks For Internal Wiring In 4160 Volt Switchgear.
COOLING WATER	- 98% Complete.
FIRE PROTECTION	- Pump Test Complete.
UNDERGROUND SYSTEM	- Working on Punch List Items.
ADDITIONAL STORAGE YARDS	- Complete.
EQUIPMENT STORAGE MAINTENANCE PROGRAM	- Received information from MWK and FW concerning preservation of equipment in storage. On Going Program as per Recommendations.
SUBSTATION	- In Progress, APCO Equipment Foundations Complete. - Some Structures and Insulators Have Been Erected. - PSDF Construction Began Fabrication For Cable Bus Support.
RAW WATER TANK	- Foundation Began 05-22-95, Completed 06-01-95. - Material for Tank on site. - Tank Erection Is Complete. Painting Remains To Be Done.
ASH STORAGE BUILDING	- Completed Grade Work On 07-14-95. - Drilled Piers Installed 07-20-95 and 07-21-95.
MWK STACK	- Drilled Piers Installed 07-21-95.
FW STACK	- Drilled Piers Installed 07-21-95.
LABOR BROKER	- Site Craft Personnel -

Electricians	26
Boilermakers	4
Pipefitters	34
Carpenters	13
Laborers	19
Iron Workers	6
Operators	8
Painters	2
Cement Masons	2
Millwrights	2
Total Craft	116

77

POWER SYSTEMS DEVELOPMENT FACILITY

CONSTRUCTION PROGRESS

AS OF 07/25/95

SITE PREPARATION (ELLARD)	- Complete.
DRILLED PIERS (RUSSO)	- Complete.
WAREHOUSE/MAINTENANCE BUILDING (SUNBELT)	- Essentially Complete
ADMINISTRATION BUILDING (SUNBELT)	- Complete.
PULL BOXES	- Complete.
TEMPORARY POWER	- Process Structure Board Complete and Energized. Administration Building and Process Structure Elevator Energized.
ADMIN BLDG ELECTRICAL ROOM & CONTROL ROOM	- Foxboro Cabinets Set and Powered On in Control Room. - Set 480 Volt Switchgear # 3 & 5 in Equipment Room. - Cable Tray Installation Complete. - Conduit Installation In Progress. - MCC Foundations Complete.
DUCT RUNS	- All Complete, Except: PB # 8 - Cooling Tower Yard Lighting, In Progress. PSDF to E. C. Gaston, Complete. PB # 2 - Fuel Cells
GROUNDING	- Grid Installation and Tie to E. C. Gaston, In Progress.
PIPE TRENCH	- Complete, Except For Permanent Handrails, etc. - Access Platform, Above Trench, Complete. - Installing Pipe in Trench. 43% Installed. - Heat Tracing For Pipe Trench Equipment Has Been Ordered.
FIRE PROTECTION PUMP HOUSE	- Start-up and Test Complete. - Repaired Leaks through Check Valves and Gate Valves.
FIRE WATER STORAGE TANK AND FOUNDATION	- Complete.
ELEVATOR	- Complete, with Temporary Car.
PROCESS STRUCTURE SUMP	- Complete.

POWER SYSTEMS DEVELOPMENT FACILITY

CONSTRUCTION PROGRESS

AS OF 07/25/95

PROCESS STRUCTURE
- Foundation Is Complete. Sequence 2 Steel Erection, Complete.
- First Equipment, Heat Transfer Fluid System, Set In Place 01-04-95.
- At Grade Equipment in Sequence 2 has been set. MWK Sulfator set 02-03-95. Sequence 3 Steel Erection, Complete.
- Sequence 8 Steel And Stairwell Complete To Elev. 192'.
- Sequence 4 Steel Erection Complete.
- Equipment Setting In Sequence 2 & 4, Complete.
- Field fabrication of Process Air & HTF piping systems underway.
- Westinghouse & CPC filter vessels installed.
- Sequence 6 Steel Erection Complete.
- Sequence 5 Steel Delivery, Complete.
- Continued Installing Piping for MWK, 3,500 Feet Installed.
- Trial fit-up of MWK Reactor Loop Is Complete.
- MWK Cable Tray System In Progress.
- Rough Set FW Alkalai Getters On 06-19-95 and 06-20-95.
- P. A. System Installation In Progress. Some Stations Are Operational.
- Sequence 5 Steel Erection In Progress.
- Final Assembly of MWK Reactor Loop In Progress. 12 of 25 Joints Complete.

COAL STORAGE STRUCTURE
- Complete.
- Installing Lighting, Grounding, and Lightning Protection.

COAL STRUCTURE
- Complete, Except for Steel Left Out for Coal Silo Installation.
- Silo Fabrication Began On 7-13-95.

MWK MCC BUILDING
- Buildings Are Complete.
- Cable Tray Installation Complete.
- Foxboro Cabinets Set and on Temporary Power.
- Lighting Installed.

FW MCC BUILDING
- Buildings Are Complete.
- Cable Tray Installation Complete.
- Foxboro Cabinets Set and on Temporary Power.
- Lighting Installed.

PROCESS WATER
- The process water piping on site has been installed as far as design is complete. The supply line from E. C. Gaston to PSDF Is Complete.
- Railway Boring is Complete.
- Awaiting Design and Procurement of Raw Water Pumps.

DEMIN WATER
- The demin water on site has been installed as far as design is complete.
- The supply line from E. C. Gaston Steam Plant to the PSDF is complete.
- Awaiting Design and Procurement of Demin Pumps.

POTABLE WATER
- Installation of Permanent Tie-In to Wilsonville Water Main and Connections to Administration Building and Warehouse Is Complete.
- Disinfection And Test Of Admin And Warehouse Water System, Complete.
- Received booster pump and tank assembly. Poured pad for booster pump.
- Ordered Booster Pump House.

SEWAGE SYSTEM
- Complete.

POWER SYSTEMS DEVELOPMENT FACILITY

PLANS FOR AUGUST AND SEPTEMBER 1995

Electrical - Complete Cable Bus Installation Between Substation And Electrical Equipment Building.

- Hi-Pot Test Bus And 5KV Cables.
- Essentially Complete Grounding System.
- Install And Verify Control Circuits And I/O For Foxboro Controls For Incoming Supply Breaker.
- Install Batteries, D. C. Panel, UPS, And Miscellaneous Power Distribution Panels.
- Energize Substation And 4KV Switchgear.
- Energize 4160 Volt / 480 Volt Transformers And Switchgear.
- Energize 480 Volt MCC's Where Possible.

Civil - Complete Sequence 5 And 7 Steel Erection.

- Erect MWK Stack.
- Erect Cooling Tower.
- Erect Steel For Ash Storage Structure.
- Fabricate And Erect Silos.
- Rough Set FW Equipment In Structure.

Mechanical - Complete Final Assembly Of MWK Reactor Loop.

- Continue Piping For MWK.
- Complete Raw Water And Demin Water From E. C. Gaston.
- Concentrate On Cooling Water And Service Water Loops In Process Structure.

POWER SYSTEMS DEVELOPMENT FACILITY

BOP ENGINEERING

Civil / Structural Design

Estimated % Complete	-	89%
Scheduled % Complete	-	91%
Drawings Remaining	-	24

Electrical Design

Estimated % Complete	-	47%
Scheduled % Complete	-	51%
Drawings Remaining	-	159

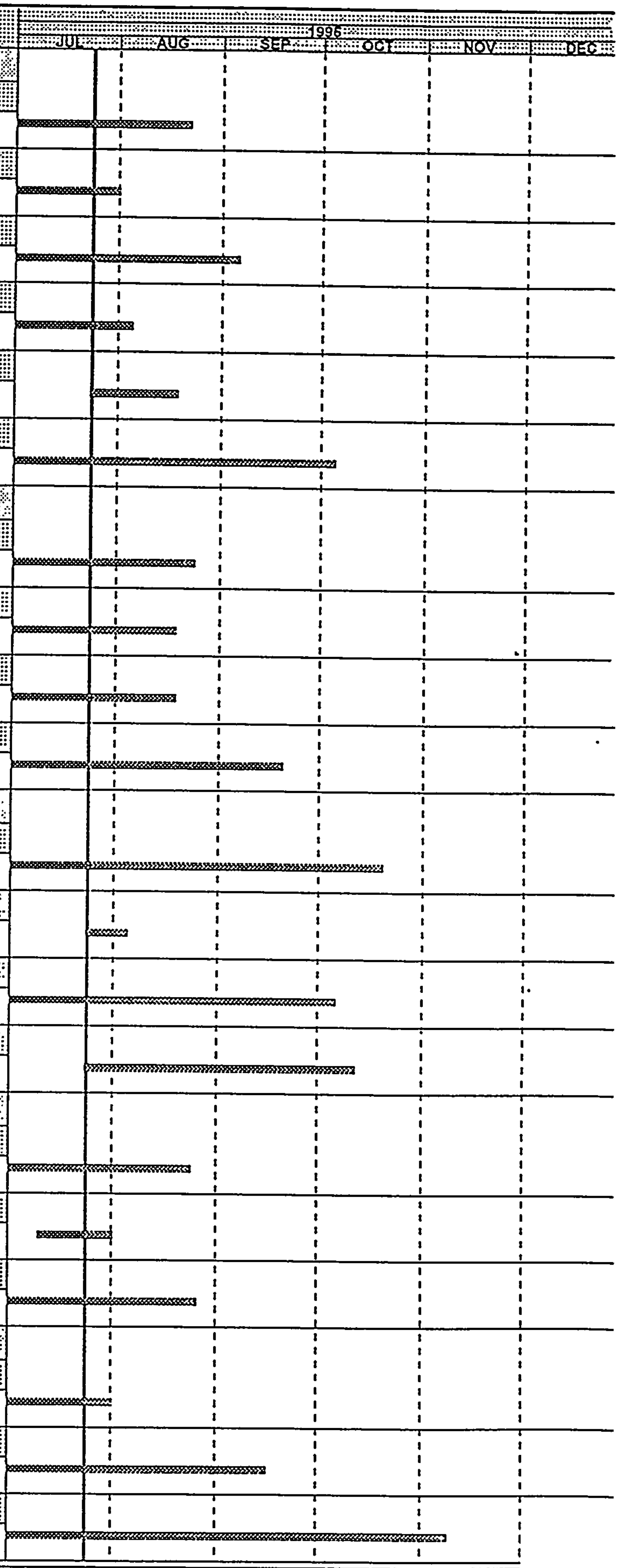
Mechanical Design

Estimated % Complete	-	79%
Scheduled % Complete	-	83%
Drawings Remaining	-	69

I&C Design

Estimated % Complete	-	51%
Scheduled % Complete	-	50%
Drawings Remaining	-	146

Activity ID	Orig Dur	Rem Dur	Early Start	Early Finish
100/101 COAL & LIMESTONE				
+ COAL & LIMESTONE MILL SYSTEM				
	11	21	01MAY95A	21AUG95
+ COAL HANDLING CONCRETE				
	128	6	31JAN95A	31JUL95
+ ELECTRICAL FOR MILLS				
	56	31	16JUN95A	05SEP95
+ COAL HANDLING CONVEYOR				
	10	9	05JUN95A	04AUG95
+ ELECTRICAL FOR COAL CONVEYOR				
	20	20	24JUL95	18AUG95
+ I&C FOR COAL & LIMESTONE				
	134	52	28MAR95A	04OCT95
PROCESS STRUCTURE - COMMON				
+ STRUCTURAL STEEL				
	124	23	01MAR95A	23AUG95
+ STRUCTURAL OVERHEAD CRANE				
	45	20	16JUN95A	18AUG95
+ STRUCTURAL ELEVATOR				
	45	19	16JUN95A	18AUG95
+ PS STRUCTURE HEAT TRACING				
	209	41	22NOV94A	19SEP95
500 ASH SYSTEMS				
+ ASH HANDLING SYSTEM				
	20	62	16JUN95A	19OCT95
+ ASH HANDLING CONCRETE				
	10	10	24JUL95	04AUG95
+ ELECTRICAL FOR ASH HANDLING				
	78	53	16JUN95A	05OCT95
+ I&C FOR ASH HANDLING				
	57	57	24JUL95	11OCT95
700 FINAL GAS CLEANUP				
+ BAGHOUSE & DUCTWORK				
	38	38	30JUN95A	23AUG95
+ BAGHOUSE FOUNDATION				
	16	6	10JUL95A	31JUL95
+ ELECTRICAL FOR BAGHOUSE				
	50	25	16JUN95A	25AUG95
1000 I&C				
+ PLANT CONTROLS (DCS)				
	6	6	30JUN95A	31JUL95
+ DEVELOP & CONFIGURE DATABASE				
	158	39	03FEB95A	15SEP95
+ PCD LOOP DRAWINGS				
	176	77	26DEC94A	08NOV95



Project Start 01JAN91
Project Finish 18OCT96
Data Date 24JUL95
Plot Date 24JUL95

Early Bar
Progress Bar
Critical Activity

PSR1

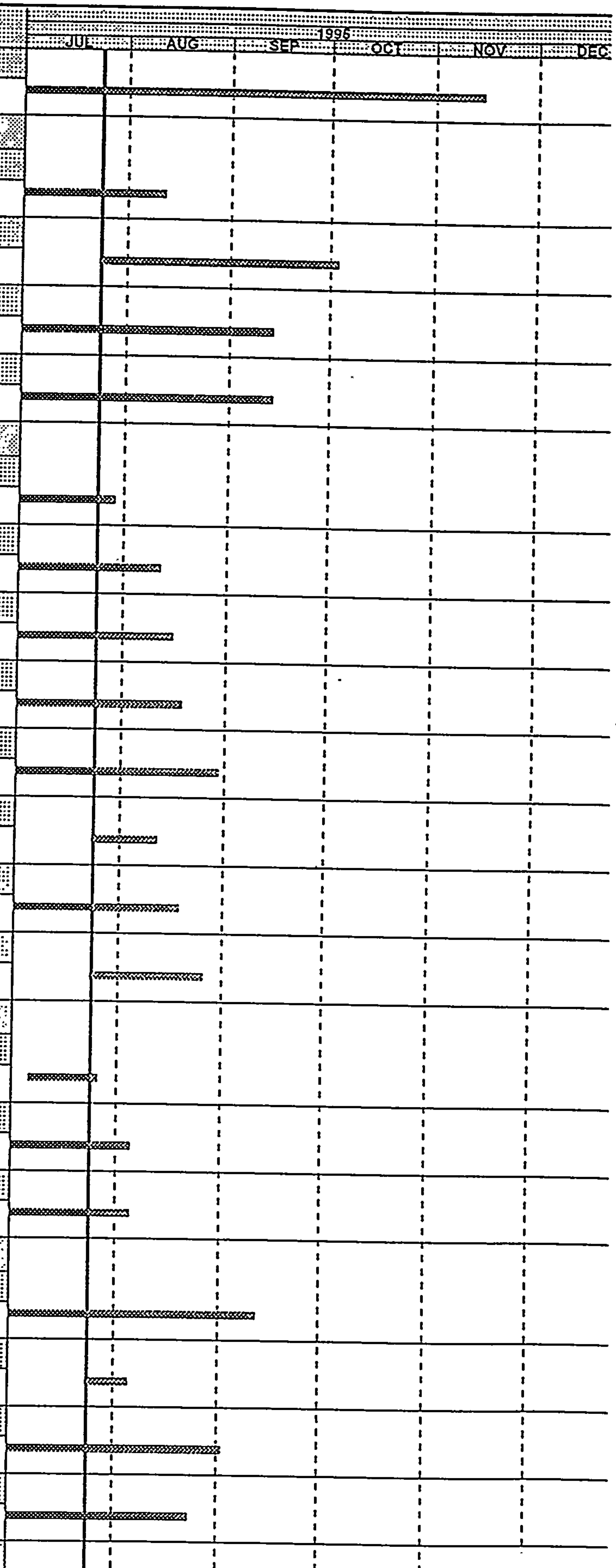
Sheet 1 of 3

SOUTHERN COMPANY SERVICES

POWER SYSTEMS DEVELOPMENT FACILITY

TOTAL SUMMARY BY AREA/DETAILED STEP

Activity ID	Orig Dur	Rem Dur	Early Start	Early Finish
+ I&C DATA SYSTEMS				
	228	81	26DEC94A	14NOV95
2000 BOILER/STEAM/CONDENSATE				
+ ELEC FOR FEEDWATER/COND PUMPS				
	40	15	16JUN95A	11AUG95
+ I&C FOR FEEDWATER/ COND				
	50	50	24JUL95	02OCT95
+ AUX BOILER				
	52	36	30JUN95A	13SEP95
+ ELECTRICAL FOR AUX BOILER				
	62	37	16JUN95A	13SEP95
2100 COOLING/CIRC WATER				
+ COOLING WATER SYSTEM				
	5	5	06JUN95A	28JUL95
+ COOLING WATER SYSTEM FOUNDATION				
	34	15	26JUN95A	11AUG95
+ COOLING WATER SYSTEM PIPING				
	9	17	25MAY95A	15AUG95
+ ELECTRICAL FOR COOLING WATER SYSTEM				
	45	20	16JUN95A	18AUG95
+ I&C FOR COOLING WATER SYSTEM				
	42	27	19JUN95A	29AUG95
+ CIRC WATER SYSTEM FOUNDATION				
	15	15	24JUL95	11AUG95
+ ELECTRICAL FOR CIRC WATER SYSTEM				
	45	20	16JUN95A	18AUG95
+ I&C FOR CIRC WATER SYSTEM				
	25	25	24JUL95	25AUG95
2200 SERVICE AIR				
+ SERVICE/INST AIR PIPING				
	20	2	06JUL95A	25JUL95
+ SERVICE/INST AIR FOUNDATIONS				
	63	10	08MAY95A	04AUG95
+ ELECTRICAL FOR SERVICE AIR SYSTEM				
	63	10	08MAY95A	04AUG95
2300 AUX FUELS				
+ PROPANE SYSTEM				
	50	35	30JUN95A	11SEP95
+ FOUNDATIONS FOR PROPANE SYSTEM				
	10	10	24JUL95	04AUG95
+ ELECTRICAL FOR PROPANE SYSTEM				
	55	30	16JUN95A	01SEP95
+ HEAT TRACING FOR PROPANE SYSTEM				
	75	20	08MAY95A	22AUG95
2400 FIRE PROTECTION				



Project Start	01JAN91
Project Finish	18OCT96
Data Date	24JUL95
Plot Date	24JUL95

Early Bar
Progress Bar
Critical Activity

PSR1

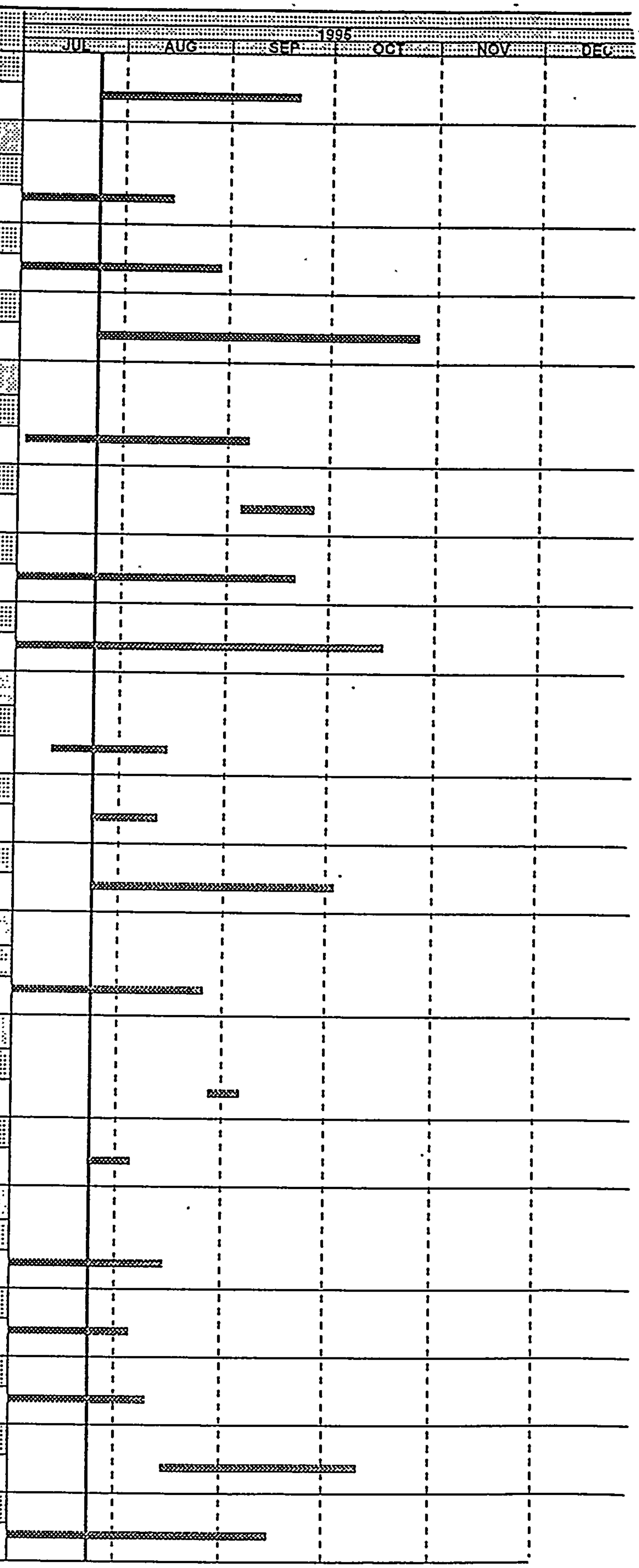
Sheet 2 of 3

SOUTHERN COMPANY SERVICES

POWER SYSTEMS DEVELOPMENT FACILITY

TOTAL SUMMARY BY AREA/DETAILED STEP

Activity ID	Orig Dur	Rem Dur	Early Start	Early Finish
+ PROCESS STRUC FIRE PROTECTION				
	42	42	24JUL95	20SEP95
2500 WASTE WATER TREATMENT				
+ WASTE WATER SYSTEM				
	16	16	30JUN95A	14AUG95
+ ELEC FOR WASTE WATER SYSTEM				
	51	26	16JUN95A	28AUG95
+ I&C FOR WASTE WATER SYSTEM				
	67	67	24JUL95	25OCT95
2600 NITROGEN SYSTEM				
+ NITROGEN GENERATION SYSTEM				
	46	32	03JUL95A	06SEP95
+ FOUND FOR NITROGEN SYSTEM				
	15	15	05SEP95	25SEP95
+ ELEC FOR NITROGEN SYSTEM				
	95	42	08MAY95A	20SEP95
+ I&C FOR NITROGEN SYSTEM				
	83	60	20JUN95A	16OCT95
2700 DEMIN				
+ DEMIN SYSTEM				
	24	16	12JUL95A	14AUG95
+ ELECTRICAL FOR DEMIN				
	15	15	24JUL95	11AUG95
+ I&C FOR DEMIN SYSTEM				
	50	50	24JUL95	02OCT95
2800 SAFETY/SECURITY				
+ PROCESS AREA LIGHTING				
	76	25	10MAY95A	25AUG95
2900 MISC UTILITIES				
+ MISC UTILITIES DESIGN				
	6	6	28AUG95	05SEP95
+ ELECTRICAL FOR MISC UTILITIES				
	10	10	24JUL95	04AUG95
3000 MISC ELECTRICAL				
+ LIGHTNING PROTECTION				
	20	16	10MAY95A	14AUG95
+ DIESEL ENGINE GENERATOR				
	79	10	14APR95A	04AUG95
+ CABLE ROUTING				
	91	13	03APR95A	09AUG95
+ GROUNDING				
	40	40	15AUG95	10OCT95
+ ELEC FOR MISC BUILDINGS				
	180	38	03JAN95A	14SEP95



Project Start 01JAN91
Project Finish 18OCT96
Data Date 24JUL95
Plot Date 24JUL95

Early Bar
Progress Bar
Critical Activity

PSR1

Sheet 3 of 3

SOUTHERN COMPANY SERVICES

POWER SYSTEMS DEVELOPMENT FACILITY

POWER SYSTEM DEVELOPMENT FACILITY
PROCUREMENT STATUS OF MAJOR SYSTEMS

TITLE	INQ. NO.	AWARD DATE	FORECAST DELIVERY DATE
Structural Steel Fab & Erection	7HGP93-005	A 01/20/94	08/17/95
Furnishing & Erecting Coal & Limestone Conveyors	7HGP94-010	A 02/03/95	09/30/95
Furnishing & Erecting Stacks	7HGP94-022	A 02/06/95	08/15/95
Engine Generator	7HGP94-023	A 03/07/95	08/17/95
Coal & Limestone Mill Systems	7HGP93-001A	A 03/21/95	10/20/95
Process Structure Overhead Crane	7HGP95-027	A 03/23/95	09/01/95
Nitrogen System LP	7HGP94-016	A 04/04/95	10/02/95
Nitrogen System Generation	7HGP94-016	A 04/04/95	05/29/96
Service/Instrument Air Compressors	7HGP95-030	A 04/07/95	08/31/95
Fabric Filter Baghouse	7HGP95-026	A 04/14/95	09/01/95
Crushed & Pulverized Storage Silos	7HGP95-40	A 05/02/95	09/01/95
Relief Valves (MWK & FW)	7HGP95-041	A 05/08/95	08/25/95
MCC's	7HGP95-039	A 05/09/95	08/18/95
High Pressure Nitrogen Compressor	7HGP95-046	A 05/11/95	11/20/95
Cooling Tower	7HGP95-038	A 05/17/95	08/15/95
Cooling Water Heat Exchangers	7HGP95-045	A 05/24/95	08/11/95
Ups	7HGP95-048	A 05/24/95	08/30/95
BOP Pumps	7HGP95-047	A 05/30/95	09/08/95
Miscellaneous Valves (MWK)	7HGP95-053	A 06/02/95	10/27/95
Auxiliary Boiler (Design/Fab/Deliver)	7HGP95-057	A 07/17/95	10/09/95
Propane System	7HGP94-020	A 07/05/95	08/25/95
Pipe Trench Insulation	7HGP95-069	08/14/95	10/10/95
Miscellaneous Valves (FW)	7HGP95-053	08/15/95	
Miscellaneous Valves (BOP)	7HGP95-053	08/15/95	
Insulation	7HGP95-053	09/05/95	10/30/95

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

4. TEST PLAN FOR THE MWK TRAIN

Table 1. Table of Tests based on Schedule presented in Figure 1.

Combustion Campaign (CC1)	Gasification Campaign (GC1)
Westinghouse Candle Filter Inlet temperature 1300°F Alabama bituminous coal with Dolomite Pulse gas pressure, P1, 160 hours Reduced pulse gas pressure, P2, 160 hours Increased face velocity, 160 hours Pulse strategies, 160 hours Limestone as sorbent, 160 hours	Westinghouse Candle Filter Inlet temperature 1200°F and 1400°F PRB subbit. and Alabama bituminous coal with dolomite and limestone <u>At 1200°F</u> PRB Subbit. w/ dolomite 200 hours PRB Subbit. w/ limestone 200 hours <u>At 1400°F</u> Alabama bit. coal w/dolomite Pulse gas pressure, P1, 200 hours Pulse strategies, 200 hours Increased face velocity, 200 hours
CC2 CPC Moving Granular Bed Filter Inlet temperature 1300°F Alabama bituminous and PRB subbit. with dolomite Minimum inlet dust loading, 200 hours Spoil cyclone, 200 hours Increased gas space velocity, 200 hours Subbit. coal with dolomite, 200 hours Limestone as sorbent, 200 hours (As tests come to equilibrium quickly, each set may contain subsets such as media circulation rates and filter media depth.)	GC2 CPC Moving Granular Bed Filter Inlet temperature 1600°F Alabama bituminous and PRB subbit. with dolomite Minimum inlet dust loading, 200 hours Spoil cyclone, 200 hours Increased gas space velocity, 200 hours Subbit. coal with dolomite, 200 hours Limestone as sorbent, 200 hours (As tests come to equilibrium quickly, each set may contain subsets such as media circulation rates and filter media depth.)
CC3 IF&P Candle Filter Inlet temperature 1400°F Alabama bituminous coal with dolomite Alternate high sulfur bituminous coal Test conditions to match WCF	GC3 IF&P Candle Filter Inlet temperature 1200°F and 1400°F Alabama bituminous coal with dolomite Alternate high sulfur bituminous coal Test conditions to match WCF

Alabama Bituminous coal analysis

Proximate Analysis (wt%)	
Moisture	8.20
Ash	13.40
Fixed Carbon	51.50
Volatiles	26.90
Total	100.00

Ultimate Analysis (moisture free, wt%)	
Carbon	74.10
Hydrogen	4.60
Oxygen	4.10
Nitrogen	1.60
Sulfur	0.88
Ash	14.60
Chlorine	0.09
Total	100.00

Ash analysis (wt%)	
AL2O3	27.60
Fe2O3	7.00
CaO	1.30
MgO	1.30
MnO2	0.02
P2O5	0.45
K2O5	2.70
SiO2	57.40
Na2O	0.75
SO3	1
TiO2	1.5
Total	101.02

Prepared coal analysis
final moisture content = 5%

	new analysis (wt%)
Carbon	70.42
Hydrogen	4.37
Oxygen	3.90
Nitrogen	1.52
Sulfur	0.84
Ash	13.87
Chlorine	0.09
Moisture	5.00
Total	100.00

Mine Black Thunder Coal analysis

Proximate Analysis (wt%)	
Moisture	27.67
Ash	5.62
Fixed Carbon	35.74
Volatiles	30.97
Total	100.00

Ultimate Analysis (moisture free, wt%)	
Carbon	69.77
Hydrogen	4.99
Oxygen	16.03
Nitrogen	0.96
Sulfur	0.48
Ash	7.77
Total	100.00

Ash analysis (wt%)	
AL2O3	17.37
Fe2O3	5.42
CaO	20.29
MgO	4.35
MnO2	0.02
P2O5	1.12
K2O5	0.71
SiO2	31.99
Na2O	1.89
SO3	18.57
TiO2	1.32
Total	103.05

Prepared coal analysis
final moisture content = 5%

	analysis (wt%)
Carbon	66.28
Hydrogen	4.74
Oxygen	15.23
Nitrogen	0.91
Sulfur	0.46
Ash	7.38
Moisture	5.00
Total	100.00

Plum Run dolomite analysis, wt %

Moisture	0.10
Carbon Dioxide - CO2	46.00
Calcium Oxide - CaO	29.30
Magnesium Oxide - MgO	21.00
Silicon Dioxide - SiO2	2.10
Aluminum Oxide - AL2O3	0.40
Iron Oxide - Fe2O3	0.54
Sodium Oxide - Na2O	0.06
Potassium Oxide - K2O	0.05
Sulfur Trioxide - SO3	0.40
Chlorine - Cl	0.05
Total	100.00

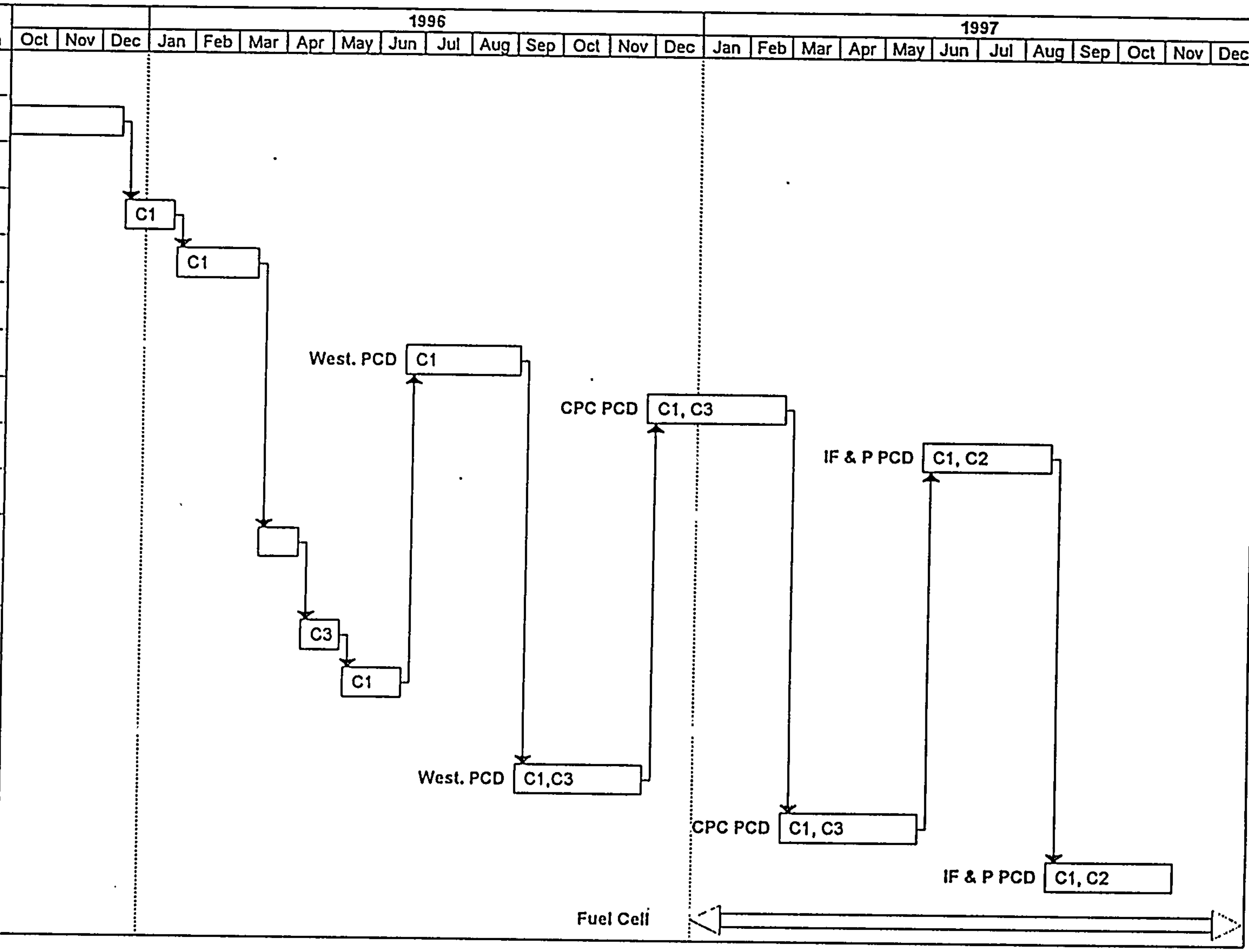
CaCO3	52.3
MgCO3	44.1
Inerts	3.6
Total	100

Limestone analysis, wt%

CaCO3	97.45
MgCO3	1.58
Inerts	0.97
Total	100

Figure 1: Test schedule for Kellogg Reactor train, October 1995 to December 1997

ID	Task Name	Duration
1	COMBUSTION MODE	0w
2	Cold & Hot Shakedown	11w
3	Characterization Tests	13w
4	West. PCD	5w
5	CPC PCD	8w
6	Performance Tests	61w
7	CC1	11w
8	CC2	13w
9	CC3	12w
10	GASIFICATION MODE	0w
11	Hot Shakedown	4w
12	Characterization Tests	10w
13	West. PCD	4w
14	CPC PCD	6w
15	Performance Tests	62w
16	GC1	12w
17	GC2	13w
18	GC3	12w
19	Fuel Cell	52w



C1 - Alabama bituminous coal (1-1.2 % S)
C2 - Alternate bituminous coal (3 %S)
C3 - PRB subbituminous coal

date: 7/20/95

Task

TESTS	Actual Time expected	Real Time shceduled
Characterization tests		
Combustion mode		
• w/ West. filter	1.5 w	5 w
• w/ CPC GBF	1.5 w	8 w
Gasification mode		
• w/ West. filter	1.5 w	4 w
• w/ CPC GBF	1.5 w	6 w
Test Campaigns		
CC1 (w/ West. filter)	5 w	11 w
GC1 (w/ West. filter)	6 w	12 w
CC2 (w/ CPC filter)	6 w	13 w
GC2 (w/ CPC filter)	6 w	13 w
CC3 (w/ IF&P filter)	6 w	12 w
GC3 (w/ IF&P filter)	6 w	12 w

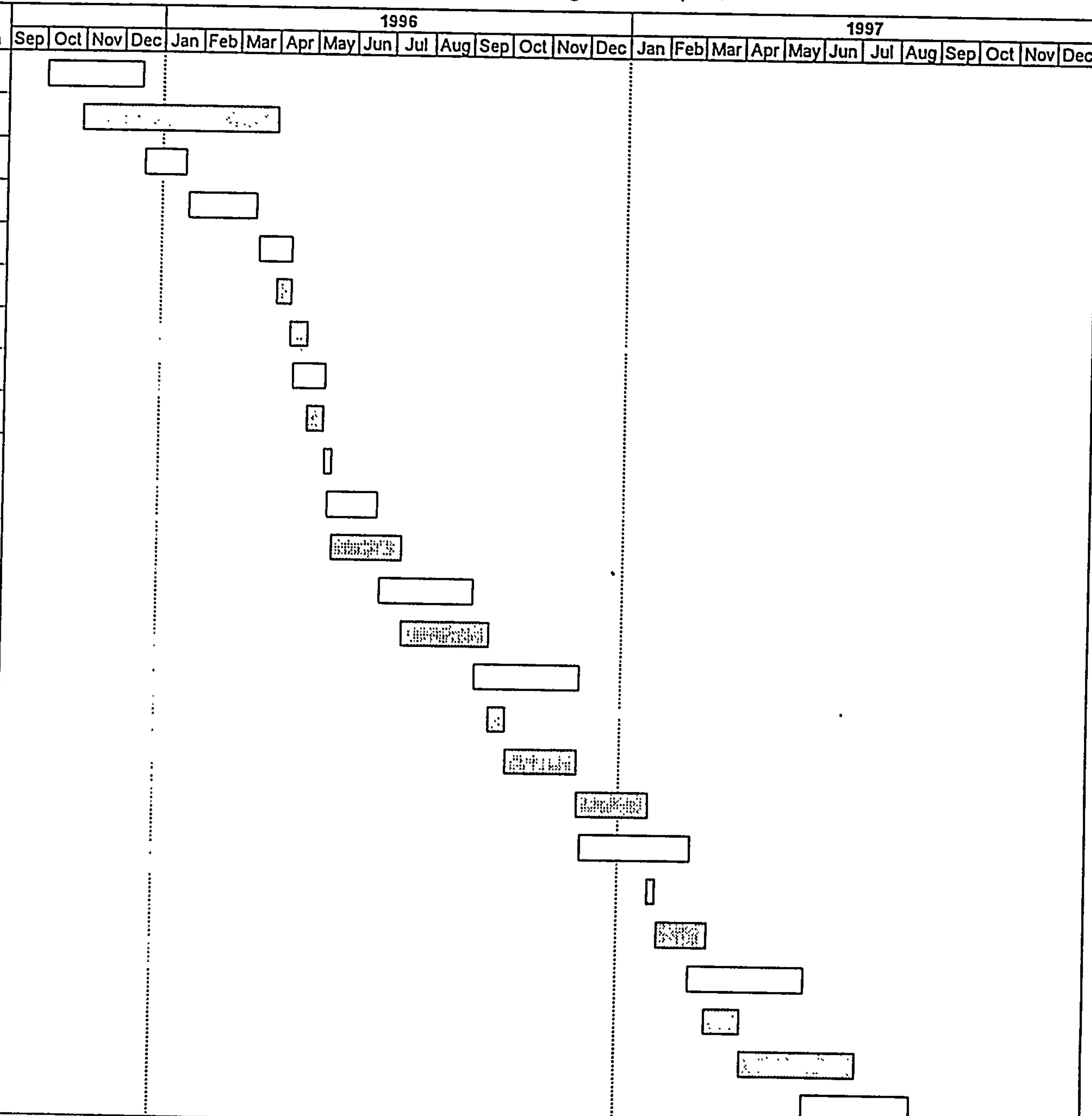
Scheduled realtime includes the following:

Startup time - 48 hours
Shutdown and cooldown time - 48 hours
Operation mode change times:
Combustion to gasification - 72 hours
Gasification to combustion - 120 hours
Filter change time - 48 to 96 hours
Orifice plate change time - 8 to16 hours

Designated candle changes, inspection, cake sample, etc.
On-line operational problems
Unscheduled outages
Scheduled maintenance

Combined proposed schedule of tests for Kellogg and Foster Wheeler trains through December, 1997

ID	Text1	Task Name	Duration
1	MWK	Combustion, cold & hot shakedown	11w
2	FW	Cold shakedown	22w
3	MWK	Comb. charact., Westinghouse PCD	5w
4	MWK	Comb. charact., CPC PCD	8w
5	MWK	Gasification, hot shakedown	4w
6	FW	MASB installation	2w
7	FW	MASB & GT, hot & cold shakedown	2w
8	MWK	Gasif. charact., Westinghouse PCD	4w
9	FW	Simple cycle operation	2w
10	FW	MASB inspection	1w
11	MWK	Gasif. charact., CPC PCD	6w
12	FW	First generation, hot shakedown	8w
13	MWK	Comb. perform (CC1), West. PCD	11w
14	FW	First generation, Campaign 1	10w
15	MWK	Gasif. perform (GC1), West PCD	12w
16	FW	Inspection after Campaign 1	2w
17	FW	Second gen., hot shaked'n (IF&P) (1)	8w
18	FW	Second generation, Campaign 2	8w
19	MWK	Comb. perform (CC2), CPC PCD	13w
20	FW	Inspection after Campaign 2	1w
21	FW	Install Westinghouse PCD (1)	6w
22	MWK	Gasif. perform (GC2), CPC PCD	13w
23	FW	Hot & cold shakedown	4w
24	FW	Second generation, Campaign 3 (2)	13w
25	MWK	Comb. perform (CC3), IF&P PCD	12w



(1) - Westinghouse PCD could be installed in December, 1996 if circumstances demanded it. (2) - Includes inspection periods

7/13/95

COMBUSTION MODE OBJECTIVES

OPERATION OBJECTIVES

- Maintain stable coal combustion conditions
- Demonstrate reactor temperature control
- Quantify heat losses
- Develop/verify reactor control correlations such as
    - Circulation rate vs. level and density of solids in the standpipe
    - Circulation rate vs. aeration rates through nozzles in J-leg, HX0203 return leg
    - Circulation rate vs. ΔPs, reactor temperature profiles
    - NOx emissions vs. secondary (overfire) air flowrate
- Develop/verify other correlations:
    - Particle loading vs. spoiling gas port on CY0201 and spoiling gas rates
    - Temperature, flowrate at PCD inlet vs. RO201, RO301 orifices
- Pressure balance between RO201 and HX0202
- Verify operation of screw coolers
- Meet emissions compliance objectives on air and NPDES permits

PERFORMANCE OBJECTIVES

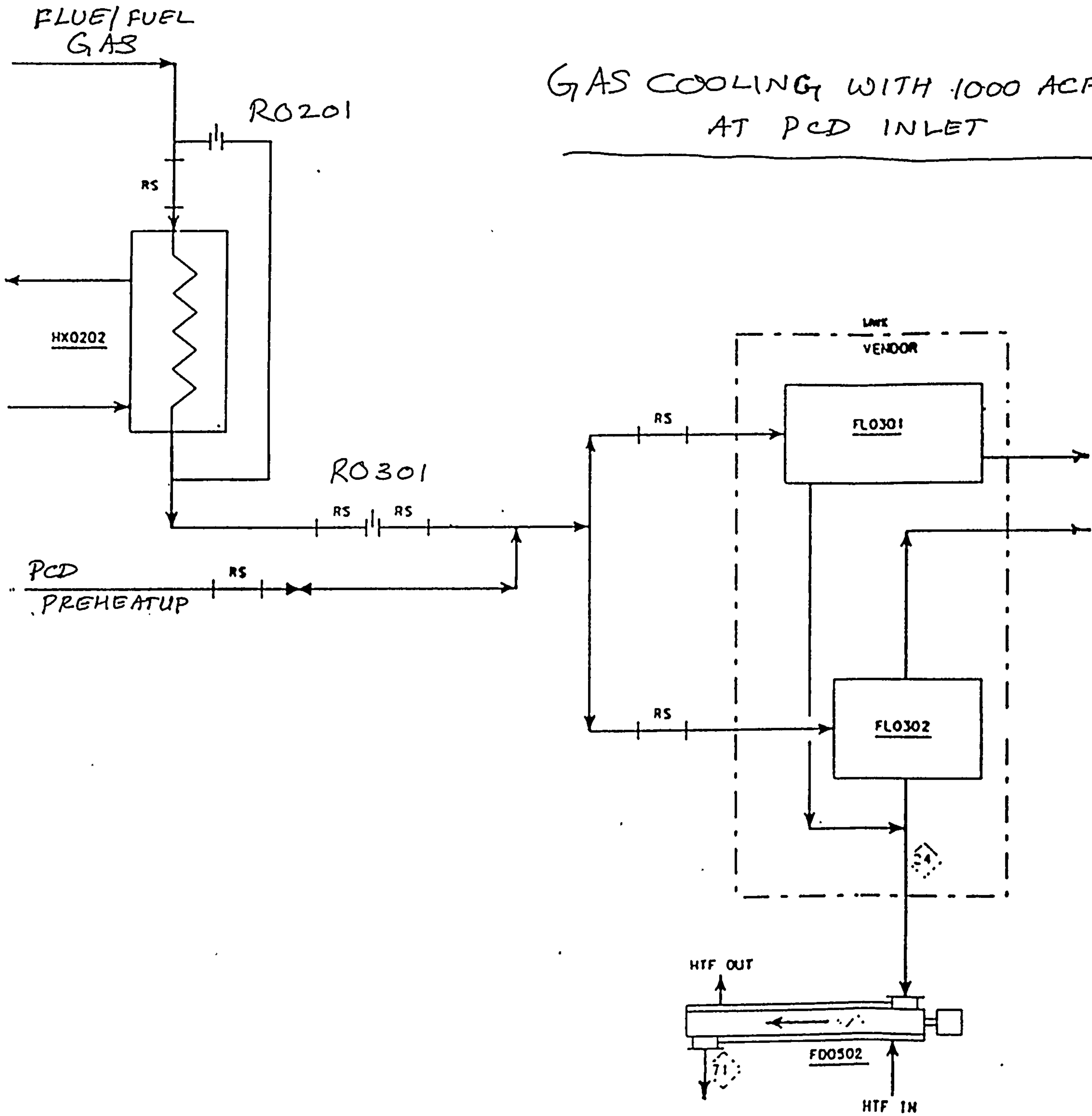
- Measure combustion efficiency, NOx emissions, SO_2 capture, sorbent utilization
- Evaluate reactor exit dust concentrations, gas compositions
- Determine effect of coal/sorbent grind sizes on reactor performance and sorbent utilization
- Measure reactor heat release rates, heat losses
- Evaluate performance of combustor heat exchanger: heat transfer rates
- Evaluate equilibrium bed material: size distribution and chemical analysis
- Reactor ΔPs, circulation rates, bed density profiles, temperature profiles
- Effect of primary air split, primary/secondary air splits, excess air, coal type, sorbent type, Ca/S ratio, reactor temperature and pressure, and solids flow through HX0203
- Mechanical integrity of high wear components such as pipes in Simon system
- Corrosion/erosion coupons

COMBUSTION MODE VARIABLES

Variable	Low	Design	High
Coal feed rate, lb/hr			
bituminous	part load	1604	full load
subbituminous	part load	1668	full load
Coal grind size, µm	100	100	coarse
Ca/S molar ratio			
dolomite	1.33	1.5	3
limestone	1.33	1.5	1.58
Reactor temp, °F	1500	1600	1600
Reactor pres, psia	160	160-310	310
Excess air. %	10	15	40
Solids thru HX0203, %	40	50	60
Staged air split, % (primary, secondary)	70/40	80/30	110/0
Primary air split (1st/2nd levels)	40/60	50/50	60/40
Riser gas velocity, fps	0.9 x design	design	1.1 x design
PCD inlet conditions			
temp, °F	1000	1000-1525	1525
pres, psia	160	160-310	310
loading, ppmw	4,000	4,000-10,000	10,000
rate, ACFM	861	1000	1,385
rate, lb/hr	20,920	~ 24,000	26,000
Spoiling gas rate, lb/hr	0	0-2300	2,300
HX0202 bypass, %	0	0-100	100

Other variables			
Coal type	Alabama bituminous	Black Thunder subbituminous	
Sorbent type	Plum Run dolomite	Longview limestone	
Coal feed point	upper	lower	
Spoiling gas nozzle	Radish Tangential	Radish ⊥	Cone tangential
RO201 bore ϕ, in	6.437	others	
RO301 bore ϕ, in	1.875	2.187	others

GAS COOLING WITH 1000 ACFM AT PCD INLET



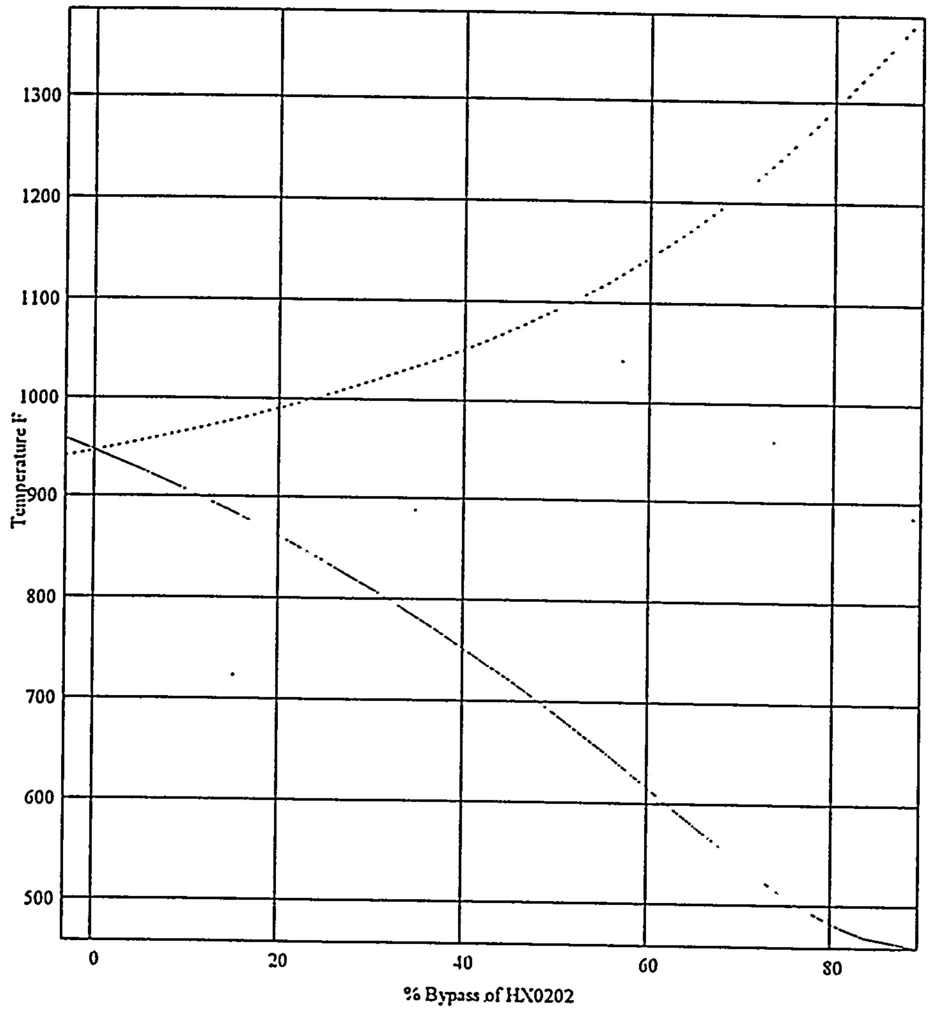
Comb. Mode

$$T := 957, 947 .. 457$$

$$W(T) := \frac{38.61 \cdot \frac{141.4}{0.29} \cdot \left[\frac{1044 - (T - 456)}{\ln\left(\frac{1044}{T - 456}\right)} \right]}{1500 - T}$$

$$pbyp(T) := \frac{24841 - W(T)}{24841} \cdot 100$$

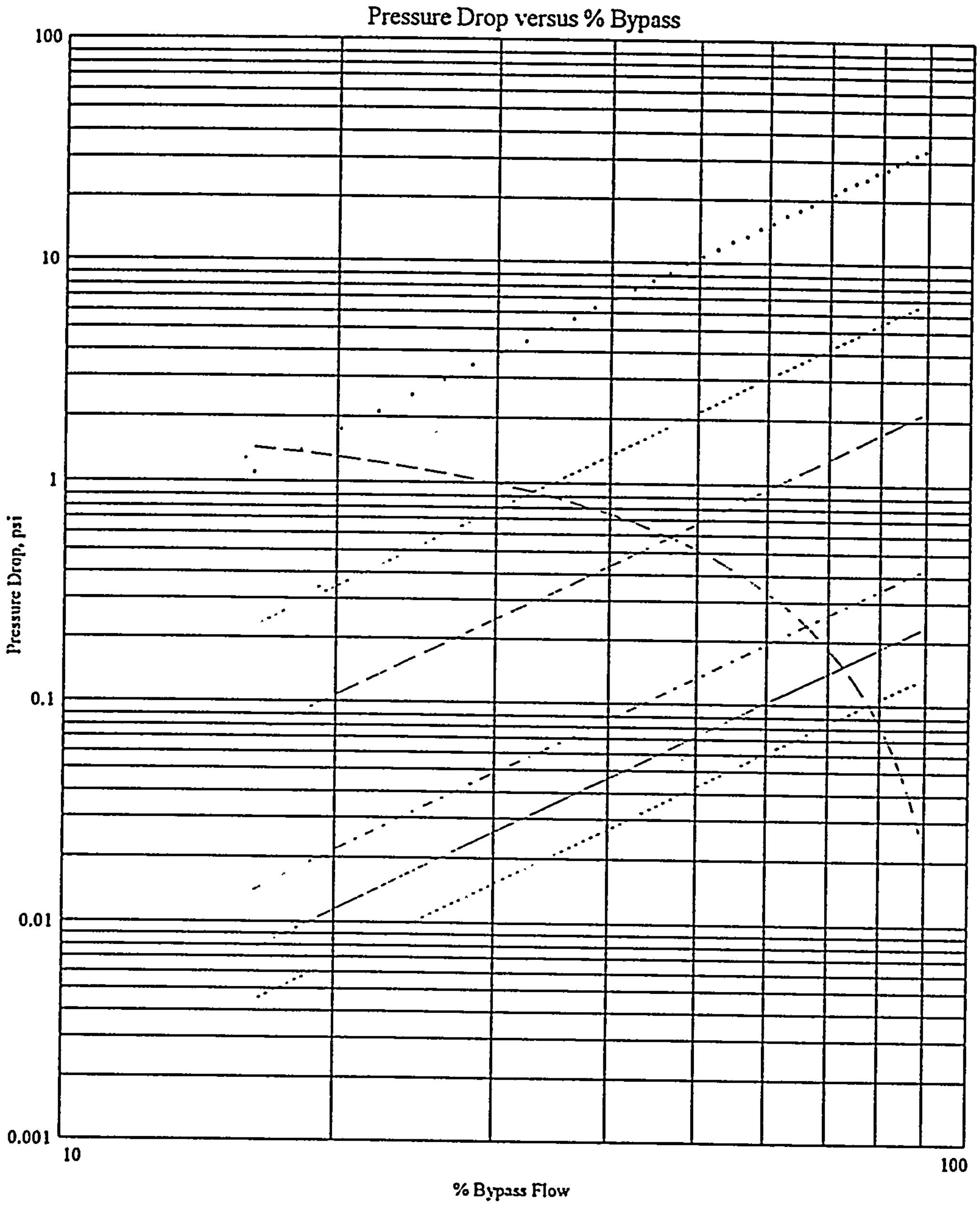
$$Avg\_out(T) := \frac{W(T) \cdot T + (24841 - W(T)) \cdot 1500}{24841}$$



— Temperature of HX0202 exit
···· Temperature to PCD

Dirty Heat Exchanger

Comb mode
300 psia



- ••• 2" Orifice
- ···· 3"
- — 4"
- -· 6"
- — 7"
- ···· 8"
- — HX0202

RO301

$dp := 90 \quad D := 8$

Given

$$dp = \frac{W^2 \cdot \left[P \cdot \frac{MW}{10.73 \cdot (T + 460)} \right]^{-1}}{1891^2 \cdot d^4 \cdot 0.6^2 \cdot \left[1 - \left[0.41 + 0.35 \cdot \left(\frac{d}{D} \right)^4 \right] \cdot \frac{dp}{1.3 \cdot P} \right]^2}$$

$$\left[1 - \left[0.41 - 0.35 \cdot \left(\frac{1.875}{D} \right)^4 \right] \cdot \frac{dp}{1.3 \cdot 315} \right] = 0.91$$

$delp(W, P, MW, T, d) := Minerr(dp)$

$delp(24841, 315, 29.9, 1000, 1.8) = 92.233$

$delp(24841, 315, 29.9, 1000, 1.875) = 75.526$ Combustion MWK Value=92.7

$delp(24841, 315, 29.9, 1300, 2.187) = 46.21$ Combustion MWK=47.1

$delp(18811, 315, 24.9, 1400, 1.937) = 55.752$ Gasification MWK=57.9

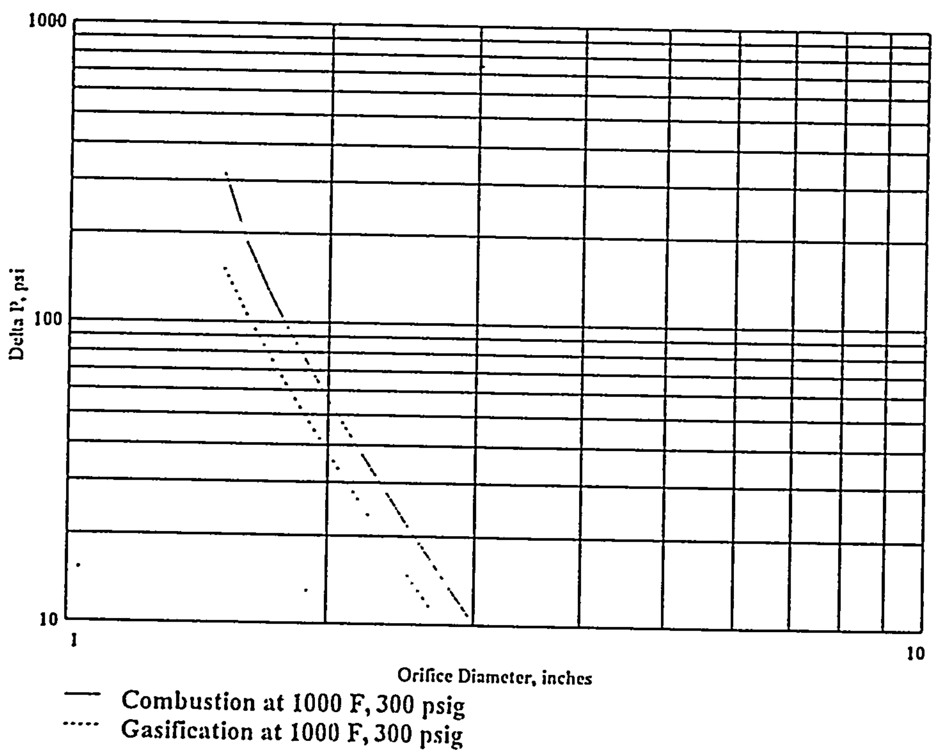
$W := 24841$

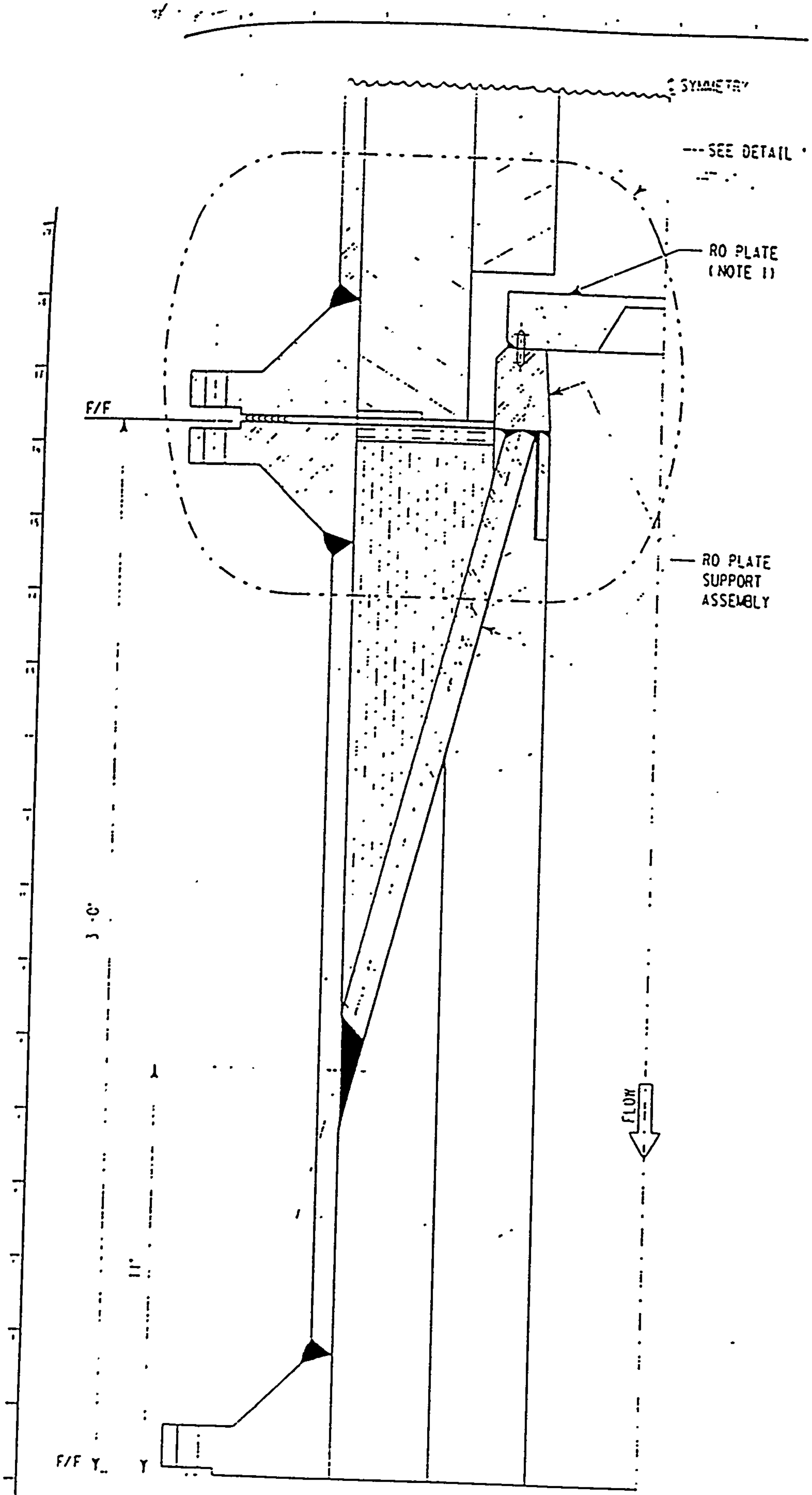
$i := 0 .. 65$

$d_i := 1.5 + 0.1 \cdot i$

$gas_i = delp(18881, 315, 24.9, 1000, d_i)$

$delp_i := delp(24841, 315, 29.9, 1000, d_i)$



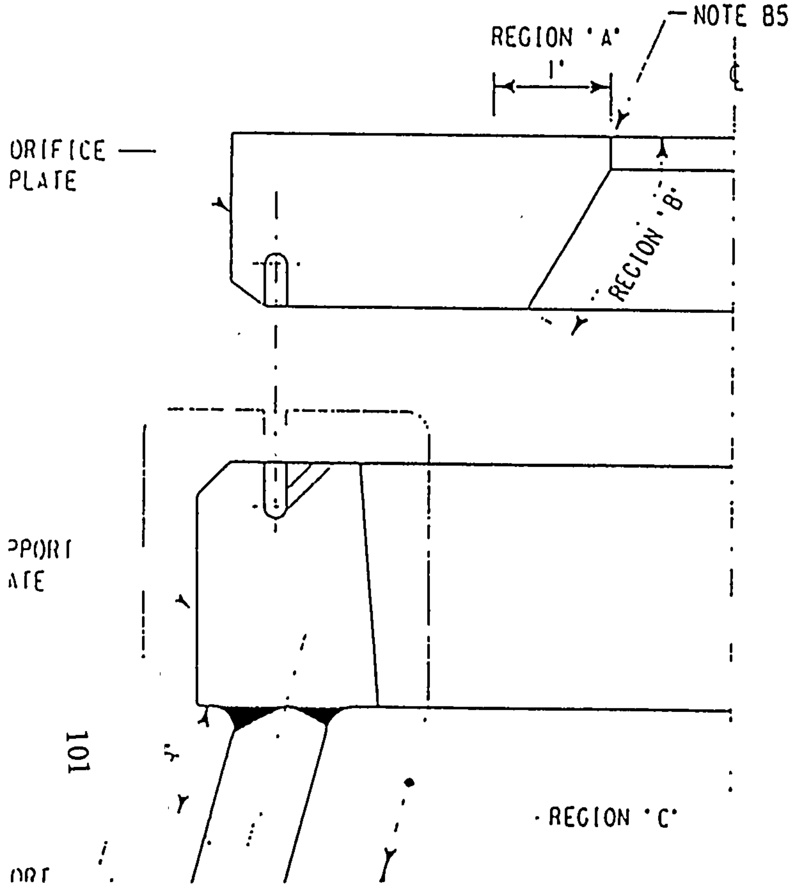


ELEVATION VIEW

RO-201: INSTALL AS SHOWN (FLOW DOWN) - REF. ISO 67-CPM03 (CPM03-2)
RO-301: INSTALL INVERTED (FLOW UP) - REF. ISO 67-BPM04 (BPM04-4)
(ORIFICE PLATE AT BOTTOM OF ASSEMBLY)

TABLE I
RESTRICTION ORIFICE PLATE DESIGN DATA

TAG NO.	LINE NUMBER	OPERATING MODE	P & I NO.	ΔP (PSI) (NOTE E)	OPERATING TEMP. (°F)	UPSTERAM PRESS. (PSIG) (NOTE 4)	ORIFICE BORE (NOTE E)
RO-201-1	PM-03	GASIFICATION	62-0014	0.10	1768	285	6.625"
RO-201-2	PM-03	COMBUSTION	62-0014	0.16	1584	285	6.437"
RO-301-1	PM-04	GASIFICATION	62-0016	113	1000	285	1.687"
RO-301-2	PM-04	GASIFICATION	62-0016	57.9	1400	285	1.937"
RO-301-3	PM-04	COMBUSTION	62-0016	92.7	1000	285	1.875"
RO-301-4	PM-04	COMBUSTION	62-0016	47.1	1300	285	2.187"



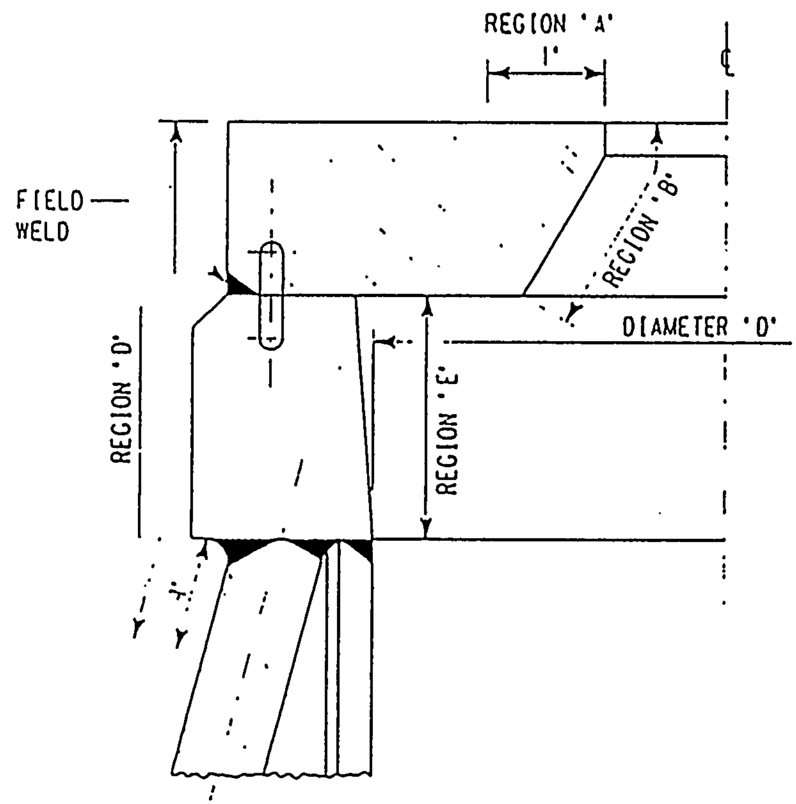


Table C1. Combustion-mode Characterization Tests for Kellogg reactor with Westinghouse PCD

Test number	PCD test #	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr	Reactor temp, °F	Reactor pres, psia
CCT1 (*1)	CCT1-F*	48	AL bit	dolomite	1604	3.0 → 1.5	120	1550	160
CCT2	CCT2-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	1550	210
SHUTDOWN									
CCT3	CCT3-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	1550	260
CCT4	CCT4-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	1550	310

Test number	Coal feed pt.	Excess air, % (*2)	Solids thru HX0203, %	Staged air split, % (primary, secondary)	Riser gas velocity, fps	Primary air split (1st/2nd levels)
CCT1 (*1)	lower	25	40→ 60	80/30	as design	50/50
CCT2	lower	10→ 25	50	80/30	as design	50/50
SHUTDOWN						
CCT3	lower	25	50	70/40→110/0	as design	50/50
CCT4	lower	25	50	80/30	as design	40/60→ 60/40

Test number	PCD inlet conditions temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	Spoiling gas nozzle in service	rate, lb/hr	HX0202 bypass, %	RO201 bore ϕ, in	RO301 bore ϕ, in
CCT1 (*1)	1000	160	4000	1385	25,500	Radish	0-2,300	0	N/S	N/S
CCT2	1000	210	4000	1055	25,500	Radish	as needed	0	N/S	N/S
SHUTDOWN										
CCT3	1300	260	4000	1026	25,500	Tangential	0-2,300	75	~7	N/S
CCT4	1300	310	4000	861	25,500	Tangential	as needed	75	~7	N/S

(*1) Expected to be completed during Hot Shakedown

(*2) May be allowed to rise to alleviate operating difficulties associated with high intensity heat release. Additionally reactor temperature may be allowed to fall.

Table C2. Combustion-mode Characterization Tests for Kellogg reactor with CPC PCD

Test number	PCD test number	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr	Reactor pres, psia	Reactor temp, °F
CCT5	CCT5-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	160	1550
CCT6	CCT6-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	210	1550
SHUTDOWN									
CCT7	CCT7-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	260	1550
CCT8	CCT8-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	310	1550
CCT9	CCT9-F*	48	AL bit	dolomite	1604	~1.5 {90% ret'n}	120	310	1550

Test number	Coal feed pt.	Excess air, % (*2)	Solids thru HX0203, %	Staged air split, % (primary, secondary)	Primary air split (1st/2nd levels)	Riser gas velocity, fps
CCT5	lower	25	50	80/30	50/50	as design
CCT6	lower	25	50	80/30	50/50	as design
SHUTDOWN						
CCT7	lower	25	50	80/30	50/50	as design
CCT8	lower	25	50	80/30	50/50	as design
CCT9	lower	25	50	80/30	50/50	as design

Test number	PCD inlet conditions					Spoiling gas		HX0202	RO201	RO301
	temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	nozzle in service	rate, lb/hr	bypass, %	bore ϕ, in	bore ϕ, in
CCT5	1000	160	4000	1385	25,500	Perpendicular	0 - 2,300	0	N/S	N/S
CCT6	1000	210	4000	1055	25,500	Perpendicular	as needed	0	N/S	N/S
SHUTDOWN										
CCT7	~ 1480	260	4000	1132	25,500	TBD	TBD	100	N/S	N/S
CCT8	~ 1480	310	4000	950	25,500	TBD	TBD	100	N/S	N/S
CCT9	~ 1480	310	4000	950	25,500	TBD	TBD	100	N/S	N/S

(*2) May be allowed to rise to alleviate operating difficulties associated with high intensity heat release. Additionally reactor temperature may be allowed to fall.

Table 9.1 Test Campaign 1 - Combustion Mode with Westinghouse PCD

Test number	PCD test #	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr	Reactor temp, °F	Reactor pres, psia
TC01-K1	TC01-F*	80	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC01-K2		80	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC01-K3	TC01-F*	80	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC01-K4		80	AL bit	dolomite	1604	{80% ret'n}	107	1550	260
TC01-K5	TC01-F*	80	AL bit	dolomite	1604	{85% ret'n}	113	1550	260
TC01-K6		80	AL bit	dolomite	1604	{95% ret'n}	127	1550	260
TC01-K7	TC01-F*	80	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC01-K8		80	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC01-K9	TC01-F*	80	AL bit	limestone	1604	{95% ret'n}	68	1550	260
TC01-K10		80	AL bit	limestone	1604	{85% ret'n}	61	1550	260

Test number	Coal feed pt.	Excess air, %	Solids thru HX0203, %	Staged air split, % (primary, secondary)	Primary air split (1st/2nd levels)	Riser gas velocity, fps	Coal grind size, µm
TC01-K1	lower	10	~ 50	80/30	50/50	as design	100
TC01-K2	lower	15	~ 50	80/30	50/50	as design	100
TC01-K3	lower	40	~ 50	80/30	50/50	as design	100
TC01-K4	lower	optimum (*1)	~ 50	80/30	50/50	as design	100
TC01-K5	lower	optimum	~ 50	80/30	50/50	as design	100
TC01-K6	lower	optimum	~ 50	80/30	50/50	as design	100
TC01-K7	lower	optimum	~ 50	80/30	50/50	1.1 x design	100
TC01-K8	lower	optimum	~ 50	80/30	50/50	0.9 x design	100
TC01-K9	lower	optimum	~ 50	80/30	50/50	as design	100
TC01-K10	lower	optimum	~ 50	80/30	50/50	as design	100

(*1) For PCD inlet condition calculations optimum excess air is assumed to be 15%

Table 9.1 Test Campaign 1 - Combustion Mode with Westinghouse PCD (cont)

Test number	PCD inlet conditions					Spoiling gas		HX0202 bypass, %	RO201 bore ϕ, in	RO301 bore ϕ, in
	temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	nozzle in service	rate, lb/hr			
TC01-K1	1300	248	4000	1000	23630	TBD	TBD	75	~ 7	N/S
TC01-K2	1300	252	4000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K3	1300	255	4000	1138	27683	TBD	TBD	75	~ 7	N/S
TC01-K4	1300	252	6000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K5	1300	252	10000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K6	1300	252	4000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K7	1300	252	4000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K8	1300	252	4000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K9	1300	252	4000	1000	24020	TBD	TBD	75	~ 7	N/S
TC01-K10	1300	252	6000-10000	1000	24020	TBD	TBD	75	~ 7	N/S

Test number	Purpose
TC01-K1 TC01-K2 TC01-K3	optimize excess air value
TC01-K4 TC01-K5 TC01-K6	quantify effect of Ca/S molar ratio
TC01-K7 TC01-K8	quantify influence of riser velocity
TC01-K9 TC01-K10	quantify effect of Ca/S molar ratio and evaluate effect of using limestone as sorbent

Table 11.1 Test Campaign 3 - Combustion Mode with CPC PCD

Test number	PCD test #	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr	Reactor temp, °F	Reactor pres, psia
TC03-K1	TC03-F1	100	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC03-K2	TC03-F2	100	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC03-K3	TC03-F3	100	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
TC03-K4	TC03-F4.1-4.5	100	AL bit	dolomite	1604 (*2)	{90% ret'n}	120	1450→ 1600	260
TC03-K5	TC03-F5.1-5	100	AL bit	dolomite	1604	{90% ret'n}	120	1550	260→200
TC03-K6	TC03-F6.1-4 & F7.1-3	100	AL bit	dolomite	1604	{90% ret'n}	120	1550	260
SHUTDOWN									
TC03-K7	TC03-F8	100	subbit (*1)	dolomite	1668	{90% ret'n}	69	1550	260
TC03-K8	TC03-F9-10	100	subbit (*1)	dolomite	1668	{90% ret'n}	69	1550	260
TC03-K9	TC03-F11	100	subbit (*1)	limestone	1668	{95% ret'n}	39	1550	260
TC03-K10	TC03-F12-13	100	subbit (*1)	limestone	1668	{80% ret'n}	33	1550	260

Test number	Coal feed pt.	Excess air, %	Solids thru HX0203, %	Staged air split, % (primary, secondary)	Primary air split (1st/2nd levels)	Riser gas velocity, fps	Coal grind size, μm
TC03-K1	lower	optimum (*3)	~ 50	80/30	50/50	as design	100
TC03-K2	lower	optimum	~ 50	80/30	40/60→ 60/40	as design	100
TC03-K3	lower	optimum	~ 50	110/0→ 70/40	50/50	as design	100
TC03-K4	lower	optimum	vary	80/30	50/50	as design	100
TC03-K5	lower	optimum	~ 50	80/30	50/50	as design	100
TC03-K6	lower	optimum	~ 50	80/30	50/50	as design	coarse
SHUTDOWN							
TC03-K7	lower	25	~ 50	80/30	50/50	as design	100
TC03-K8	lower	10	~ 50	80/30	50/50	as design	100
TC03-K9	lower	optimum (*3)	~ 50	80/30	50/50	as design	100
TC03-K10	lower	optimum	~ 50	80/30	50/50	as design	100

(*1) Black Thunder subbituminous coal
(*2) Load will be varied
(*3) For PCD inlet condition calculations optimum excess air is assumed to be 15%

Table 11.1 Test Campaign 3 - Combustion Mode with CPC PCD (cont)

Test number	PCD inlet conditions temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	Spoiling gas nozzle in service	rate, lb/hr	HX0202 bypass, %	RO201 bore ϕ, in	RO301 bore ϕ, in
TC03-K1	1300	252	4000	1000	24,020	TBD	TBD	100	N/S	N/S
TC03-K2	1300	252	6000	1000	24,020	TBD	TBD	100	N/S	N/S
TC03-K3	1300	252	10000	1000	24,020	TBD	TBD	100	N/S	N/S
TC03-K4	1300	252	6000	1000	24,020	TBD	TBD	100	N/S	N/S
TC03-K5	1300	252	4000	1000	24,020	TBD	TBD	100	N/S	N/S
TC03-K6	1300	252	4000-max	1000	24,020	TBD	TBD	100	N/S	N/S
SHUTDOWN										
TC03-K7	1300	255	4000	1039	25,230	TBD	TBD	100	N/S	N/S
TC03-K8	1300	255	6000-10000	861	20,920	TBD	TBD	100	N/S	N/S
TC03-K9	1300	255	4000	921	22,354	TBD	TBD	100	N/S	N/S
TC03-K10	1300	255	6000-10000	921	22,354	TBD	TBD	100	N/S	N/S

Test number	Purpose
TC03-K1	base test
TC03-K2	evaluate effect of primary air split
TC03-K3	evaluate effect of staged air split
TC03-K4	evaluate effect of reactor temperature changes
TC03-K5	evaluate effect of reactor pressure change
TC03-K6	evaluate effect of coal size
TC03-K7 TC03-K8	optimize excess air value
TC03-K9 TC03-K10	evaluate effect of Ca/S molar ratio

GASIFICATION MODE OBJECTIVES

OPERTION OBJECTIVES

- Demonstrate transition from combustion to gasification
- Demonstrate standpipe operation - transition from LASH (high density) to Char/LASH mixture (low density) operation
- Maintain stable coal gasification conditions and demonstrate reactor stability
- Demonstrate solids discharge from the sulfator through the screw cooler FD0602 into SI0602
- Verify operation of screw coolers
- Develop/verify reactor control and other correlations and quantify heat losses
- Meet emissions compliance objectives on air and NPDES permits

PERFORMANCE OBJECTIVES

- Measure carbon conversion, H_2S capture, sorbent utilization
- Evaluate fuel gas quality, heating value, dust concentration and size distribution
- Evaluate effect of staged concept on gasifier performance
- Determine effect of coal grind on reactor performance
- Evaluate effect of solids residence time on gasifier performance
- Calculate heat release rate in mixing zone; Verify hydrodynamic operations in mixing zone
- Evaluate equilibrium circulating bed material: size distribution and carbon content
- Reactor ΔPs, circulation rates, bed density profiles, temperature profiles
- Effect of steam/coal ratio, air/coal ratio, coal type, sorbent type, Ca/S ratio, reactor temperature and pressure
- Determine sulfation efficiency
- Evaluate SO_2 capture by residual in-bed sorbent
- Corrosion/erosion coupons - sulfidation, nitradation effects

GASIFICATION MODE VARIABLES

Variable	Low	Design	High
Coal feed rate, lb/hr			
bituminous	part load	3124	full load
subbituminous	part load	3248	full load
Coal grind size, μm	100	100	coarse
Ca/S molar ratio			
dolomite	1	1.5	2
limestone	1	1.5	3
Reactor temp, °F	1700	1800	1800
Reactor pres, psia	200	200-260	260
Steam/coal ratio	0	0.34	0.5
Air/coal ratio	3	3.4-3.6	3.9
Primary air split (1st/2nd levels)	40/60	50/50	60/40
Riser gas velocity, fps	0.6 x design	design	1.5 x design
PCD inlet conditions			
temp, °F	1200	1200-1700	1700
pres, psia	179	179-255	255
loading, ppmw	4,000	4,000-16,000	16,000
rate, ACFM	893	1000	1,100
rate, lb/hr	16,177	16,177-19,520	19,520
Spoiling gas rate, lb/hr	0	0-2,300	2,300
HX0202 bypass, %	0	0-100	100

Other variables			
Coal type	Alabama bituminous	Black Thunder subbituminous	
Sorbent type	Plum Run dolomite	Longview limestone	
Coal feed point	upper	lower	
Spoiling gas nozzle	Radish Tangential	Radish ⊥	Cone tangential
RO201 bore ϕ, in	6.625	others	
RO301 bore ϕ, in	1.687	1.937	others

Table C3. Gasification Mode Characterization Tests for Kellogg reactor with Westinghouse PCD

Test number	PCD test number	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr
GCT1 (*1)	GCT1-F*	48	subbit (*2)	dolomite	3248	1.5	134
GCT2	GCT2-F*	48	subbit (*2)	dolomite	3248	1.5	134
GCT3	GCT3-F*	48	subbit (*2)	dolomite	3248	1.5	134
GCT4	GCT4-F*	48	subbit (*2)	dolomite	3248	1.5	134

Test number	Reactor temp, °F	Reactor pres, psia	Steam/Coal ratio	Coal feed pt.	Air/Coal ratio	Primary air split (1st/2nd levels)	Riser gas velocity, fps	Coal grind size, μm
GCT1(*1)	1700	260	0.34	upper	3.4	50/50	as design	100
GCT2	1700	260	0→ 0.5	upper	3.4	50/50	as design	100
GCT3	1700	260	0.34	upper	3.0→ 3.9	50/50	as design	100
GCT4	1700	260	0.34	upper	3.4	40/60→60/40	as design	100

Test number	PCD inlet conditions					Spoiling gas		HX0202	RO201	RO301
	temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	nozzle in service	rate, lb/hr	bypass, %	bore ϕ, in	bore ϕ, in
GCT1 (*1)	1200	215	4000	1000	17747	TBD	TBD	50	~ 5	2.1
GCT2	1200	215	4000	936-1030	16610-18280	TBD	TBD	50	~ 5	2.1
GCT3	1200	215	4000	931-1100	16511-19520	TBD	TBD	50	~ 5	2.1
GCT4	1200	215	4000	1000	17747	TBD	TBD	50	~ 5	2.1

(*1) may be completed during hot shakedown
(*2) Black Thunder subbituminous coal

Table C4. Gasification Mode Characterization Tests for Kellogg reactor with CPC PCD

Test number	PCD test number	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr
GCT5	GCT5-F*	48	AL bit	dolomite	3124	1.5	234
GCT6	GCT6-F*	48	AL bit	dolomite	3124	2.0	312
GCT7	GCT7-F*	48	AL bit	dolomite	3124	1.5	234
GCT8	GCT8-F*	48	AL bit	dolomite	3124	1.5	234
GCT9	GCT9-F*	48	AL bit	dolomite	3124	1.5	234

Test number	Reactor temp, °F	Reactor pres, psia	Steam/Coal ratio	Coal feed pt.	Air/Coal ratio	Primary air split (1st/2nd levels)	Riser gas velocity, fps	Coal grind size, μm
GCT5	1700	260	0.34	upper	3.6	50/50	as design	100
GCT6	1700	260	0.34	upper	3.6	50/50	as design	100
GCT7	1700	260	0→0.5	upper	3.6	50/50	as design	100
GCT8	1700	260	0.34	upper	3.0→3.9	50/50	as design	100
GCT9	1700	260	0.34	upper	3.6	100/0→40/60	as design	coarse

Test number	PCD inlet conditions					Spoiling gas		HX0202	RO201	RO301
	temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	nozzle in service	rate, lb/hr	bypass, %	bore ϕ, in	bore ϕ, in
GCT5	1200	179	4000	1000	18,080	TBD	TBD	50	~ 5	1.75
GCT6	1200	179	4000	1000	18,080	TBD	TBD	50	~ 5	1.75
GCT7	1200	179	4000	939-1027	17,000-18,580	TBD	TBD	50	~ 5	1.75
GCT8	1200	179	4000	893-1052	16,177-19,031	TBD	TBD	50	~ 5	1.75
GCT9	1200	179	4000	845	18,080	TBD	TBD	50	~ 5	1.75

Table 10.1 Test Campaign 2 - Gasification Mode with Westinghouse PCD

Test number	PCD test number	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr
TC002-K1	TC002-F*	100	subbit (*1)	dolomite	3248	1.5	134
TC002-K2	TC002-F*	100	subbit	dolomite	3248	1.0	89
TC002-K3	TC002-F*	100	subbit	limestone	3248	2.0	96
TC002-K4	TC002-F*	100	subbit	limestone	3248	1.5	72
SHUTDOWN							
TC002-K5	TC002-F*	100	AL bit	dolomite	3124	1.5	234
TC002-K6	TC002-F*	100	AL bit	dolomite	3124	1.5	234
TC002-K7	TC002-F*	100	AL bit	dolomite	3124	1.5	234
TC002-K8	TC002-F*	100	AL bit	dolomite	3124	1.5	234
TC002-K9	TC002-F*	100	AL bit	dolomite	3124	1.5	234
SHUTDOWN							
TC002-K10	TC002-F*	100	AL bit	dolomite	3124	1.5	234

Test number	Reactor temp, °F	Reactor pres, psia	Steam/Coal ratio	Coal feed pt.	Primary air split (1st/2nd levels)	Air/Coal ratio	Riser gas velocity, fps	Coal grind
TC002-K1	1700	260	0.34	upper	50/50	3.4	as design	as design
TC002-K2	1700	260	0.34	upper	50/50	3.4	as design	as design
TC002-K3	1700	260	0.34	upper	50/50	3.4	1.5 x design	as design
TC002-K4	1700	260	0.34	upper	50/50	3.4	0.6 x design	as design
SHUTDOWN								
TC002-K5	1700	260	0.34	upper	50/50	3.6	as design	as design
TC002-K6	1700	260	0.34	upper	50/50	3.6	as design	coarse
TC002-K7	1700	260	0.34	upper	100/0	3.6	as design	as design
TC002-K8	1700	260	0.34	upper	40/60	3.6	as design	as design
TC002-K9	1700	260	0.34	upper	0/100	3.6	as design	as design
SHUTDOWN								
TC002-K10	1700	260	0.34	lower	50/50	3.6	as design	as design

Table 10.1 Test Campaign 2 - Gasification Mode with Westinghouse PCD (cont)

Test number	PCD inlet conditions temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	Spoiling gas nozzle in service	rate, lb/hr	HX0202 bypass, %	RO201 bore ϕ, in	RO301 bore ϕ, in
TC002-K1	1200	215	4000	1000	17,747	TBD	TBD	50	~ 5	2.1
TC002-K2	1200	215	8000-12000	1000	17,747	TBD	TBD	50	~ 5	2.1
TC002-K3	1200	215	4000	1000	17,747	TBD	TBD	50	~ 5	2.1
TC002-K4	1200	215	8000-12000	1000	17,747	TBD	TBD	50	~ 5	2.1
SHUTDOWN										
TC002-K5	1400	255	4000	947	18,808	TBD	TBD	74	~ 7	N/S
TC002-K6	1400	255	8000-12000	947	18,808	TBD	TBD	74	~7	N/S
TC002-K7	1400	255	4000	947	18,808	TBD	TBD	74	~ 7	N/S
TC002-K8	1400	255	4000	947	18,808	TBD	TBD	74	~ 7	N/S
TC002-K9	1400	255	4000	947	18,808	TBD	TBD	74	~ 7	N/S
SHUTDOWN										
TC002-K10	1400	255	4000	947	18,808	TBD	TBD	74	~ 7	N/S

Test number	Purpose
TC002-K1 TC002-K2	evaluate effect of Ca/S molar ratio
TC002-K3 TC002-K4	evaluate effect of Ca/S molar ratio and riser gas velocity using limestone
TC002-K5 TC002-K6	evaluate effect of coal size
TC002-K7 TC002-K8 TC002-K9	evaluate effect of primary air split on mixing zone heat release rate
TC002-K10	evaluate effect of lower coal injection point

Table 12.1 Test Campaign 4 - Gasification Mode with CPC PCD

Test number	PCD test number	duration, hrs	Coal	Sorbent	Coal feed rate, lb/hr	Ca/S molar ratio	Sorbent feed rate lb/hr
TC004-K1	TC004-F*	100	AL bit	dolomite	3124	1.5	234
TC004-K2	TC004-F*	100	AL bit	dolomite	3124	1.5	234
TC004-K3	TC004-F*	100	AL bit	dolomite	3124	1.5	234
TC004-K4	TC004-F*	100	AL bit	dolomite	3124	1.5	234
TC004-K5	TC004-F*	100	AL bit	dolomite	3124	1.5	234
TC004-K6	TC004-F*	100	AL bit	dolomite	3124	1.5	234
SHUTDOWN							
TC004-K7	TC004-F*	100	subbit (*1)	dolomite	3248	1.5	134
TC004-K8	TC004-F*	100	subbit (*1)	dolomite	3248	1.5	134
TC004-K9	TC004-F*	100	subbit (*1)	limestone	3248	3.0	144
TC004-K10	TC004-F*	100	subbit (*1)	limestone	3248	1.5	72

Test number	Reactor temp, °F	Reactor pres, psia	Steam/Coal ratio	Coal feed pt.	Primary air split (1st/2nd levels)	Riser gas velocity, fps	Coal grind size, dμ
TC004-K1	1700	260	0.34	upper	45/55	as design	as design
TC004-K2	1700	260	0.34	upper	55/45	as design	as design
TC004-K3	1700	260	0.34	upper	50/50	as design	as design
TC004-K4	1650	260	0.1	upper	50/50	as design	as design
TC004-K5	1750	260	0.7	upper	50/50	as design	as design
TC004-K6	1700	260	1.5	upper	50/50	as design	as design
SHUTDOWN							
TC004-K7	1700	260	0.34	upper	50/50	as design	as design
TC004-K8	1700	260	0.34	upper	50/50	as design	as design
TC004-K9	1700	260	0.34	upper	50/50	as design	as design
TC004-K10	1700	260	0.34	upper	50/50	as design	coarse

(*1) Black Thunder subbituminous coal

Table 12.1 Test Campaign 4 - Gasification Mode with CPC PCD (cont)

Test	PCD inlet conditions					Spoiling gas		HX0202	RO201	RO301
number	temp, °F	pres, psia	loading, ppmw	rate, ACFM	rate, lb/hr	nozzle in service	rate, lb/hr	bypass, %	bore ϕ, in	bore ϕ, in
TC004-K1	1620	255	4000	1059	18,080	TBD	TBD	100	N/S	N/S
TC004-K2	1620	255	8000	1059	18,080	TBD	TBD	100	N/S	N/S
TC004-K3	1620	255	12000	1059	18,080	TBD	TBD	100	N/S	N/S
TC004-K4	1570	255	8000	1033	18,080	TBD	TBD	100	N/S	N/S
TC004-K5	1670	255	4000	1084	18,080	TBD	TBD	100	N/S	N/S
TC004-K6	1620	255	4000-max	1059	18,080	TBD	TBD	100	N/S	N/S
SHUTDOWN										
TC004-K7	1620	255	4000	1036	17,747	TBD	TBD	100	N/S	N/S
TC004-K8	1620	255	8000-12000	1036	17,747	TBD	TBD	100	N/S	N/S
TC004-K9	1620	255	4000	1036	17,747	TBD	TBD	100	N/S	N/S
TC004-K10	1620	255	8000-12000	1036	17,747	TBD	TBD	100	N/S	N/S

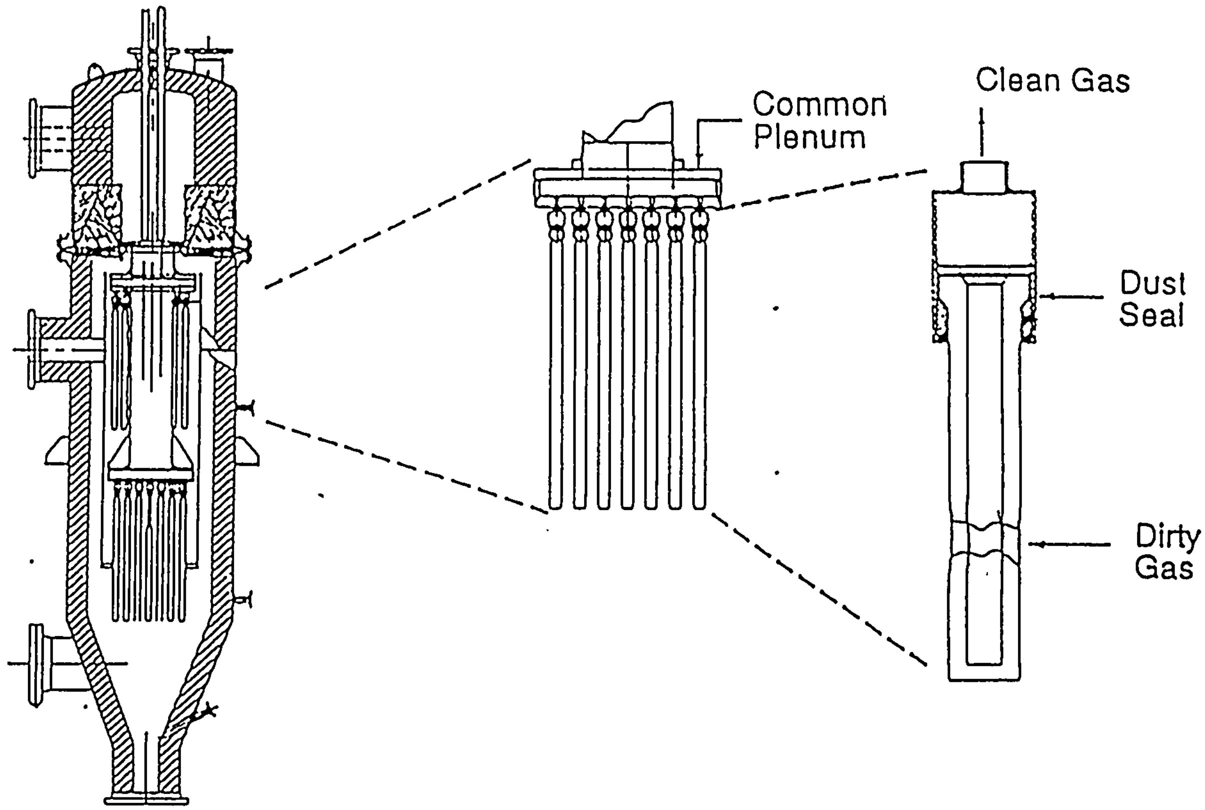
Test number	Purpose
TC004-K1 TC004-K2 TC004-K3	evaluate effect of primary air split
TC004-K4 TC004-K5 TC004-K6	quantify effect of steam/coal ratio
TC004-K7 TC004-K8	base tests
TC004-K9 TC004-K10	evaluate effect of Ca/S molar ratio and effect of coal size

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

5. TEST PLAN FOR THE PCDS IN MWK TRAIN

Westinghouse PCD



Westinghouse PCD Characterization Test

	Combustion	Gasification
Temp, F	1000 & 1300	1200
Pres, psig	160 - 310	215
Face Vel, Ft/min	3.3 - 5.4	3.6 - 4.3
Loading, ppm	4000	4000

Fuel: Bituminous
Sorbent: Dolomite
Elements: Used Tidd

Base Filter Operating Parameters:
Tubesheet DP:
Pulse Pres: 1200 PSI
Cycle Time: As Req'd

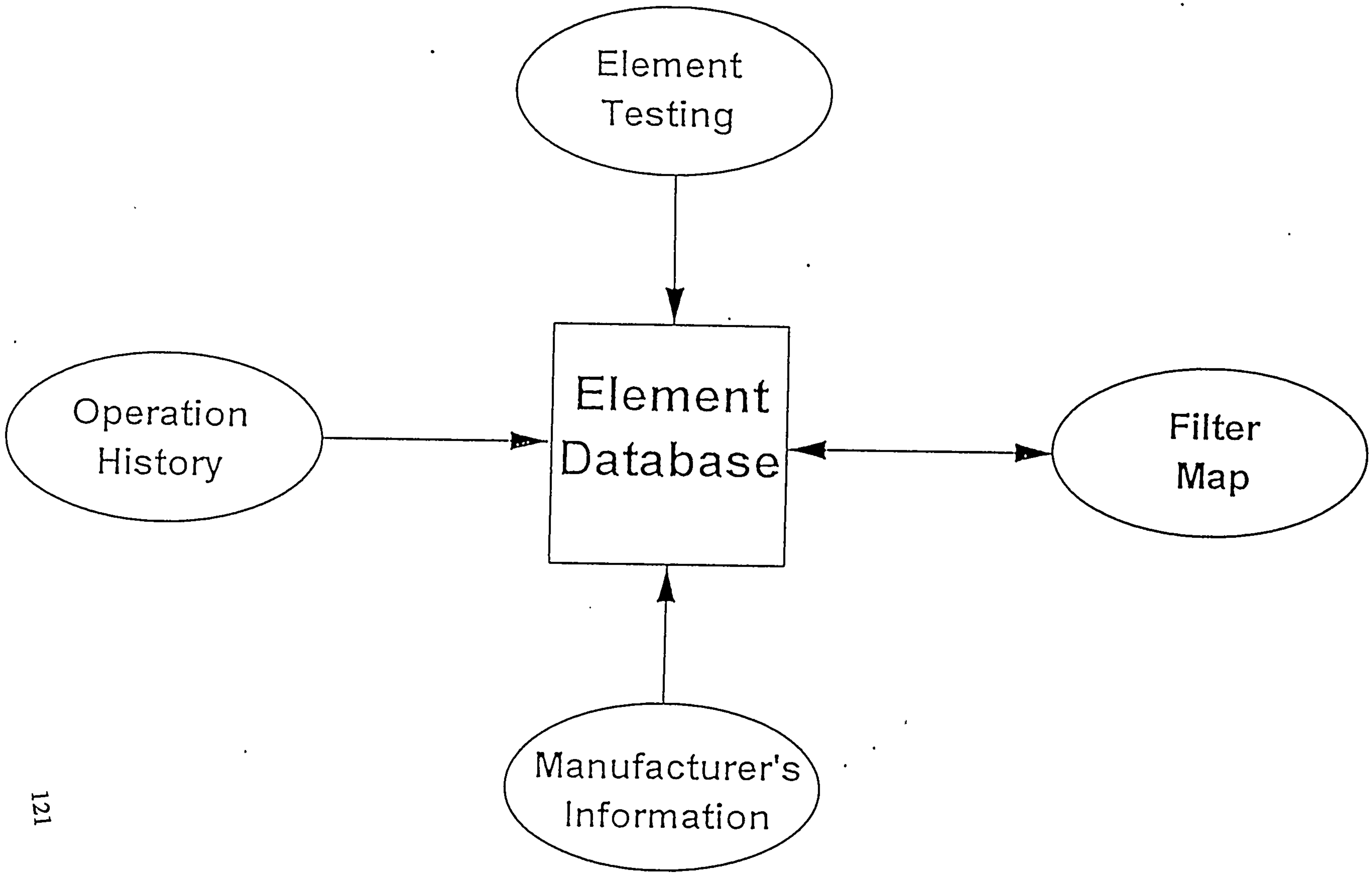
Westinghouse PCD Combustion Test Campaign

MWK Test #	PCD Test #	Sorbent	Loading, PPM	Filter Operating Parameters
TC01-K1	TC01-F1	DOLOMITE	4000	Base
TC01-K2	TC01-F2	DOLOMITE	4000	Base
TC01-K3	TC01-F3	DOLOMITE	4000	Base
TC01-K4	TC01-F4	DOLOMITE	6000	Base
TC01-K5	TC01-F5	DOLOMITE	10000	Base
TC01-K6	TC01-F6	DOLOMITE	4000	Vary Pulse Pres
TC01-K7	TC01-F7	DOLOMITE	4000	Vary Tubesheet DP
TC01-K8	TC01-F8	DOLOMITE	4000	Vary Cycle Time
TC01-K9	TC01-F9	LIMESTONE	4000	Base
TC01-K10	TC01-F10	LIMESTONE	6000	Base
	TC01-F11	LIMESTONE	10000	Base

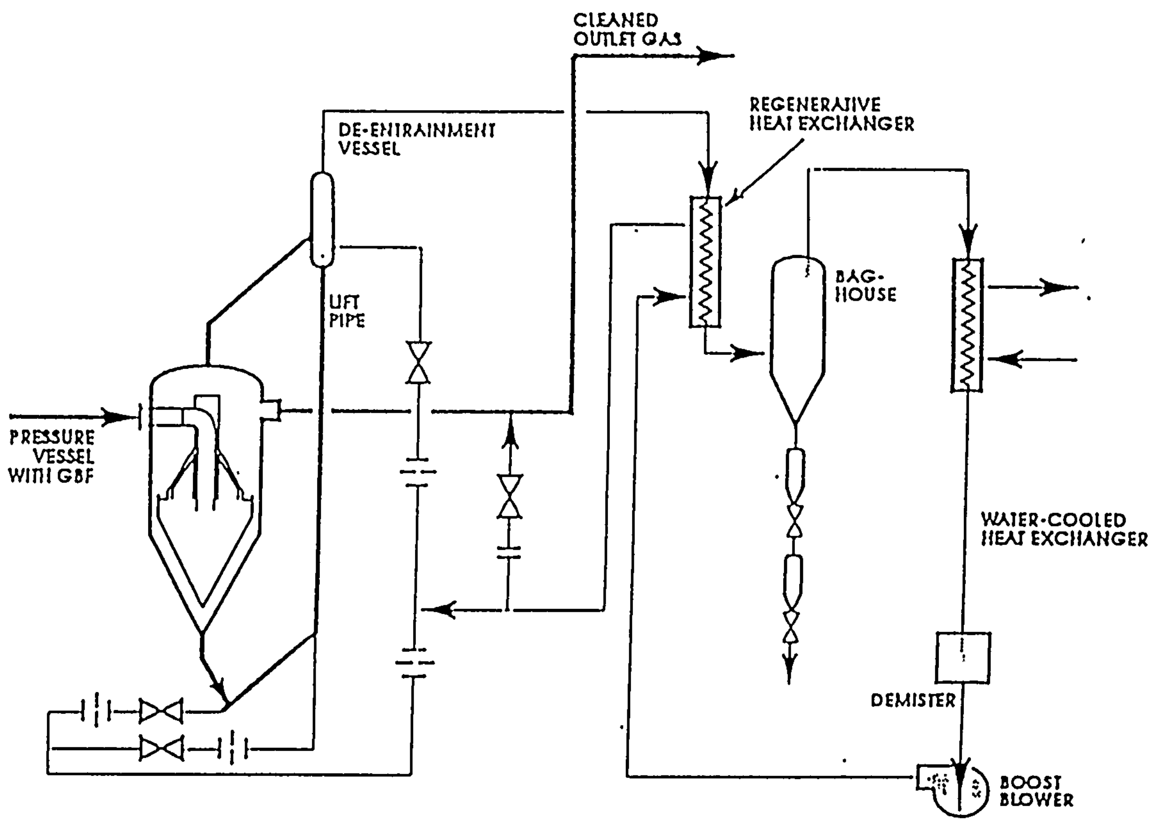
Fuel: Bituminous
Temperature: 1300 F

Pressure: ~250 psi
Face Vel: 3.9 - 4.4 ft/min

Ceramic Element Database



Combustion Power Company Process Diagram



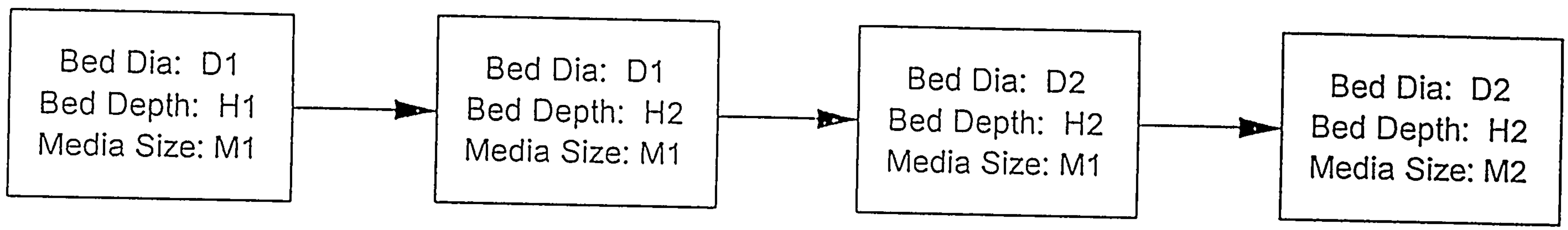
Combustion Power Company PCD Characterization Test

	Combustion	Gasification
Temp, F	1000 & 1480	1200
Pres, psig	160 - 310	180
Loading, ppm	4000	4000

Fuel: Bituminous
Sorbent: Dolomite

Bed Depth: H1
Bed Diameter: D1

Combustion Power Company PCD Characterization Test



Combustion Power Co. PCD Combustion Test Campaign

MWK Test #	PCD Test #	Fuel/Sorbent	Loading, PPM	Filter Operating Parameters
TC03-K1	TC03-F1	BIT/DOL	4000	BASE
TC03-K2	TC03-F2	BIT/DOL	6000	BASE
TC03-K3	TC03-F3	BIT/DOL	10000	BASE
TC03-K4	TC03-F4	BIT/DOL	6000	VARY ASH/MEDIA RATIO
TC03-K5	TC03-F5	BIT/DOL	4000	LOAD FOLLOWING
TC03-K6	TC03-F6	BIT/DOL	6000	COUNTERFLOW AIR OPT.
	TC03-F7	BIT/DOL	VARIES	LOADING "SPIKE"
TC03-K7	TC03-F8	SUB/DOL	4000	BASE
TC03-K8	TC03-F9	SUB/DOL	6000	BASE
	TC03-F10	SUB/DOL	10000	BASE
TC03-K9	TC03-F11	SUB/LIME	4000	BASE
TC03-K10	TC03-F12	SUB/LIME	6000	BASE
	TC03-F13	SUB/LIME	10000	BASE

Temperature: 1300 F
Pressure: ~250 psig
Volumetric Flow: ~1000 acfm

Combustion Power Company PCD Gasification Test Campaign

MWK Test #	PCD Test #	Fuel/Sorbent	Temp, F	Loading, PPM	Filter Operating Parameters
TC04-K1	TC04-F1	BIT/DOL	1620	4000	BASE
TC04-K2	TC04-F2	BIT/DOL	1620	8000	BASE
TC04-K3	TC04-F3	BIT/DOL	1620	12000	BASE
TC04-K4	TC04-F4	BIT/DOL	1570	8000	VARY ASH/MEDIA RATIO
TC04-K5	TC04-F5	BIT/DOL	1670	4000	BASE
TC04-K6	TC04-F6	BIT/DOL	1620	8000	COUNTERFLOW AIR OPT.
	TC04-F7	BIT/DOL	1620	VARIES	LOADING "SPIKE"
TC04-K7	TC04-F8	SUB/DOL	1620	4000	BASE
TC04-K8	TC04-F9	SUB/DOL	1620	8000	BASE
	TC04-F10	SUB/DOL	1620	12000	BASE
TC04-K9	TC04-F11	SUB/LIME	1620	4000	BASE
TC04-K10	TC04-F12	SUB/LIME	1620	8000	BASE
	TC04-F13	SUB/LIME	1620	12000	BASE

Pressure: ~255 psig

Volumetric Flow: ~1000 acfm

Combustion Power Company PCD Evaluation Criteria

- Collection Efficiency
- Operability
- Maintainability
- Media Degredation
- Ash/Media Separation
- Transport Piping Erosion

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

6. DRAFT TEST PLAN FOR THE FW TRAIN

Test Plan for Foster Wheeler Advanced PFBC Train

Initial Draft

July 25, 1995

Challenges offered by the Foster Wheeler train

- Achieve integrated operation of novel power plant design
  - MASB with gas turbine/compressor/generator
  - Circulating PFBC with external heat exchanger
  - HTHP filter for PFBC + alkali getter
  - Carbonizer and char transfer system
  - HTHP filter for carbonizer (x 2) + alkali getter

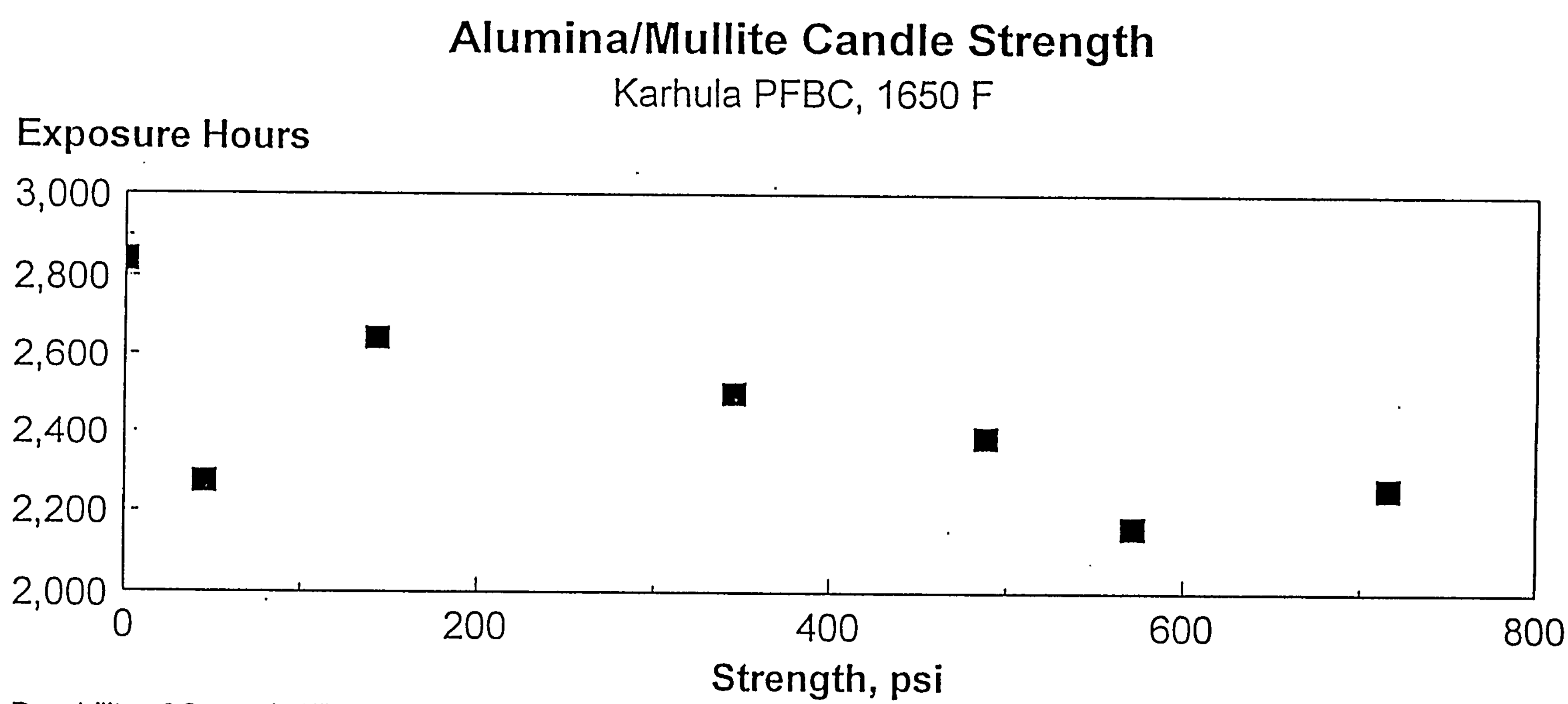
Design modifications

- Backup propane burner
  - Originally two MASBs to be built
  - If MASB fails mechanically, then two flawed MASBs
  - Collect data at PSDF before designing Mark II MASB
  - Need insurance if first MASB fails
  - Cannot operate carbonizer with backup propane burner
- Cooler to lower fuel gas temperature to carbonizer PCD
  - Increases operating flexibility

Carbonizer PCD Concerns

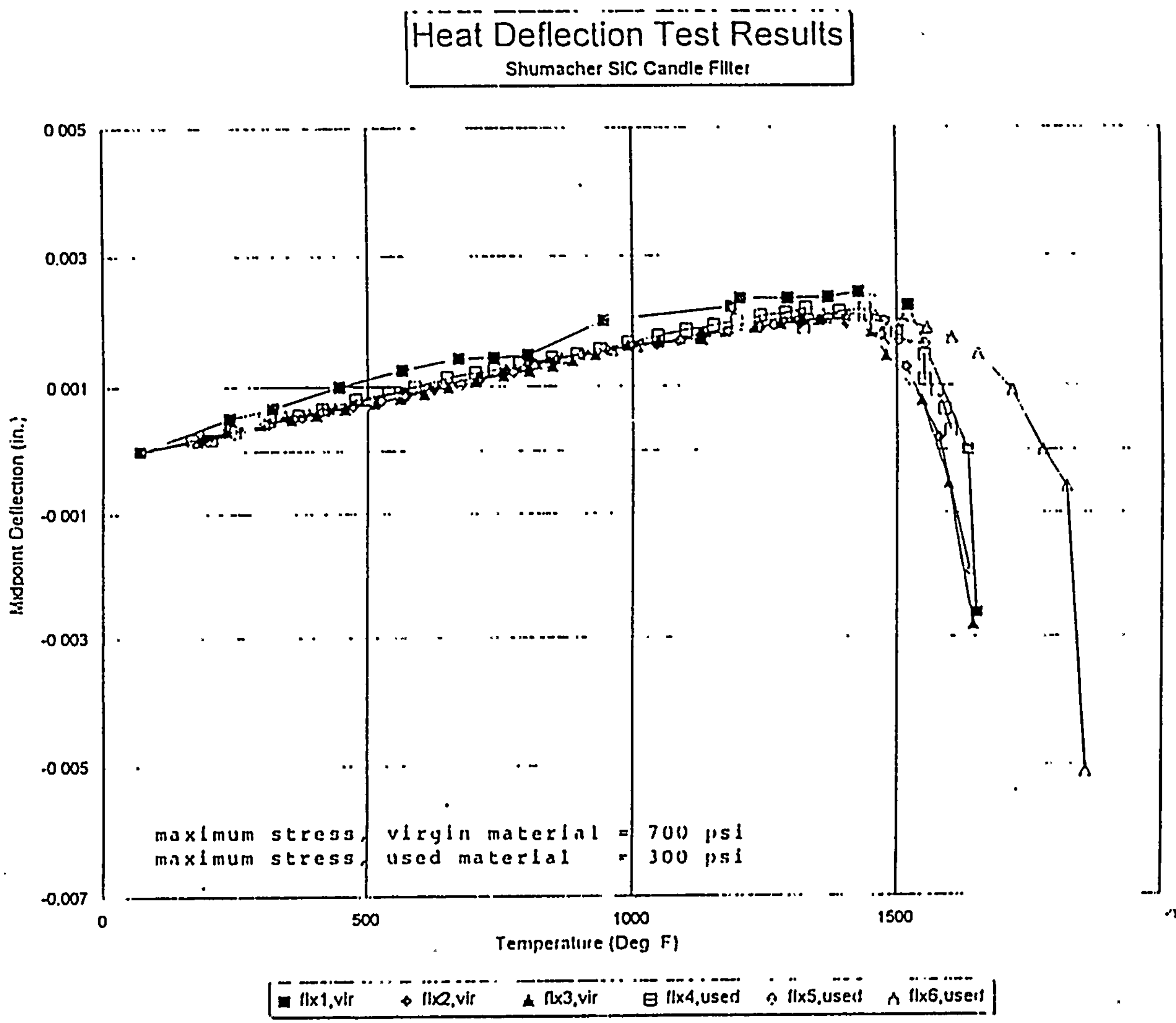
- Stability of Ceramic Materials In High Temperature Reducing Environment is Unknown
- Material Strength Deteriorates With Temperature and Alkali Content
- Alkali Content Higher Under Reducing Conditions
- High Temperature Operation (>1600 F) Limits Material Options
- No Operational Flexibility To Decrease Temperature

Alumina/Mullite



Durability of Ceramic Filters
Mary Anne Alvin - Westinghouse

Clay Bonded SiC



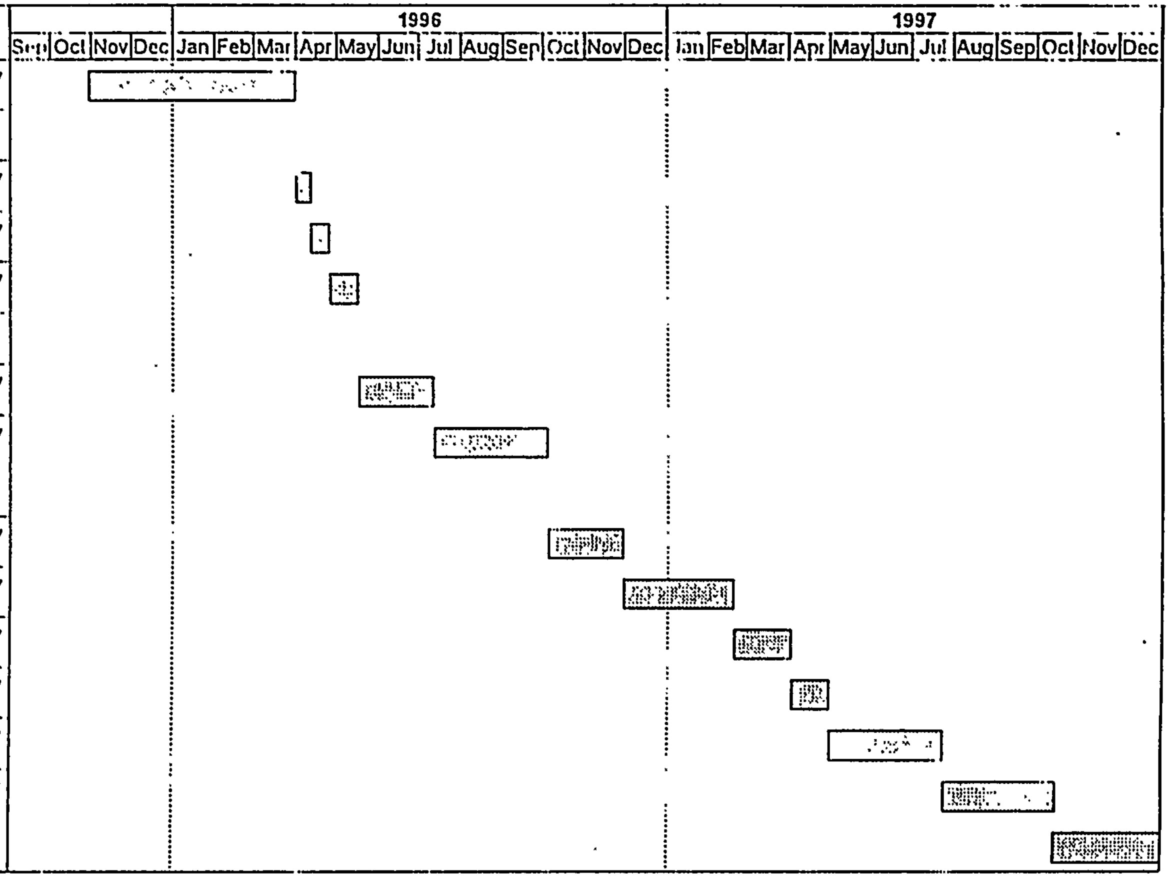
Jack Spain
SRI

Carbonizer PCD Recommendations

- Install Cooler Between Carbonizer and PCD
- Limit Initial Carbonizer Filter Testing To 1350 F
- Evaluate Performance of Ceramic Materials Before Increasing Temperature

Proposed schedule of tests for Foster Wheeler advanced PFBC train through December, 1997

ID	PCD inlet, F	Task Name	Duration
1		Cold shakedown (w/o MASB + GT) (1)	22w
2		MASB + GT	
3		Installation	2w
4		Hot & cold shakedown	2w
5		Simple cycle operation	3w
6		First generation	
7	1550	Hot shakedown	8w
8	1550	Campaign 1	12w
9		Second generation	
10	1580/1350	Hot shakedown (IF&P PCD)	8w
11	1580/1350	Campaign 2 (IF&P PCD)	12w
12		Install Westinghouse PCD	6w
13	1610/1350	Hot & cold shakedown (West PCD)	4w
14	1610/1350	Campaign 3 (West PCD)	12w
15	TBD/1450	Campaign 4 (West PCD)	12w
16	TBD/1550	Campaign 5 (West PCD)	12w



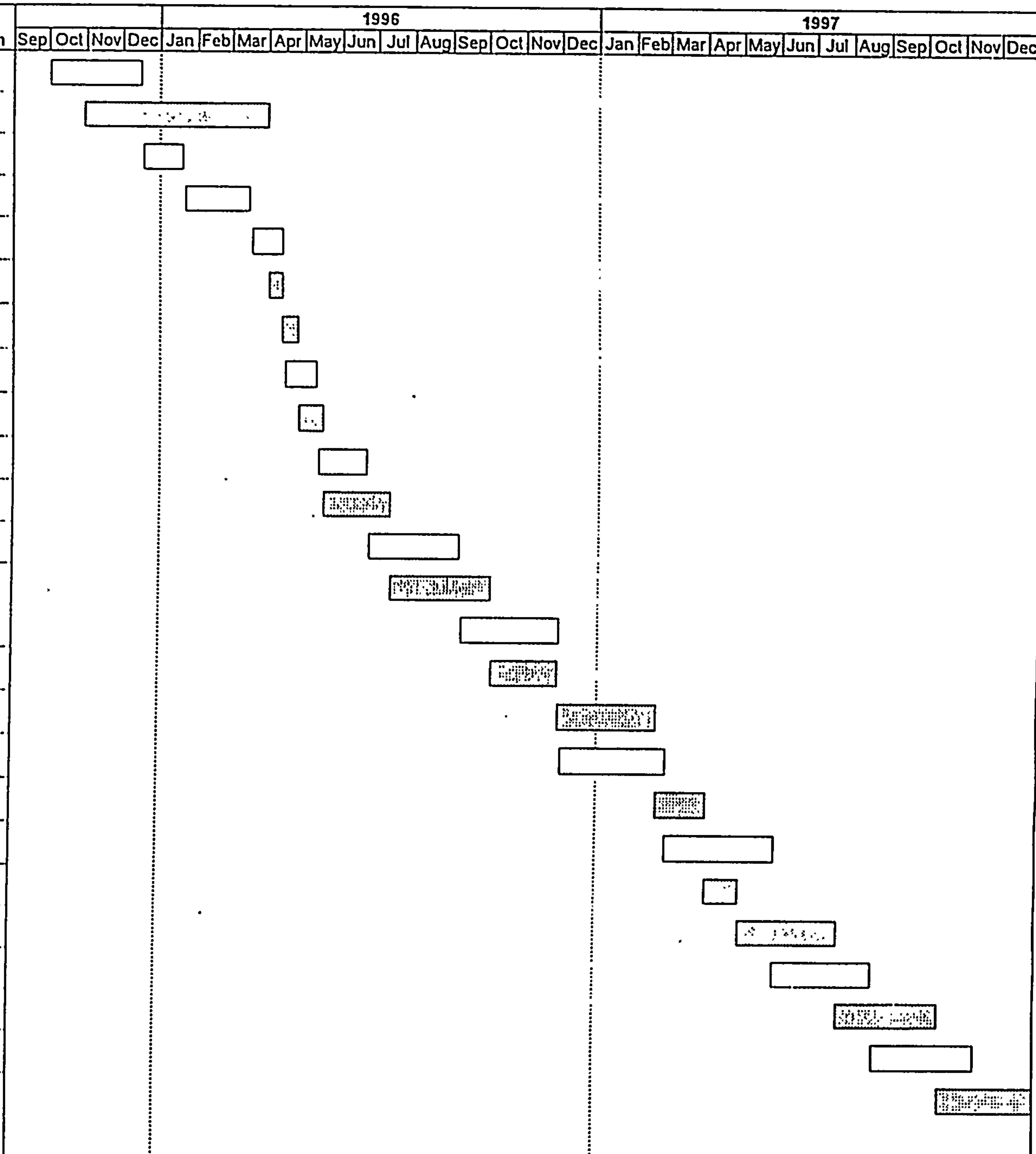
(1) - by occasion, to end 31 March, 1996

7/24/95

Combined proposed schedule of tests for Kellogg and Foster Wheeler trains through December, 1997

7/24/95

ID	PCD inlet, F	Task Name	Duration
1		Combustion, cold & hot shakedown	11w
2		Cold shakedown	22w
3	1000 & 1300	Comb. charact., (West PCD)	5w
4	1000 & 1480	Comb. charact., (CPC PCD)	8w
5	1000	Gasification, hot shakedown	4w
6		MASB installation	2w
7		MASB & GT, hot & cold shakedown	2w
8	1200	Gasif. charact., (West PCD)	4w
9		Simple cycle operation	3w
10	1200	Gasif. charact., (CPC PCD)	6w
11	1550	First generation, hot shakedown	8w
12	1300	Comb. perform (CC1), (West. PCD)	11w
13	1550	First generation, Campaign 1	12w
14	1200 & 1400	Gasif. perform (GC1), (West PCD)	12w
15	1580/1350	Second gen., hot shaked'n (IF&P PCD	8w
16	1580/1350	Second gen, Campaign 2 (IF&P PCD)	12w
17	1300	Comb. perform (CC2), (CPC PCD)	13w
18		Install Westinghouse PCD	6w
19	TBD	Gasif. perform (GC2), (CPC PCD)	13w
20	1610/1350	Hot & cold shakedown (West PCD)	4w
21	1610/1350	Second gen, Campaign 3 (West PCD)	12w
22	TBD	Comb. perform (CC3), (IF&P PCD)	12w
23	TBD/1450	Second gen, Campaign 4 (West PCD)	12w
24	TBD	Gasif. perform (GC3), (IF&P PCD)	12w
25	TBD/1550	Second gen, Campaign 5 (West PCD)	12w



Approach to testing HTHP filters

- Increase temperatures cautiously

  Operate PFBC at low temperature

  Cool carbonizer fuel gas

  Lower temperatures still of commercial interest

  Candles exposed to constant temperature conditions for minimum of 500 hours

  Candle replacement program

- Develop data base to make decisions on "best" operating temperature for future Demonstration plant.

Summary of Campaign Test Conditions

	Carb inlet temp, F	Comb inlet temp, F	Coal	Sorbent
Campaign 1	N/A	1550	Alabama	Dolomite
Campaign 2	1350 (IF&P)	1580	Alabama	Dolomite
Campaign 3	1350 (W)	1610	Alabama	Dolomite
Campaign 4	1450 (W)	TBD	Alabama	Dolomite
Campaign 5	1550 (W)	TBD	Alabama	Dolomite

Hot Shakedown Tests for MASB and GT

Operating mode: Simple cycle operation, firing only propane

Prime objectives

1. Confirm stable and controlled operation of MASB, in conjunction with operating GT, over range of operating conditions
2. Synchronize generator and check out power distribution systems
3. Check out all instrumentation and tune controls prior to feeding coal
4 Check turbine trip sequence, and gas by-pass quench systems
5. Achieve 100 hours of operation and make inspection of burner and GT

To be decided: Operating test conditions
How to obtain temperature profile within MASB

Hot Shakedown Tests for First Generation (1)

Operating mode: First generation, expanding flue gas through GT without topping

Coal: Alabama low-sulfur bituminous
Sorbent: Dolomite

Prime objectives

1. Prepare plant for continuous controlled operation
2. Determine if flue gas expansion alone is sufficient to run turbine
3. Determine optimum air split from flue gas composition
4. Complete H&M balance to check adequacy of sampling and measurement equipment
5. Confirm HTHP filter operation and pulse cleaning strategy
6. Check turbine trip sequence and combustor by-pass quench system

Hot Shakedown Tests for First Generation (2)

Test number	Combustor pressure, psia	Filter inlet temp, °F	Excess air, %	Ca/S molar ratio, -	Comment
FW-HS-1	90 (1)	1550 (2)	AF	90 % ret'n	Staged-air optimization

(1) Probable maximum operating pressure for this operating mode
(2) Mean combustor temperature around 1560°F

To be decided: Operate with heat transfer panel installed or wait for integrated operation

Campaign 1 Test Conditions (1)

Operating mode:	First generation, expanding flue gas through GT without topping
Coal:	Alabama low-sulfur bituminous
Sorbent:	Dolomite

Prime objectives

1. Achieve steady operation of a circulating PFBC with external heat exchanger
2. Characterize sulfur retention performance
3. Achieve 500 hours HTHP filter candle exposure at constant temperature of 1550°F.
4. Extended operation of GT and MASB in absence of fuel gas.
5. Assess effectiveness of combustor alkali getter.
6. Operational experience.

Campaign 1 Test Conditions (2)

Test number	Combustor pressure, psia	Filter inlet temp, °F	Excess air, %	Ca/S molar ratio, -	Comment
FW-1-1	90 (1)	1550 (3)	AF	90 % ret'n	Shakedown testing
FW-1-2	65 (2)	1550	AF	90 % ret'n	
FW-1-3	90	1550	AF	80 % ret'n	
FW-1-4	90	1550	AF	70 % ret'n	
FW-1-5	90	1550	AF	95 % ret'n	Long-term testing

(1) Probable maximum operating pressure for this operating mode
(2) Probable minimum operating pressure for this operating mode
(3) Mean combustor temperature around 1560°F

To be decided: Operate with heat transfer panel installed or wait for integrated operation

Hot Shakedown Tests for Second Generation (1)

Operating mode: Second generation, topping with fuel gas

Coal: Alabama low-sulfur bituminous
Sorbent: Dolomite

Prime objectives

1. Prepare plant for continuous controlled operation
2. Achieve controlled transfer of char from carbonizer to combustor
3. Determine that MASB operates on fuel gas and remains stable during filter cleaning sequence
4. Check turbine trip sequence, and carbonizer and combustor bypass quench system
5. Complete H&M balance to check adequacy of sampling and measurement equipment
6. Confirm HTHP filter operation and pulse cleaning strategy
7. Determine physical properties of PFBC ash

Hot Shakedown Tests for Second Generation (2)

Test number	Carbonizer pressure, psia	Carbonizer temp, °F	Ca/S molar ratio, -	Comment
FW-HS-2	125	1600 (1)	90 % ret'n	Possibly protracted

(1) Carbonizer filter inlet temperature to be 1350°F.

To be decided: Gas cooler to be incorporated into fuel gas path ahead of filter

Campaign 2 Test Conditions (1)

Operating mode:	Second generation, topping with fuel gas
Coal:	Alabama low-sulfur bituminous
Sorbent:	Dolomite

Prime objectives

1. Achieve steady integrated operation of an advanced PFBC power plant
2. Characterize sulfur retention performance
3. Achieve 500 hours carbonizer HTHP filter candle exposure (IF&P) at constant temperature of 1350°F.
4. Achieve 500 hours combustor HTHP filter candle exposure at constant temperature of 1580°F with combustor operating at 1600°F
5. Extended operation of GT and MASB in burning fuel gas.
6. Characterize emissions performance of MASB
7. Collect heat transfer data from combustor panel
8. Assess effectiveness of carbonizer and combustor alkali getters

Campaign 2 Test Conditions (2)

Test number	Carbonizer pressure, psia (1)	Carbonizer temp, °F	Ca/S molar ratio, -	Comment
FW-2-1	135	1600	90 % ret'n	Effect of temp
FW-2-2	135	1650	As FW-2-1	" "
FW-2-3	135	1700	As FW-2-1	" "
FW-2-4	135	1650	70 % ret'n	Effect of Ca/S
FW-2-5	135	1650	80 % ret'n	" "
FW-2-6	160	1650	As FW-2-2	Turn down cond'n
FW-2-7	100	1650	As FW-2-2	" "
FW-2-8	75	1650	As FW-2-2	" "
FW-2-9	175	1650	As FW-2-2	Full load

(1) Combustor pressure will vary to suit

Campaign 3 Test Conditions (1)

Operating mode: Second generation, topping with fuel gas

Coal: Alabama low-sulfur bituminous
Sorbent: Dolomite

Prime objectives

1. Achieve 500 hours carbonizer HTHP filter candle exposure (Westinghouse) at constant temperature of 1350°F.
2. Achieve 500 hours combustor HTHP filter candle exposure at constant temperature of 1610°F with combustor operating at 1640°F
3. Characterize sulfur retention performance
4. Assess effectiveness of combustor alkali getter
5. Determine turndown rates and dynamic responses while keeping filter inlet temperatures constant

Campaign 3 Test Conditions (2)

Test number	Carbonizer pressure, psia (1)	Carbonizer temp, °F	Ca/S molar ratio, -	Comment
FW-3-1	135	1650	90 % ret'n	Effect of Ca/S
FW-3-2	135	1650	70 % ret'n	" "
FW-3-4	135	1650	80 % ret'n	" "
FW-3-5	135	1650	95 % ret'n	Steady operation

(1) Combustor pressure will vary to suit

To be decided:

1. Can combustor operate at 1640°F ?
2. Is 1350°F appropriate carbonizer filter inlet temperature ?
3. Will Kellogg results be available to influence de[illegible] ?

Campaign 4 Test Conditions

Operating mode: Second generation, topping with fuel gas

Coal: Alabama low-sulfur bituminous
Sorbent: Dolomite

Prime objectives

1. Achieve 500 hours carbonizer HTHP filter candle exposure (Westinghouse) at constant temperature of 1450°F.
2. Achieve 500 hours combustor HTHP filter candle exposure at constant temperature of interest
3. Other objectives to be defined

To be decided:

1. Combustor filter inlet temperature dependent on results from Foster Wheeler and Kellogg testing.
2. Is 1450°F appropriate carbonizer filter inlet temperature, and will Kellogg results be available to influence decision ?

Campaign 5 Test Conditions

Operating mode: Second generation, topping with fuel gas

Coal: Alabama low-sulfur bituminous
Sorbent: Dolomite

Prime objectives

1. Achieve 500 hours carbonizer HTHP filter candle exposure (Westinghouse) at constant temperature of 1550°F.
2. Achieve 500 hours combustor HTHP filter candle exposure at constant temperature of interest
3. Other objectives to be defined

To be decided:

1. Combustor filter inlet temperature dependent on results from Foster Wheeler and Kellogg testing
2. Is 1550°F appropriate carbonizer filter inlet temperature, and will Kellogg results be available to influence decision ?

APPENDIX B

PRESENTATIONS FROM THE 75% DESIGN REVIEW MEETING

7. OUTYEAR PLANS

Power Systems Development Facility

Outyear Plans

Reasons for Outyear Test Plans Now

- Justify budget requests for operating funds.
  - DOE budgets two years in advance
  - EPRI
  - SCS and other participant's plans
- Solidify the vision of the participants for the PSDF.
- Use the plan to sell the PSDF to additional participants.
  - Additional technologies
  - Added cost share

PSDF Mission

The mission of the PSDF is to be a site where new process configurations and components for advanced power systems can be tested in an integrated process environment at a large enough size to provide data for scale up toward commercialization.

PSDF Vision - 2000

- The PSDF will be recognized by equipment vendors, process developers, and generators of electric power as the best place to test new components and integrated process configurations for advanced power systems.

- Data from testing at the PSDF will be recognized as a clear indicator of the usefulness of new components and integrated process configurations for advanced power systems and will be sufficient to support scale up toward commercialization.

PSDF Vision - 2000

- Public and private funding agencies will recognize the PSDF as a readily accessible, politically neutral, cost effective testing location for advanced power system components and integrated process configurations.

- The staff at the PSDF will be recognized as experts in their respective technologies by all of their customers.

Process for Developing Outyear Plans for the PSDF

- Assume that the first test period is completed successfully.

- Develop a list using the DOE PSDF Technical Team.
- Review by DOE technical managers.
- Send to current participants for comments.

- Review policy considerations in the PSDF Steering Committee.

- Gary Styles (SCS) and Dale Schmidt (DOE) will help reach a consensus on the outyear plans.

Initial Test Plan Priorities

- Study high temperature PCDs under conditions expected in IGCC and advanced PFBC systems.
- Demonstrate transport reactor operation under gasification and combustion conditions.
- Demonstrate integrated operation of the Foster Wheeler advanced PFBC system.
- Demonstrate integration of advanced PFBC with a topping combustor and gas turbine.
- Demonstrate operation of a fuel cell on coal-derived gas using hot gas cleanup.

Current Ideas for the PSDF Outyear Plan
Generic

- Support DOE CCT projects while in operation.
- Continue PCD testing, emphasizing new filter element materials and additional system developers.
- Operate the advanced PFBC system in configurations which emphasize lower NOx production.
- Demonstrate operation of additional fuel cell types on coal-derived gas with advanced hot gas cleanup systems.
- Operate with diverse coals and sorbents to demonstrate improved sulfur, nitrogen, and HAPs control.

Current Ideas for the PSDF Outyear Plan

Generic

- Carry out modelling, economic studies, and incremental process improvements to make advanced power systems simpler and more reliable.
- Identify and test technologies for removal of contaminants such as alkalies and chlorides.
- Demonstrate new measuring instruments and control systems for advanced power systems.

Current Ideas for the PSDF Outyear Plan

Transport Reactor

- Advanced Power Generation

  - Demonstrate slurry feed system to replace lockhoppers on transport reactors.
  - Demonstrate mechanical valves or chokes (as used in FCC systems) as a replacement for ash handling lockhoppers.
  - Addition of a transport gasifier to operate with the existing system acting as a combustor/sulfator.

Current Ideas for the PSDF Outyear Plan

Transport Reactor

- Hot Gas Desulfurization and Fuel Cells

  - Addition of a transport hot gas desulfurization unit in either a bulk or slipstream configuration.
  - Addition of a direct sulfur recovery process to the advanced gasifier unit (AGU).
  - Test sintered metal filter elements at lower temperatures (750 F) to increase dependability, decrease PCD size, and increase face velocities (to decrease costs).

Current Ideas for the PSDF Outyear Plan

Transport Reactor

- Oxygen-Blown Gasification
  - Test the transport reactor in oxygen-blown gasification operation.
  - Produce hydrogen/syngas and electric power.
  - Use other carbon feedstocks.
  - Use liquid and slurry or emulsion feeds.
  - May make operation of a gasifier/fuel cell easier.

Current Ideas for the PSDF Outyear Plan

Process Improvements

- Test an advanced PFBC system using two transport reactors.
- Test the Stamet dry coal feed pump.
- Use recycle gas for PCD backpulsing under gasification conditions.
- Test HAT or other water-augmented gas turbine cycles.
- Demonstrate an externally fired heat exchanger using coal-derived gas.

Current Ideas for the PSDF Outyear Plan

Granular Bed Filters and Membrane Separators

- Use chemically reactive media being developed by RTI to control alkali using the CPC GBF.
- Test the Westinghouse GBF at the PSDF.
- Test Westinghouse's Integrated Low Emission Cleanup System at the PSDF as a desulfurizer. (Use of sorbent in a candle filter).

- Test Bend Research's composite metal membrane to provide hydrogen from coal-derived gas to a solid oxide fuel cell.