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Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion Project

Quarterly Report
April - June 1996

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

For
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POWER SYSTEMS DEVELOPMENT FACILITY

QUARTERLY TECHNICAL PROGRESS REPORT
APRIL 1 - JUNE 30, 1996

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1.0 INTRODUCTION AND SUMMARY

This quarterly technical progress report summarizes the work completed during the first quarter, April 1 through June 30, 1996, under the Department of Energy (DOE) Cooperative Agreement No. DE-FC21-90MC25140 entitled "Hot Gas Cleanup Test Facility for Gasification and Pressurized Combustion." The objective of this project is to evaluate hot gas particle control technologies using coal-derived gas streams. This will entail the design, construction, installation, and use of a flexible test facility which can operate under realistic gasification and combustion conditions. The major particulate control device issues to be addressed include the integration of the particulate control devices into coal utilization systems, on-line cleaning techniques, chemical and thermal degradation of components, fatigue or structural failures, blinding, collection efficiency as a function of particle size, and scale-up of particulate control systems to commercial size.

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

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

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

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

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

2.0 REVIEW OF TECHNICAL PROGRESS

2.1 PROJECT MANAGEMENT

A PSDF dedication ceremony was held on April 11. The DOE, EPRI, and project participant personnel attended the ceremony. The PSDF personnel prepared and presented technical information at display areas for the PSDF tour made by dignitaries following the ceremony.

The Cooperative Agreement for the Power Systems Development Facility, DE-FC21-90MC25140, between Southern Company Services and the Department of Energy is currently scheduled to expire on March 13, 1997 which is the end of Budget Period 5. SCS is currently preparing a Request for Renewal of this Cooperative Agreement. This Request for Renewal will be submitted to the Department of Energy in September 1996. This request will cover annual Budget Periods #6 through #10 and would extend the Cooperative Agreement through March 13, 2001. The scope of Budget Period #6 will include the completion of the construction phase of the Advanced Pressurized Fluidized Bed Combustion Module (APFBC) which includes Foster Wheelers' technology for second generation Pressurized Fluidized Bed Combustion (PFBC), associated Particulate Control Devices (PCD's), the Compressor/Turbine Module, related Balance of Plant facilities, the operation and testing of this Module and the continued operation and testing of the Advanced Gasifier Module which involves M.W. Kellogg's transport reactor, associated Particulate Control Devices and related Balance of Plant facilities. Budget Periods #7 through #10 will cover the operation and testing of these modules plus the Fuel Cell Module. Extending the Cooperative Agreement through March 13, 2001 will allow the facility to extensively test the equipment included in the current scope of the project and provide the opportunity to economically test additional Particulate Control Devices and potentially other advanced coal -based power generation equipment that may need to be tested on a large scale pilot basis.

During the quarter, all PCD participants and SRI formulated a new statement of work which will be used to define their activities for the upcoming budget periods. The participants were asked to evaluate their testing requirements as well as the level of manpower support they would provide.

The first candle filter was placed in June. Eighty-five Pall 442T elements were ordered as well as 20 Pall 326 elements. These are expected to arrive in July. Orders to 3M as well as Schumacher should be placed in July.

The EPRI fuel skid module that was located at Kaltec of Minnesota was shipped to the PSDF site on June 10, 1996. The module is stored in a secured laydown area for future use.

2.2 PHASE 2 - DETAILED DESIGN ACTIVITIES

2.2.1 Task 2.1 Detailed Design

2.2.1.1 MWK: PSDF Transport Train

The detailed design is complete. Engineering support continues on an as required basis with most of the activities focused around gas analyzer probes, cabinets and analyzers, and drawing and design intent clarifications.

2.2.1.2 FW Team Activities

Design completion

To complete the remaining portions of the FW and the BOP design, the necessary SCS design personnel moved to the PSDF site. By mid-April all seven design staff members had moved to the site. The work to be completed included electrical, instrumentation, and drafting activities. The Intergraph design model was installed and made operational, and work proceeded on checking drawings from the electronic files prepared by Foster Wheeler. A review was completed of SAMA, hard and soft logic, and interlock drawings in conjunction with the IRS.

During the period, equipment required for completion of FW construction were identified and costed. Items included gaskets, bolts, nuts, washers, piping, valves, instruments, bulks and BOP. Also, the Project files were transferred from Inverness for storage and use at the site. The new material were cataloged and incorporated into the current document control system.

MASB

In April, several manufacturing faults were rectified on the main burner assembly which was returned to the company for thermal barrier coating. Application of the coating was delayed for over a week as a problem was experienced in adequately shielding those parts that did not require coating. The spool piece was successfully hydro-tested at the beginning of April. All parts, spool piece and burner, were delivered to UTSI for assembly towards the end of May. The MASB will be delivered to the site by mid-August.

Gas turbine

Even though CT fabrication is on hold, US Turbine has progressed the job on a fill-in work basis. Three tasks remain: completion of electrical design (less than a week), PLC programming (6-8 weeks), and design, manufacture, and installation of the turbine enclosure (8 weeks). The incomplete electrical design information prevents SCS from completing their portion of the design work; however, once information is available only 200 hours will be required to complete the design. Due to a heavy work schedule, US turbine will not be able to do any work on the CT until after September.

Schedule for construction

A number of steps have been taken to support construction of the FW train. Consequently, work was carried out to determine the cost of various construction options. It was agreed that the refractory-lined pipe needs to be installed ahead of any other construction activity. A possible construction sequence is: final set the combustor along with the cyclone, J-valve, FBHE, and solids cooler; cure out the refractory in the combustor components; final set the carbonizer; install the N-valve; and connect up the PCDs. The pipe work connecting the PCDs to the alkali getters would not be scheduled until the pipe work from the alkali getters to the MASB was installed. This approach is necessary as these latter sections have no slip flanges which greatly reduces the ability to make adjustments to achieve a fit. In contrast the pipe between the PCDs and the alkali getters has slip flanges and is capable of adjustment in all three dimensions.

In June, construction of the combustor loop for cure out of the refractory began. Initial work included a repair to the refractory in the combustor cyclone and repairs to refractory and flanges in the pipe sections taking the FBHE fluidizing air to the combustor. The cure out will be carried out in August.

FW test plan schedule

To assist with budget preparation, the FW test schedule was updated and made compatible with the MWK test schedule. This schedule has simple cycle commissioning in April 1997, PFBC commissioning in September 1997, and commissioning for integrated operation in January 1998. Meeting this schedule assumes that construction of the FW train will commence no later than October 30, 1996. The schedules of the two trains now allows the IF&P PCD to be tested initially on the MWK train with carbonizer commissioning proceeding with the Westinghouse PCD in service. Currently, the Westinghouse PCD is located in the MWK train and is not available to be incorporated into the FW train. How this will impact the FW construction activity remains to be assessed.

2.2.1.3 Balance-of-Plant Activities

The balance-of-plant design, engineering, procurement and construction support activities are complete except for electrical and instrumentation.

The FW Instrument Reference Schedule was reviewed and assigned terminations to those I/O which had not previously been assigned. FW SAMA logic, hard interlock logic for the emergency trip system, software interlock logic, instrument location and installation drawings, sequence logic, emergency trip system ladder diagrams, overall plant control philosophy document, char transfer system process description, and the startup process descriptions were reviewed. Work on the DCS configuration, graphics development, instrument data sheets, and database development continued. A review of DCS termination drawings was completed.

2.2.1.4 Process Hazard Review

Due to several changes and additions in design of several sections of the plant since the 1995 design hazard review, these sections were rereviewed. The sections rereviewed included the coal and sorbent handling (Areas 100 and 150), ash (Area 800), sampling systems, service water (Area 2100), circulating water (Area 2100), waste water (Area 2500), demineralized water (Area 2700), steam condensate (Area 2000), steam condensate cooler, service and instrument air (Area 2200), auxiliary fuel (Area 2300), fire protection (Area 2400) and the propane crossover between low and high pressure propane (Area 2300). All required design changes are complete.

2.2.2 Task 2.3 Environmental Permitting and Compliance and Safety Issues

Environmental Issues: The First Quarter Discharge Monitoring Report(DMR) for the PSDF was prepared and submitted to the Alabama Department of Environmental Management (ADEM) in April. Browning-Ferris Industries (BFI) will handle ash disposal and other non-hazardous wastes that are expected to be generated during plant operations. Any hazardous wastes will be handled by Chemical Waste Management. In May, a request was sent to ADEM asking for consideration in postponing the Title V Operating Permit for the PSDF from December 1996 to December 1999. The reason for the request is that sufficient emission data will not be available to complete the application by December 1996. The request was looked on favorably by ADEM and the application deadline was postponed until December 1999. However, an abbreviated application has to be completed and submitted by December 1996.

Safety Issues: Respirator and hearing tests were given to employees on April 27 by Occupational Health Dynamics of Birmingham. The care of the respirator was covered in a plant-wide safety meeting. Four plant personnel attended the annual Alabama Power Health and Safety Symposium on June 27 and 28 in Birmingham, Alabama. Several ideas are being considered to make the safety program and effort more visible.

2.2.3 Task 2.4 Particle Characterization and Collection

Design of the impactor internals was completed in April. Initially, Haynes Alloy 556 was selected as the material of construction for the impactor jet plates, inlet transition, gas distribution stage, stage retainer cup, and internal spacer. SRI is currently working with Oak Ridge National Lab to determine whether it would be feasible to make these parts out of iron aluminide. Haynes Alloy 230 foil and iron aluminide foil are being considered for the material of construction for the substrates, since the Haynes 556 is not available in a 2-mil foil. The complete drawing package of the impactor internals is included in Figures 1 - 7. The drawing package was submitted along with a request for quotation (RFQ) on June 5. Bids are expected back in July.

Substrate evaluations were continued in April and May. The results of the tests performed are summarized in Table 1. April's evaluations focused on testing of a second sample of Havar, a cobalt-based alloy, and six different ceramic fiber papers: Rath RPL-1, Kaowool 700, Kaowool Ultrafelt, Rath FK-AL-2, Kaowool 3000, and Fiberfrax 970F. The materials tested in May included a 310 stainless steel modified with tantalum and nitrogen; three different formulations of iron aluminide; chromized versions of 316 stainless steel, Havar, and Haynes 230; and an aluminized version of Haynes 230. Only three of these materials exhibited acceptable weight changes after pretreatment. Both the Rath RPL-1 and the Kaowool Ultrafelt lost only 0.03 mg in a two-hour test at 1800°F after a two-hour pretreatment at 2000°F. Unfortunately, the Kaowool Ultrafelt is not available in a thickness of less than 0.1 in., which is too thick for use as a substrate. One formulation of the iron aluminide (Fe-23, Al) gained only 0.12 mg in a two-hour test at 1600°F after a two-hour pretreatment at 1800°F. This form of iron aluminide showed no additional weight gain in subsequent tests at the same temperature. The chromized foils were found to be unacceptable for a variety of reasons. Aluminized 310SS and Havar will be evaluated in July.

To evaluate the effects of a combustion environment on the substrate materials, a substrate test container has been built for mounting inside the Westinghouse PCD. This container is made of expanded stainless steel and can hold up to 13 samples. The samples scheduled for installation during initial PCD operation are:

- Rath RPL-1 fiber
- Kaowool Ultrafelt fiber
- Modified 310 stainless steel
- FeAl (Fe-23, Al)
- FAPY (Fe-8, Al-5, Cr)
- Fe_3Al (Fe-16, Al-5, Cr-Zr-C)
- Aluminized 316 SS
- Aluminized 310SS
- Aluminized Haynes 230
- Aluminized Havar

The samples were installed into the PCD in June.

Table 1. Results of Substrate Evaluation Tests Performed in April and May

			Wt Change, mg		Diam Change, in.	
Substrate Material	Pretreatment Time/Temp	Test Time/Temp	Pre-treat	Test	Pre-treat	Test
Havar (0.01")	2 hrs/1800°F	2 hrs/1800°F	+12.2	+7.59	N.M.	N.M
Havar (0.01")	2 hrs/1800°F	2 hrs/1600°F	+7.59	+0.80	N.M.	N.M
Rath RPL-1 (0.01")	2 hrs/2000°F	2 hrs/1800°F	-13.11	-0.03	-0.025	N.D.
Kaowool 700 (0.03")	2 hrs/2000°F	2 hrs/1800°F	-27.11	-0.56	-0.058	N.D.
Kaowool Ultrafelt (0.1")	2 hrs/2000°F	2 hrs/1800°F	-1.47	-0.03	-0.055	N.D.

Rath FK-AL-2 (0.02")	2 hrs/2000°F	2 hrs/1800°F	-22.78	-0.22	-0.023	N.D.
Rath FK-AL-2 (0.02")	2 hrs/2000°F	2 hrs/1800°F	-22.10	-0.60	-0.002	N.D.
Kaowool 3000 (0.02")	2 hrs/1800°F	2 hrs/1600°F	-28.65	-0.18	-0.001	N.D.
Fiberfrax 970F (0.03")	2 hrs/1800°F	2 hrs/1600°F	-66.46	-0.52	-0.030	N.D.
Modified 310 stainless	2 hrs/1800°F	2 hrs/1600°F	+5.53	+0.22	N.D.	N.D.
FAPY (Fe-8, Al-5,Cr)	2 hrs/1800°F	2 hrs/1600°F	+1.99	-0.32	N.D.	N.D.
Fe_3Al(Fe-16,Al-5,Cr-Zr-C)	2 hrs/1800°F	2 hrs/1600°F	+1.43	-0.27	N.D.	N.D.
FeAl (Fe-23, Al)	2 hrs/1800°F	2 hrs/1600°F	+2.32	+0.12	N.D.	N.D.
Chromized 316 stainless	2 hrs/1800°F	2 hrs/1600°F	Coating flaked off during pretreatment			
Chromized Havar	2 hrs/1800°F	2 hrs/1600°F	Coating flaked off and sample curled			
Chromized Haynes 230	2 hrs/1800°F	2 hrs/1600°F	+9.97	+2.63	N.D.	N.D.
Aluminized 316 stainless	2 hrs/1800°F	2 hrs/1600°F	+0.85	+1.35	N.D.	N.D.

Note: N.M. = Not measured.
N.D. = Not detectable.
Diameter change is based on the average of four measurements.

The particulate sampling systems utilize a Compumotor AT6400 position indexer with a micropositioning stepper motor for sampler insertion and retraction, while the remainder of the sampling system (valves, limit switches, etc) will be controlled and monitored using the AT6400's 24 programmable inputs and outputs. The high-level logic and operator interface for the sampling process will be provided to the AT6400 by a dedicated IBM-PC computer. Integration of the hardware and development of the control software is the responsibility of InControl, Inc. Southern Research personnel met with InControl during May to evaluate the current state of the control software and to plan the final implementation and testing. InControl and Southern Research plan to have version 1 of the control software ready for preliminary evaluation by August 1.

2.2.4 Task 2.5 Particle Control Technologies

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

Combustion Power Company GBF

CPC visited the PSDF on May 8-9 to discuss the test plan, schedule and to develop a Statement of Work for the upcoming budget periods. It is anticipated that shakedown of the granular bed filter system will occur in the fourth quarter of 1996 with operations beginning in 1997.

Industrial Filter & Pump PCD

On May 17, IF&P visited PSDF to discuss the development of a new Statement of Work and Preliminary Test Plan which will function as the foundation for their budget in the upcoming months. IF&P also discussed the performance of the IF&P filter system at UNDEERC and left copies of their report and a complete set of pictures taken at the disassembly of the vessel.

During the meeting the possibility of installing the Industrial PCD initially on the MWK side of the plant was discussed. It would be installed in place of the Westinghouse vessel (FL0301) and would be operational in the fourth quarter of 1997. Fabrication of the PCD must be completed in 10 months since all additional purchase orders concerning the PCD internals are on hold until October 1, 1996, and since two months should be allowed for shipment, installation and assembly of the PCD. IF&P has been asked to identify any long-lead items which may delay this schedule.

Revisions of the drawings submitted in February were prepared and received from IF&P. The drawings were reviewed on June 25 at the PSDF. In attendance were:

Chuck Novotny, David Stanislaw	IF&P
Jerry Bitner	Mallett Technologies
Jim Longanbach, Rich Dennis, Darren Mollott	METC
Rich Brown	EPRI
Matt Davidson, Brett Wingard, Howard Hendrix	SCS

Westinghouse PCDs

The P&ID for the FL0301 pulse skid was modified to reflect as-built conditions. An installation manual for PCD352 has been prepared and submitted to SCS.

2.3 PHASE 3 - CONSTRUCTION, PROCUREMENT AND INSTALLATION

2.3.1 Task 3.3 Construction and Installation

Installation of the granular bed filter system has continued throughout this quarter. By the end of May, the filter internals and the majority of the refractory-lined pipe had been installed. The media make-up hopper, the de-entrainment vessel, baghouse and the recuperative heat exchanger were in place. The recuperative heat exchanger is propped within the structure but is not welded together.

During the refractory cureout of the MWK Transport Reactor, the gas will flow through the empty granular bed filter vessel. Preparations to the vessel, including installing blind flanges on all open ports were completed in April. It is expected that the CPC vessel will be used as a flowpath throughout the majority of this quarter.

At the end of May, a field fit problem was discovered in the fit up of the crossover piping between the recuperative gas heat exchanger and the refractory lined piping. Initially, there was concern that there had been a manufacturing error, however, Construction realized that the problem was due to a culmination of tolerances in the fitup of the refractory lined spools. Construction loosened all of the joints in the refractory spools and was able to resolve the fitup problem without modifying the piping.

All major items are at the jobsite for installation. CPC has been requested to supply the Programmable Logic Controller for the system during the month of July.

Construction and Maintenance finished all work on FL0301 during the quarter. During April, the pulse piping was installed both internally and externally. E&I installed all tubesheet instrumentation inside of the vessel head and Construction installed all exterior instrumentation.

During May all electrical work was completed and loop checks begun. Westinghouse personnel were on site May 28-30 to inspect instrument and pulse system connections, which were deemed satisfactory.

The month of June focused mostly on the completion of the Foxboro logic to drive the pulse system. The program was written in ladder logic to achieve the speed required to open the fast-acting pulse valves. Throughout the month, the pulse skid was tested as the program developed.

On June 6, Southern Research met with representatives of EDM Technologies to inspect the prototype cyclone manifold. The inspection revealed that the receptacles were badly warped as a result of the extensive weld repairs that were necessary to fill in voids in the casting. At least one of the receptacles was warped so badly that additional machining could not restore a satisfactory sealing surface. There was also concern that some of the weld repairs may have compromised the structural integrity of the manifold. After discussing various options, all parties agreed that it may not be possible to produce a functional cyclone manifold from the prototype. The representatives of EDM Technologies suggested that the manifold could be machined from a solid block of Haynes 556 and offered to prepare a cost estimate for that approach.

On June 24, Southern Research received the cost estimate for machining the manifold from a solid block. The total cost, including the materials and the CNC and EDM machining, was more than the total cost of the casting approach including the preparation of the wax patterns and of the casting and the final EDM machining. Since the casting approach is less expensive than the machining approach, Southern Research has recommended that the second cyclone manifold be made by casting. Orders for preparing the wax patterns and doing the casting will be released in July.

In June, ThermaFab Alloy began work on the modifications to the impactor precutter, shell, and bauxite canister. The modified parts should be received by August. Based on an evaluation of three bids, Accuratus Ceramic Corporation was selected to fabricate the ceramic liners for the bauxite cartridges. The order was placed in April, and the parts are expected in July.

SRI continued to work with SCS construction personnel on the installation of the particulate sampling systems. In April, a list of all tubing and fittings required for the installation was prepared and submitted, and SCS placed orders for these items. Most of these parts were received in May and early June. The two insertion mechanisms in the MWK structure have been set in place and supported, and the control panels for these systems have been installed and wired. The installation of tubing and fittings will begin in July.

The final two Instrument Air compressors in the Balance-of-plant were commissioned in April. A modification to allow the off-line dryers for these two compressors to continuously regenerate was installed in May, and the dryers were commissioned. Construction on the recycle gas compressor and sulfator startup heater was completed in May, and both of these pieces tested.

Installation of the High Pressure pulse air and nitrogen compressors progressed this quarter. The Norwalk air compressor installation, its suction dryer, discharge receiver tank, and associated piping (air and water) were completed. There were also discussions on the control schemes of the trio of nitrogen compressors, with agreement on a single PLC to coordinate the sequencing and loading of the compressors. A system of cross-overs to allow the use of high pressure air in place of nitrogen and vice versa was also installed to allow some flexibility in pulsing the PCD's during combustion operation; and will be used during the initial trials until the nitrogen compressors are operational before gasification operation.

The equipment cooling water systems were completed this quarter. Testing of the Cooling Tower Fans indicated too much vibration. The fans were reassembled to achieve lower vibrations by improving the fan's balance. The vibrational analysis has also shown a lack of sufficient structural support for the fans. During the next quarter the vendor will be contacted to strenghthen the supports. Permanent connections to cooling water lines were made after completion of the various flushes of the closed loop cooling water piping.

Chemical feed pumps for the Condensate and Steam system were installed and tested in April, completing installation of the Condensate system. After calibration of the chemical addition pumps, an initial fill of the steam system was completed. Initial chemical additions were also made to the MWK and SCS Closed Loop Cooling systems, and funtional checks performed on each system. The chemical addition systems were then used to adjust the pH of the condensate as the heat exchangers and steam drum were filled in preparation of test-firing the Thermal Oxidizer burner. The steam drum blowdown drain system and salvage tank installation was completed in April as well. A nitrogen pad was applied to the steam/condensate system for protection until startup. Chemical pumps were installed in the Wastewater Treatment System, but have yet to be tested and calibrated. Chemical feed pumps and the chemical pot feeder were installed in the Circulating Water System.

Significant progress was made on installation of the Wastewater Treatment System. The rapid mixer and flocculating mixers were installed. The oil/water separator was put into place with piping still to be finished. Work has started on the relocation of the cooling water blowdown flow element. A leg of the blowdown piping will be brought above ground where the flow element and the blowdown rate control valve will be located. Also, a dechlorination agent will be injected into the raised leg of piping.

Installation of the fuel and sorbent pulverizer systems was completed in April, with the installation of the mills and air heater ductwork, and the installation of the sizing and feed equipment above the silos. These mills are equipped with individual propane-fired, partially recirculating transport air heaters to transport the ground material to the sizing equipment, fans, cyclones, screen-sizers, and baghouses for the vented gases. As these systems storage silos are being connected into the circuits, the dense phase transporters are also being connected, to provide the pulverized feedstocks to the process structure.

Construction on the MWK process equipment required for Combustion was completed, with the exception of punch-list work. Construction is continuing to work on equipment required for operation of the MWK transport reactor as a gasifier.

Planning on the FW Construction sequence is well underway, with the tabulation of the required materials and equipment and sequencing of tasks begun. FW equipment installation is scheduled to begin this summer, with the installation of the refractory lined vessels and piping that still require firing at high temperature to cure-out the refractory; this is needed early to minimize the impact of the hot air on auxiliary piping and wiring installation later in the sequence.

2.3.2 Task 3.6 Preparations for Operations

Commissioning Related Activities

A number of MWK and BOP subsystems have been commissioned and several systems were operated for a number of days to continue cleaning the fluid side. These systems were the Heat Transfer Fluid, SCS Closed Loop Cooling Water, MWK Closed Loop Cooling Water, and Cooling Tower Circulation Water (SCS, MWK, & FW loops) systems. Several of the support pumps and compressors were also tested and commissioned.

Details of some of the commissioning activities are given below:

Feedstock preparation: The belt conveyor system installation was completed this quarter, and commissioning begun. This system was bought as a "turn-key" installation and the commissioning of the system went relatively well. The controls were tested, wiring problems corrected, PLC programming changes tested, and the belts were operated in April. The sequencing of the belts, flop-gates and silo levels was demonstrated after several actuators were modified for proper operation.

Installation of the coal and sorbent mills was completed this quarter, and commissioning of the systems begun. Sorbent (dolomitic stone) was fed through the crusher to the crushed storage silo, during which several problems with the crusher and the silo level controls were corrected. The transfer of sorbent was in preparation of the commissioning of the sorbent mill system which was started in late May. The sorbent mill system was successfully dry run by the end of May, with a rotary feeder having to be regeared to feed the sorbent into the mill. Several runs of both sorbent and coal to check product size distributions were conducted, and adjustments made, and cold flow tests also done. Some final adjustments to the mills will be completed in July. Also, a different vendor's equipment was installed on the silo level systems in June, due to the lack of consistent, accurate operation with the original equipment.

<u>BOP Dense Phase Transport Systems</u>: Installation of the balance of plant transport systems were completed in May, and testing of these systems conducted in May and June. There was some trouble in air testing the start-up material transport piping due to the poor finish of the supplied fittings, these fittings were modified, after which the piping passed the pressure tests.

Functional check list were prepared for FD0140, FD0154, FD0104, and FD0820 and FD0810 (ash silo). The dense phase systems of FD0140, FD0154 and FD0104 were functionally checked. For the FD0140 system, the three way valves were not set up the same as the logic. The valves were taken apart and reassembled so that the switch and the panel matched where the valve was to go. One of the proximity switches on the three way was found to be broken so it is necessary to force the PLC program to ignore this valve until the replacement part arrives. For the FD0154 and FD0104 systems, the high high level switches on the FD0210 and FD0220 wiring was changed for the logic to work. Also the logic for the level switch on FD0104 had to be reversed.

The FD0810 transporter to transport sulfator ash will be completed later. The FD0140 (used for initial reactor filling) and FD0820 (bag house ash) dense phase pumps has worked well so far, although the FD0820 has not transported much solids as the FD0140 system has. The FD0810 (sulfator ash) and FD0610 (sulfator sorbent addition) have not been put in service. The FD0154 (sorbent transport from pulverized silo to MWK silo) and the FD0104 (coal transport from the pulverized silo to the MWK silo) have been further dry tested but have not been tested on solids.

MWK Dense Phase Transport Systems: Final commissioning testing on the Dense Phase systems were completed this quarter. Commissioning trials of the Dense Phase systems inside the process structure were completed in April by transferring alumina from system to system using temporary piping loops to short-circuit the system for testing. Alumina will be used as a start-up bed material until the process has created enough ash to use as a start-up bed. The sizing of the alumina corresponds with the specifications for the mill outputs, although the density is almost twice that of coal ground to the same size. This density difference from original design presented a challenge to some of the equipment, although the hardness of the alumina crystals, interacting with some sizing concerns, forced an increase in some clearances to allow the alumina to flow without galling or gouging the feeder turntables. After the clearance was opened up the feeders operated with some difficulty using the alumina.

Clyde pneumatic Conveying personnel completed commissioning of the FD0210 (coal), FD0220 (sorbent), FD0510 (standpipe ash), FD0520 (PCD ash) and FD0530 (ash to silo) in early April. The FD0530 rotofeed system was problematic. The rotofeeder would siege and stop the motor, The rotofeeder was taken apart to inspect. The stainless steel rotating part was galling and sieging against the top plate (which allows ash to fall through an open section of the plate while the rotating part takes a fixed volume of ash under the plate to the transport route). The solution was to increase the gap between the rotating plate and the top stationary plate. The galling was thought to be due to the abrasive nature of the alumina. Flex hoses were installed on the breather pipe vents for the FD0210 and FD0220 to remove forces from the weigh cells.

During initial testing where alumina was used, several problems have developed with the Clyde Pneumatics Conveying equipment. The rotofeeders on FD0210 (coal), FD0220 (sorbent), and FD0530 (spent solids) tend to bind and the motors have to be helped along. For FD0210 and FD0530 spacers were installed to allow more clearance between the rotor and the internal plates. The other problem has been associated with the Spheri valves. The valves tend to bind between the valve hemisphere and the pressure seal (which is what provides the pressure seal). Again additional spacing has been added to the FD0520 (PCD fines) and FD0510 (standpipe ash) bottom Spheri valves so that the hemisphere part will not bind yet still allow the inflated seal to provide sealing.

Dense Phase system interconnections with the DCS and the Reactor control system were tested, including the control interlocks, the transport air system, and testing feedstock injection while the reactor is under pressure. Several modifications were needed on the seal valves to increase clearances and prevent binding due to grit interferences. The systems demonstrated with some difficulty injection rates up to 2000 pounds an hour and withdrawal rates of over 3000 pounds an hour.

Equipment history sketch:

<u>FD0210</u>

6/18/96 Alumina was added to reactor. A spacer had been placed in the rotofeeder per the experience with FD0530. The bottom of the rotofeeder had moisture and would not transport. Rotofeeder was taken apart and cleaned out.

6/29/96 Tried to add alumina. Rotofeeder was binding. Would turn for short period of time and would stop. Turning by hand would help.

<u>FD0220</u>

6/28/96 Line from rotofeeder is small, and plugs easily. Rotofeeder stops frequently.

<u>FD0510</u>

6/21/96 Alumina was transferred from the reactor standpipe. Both Spheri Valves would not rotate. The gap for the bottom Spheri Valve was increased to add clearance. The pressure seal was replaced. The upper Spheri Valve was loosened by increasing pressure on the actuator piston.

7/17/96 Top Spheri Valve would not rotate. Maintenance took off air lines to one side of the actuator and was able to get it to rotate.

<u>FD0520</u>

7/18/96 The bottom Spheri Valve would not completely close. The Spheri Valve was removed. Some chunks of refractory was found on top of the hemisphere. The top of the hemisphere was scored. The pressure seal was replaced and the spacing was increased. The top of the hemisphere was polished with sand paper.

<u>FD0530</u>

4/96 Alumina was transferred from the FD0530 bin to FD0220. The rotofeeder bound tight. The motor could not be rotated by hand. The rotofeeder was taken to the shop. The plate on top of the rotor was scored and the area near the shaft indicated metal to metal galling with the metal possibly causing the binding. The gap between the rotor and the top plate was increased by using shims.

6/28/96 Alumina was transferred from the FD0530 bin to the ash silo. The motor continuously would stop. The motor could be turned by hand but with some difficulty. Rotating the motor forward and backwards by hand would eventually free the rotor. The rotofeeder would not operated continuously until the feeder was nearly empty.

7/13/96 Alumina was transferred from the FD0530 bin to the ash silo. The feeder worked for about fifteen minutes before it quit. Again rotating the motor by hand would allow operation for a short period of time.

During the preliminary run through of FD0530, the whole program remained locked in the first cycle. The PLC programs are geared to completion of each and every condition. If any condition is not satisfied then nothing happens. The following are details of preliminary testing of the FD0530 system.

The first step in FD0530 cycle did not complete because the differential pressure, PDS8562, between the lock hopper and the storage bin would not indicate that the pressure had dropped when the lock vessel vent valve was opened. The problem was that the high leg of the switch had water on the process side. The PDS8562 switch setting was increased from 0 to 15 milibar i.e., at less than 15 milibar the lock vessel will be considered to be depressured. Should solids accumulate in the lock vessel vent the switch may not work in the future since 15 milibar is only about 6 inches of water (the maximum setting on the switch is 60 milibar). Thus the vent line will need a purge to prevent water from entering the unit. During later operation, it was found that this pressure switch was wired to the normally open contacts whereas it should have be wired to the normally closed contacts.

The DCS showed that out-of-range was a condition as part of the interlock, however there were no steps in the program that used the out-of-range condition. The out-of-range condition was recently added into the program. So now when any instrument becomes out of range the program will stop on the next cycle.

One instrument that was not present on the system was the storage bin temperature, TE8562 and its associated TT8562. A resistor was installed on the PLC to take the place of the temperature switch for now until the temperature instruments can be installed.

After the above repairs, FD0530 would cycle completely through the rotofeed fill cycle. At the start of the rotofeed fill which is started by a low-level in the rotofeed vessel, the vent valve on the lock vessel is vented. When the pressure switch PDS8562 is satisfied, then the isolation Spheri valve is opened followed by the lock vessel Spheri valve. These valves remain open for 30 seconds or until the level switch in the lock vessel shows level. then the lock vessel vent valve is closed followed by the isolation Spheri valve and the lock vessel Spheri valve. The lock vessel pressure is equalized with the rotofeed vessel. When the pressure has equalized, the rotofeed vessel Spheri valve opens for 25 seconds. The rotofeed vessel Spheri valve then closes. At this point the cycle restarts if the level prove in the rotofeed vessel is still low. During this test the rotofeeder motor was running.

A DCS representation is being added to know where the levels are in FD0530.

Main Air Compressor: The main air compressor functional checks were completed April 30. Both the I751 and I750 checkouts associated with the main air compressor were done in conjunction with the other trip scenarios. Additionally, all DCS alarms were checked to ensure correct setpoint and verify operation. The common trouble alarm light, common shutdown alarm light, and DCS run/stop light for the main air compressor, and the common trouble alarm light and the run/stop light for the dryer were checked.

Recycle Gas Booster Compressor: The Recycle Gas Booster Compressor functional checks were completed May 17. The following items were checked: Separator (SP414) level control, Compressor (CO0401) discharge pressure control, Compressor (CO0401) discharge temperature control, Recycle Gas to FD0530 temperature control, I750 trips, DCS alarms, PLC point checks, and the data highway from the PLC to DCS. CO0401 was commissioned on May 20 and 21. The compressor was commissioned in June.

At 13:00 on Friday, June 28th attempts to start the Recycle Gas Compressor, CO0401, under normal operating pressures began. The first problem encountered was the bypass valve open switch (PZSO478) was not made even though the valve (PV478) was in the neutral position and the DCS (PIC478) was calling for the valve to be open. When the valve was manually open, the switch made. It was decided to leave the valve in manual for the first 15 seconds then place it in neutral to build discharge pressure via PIC478. Additionally, the air valve which supplies air to combustor heat exchanger through FV230 was being closed in an effort to simulate a normal startup with a smooth transition from air to recycle gas. On the first start the compressor tripped after 2 minutes due to low discharge pressure because PV478 did not respond to PIC478. The theory was that the valve was not "exactly" in neutral so the DCS could not control it. A compressor start was attempted again paying close attention to placing the valve in neutral. Again the compressor tripped after two minutes on a low discharge pressure.

The valve was stroked and worked properly. A compressor start was tried once more. Again the valve was not closing when the DCS called for it to close. During this run PV478 was manually closed in the field. The pressure safety relief valve (PRV408) began lifting at 300 psig. The compressor tripped after 2 minutes due to low discharge pressure. The pressure safety relief valve was prematurely lifting (designed to lift at 350 psig) preventing us from building sufficient discharge pressure; so, the gate valve (VL101AV) downstream of the relief valve was closed.

The compressor was started and still PV478 was not reacting to the controller output. Again, it was manually closed. When PV478 was closed the discharge pressure increased quickly and the compressor immediately tripped on a high discharge pressure. It was decided that the problem with PV478 should solved. The open switch was now functioning properly. The valve was stroked again and functioned. Examining the logic it was determined that there was an error in the rung which sent the signal to the solenoid on PV478. The rung which energized the solenoid on PV478 was inverted but should not have been. Basically, after the 15 second timer timed out the PLC was deenergizing the solenoid instead of energizing it. The logic was changed to set the valve control correctly. Unsure if indeed the pressure safety valve was lifting early, the gate valve downstream of PRV408 was opened.

The compressor was started but the discharge pressure did not build because the safety started lifting around 300 psig. The following actions were taken:

- gate valve following the pressure safety relief valve was closed again
- PIC478 started in automatic and tuned during the start up period
- the 2 minute timer was increased to 20 minutes so there would be more time to tune PIC478 before the compressor would trip on a low discharge pressure
- FV230 was closed to make it easier tune PIC478

The compressor was started again around 17:35 but it tripped on low suction pressure after 15 seconds. By closing FV230 the total air flow to reactor was decreased, so when the compressor was started the reactor pressure was decreased below the minimum suction pressure (110 psig). FV337 was opened and other FI's were set to allow more flow into the reactor.

The compressor was started again at 18:10, and the discharge pressure increased to 315 psig, but the compressor tripped after 20 minutes. It was realized that the discharge pressure must reach 340 psig to reset the low discharge pressure switch. This posed a problem because the high discharge pressure switch was set to trip at 350 psig giving only a 10 psig range to control within. The compressor was started again and discharge pressure was slowly raised to 341 psig which reset the switch. With the compressor running smoothly PIC478 was tuned. The compressor tripped while FIC230 was being tuned.

With PIC478 tuned the compressor could be started and the discharge pressure placed in a successful operating range in less than 20 minutes, so the timer was reset to 5 minutes. The compressor was started again around 20:00 and the discharge pressure was increased to 341 psig which reset the switch. The discharge pressure setpoint was decreased to around 320 psig and the compressor was run for approximately 30 minutes with no further attempts to tune FIC230. The thermostatic valve which controls oil temperature by regulating flow to the oil cooler functioned properly. The oil temperature gradually increased from 100 °F to 130 °F where it then stabilized for the remaining compressor run time. At some point during the day there was a high level in the separator (SP414) which made the flow path from LV455 to downstream of PV287 questionable. All condensate was vented out the bottom of the sight glass for the remainder of the day to prevent any problems.

On Saturday, June 29th the low discharge pressure switch was reset to clear at 315 psig instead of 340 psig and alarm at 292 psig instead of 315 psig to give an acceptable operating range. At 8:00 the compressor was started without any problems. Both PIC478 and FIC230 were placed in automatic with 2000 lb/hr of air from the main air compressor passing through FV230. The compressor was started and the discharge pressure was gradually increased to 250 psig to match the discharge pressure of the main air compressor. While PIC478 maintained this pressure, the manual valve decreasing air flow from the main air compressor to the combustor heat exchanger was gradually closed. The flow through FV230 was maintained at 2000 lb/hr by FIC230. Both controllers made minor adjustments but there were no major deviations from the setpoints. When the manual valve was completely closed the recycle gas compressor discharge pressure was increased to around 320 psig. The compressor was run for about 15 minutes when an oil leak was discovered. Oil from the distribution block to the cylinder bore was bubbling out of the fitting . Thus, the compressor was shutdown to fix the leak. During this run LIC455 was monitored and functioned properly.

At 8:45 the compressor was started again. Attempts to tune FIC444 began. Tuning FIC444 proved to be difficult resulting in multiple compressor trips. With the controllers tuned and the air to gas transition completed, it was decided to raise the reactor pressure and run the recycle gas compressor under its maximum suction pressure (250 psig). At 13:30 the recycle gas compressor tripped when the suction pressure exceeded 250 psig. At 13:50 the compressor was started again for one additional continuous run under high pressure. For the next start PIC478 was initially set at 250 psig (it was set at 150 psig for the previous runs). After the 15 second timer timed out the controller overshot and tripped the compressor. The initial setting on PIC478 will be set at 150 psig with steps of 25 to 50 psig in the setpoint to 300 psig. The compressor was started successfully and ran for 40 minutes while vibration readings were taken and found acceptable. The attached graph (Figure 8) displays the compressor suction and discharge pressure profiles for this commissioning run.

On Wednesday July 3rd the flow path from LV455 to downstream of PV278 was checked using instrument air and found clear.

Reactor Startup Burner: The Transport Reactor Start-Up Heater has not yet passed the functional tests, due to damage to both the ignitor rod and the flame detection rod. This equipment did not come with complete instructions to adequately 'bench' test the ignitor and flame detection rod before mounting in the burner. This is further complicated by the lack of a visual flame view port. After much discussion with the vendor and his sub-vendors, a method to test the equipment was agreed on. The originally supplied ignitor and flame detection rod were found unserviceable and had to be replaced. Several problems have arisen during the course of the Start-up Burner check-out. The burner is the vendor's first high pressure application, and the design was inadequate and unsafe for operation as it was received. The vendor provided a burner optimized for natural gas firing contrary to the specification for propane. Several modifications were made to temporarily use the existing equipment, and the burner has been operating since; although several concerns still exist that must be addressed: the lack of safe turn-down in fuel flow, the lack of automatic compensation for reactor pressure variations, and separate pilot combustion air. SCS and MWK are in discussions and participating in an effort to redesign the burner to better and more safely meet the design specifications. The target date for a redesigned burner system from the sub-vendor is late July or early August. In the meantime, the modifications made to the original burner, with the vendor's concensus, will allow safe operation until the redesigned burner arrives, allowing start-up to continue with refractory cure-out and other commissioning activities.

Transport Reactor: Functional checks on the Transport Reactor Loop (RX0201) and the Transport Reactor Startup Burner (BR0201) were completed this quarter. The first warming of the transport reactor occurred in May. On Friday, May 17, the MWK Transport Reactor and associated refractory lined piping was pressure tested down to PV287. The Main Air Compressor was used to admit air into the eight combustion air nozzles on the Reactor. The pressure was gradually raised in 35 psig increments, with a 10 minute hold after each pressure increase. The test reached a pressure of 239.4 psig by the end of the day. While the leak test was under way, several leaks were discovered at nozzle joints. Many of these leaks were stopped by tightening bolts. However, several nozzle leaks could not be stopped by tightening, which could result in replacing the "flex" gaskets at each location. On May 31, another pressure test was attempted. Using the process air compressor to raise the reactor pressure (and associated piping), and (planned) testing the operation of the safety valves during the test, the reactor pressure finally reached proof pressure of 385 psig. Several leaks were identified for repair before the pressure test results are acceptable. Such pressure tests have become normal operating procedure prior to start-up after any maintenance or inspection that requires breaking the reactor system's pressure boundary.

During the month of June, three major Start-Up milestones in the commissioning of the Transport Reactor were completed: (1) the first, complete system pressure test, (2) Transport Reactor refractory cure, and (3) fluidization trials.

1) The Transport Reactor completed the first successful, full pressure test on the first of the month, after several modifications on the Start-Up Burner were completed. This test was on the complete system from the process compressor, through the Reactor and the GBF vessel, to the pressure let-down valve. Several problems with the packing on the Start-Up Burner ignitor were corrected with the deletion of the retracting mechanism for the ignitor. Cooling air ports were installed on both the ignitor and the flame rod to prevent failures due to overheating, and there has been no failure during the subsequent light-offs.

2) The Reactor refractory joints cure was done during the second week of June, and the reactor outlet temperatures reached about 1000^{o}F before the burner was plugged by accumulated trash in the fuel line. Figure 9 - 11 show reactor and burner exit temperatures during the cure. The Start-Up Burner's discharge temperature was 1750 ^{o}F and flowing 2.8M BTU/hr at maximum flow before ramping the temperatures back in preparation for a shut-down. The burner was shut-down, inspected and cleaned, and preparations for the Fluidization Trials made.

3) The month of June ended with the Transport Reactor undergoing a hot fluidization test with alumina (the start-up bed material) circulating while the Start-Up Burner was heating the reactor. This test was cut short by the erosion of the pressure let-down valve body and trim by the alumina. This valve was

subjected to solids because the flow path was routed through the empty Combustion Power Company Granular Bed Filter to protect the candles from high moisture in the gas/air during the cure. This failure occured after sufficient flow, circulation, and temperatures were achieved to relieve concerns of moisture fouling the PCD candles.

Software and Hardwired Interlock Logic: The functional testing of the two hard-wired interlocked tripping systems for the MWK process was completed in early May. The first interlocked trip system, I750, involved a number of systems and thus several different functional checklists. Since any changes in the I750 system could affect the logic in any or all of the associated systems, each trip was checked across all the systems. Other paragraphs of this report outline the results from a partial check of I750 involving the steam system functional checks, feedstock feed system functional checks, reactor functional checks, and the air system functional checks. The second interlocked trip system, I751, also impacts many of the same systems, but with a different focus - to purge the reactor with nitrogen in the event of an upset to allow safe shutdown. These tests discovered several valves with incorrectly specified operators (fail closed instead of fail open) and other inconsistencies in the configuration design. These two panels had many inputs that could easily be changed to get a particular subsystem operating during commissioning, which could compromise the function of the interlocks, so an additional proof check is planned before firing coal in the reactor.

PCD Backpulse System: The high pressure piping for the Westinghouse PCD back-pulse system was proof tested in late May to 1825 psig using high pressure bottled nitrogen. (A hydrostatic leak test was impractical because of the difficulty of draining the piping.) The backpulse skid controls were perfected during June. Due to the very high speed operation of the pulse valves, these controls were required to use just the components internal to a single control processor card to minimize time lost in communication between I/O and processor cards.

Thermal Oxidizer: The Thermal Oxidizer was turned over for testing in late April, and the first firing and curing occurred in May. Functional checks of the system were completed, and several modifications in the control system design made to better improve the operability of the Thermal Oxidizer. On May 6, commissioning of the Thermal Oxidizer began with functional checking of the blower control loops and PLC details. Blower functional checks included the blower discharge pressure, Thermal Oxidizer temperature and excess oxygen. The inlet air damper (PV-8798) was adjusted to read a discharge pressure of 40 InWG and then put into automatic. It was soon found that the combustion air damper (FV-8773) was a problem; the valve is oversized for the application and the positioner is too weak to hold the valve in a minimum position. The propane valve (FV-8753) was set to a minimum flow position and operations attempted to light the pilot. After several attempts it appeared that the pilot was being blown out; and after several adjustments to the fuel and air, a weak, stable flame was visually observed but could not be detected by the flame scanners. The flame scanners were inspected and found badly corroded; these were replaced. After control changes to allow less air during the pilot operation were made; the pilot was lit and the flame scanner detected the flame; but when the air flow was raised to light off the main burner, the pilot flame blew out. A bypass air line to regulate the air flow to the pilot burner was installed. During the installation of the bypass line, the ignitor was slightly damaged; after repairing the ignitor; the gap was manually adjusted so that the ignitor produced a continuous spark. In fact, the spark was bright enough to be detected by the flame scanners. The pilot burner propane flow orifice was also cleaned of some trash at this time, after which the burner is operating to specification, allowing the cure-out of the Thermal Oxidizer refractory lining to proceed.

During the curing of the Thermal Oxidizer, several problems were identified: concerns about the accuracy of the flow metering devices were raised and solutions were implemented including pressure and temperature corrections included in the DCS configuration, some of which will be verified by pitot traverses of the ducting. The waste heat boiler occasionally generated a noise that appeared to be a harmonic resonance within the Waste Heat Boiler, probably caused by flow induced vibration. The oxygen analyzer was very suspect throughout the run, and was later found to be missing components to properly communicate with the DCS. A possible flow maldistribution in the waste heat boiler was also found. The positioner on FV-8773 failed two days into the cure. This happened a second time before a regulator was installed between the instrument air supply and the actuator so the valve could be manually adjusted pneumatically. Some tuning of the control valves was accomplished during the cure-out. While in operation, the Thermal Oxidizer was checked for "hot spots" indicating gaps/failure of the refractory, and none were found. The Thermal Oxidizer appears to be an efficient way to heat up the steam drum. The steam drum pressure was approximately 100 psig at a Thermal Oxidizer outlet temperature of 520°F. The objective of the 1600°F cureout was accomplished at 9:00 PM on May 15. The Thermal Oxidizer exit temperature profile during the refractory cure is shown in Figure 12.

Steam and Condensate System: The Steam/Condensate system controls were tested and commissioned in April, with the level transmitters and switches being central to the testing. The control interfaces with the boiler feed pump pressure control valves and the level control on the drum were some of the interactions tested. The drum level and pressure switches were part of the MWK process control software interlock system and hardwired emergency trip system. The function of these two systems was also proven in April to assure that all protective systems were in place before the operation of the burners was needed and the reactor was heated and pressurized. This functional testing took several weeks and required correction of a number of problems before the tests were completed.

Process Gas Sampling: A representative from Cegelec Automation, the vendor for the process gas analyzer system, and an M.W. Kellogg engineer visited the PSDF site in early May. The analyzer house technicians from Spectrum worked with the visitors during their visit. The purpose of the visit was to oversee the repair of the heat damaged components, calibrate the analyzers, complete the functional checkout of the analyzer systems and provide a general overview on the operation of the process gas sampling system. We were informed that Cegelec Automation will be closing their New Jersey office in August and will no longer be building analyzer systems for the petrochemical process industry.

The components in the moisture analyzer box were heat damaged because the incorrect temperature switches were selected by Cegelec. The selected switches were normally open; they were actually switches intended for cooling applications, which resulted in the heaters staying on continually.

The H2O analyzer and Gas Chromatograph were calibrated by the Cegelec representative. The SO_2, NO_X, O_2 and CO analyzers were calibrated by Spectrum technicians.

The remote sample conditioning boxes have yet to be mounted, and the design for the sample draw-off system is still being finalized.

Nitrogen System: The medium and low pressure nitrogen piping pneumatic tests were completed with both being commissioned. Interface lines to the on-site nitrogen generation plant were flushed and blown out. Pneumatic testing of the MWK nitrogen piping was conducted at 110% of design on low, medium, and high pressure lines.

In early May, BOC filled the low and medium pressure liquid nitrogen tanks and began to provide nitrogen product to the PSDF facility. When the third tank is delivered, BOC's contractor will be making the piping modifications required to improve the unloading process from their tanker trucks. BOC will also be installing a flowmeter to measure the liquid product unloaded into the medium pressure tanks.

The phone line for the BOC's liquid nitrogen level telemetry system was terminated. The telemetry system will provide for the automatic dispatch of a delivery truck when the tanks are one truck load below full.

A pressure control valve was installed in June in the cooling water line going to BOC's cryogenic nitrogen separation plant. BOC's equipment requires water at 50 psig.

High Pressure Nitrogen System: Field technicians from Compressed Air Products (CAP), the vendor who supplied the high pressure nitrogen system, were on site in late May to institute changes to the electrical lay-out of the system due to a change in the control philosophy. Originally, each of the three compressors was controlled by its own PLC, but it was later decided to utilize a PLC sequencer for integrated control of all three of the compressors at once. The changes were implemented and functional check-out by SCS and CAP personnel is scheduled for August after CAP delivers all of the documentation necessary for start-up.

A full system walk-down was completed in June to finalize the as-built piping and instrumentation diagram. Blowdown of the inlet piping and a pneumatic pressure test of the discharge piping are scheduled for July or early August prior to commissioning activities. Operating manual and PLC review are also necessary prerequisites for commissioning.

High Pressure Air System: The high pressure air compressor was run-in; but continued to present some problems with a mismatch between the inlet dryer capacity and the compressor demand, especially while building pressure. A bypass was installed around the dryer to allow the compressor to operate without tripping on low suction pressure.

The Norwalk high-pressure air compressor (dual cylinder, double throw), designed to back pulse the PCDs, was run approximately 20 hours during the month of June, 1996. These initial, break-in hours were terminated because of overheating of the number one cylinder, consistent lifting of the intercooler pressure relief valve (PRV), a slow leak around a head bolt in the number one cylinder, and the inability to produce 1500 psig air. To avoid damage to the machine, Norwalk personnel was contacted and brought back on-site to evaluate the problem.

David Nooner of the Norwalk company, working with the on-site millwrights, removed all the valves (8), both heads, and the cylinder-oil lubricator box. Additionally, piston clearance and sealing surfaces were checked. After a thorough examination of all the valves which consisted of testing each valve for leaks with diesel fuel and visual inspection, it was deemed necessary to rebuild three valves–two discharge valves of number one cylinder and one intake valve of number two cylinder–which required lapping the sealing surfaces and installing new internal diaphragms. Due to a poorly designed lubricator box, rain water was found to cause excessive rusting inside the reservoir in addition to contaminating the oil. The millwrights removed the box, cleaned out all the rust (local to box, but did not get into the oil lines), fabricated a new gasket, replaced the old oil (ISO 150/SAE 40) with Diester ISO 46 (Rarus 827) oil, checked the internal screens for debris, and built a Plexiglas hood to keep rain out of the reservoir.

The unit was then re-assembled and run. The leak around the head bolt of the number one cylinder still persisted and hence had to be dismantled again. Upon closer examination, it was found that the head surface of the number one cylinder was not cut flat but consisted of an inner and outer flat surfaces (supposedly, by design). The inner surface was found to be 0.005 inches recessed with respect to the outer–and sealing–surface and hence air leaked from the inner-most region of the head and out the bolt-hole area. Norwalk (John Bautzmann) chose to have our personnel machine the sealing surface down by 0.010 inches. The head was then re-installed and the compressor re-started.

The unit has since been run for about 30 hours with no apparent leaks and/or problems. It was found that by maintaining the inlet pressure at or below 105 psig (65-90 °F) the PRV does not lift and 1500 psig air is readily produced.

To maximize the life of the machine, it has been decided to incorporate unloading capability to minimize the number of start and stops. It is expected to have this system in place within 6-8 weeks.

Sulfator/PCD Preheat Warmup: The Sulfator Start-Up Burner/Heater was successfully cured in May. The burner was tested during the Thermal Oxidizer cure because of the steam requirement to vaporize high pressure propane. On May 20th, the Sulfator Start-Up Heater pilot was lit for the 24 hr. initial cure out. The Sulfator Start-Up Heater main burner was lit on the first try, but did not have an adequate turn-down ratio as published in the instruction manual. The burner turn-down was experimentally set to assure flame stability and allow for control over the temperature ramp rates required by the refractory curing procedure. The system was shut down to resolve the problem and contact the vendor. The Sulfator Start-Up Heater cure out began on May 22 and was successfully completed on May 23.

Propane System: Some work was also done on the propane supply pump, used to supply the higher pressures required by FW. A check valve was installed and the pump packing was replaced by a mechanical seal that requires less maintenance and has less leakage. Enhancements to both the steam piping and the propane supplies to various components in the plant were also done in June.

Heat Transfer Fluid (HTF) System: The HTF system is used to cool the solids that are removed from the transport reactor standpipe, the sulfator, and the fines from the particulate collection devices (PCD's). The fluid is circulated through both the outer shell and the flights of the screw cooler in all three applications. The fluid used is UCON-500, a mixture of polyalkylene glycols from Union Carbide. The fluid is pumped from a storage tank to a surge drum at 183'. The storage drum operates under a nitrogen blanket at a pressure of about 50 psig. The surge drum provides about 5 minutes of fluid capacity if fluid flow to the drum is lost. From the surge drum, the fluid gravity flows to the three screw coolers and into a return header. The fluid flows through an air cooled heat exchanger before being returned to the storage tank. The temperature of the fluid is maintained at 210 F by diverting a portion of the flow around the exchanger. If the fluid temperature drops below 210 F, electric heaters in the tank activate to maintain setpoint. A total flow of about 120 gpm is provided to the screw coolers.

The HTF system was initially filled with water. The water was circulated with strainers in the lines and the screw coolers bypassed to flush contaminants from the piping. The water was also heated by the electric heaters to verify their operation. The system was drained and dried with an air purge and the strainers were cleaned. To drain the supply header completely, a line was in stalled from the low point to the storage tank. The system was refilled with HTF fluid. The fluid was heated and circulated. The surge drum was vented to remove any moisture that remained. It was found that the high point vents provided did not adequately vent the system. Additional vents were installed during operation of the system, it was difficult to tell if proper flow was being received at each of the coolers. Flow meters were installed in the lines leading to the coolers to measure the actual flow. Flow to the fines screw cooler appeared to be low-but this problem was resolved by cleaning the strainer in the line and by bringing the nitrogen blanket on the surge drum up to normal operating pressures. A question regarding the proper operation of the three-way valve to bypass the heat exchanger is yet to be resolved. The valve should allow the fluid to flow through the exchange, through the bypass line, or any combination of the two. Instead, the valve appears to be cutting off flow when the fluid tries to bypass the exchanger. The problem was fixed by rotating the actuator 90^{o} and reversing the direction of rotation for the actuator. The HTF system was operated for a few hours to test the valve for correct operation after the change.

Baghouse (FL0700): The final hot gas clean-up system (baghouse) was completed by construction and turned over to operations in the early part of the quarter. From then until June, the system operated periodically in bypass mode to provide a flow path for Thermal Oxidizer commissioning activities. In early June, a technical representative of Fuller-Kovako, the supplier of the majority of the components for the system, was on-site to provide guidance and advice for start-up. The plant, however, was not yet ready for start-up activities, so the dust collecting bags had not been installed in the baghouse. Functional checks of the system logic had not been performed due to the on-line status of the system during Thermal Oxidizer commissioning.

The vendor representative, Robin Guinan, performed a pre-operational inspection of the system. This inspection included blowing down the compressed air supply piping, energizing the pulse cleaning timer board, sequencing the pulse cleaning valves, bumping the screw conveyor for rotation, and performing a general inspection of the installation of the equipment. No significant problems were discovered during the vendor visit. Some of the compression fittings between the pulse tubes and the compressed air header were found to be leaking, so the insulation around the fittings was removed and they were tightened further. While pressurizing the compressed air header, we discovered a sizable leak which we later eliminated by re-welding the area. After eliminating this large leak, however, we discovered that almost every one of the vertical connecting pipes emerging from the compressed air header was leaking from the threads. Correction of this problem was more involved than the previous ones because it required removal of the compression fittings and pulse tubes in order to tighten down on these threaded pipes by no less than one revolution each for alignment purposes. We discovered, however, that none of the pipes had been completely torqued down, so it was not as difficult as anticipated to achieve one more torquing revolution. With these problems corrected, the system was ready for functional checks and final commissioning prior to start-up.

The functional checks of the system were also performed in June during a Thermal Oxidizer outage period. The system responded to logic simulations of process conditions, and timer values for pulse cleaning and screw conveyor operation were monitored and adjusted. The system performed as designed and was ready for pre-conditioning and on-line service. The pre-conditioning involved introducing a coating material, fine alumina, through the dilution air fan and into the inlet gas stream to provide a preliminary solids coating for better filtration effectiveness. The screw conveyor was run to remove the coating alumina that had fallen from the bags, and the system was considered commissioned and ready for plant start-up.

Baghouse Ash Removal and Storage (FD0820 and SI0814): Functional checks of system FD0820 were performed with no major system functional problems discovered. Some ladder logic changes were necessary to correct problems with the vendor's standard function for level probes. Clyde Pneumatic Conveying, the designer of the system, incorporates the use of low level probes in most of their systems, and they attempted to match the PLC program for FD0820 to this convention. The problem with this system is that it uses a high level probe and must, therefore, be controlled by appropriate ladder logic. This problem corrected, the system was ready for process operation. Its first "hot" commissioning activities involved conveying the excess coating alumina from the baghouse screw conveyor to the ash silo, SI0814.

Construction of the ash silo system, SI0814, was completed during the first part of June, and functional checks were performed during outage time following the checks of FD0820. The system responded according to design after some minor PLC program modifications. The silo was also operated during removal of coating solids from the baghouse, and the solids were successfully removed into 55 gallon drums. The silo system was then ready for full operation under process conditions.

Instrument Air System: The instrument air dryers are designed to run continuously. During the next outage, a common instrument air header upstream of the instrument air dryers will be installed. With the common header in place all of the dryers can be left on and the dryers will receive air flow regardless of which instrument air compressors are operational.

Closed Loop Cooling Water Systems: The plant's cooling systems progressed to near operational status in April. A circulating water line for the FW cooling system, which was dislocated by a water hammer caused by a valve operating too quickly, was repaired. Flushes of the circulating water, the MWK closed-loop, and the BOP closed-loop cooling water piping were completed in April. The water treatment systems for these loops were installed and tested. Operation of the Instrument Air compressors and the Heat Transfer Fluid coolers were the first requirements for the permanent cooling systems. Operation of the MWK process air compressor, steam generation by the Thermal Oxidizer, testing of the high pressure compressors, and commissioning of the Recycle Gas Compressor, Transport Air Cooler, and Mill systems all raised the demand for cooling water in May.

In the MWK closed loop cooling water system, two centrifugal pumps, one is available as a spare, deliver 580 gpm to process equipment in the MWK train. The cooling water is supplied at a maximum temperature of 92 °F. After returning from the MWK system, the water is cooled by exchanging heat with the circulating water system in a plate-and-frame heat exchanger. Initial fill for the system is provided by the demineralized water pumps and makeup during operation is provided by the MWK steam and condensate system. A constant head on the pump suction is provided by a head tank located at the 202' level of the structure. Chemical treatment is furnished by use of a pot feeder.

Strainers were installed in the lines of the cooling loop, the system was filled with demineralized water, and the water was circulated to flush the system. The system was found to operate at a pressure lower than the design pressure of 100 psig. The pumps only develop enough head to operate at about 80-85 psig.

The MWK closed loop system was used in support of commissioning and startup activities during the second quarter. The system was operated as needed, resulting in over 25 total days of use during the quarter. The system operated reliably other than the sample cooler for AI402, a conductivity meter for the water in the steam drum, repeatedly lost cooling water flow. The supply line was blown out with air several times in an effort to clear any debris that could possibly be in the line and the outlet water was rerouted to a drain. It is believed that the flow is being blocked by debris in the sample cooler itself or in rotometer in the water line leading to the sample cooler.

In the SCS closed loop cooling water system, two centrifugal pumps, one is available as a spare, deliver 1100 gpm to process equipment in the Balance of Plant area. The cooling water is supplied at a maximum temperature of 92 °F. After returning from the BOP equipment, the water is cooled by exchanging heat with the circulating water system in a plate-and-frame heat exchanger. Initial fill for the system is provided by the demineralized water pumps and makeup during operation is provided by a booster pump connected to the MWK steam and condensate tank. A constant head on the pump suction is provided by a head tank located at the 173' level of the ash structure. Chemical treatment is furnished by use of a pot feeder.

Strainers were installed in the lines of the cooling loop, the system was filled with demineralized water, and the water was circulated to flush the system. The system was found to operate at a pressure lower than the design pressure of 110 psig. The pumps only develop enough head to operate at about 85 psig. The location for the flow meter was found to be in an unacceptable position, within a foot of a valve upstream and an elbow downstream. Instead, flowmeters were installed on two separate lines, one leading to the feed preparation structure and one leading to the utility island.

The SCS closed loop system was used in support of commissioning and startup activities during the second quarter. The system was operated as needed, resulting in over 40 days of use during the quarter. The SCS loop was used primarily to provide cooling to the instrument air compressors, although it also provided cooling to the propane and coal preparation systems.

Circulating Water System: The circulating water system provides cooling water at a maximum temperature of 90 °F to the MWK, SCS, and FW closed loop cooling systems and to the MWK steam and condensate system and to the FW condenser. There are four centrifugal pumps delivering 3400 gpm each at 115 ft. of head. The number of pumps in operation at any one time depends on the number of systems demanding cooling water. If both the FW and MWK trains are in operation, three pumps operate with one pump remaining as a spare. The cooling tower is of a modular fiberglass design with six cells and a common basin. Each cell has two fans, each with a single speed motor. Makeup is to the common basin. If the basin level drops below the operating level of 24 inches, a float valve opens allowing service water to gravity flow in to the system from the raw water tank. If the level continues to fall, a makeup pump activates at 17 inches and a second pump activates at a level of 10 inches. Cooling tower blowdown is to an unnamed tributary of Yellow Leaf Creek.

Strainers were installed, and the system was filled from the service water tank. The water was circulated through each of the loops to the closed loop cooling heat exchangers. Because the FW exchanger is not installed, a loop was added so that the underground lines to the FW system could be flushed. The water was drained and refilled several times. During the opening of the butterfly valve on the line to the FW system, a water hammer ruptured the pipe. Another water hammer during a pump start reptured the line returning to the tower from the MWK system.

Local temperature indicators were added to the discharge sump of each cell in order to help determine if the fill of a cell was freezing during cold weather operation. The flow meter and valve on the blowdown line were moved because the original location did not provide a sufficient straight run of pipe. Originally the makeup pumps were to be cutoff by a pressure switch that was to activate when the closing of the float valve caused the pumps to deadhead. This was found to be an unworkable method of control and a low flow switch was installed instead. Initial vibration monitoring indicated that the fans were improperly supported. A solution to stiffen the support of the fans has been proposed, but the preference would be for the vendor, Tower Tech, to make the needed repairs.

The cooling towers were operated as needed for support of commissioning and startup activities. The circulating water system provided cooling to the MWK and the SCS closed loop cooling systems when they were operational and provided cooling to the MWK steam and condensate system to condense and cool the steam generated during the operation of the Thermal Oxidizer and Transport Reactor. Heat loads were normally very light. No more than 4 (of 12 total) fans were operated at any time.

Service Water System: The service water system provides water to the utility stations, water to the flare seal drum, and makeup to the cooling tower. There are two service water pumps, one as a spare, that pump 350 gpm at 300 ft. of head. The service water header is maintained at a pressure of 145 psig. The cooling tower makeup pumps are sized for 350 gpm at 30 ft. of head. The service water tank is maintained at a level of 30 to 35 ft, with feed coming from two raw water pumps located at the river intake structure of neighboring Plant Gaston on Yellow Leaf Creek. Each vertical raw water pump can deliver 350 gpm at 225 ft. of head. The water is filtered before being sent to the storage tank. One pump is started when the tank level drops below 30 ft. A second pump is started if the level drops below 25 ft. The raw water pumps also supply the fire protection tank. The fire protection tank takes precedence over the service water when both require makeup water.

The raw water pumps have been run several times to replenish the service and fire water tanks. A total of about 1,000,000 gallons of water were removed from Yellow Leaf Creek during the second quarter. The raw water tanks have a recirculation line with a pressure regulating valve to provide a path for the pump minimum flow in the event that the discharge line becomes blocked. The valve would not allow enough flow to pass to prevent the pump from entering into a deadhead condition when the valve was set to the expected setpoint. In order to protect the pump, the valve was set to begin to open at about 60 psig.

The service water pumps were to operate at a pressure of 100 psig. However, it was discovered that this was not within the normal operating range of the pumps that were purchased. In order to safely operate the pumps, it was necessary to raise the setpoint on the pressure regulating valve on the recirculation line to 145 psig. The pumps were used to flush the service water lines and the flare seal drum. The pumps were also used to provide cooling water to the main air compressor for testing and to provide cooling water to the flash drum in the steam drum blowdown system.

The cooling tower makeup pumps have been used to flush the cooling tower makeup lines and to provide water to the cooling tower. The logic for the pumps originally called for a pressure switch to cut the pumps off when the float valve closed, causing the pump to deadhead. The combination of a flat pump curve and varying levels of NPSH due to changing levels in the raw water storage tank made this method of control ineffective. The pressure switch will be replaced with a low flow switch. The makeup pumps have also had problems with evidence of water on the bearings. A vendor representative inspected the pumps and removed pump A for repair.

Waste Water Treatment/Chemical Injection: The chemical injection system uses a combination of pumps and pot feeders to maintain the quality of the water in the plant. In the circulating water system, sulfuric acid for pH control and a corrosion inhibitor are added to the common basin and an algaecide and sodium hypochlorite as a biocide are added using a pot feeder. The cooling tower blowdown is dechlorinated by the addition of sodium bisulfate. The closed loop cooling water systems are treated with molybdates in a pot feeder as a corrosion inhibitor. The steam and condensate system are treated with an pH controller, oxygen scavenger, and phosphate. The waste water treatment pond uses aluminum sulfate to flocculate suspended solids and an acid and an alkaline pH controllers.

The waste water from the diesel fuel storage sump, process area sump and the coal and limestone storage area sump are collected and pumped to the waste water treatment system. The sump pumps are activated by high level switches in the sumps. The waste water treatment area consists of an oil/water separator, a rapid mix chamber, a flocculation chamber, two settling chambers, and a hold basin which discharges to an unnamed tributary of Yellow Leaf Creek. The rapid mix chamber has a 15 hp mixer and the flocculation chamber has two 3 hp mixers. The waste water treatment area also has a storage building and pumps for the addition of chemicals into the water. The water is sent to either the oil/water separator or to the rapid mixing chamber. The water flows into each of the chambers in succession through overflow weirs or through valves. The waste water treatment area is still under construction.

The chemical injection system for the steam and condensate system has been operated successfully. The pH oxygen scavenger and the pH controller, an amine, are added to the boiler feed water line to the steam drum and can only be added when the boiler feed pumps are operating. The phosphate is added directly to the steam drum. It was found that the pH controller cannot be added at a sufficient rate to have the pH within an acceptable range during initial fill without throttling the flow of BFW. Once this was known, maintaining the correct steam drum pH was possible. The phosphates could not be maintained at the correct level because of a combination of a high rate of blowdown during the cureout period and the low capacity of the phosphate pump. When the drum is being operated normally, it is expected that the phosphate level will be maintainable at the lower rate of consumption. Oxygen levels were normally below detectable limits.

The molybdates were added to the closed loop cooling systems and maintained at a level of approximately 250 ppm. Because of the loss of MWK cooling water from the flawed sample cooler, additional corrosion inhibitor was added to the system to sustain levels. Additional molybdate additions to the SCS cooling water system have been needed as each subsequent piece of equipment requiring cooling has been brought into service.

The chemical addition to the circulating water system has begun. The biocide is being added to the cooling tower in a daily slug of approximately two gallons. One day a week, two gallons of algaecide are added instead. Bacteria tests on samples of circulating water indicate that this is an acceptable rate of addition for now. The sulfuric acid metering pump was first operated manually and then in automatic feedback control to maintain a pH within an acceptable range of 7.5 to 8.0. The phosphate metering pump has been run manually to control phosphate level in the cooling tower. This pump will always be under manual control.

The chemical injection at the waste water treatment pond is ready for operation. All of the metering pumps have been checked out and calibrated and the chemical injection lines charged with chemicals. The oil water separator has been used and the mixers have been operated. The hand switch for flocculation mixer A was found not to work but has been repaired. The mixer speed adjustment on mixer B was found to work in reverse and was corrected. The pH probe was relocated to the flocculation chamber of the pond. It was necessary to replace the cell of the pH probe before the instrument could be calibrated and operated correctly.

Diesel Generator: The Diesel Generator was operated in the last week of May. This Generator required much more testing than a typical auxiliary generator because of its size (almost 2000 hp or 1.6 megawatts), and because of the extra ability to tie the generator into the power grid while the normal power feed is operating. This ability to synchronize with the power grid is useful for load sharing and to provide an extra margin if the grid is unstable due to outside load demands or failures. The generator completed all testing with capabilities at or above design.

Wilsonville Interactive Learning System (WILS)

The Wilsonville Interactive Learning System (WILS) project officially closed on May 31, 1996. SCS received delivery from Nolan Multimedia of 12 compact discs containing the WILS software. SCS will receive the source code for WILS and the necessary equipment to produce additional copies of the WILS software on CD-ROM. Also received was the promotional video which Nolan developed for the project. This eight-minute video provides a concise introduction to the PSDF and is expected to be extremely helpful in the promotion of the project. Nolan combined interviews of project participants with graphics, WILS outtakes, and onsite video to produce this work explaining the purpose of the PSDF and why it is important to our nation's energy future. This video was sent to SCS in VHS form and as a Beta master for use in replication.

The following is a summary of the deliverables:

- *Technology Resource Modules* -- There are three of these "illustrated textbooks" in WILS. The Transport Reactor Train (K-train) module contains major branches for Gasification and Combustion modes (each of which has a series of graphical menus as well as an index for quick access to systems and equipment). Also in this module, there are separate branches for Eyewash Station Locations in the MWK bays, and for direct access to P&IDs. In the HGCU section, there is an overview plus one module for the Westinghouse PCD and one module for the CPC PCD. Animation of internal processes is featured in each of the two modules.

- *Familiarization Training* -- The FAM module consists of 80 interactive graphic exercises which are presented randomly (or consecutively if "test mode" is evoked). The module also contains 160 quiz questions that directly relate to the component the user must identify in the graphic exercise. User performance data is tracked and displayed upon exiting the module.

- *Operations Training* -- OPs consists of 36 mini-modules, each with identical functionality. Virtually all have 2 levels of text (summary and detail) and provide access to the rich storehouse of visuals associated with a particular component (stills, 3D views and P&IDs). Each mini-module also contains from three to five quiz questions, which are tracked and presented in a performance summary when Ops is exited.

- *Procedures Training* -- There are three modules in this section, each dealing with sampling procedures. Video, along with some animation and graphics, are used to convey the step-by-step procedures that were shot in the summer of 1995 with the help of SRI. Each module contains five quiz questions, which are tracked as previously described.

- *WILS Archive* -- The Archive provides direct links to the glossary, a stills library (a series of slide shows accessed via an index), a 3D views library (accessed by each level of the process structure), and a P&ID library. The P&ID library contains all engineering diagrams associated with the Transport Reactor Train, including the two PCDs, Realtime Monitors and Sampling, and the Balance of Plant. P&IDs are accessed via a progressive series of menus.

- *PSDF promotional video* -- The 8.5 minute video features on-camera interviews with executives and engineers and contains video footage of the PSDF shot in July and December of 1995. A Betacam SP dub master was submitted to SCS for duplication as needed.

Nolan entered a nonproprietary version of WILS in a nationally recognized multimedia competition. The Invision Festival, sponsored by NewMedia Magazine, had a total of 44 entries in the technical training category; WILS was one of the few that made it to the finals. Although WILS did not receive a medal, the finalist status is still quite an honor. It shows that, according to the professional multimedia community, WILS has considerable merit.

Operation and Maintenance

Operations personnel continued to be involved in equipment inspections and design reviews. Several groups of operators prepared safety procedures, FW design tabulation, equipment preservation, and equipment testing. Also, operators continued to commission and operate equipment from the DCS control consoles to gain experience with those controls and displays. The Operations personnel spent most of June on-shift and operating several pieces of equipment simultaneously. They simulated the process of starting the transport reactor several times, adjusting flows and zeroing differential indications, lining up and firing the Thermal Oxidizer for steam and temperature, operating the cooling water systems, and the water treatment systems.

Mechanics completed the Westinghouse PCD instrumentation connections, pulled and modified the Transport Reactor Start-up Burner, and supported the check-out of the coal and sorbent mill systems. Work was done to rebuild some of the dense phase transporters and seal valves which became plugged with solids, as well as repairing several valves that would not operate. Also, an on-going effort to inventory FW material continued, as well as planning for the PCD tie-in outage after the refractory cure-out.

The maintenance engineering staff continued designing future modifications and assisting in several design evaluations including: (a) increasing the clearances between the feeder and the top plate on a dense phase rotofeeder to prevent the feeder from binding during the transport of alumina, (b) adding a bypass line with a butterfly valve around the thermal oxidizer inlet control valve to assist in control of the flow during start-up (low flow operation), (c) adding a connecting line and isolation valve to allow use of process air rather than recycle gas for fluidizing the combustion heat exchanger to support start-up activities, (d) redesigning the heat transfer cooling fluid lines at the screw coolers to allow flow to the closure plates (as is specified by the manufacturer), (e) adding a recirculation line on the heat transfer fluid system to prevent pump deadheading in the event of a flow valve failure, (f) helping SRI in a review of the appropriate materials to use in future construction of the sampling cyclone and impactors, (g) adding and sizing a safety relief valve for the nitrogen storage tubes and (h) comparing the FW and MWK potable water systems to determine if there is a possible cost savings by combining the two.

Three safety valves that were discharging at incorrect set pressures (PRV-201, 202, 230) were repaired/reset and tested by the vendor and have been reinstalled. The mechanical seal on the Heat Transfer Fluig B pump was leaking, and has been removed and shipped off for repair.

The E&I personnel completed calibration of most of the MWK pneumatic operated control valves and transmitters, continued work on the PLC to DCS interfaces, continued clean-up work on the MWK DCS configuration, and continued assisting with functional testing of the Foxboro Control System, as well as procuring needed test equipment for their electrical maintenance responsibilities

Maintenance Inspection and Procedures

As pumps/compressors were started, vibration readings were taken to define the initial operational state of the machine and provide a baseline set of data for future comparisons. To date taken baseline readings have been taken on 33 pieces of equipment (pumps, compressors, fans, blowers). All of this information is stored in a database that is used for trending and data analysis. It was determined that excessive vibration of the cooling tower fans was due to insufficient lateral supports. A recommendation has been presented and is currently being discussed with the vendor (Tower Tech). Work continues on debugging of high horizontal readings on the Main Air Compressor motor. It is believed that these are due to misalignments caused by thermal movements as the machine is operated.

Other monitoring and inspection equipment are also being used. The infrared camera was used to scan the thermal oxidizer and waste heat boiler during the cure cycle to verify uniform heat distribution on the outer surfaces. This will be done on all heated vessels/piping as Start-up progresses to provide a baseline database. An ultrasonic thickness gage is being used to establish baseline thickness signatures on elbows/tees (excluding Basalt lined fittings) in the ash transport systems. In the upcoming weeks, these baseline readings will be taken on all pneumatic conveying elbows/tees to establish a baseline database. The inspectorscope (borescope) has been used to record on videotape the condition of the refractory lining inside the Transport Reactor start-up burner and also the condition of the pilot and main burner tips. This will be used for comparison after the burner has been operated for a period of time to determine the degradation.

A database of all oils/grease used to date and the requirements for each piece of equipment was established. For initial start-up, the exact oil/grease recommended by the vendor was used. After further review of the specifications for each oil on the list, it may be possible to combine several oils (one oil in place of several oils) and thus reduce the total required inventory.

All of the MWK equipment has been entered into the Work Order Maintenance System (WOMS). Also, the computer bugs (WOMS running under Windows NT) have been resolved so that WOMS is now operational. Once each computer is set-up to run WOMS, and a few more details are finalized, WOMS will be put into service. This will be concurrent with the entering of BOP and sub-vendor equipment information into WOMS.

Miscellaneous

As part of the closeout of SCS Engineering, Engineering files have been transferred from the Birmingham office to Wilsonville. In addition to physically moving drawings, documents, correspondence, vendor manuals, etc. to the site, formal transfer of Document Control responsibilities occurred. Site personnel will now handle all receiving, logging, and routing of documents, maintain and retrieve files, and otherwise meet all internal and external project document interface needs.

Coal and sorbent were received on May 16. Work continued in developing contracts for disposal of ash, waste disposal, and for parts washing service.

Laboratory Services

At the beginning of the second quarter of 1996, on-site lab personnel consisted of two Southern Research Institute employees, who have previously focused on defining equipment needs, setting up the lab equipment, drafting chemical hygiene plans and preparing, developing, and testing analytical procedures. An additional chemist was added to the laboratory staff on May 28, 1996 to support the startup of the MWK process.

The laboratory is equipped to perform several analyses required to support PSDF operation. These procedures may be categorized as follows: cooling water and steam/condensate analyses, particle size analysis, evaluation of potentially hazardous waste properties, and miscellaneous analyses. The following cooling water and steam systems analyses are capable of being performed in the on-site lab:

No	TEST	METHOD
1.	Dissolved Oxygen	Test kit, meter
2.	pH	Indicator, meter
3.	Total Orthophosphate	Spectrophotometer
4.	Soluble Orthophosphate	Spectrophotometer
5.	Phosphate	Spectrophotometer
6.	Free Chlorine (ppm)	Test kit
7.	Total Chlorine (ppm)	Test Kit
8.	Free Chlorine (ppb)	Titration
9.	Total Chlorine (ppb)	Titration
10.	Molybdate	Spectrophotometer
11.	Conductivity	Meter
12.	Calcium Hardness	Titration
13.	Total Hardness	Titration
14.	Alkalinity	Titration
15.	Iron	Spectrophotometer
16.	Sulfite	Titration

17.	Phosphonate	Spectrophotometer
18.	Heterotrophic Bacteria	Test Kit
19.	Sulfate Reducer Bacteria	Test Kit

The laboratory is equipped to evaluate various properties of process solids streams. Two methods are available in the PSDF lab to measure particle size distributions. The first method is a standard sieve analysis utilizing a Ro-Tap sieve shaker and 8-in. sieves with openings from 0.75 in. to 45 micrometers, the lower limit for dry sieve analysis. The dry sieves can be used to size process feed stock on an as-received basis and can be used to determine particle size distributions of pulverized coal and dolomite. The standard dry sieve analysis can be augmented by an L&N Microtrac laser diffraction particle size analyzer capable of determining particle size distribution in a range of particle diameters from 0.45 to 704 micrometers. The ability to characterize particle size-distributions in the range below 50 micrometers will prove to be very useful in evaluating the performance of the particulate control devices being tested at the PSDF.

Sample preparation equipment has also been procured for laboratory use. This equipment will be used to prepare coal and limestone samples for analysis by an outside laboratory. An air-drying oven, a sample splitter (riffle), a crusher to reduce the sample either to minus 8 mesh (less than 2.36 mm) or to minus 4 mesh (less than 4.75 mm) and a pulverizer to further reduce the material to minus 30 mesh (less than 600 micrometers) are included.

The laboratory is also prepared to determine the suitability of spent solids and PCD fine material for disposal. The glassware and reagents needed to determine the sulfide content of the solids have been purchased and are on hand in the laboratory. The laboratory is also prepared to test the material for liquid content, reactivity, and ignitability prior to its leaving the PSDF for disposal.

Necessary equipment to determine bulk density and surface moisture content of coal and limestone is also available in the laboratory.

Numerous samples have already been analyzed in support of start-up activities at the PSDF during the second quarter (April, May, and June) 1996. Through the end of June, 143 samples had been logged into the PSDF laboratory. These included 77 cooling water/steam system samples, 64 solids samples (coal, dolomite, and alumina), and two compressor oil samples. In addition to these samples, several in-situ water analyses have been performed, including dissolved oxygen, free chlorine concentration, and pH.

Work continued during this quarter to make the laboratory information management system operational. At present, analytical results are being provided to the PSDF staff by means of the PSDF e-mail system or as hard copy. Analytical results will be made available through the laboratory information management system when that system becomes fully operational.

Data Analysis and Management

A Plant Information System (PI) from OSI Software in San Leandro, CA is under a trial evaluation. The software collects plant data, compresses the data, archives the data, and makes the data available on the LAN in real time. The system provides a UNIX based program that runs on the same Sun computer as the Foxboro AW-51. The program interfaces with Foxboro AIS, scans all points every 2 seconds and transmits the data to main program running on an Intel based Windows NT server. The NT based Data Archive program receives the data from the interface and passes it through a swinging-door compression algorithm before saving the data to disk. The Data Archive program also interacts with client applications connected to the LAN to provide engineers with both current and historical data.

The client applications that we are evaluating for use in accessing PI data are PI-Process Book and PI-Datalink. Process Book is a graphical interface for displaying current process information, recalling historical data, and creating trends of data. Datalink is an Excel spreadsheet add-in that enables the process engineer to pull data directly into a spreadsheet in various forms.

Much effort has been placed into configuring the list of tags to be archived and into increasing the reliability of the software package. The tags have mainly been configured from databases containing lists of available points on the DCS.

There was a serious reliability problem after the initial installation of the software. Most of the problems were resolved when OSI released an updated build of the Data Archive. Some changes were also made in the administration of the software which helped alleviate some of the problems. The software now works reliably.

3.0 PLANS FOR FUTURE WORK

1. MWK will continue to provide commissioning field support.

2. Preservation of FW equipment that are on site will continue. The combustor system will be prepared for refractory cure.

3. Construction at the PSDF site continues with few craft workers. Auxiliary boiler installation and other remaining work in MWK and BOP areas necessary for gasification will be completed.

4. Construction of the granular bed system will continue. Now that the refractory lined piping is complete, work will focus on the installation of the boost blowers and the small bore piping. Once the piping is complete, electrical and instrumentation work will begin.

5. July should be a very active month for the Westinghouse PCD. Current plans include swapping over from the CPC vessel to the Westinghouse vessel early in the month. Initial shakedown testing of the MWK Transport Reactor and the Westinghouse filter will be with alumina circulating in the reactor. If all goes well, coal feed should begin this month.

6. Orders for casting the cyclone manifold will be released in July. Bids will be obtained and orders placed for gaskets for the cyclone assembly and impactors. Current plans call for completing the installation of the inlet sampling system by August 1. Southern Research would then proceed with shakedown of the system during August and September, with the objective of being ready to sample in October.

7. For the next quarter, now that all of the required systems have been tested and commissioned, only the final integration trials remain; these are the first heat-ups using coke breeze and coal. After the tie-in to the Westinghouse PCD, all process equipment will be ready for operation in support of the Transport Reactor as a combustor. Coal fire should be achieved next quarter, and the initial testing of the Transport Reactor as a combustor begun. After shakedown and characterization,

the Transport Reactor will be reconfigured as a gasifier. Start-up of those required systems will begin next quarter.

SCS and MWK will continue working with the Transport Reactor Startup Burner vendor to resolve design deficiencies in the burner, with the target date for the redesigned burner system from the sub-vendor the end of July or early August. Meanwhile Startup activities will continue using the original burner, which has been modified by site personnel for temporary, yet safe, operation to progress the refractory cure-out. In addition, solids will be circulated in the transport reactor to allow setting of purge flows at various pressures.

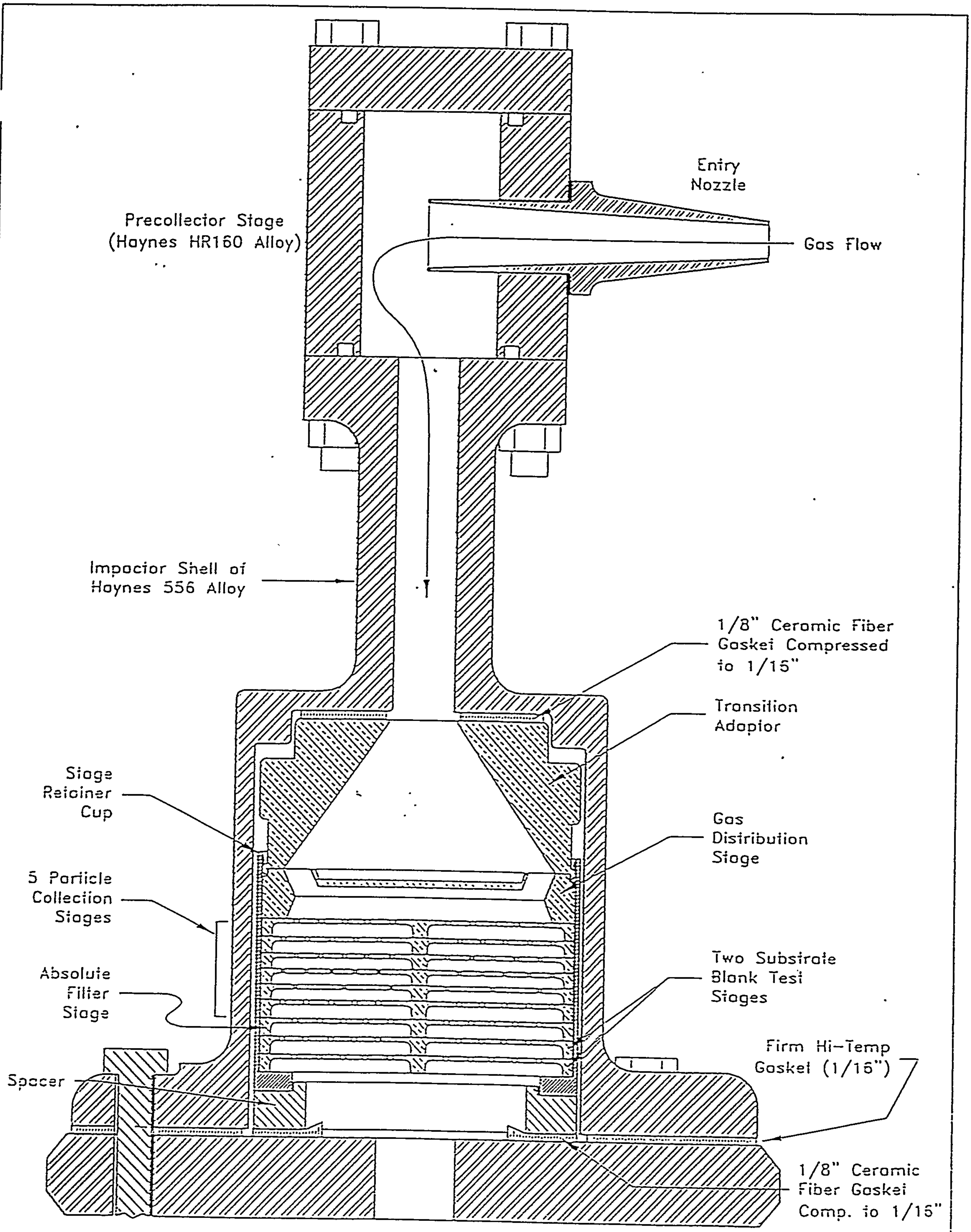
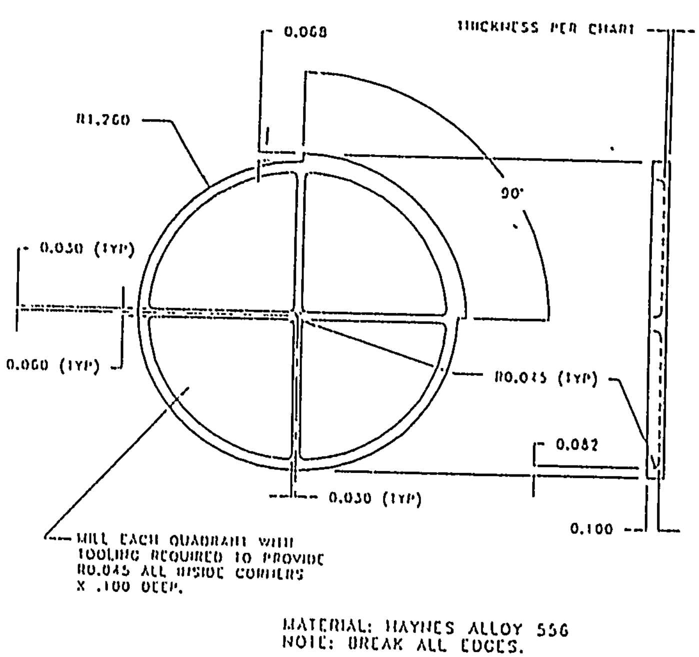
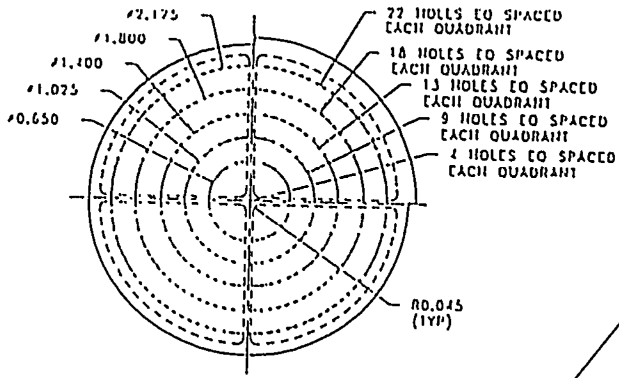


Figure 1

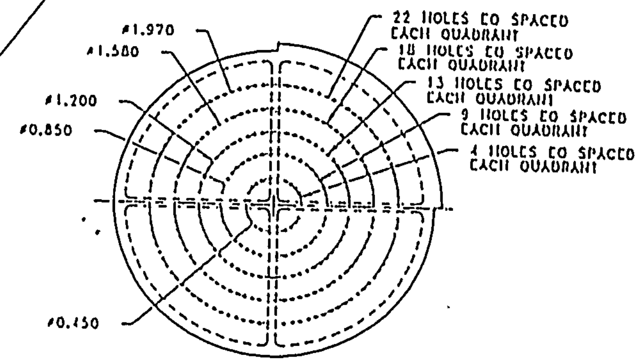
Southern Research Institute Power Systems Development Facility P.O. Box 1069	High-Temperature Cascade Impactor Assembly	Dwg. No: M7252-070 Revision: A Scale: Full	A

JET PLATE BLANK (ALL)

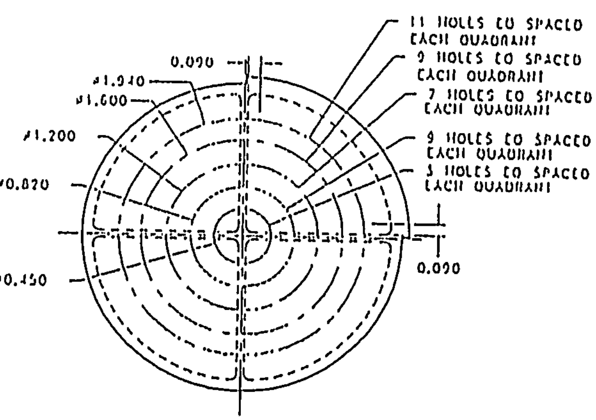




JET PLATE # 4,6,8,F,B1,B2



JET PLATE # 3,5



JET PLATE # 7

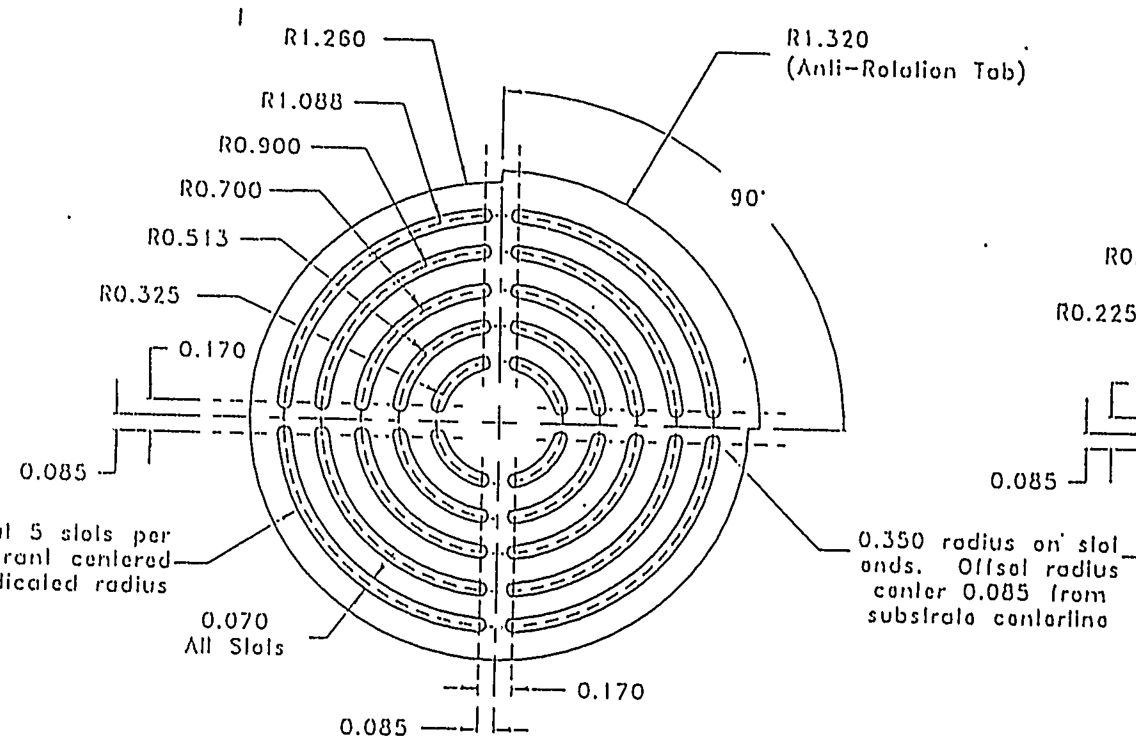
QUAN	PLATE NO.	NO. JETS	JET DIAMETER		PLATE THICKNESS
1	3	264	0.759 mm	0.0299 In	0.0375 In
1	4	264	0.533 mm	0.0210 In	0.0255 In
1	5	264	0.343 mm	0.0135 In	0.0175 In
1	6	264	0.254 mm	0.0100 In	0.0175 In
1	7	156	0.254 mm	0.0100 In	0.0175 In
1	8	264	0.948 mm	0.0373 In	0.0375 In
3	F,B1,B2	264	1.638 mm	0.0645 In	0.0375 In

...hern Research Institute
...er Systems Development Facility
... Box 1069
...onville, AL 35186
...) 669-5990 or (205)669-5068

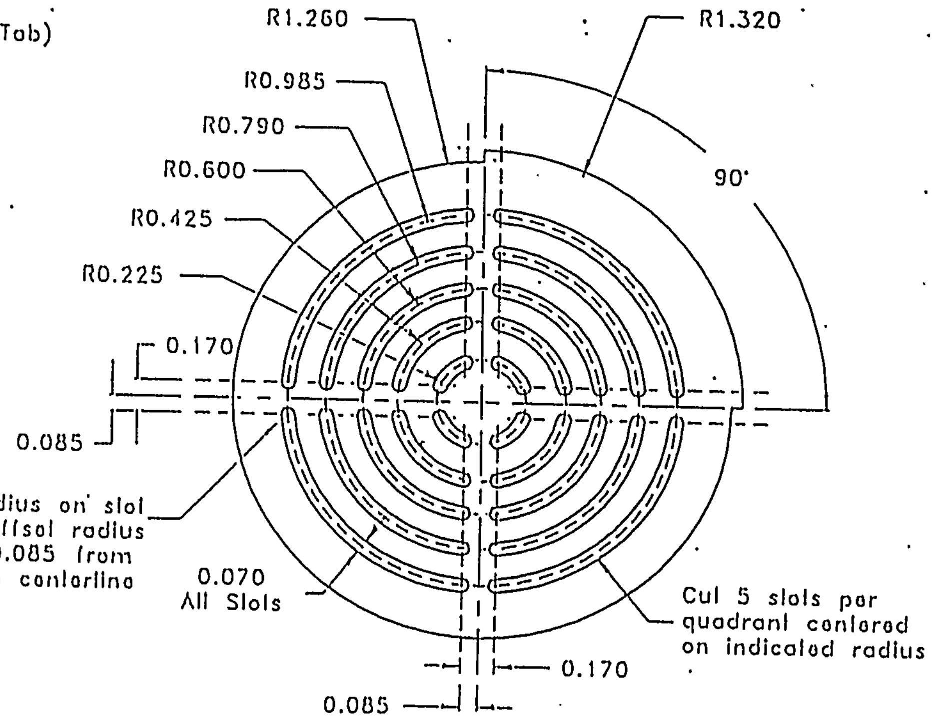
High-Temperature Cascade Impactor
Jet Plate Details

Dwg. No: M7252-071
Revision: A
Scale: None
Date: 4/4/96
File: ImpSlag4.Dwg

A SIZE



Substrate for Stages 3, 5, 7, and Blanks (2)

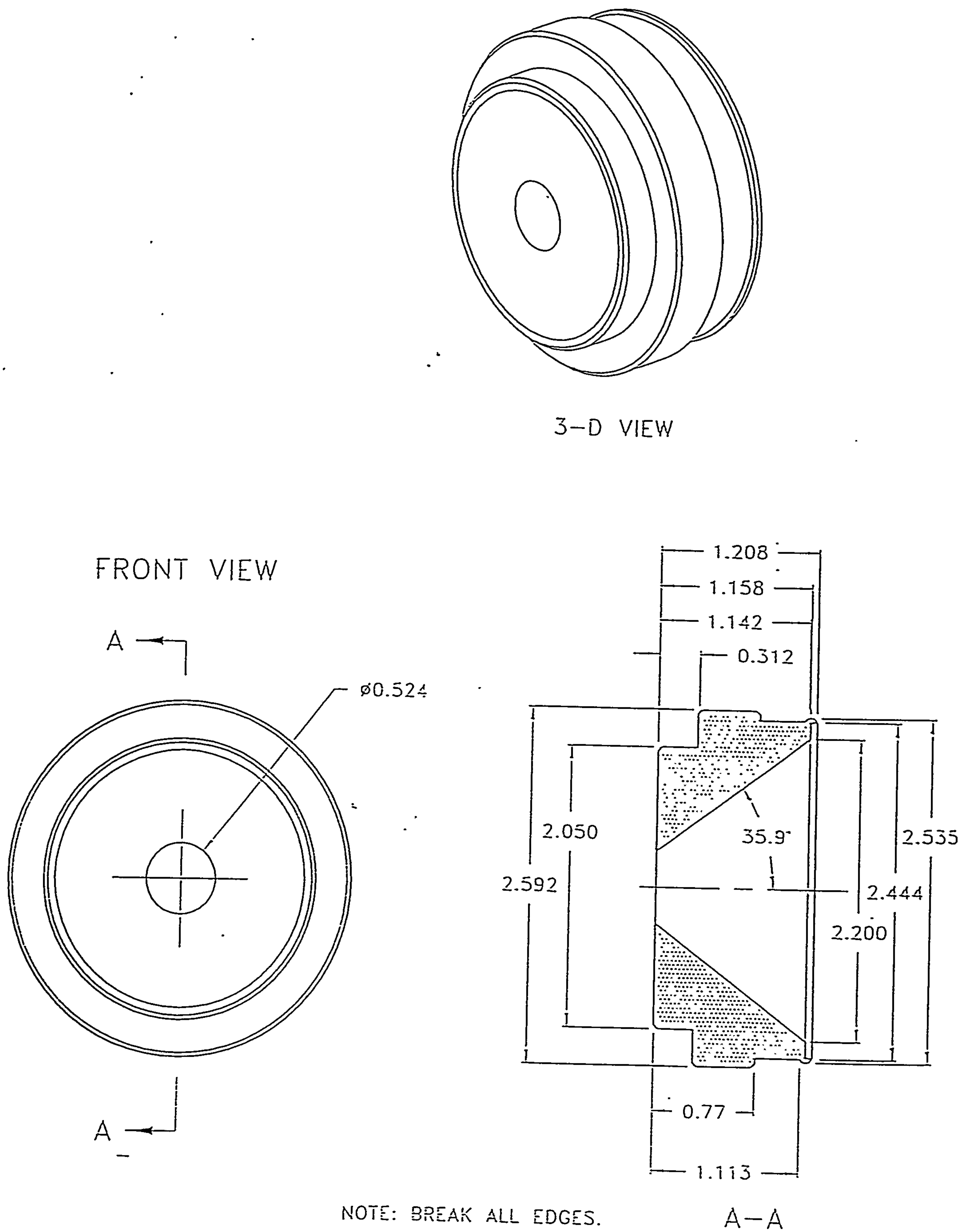


Substrate for Stages 4 and 6

Material: Haynes 230, 0.002 Thickness

...hern Research Institute ...er Systems Development Facility ... Box 1069 ...onville, AL 35186 ...) 669-5990 or (205)669-5068	High-Temperature Cascade Impactor Metal Foil Collection Substrate Details	Dwg. No: M7252-072 Revision: A Scale: Full Date: 4/4/96 File: ImpStag4.Dwg	A SIZE

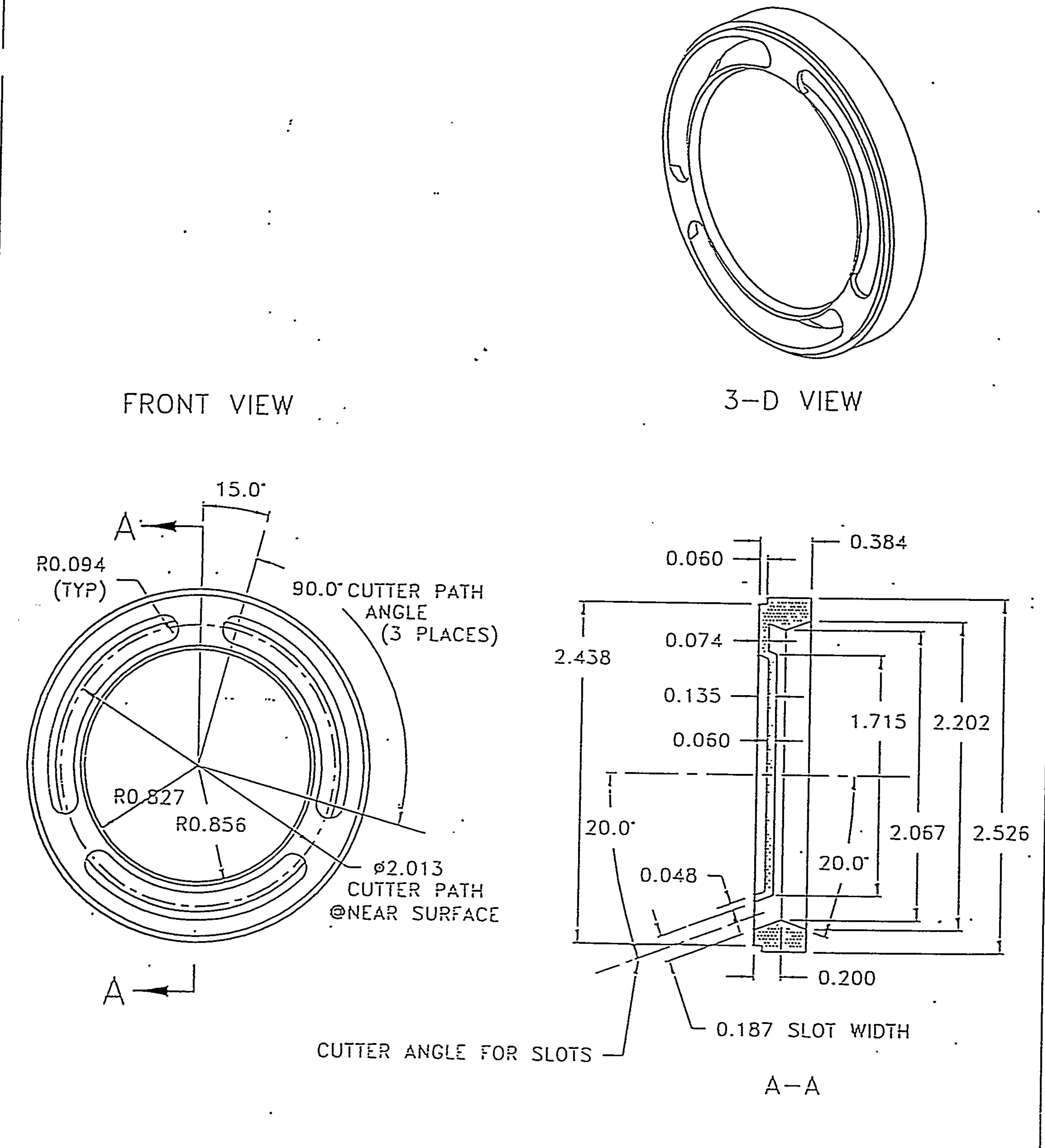
Figure 3



NOTE: BREAK ALL EDGES.
MATERIAL: HAYNES ALLOY 556

Figure 4

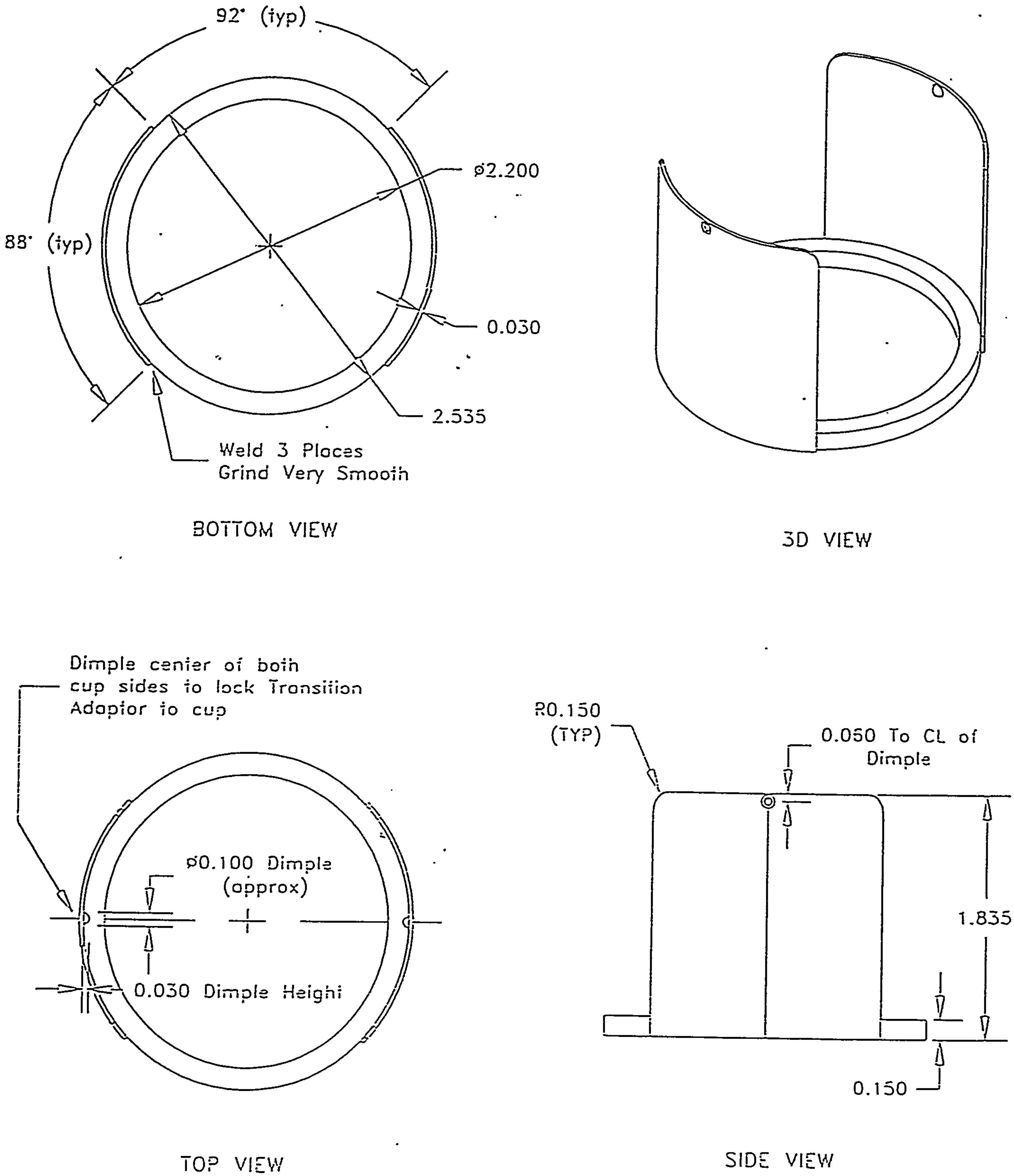
Southern Research Institute Power Systems Development Facility P.O. Box 1069	High-Temperature Impactor	Dwg. No: M7252-073 Revision: A Scale: Full	A



MATERIAL: HAYNES ALLOY 556
NOTE: BREAK ALL EDGES.

Figure 5

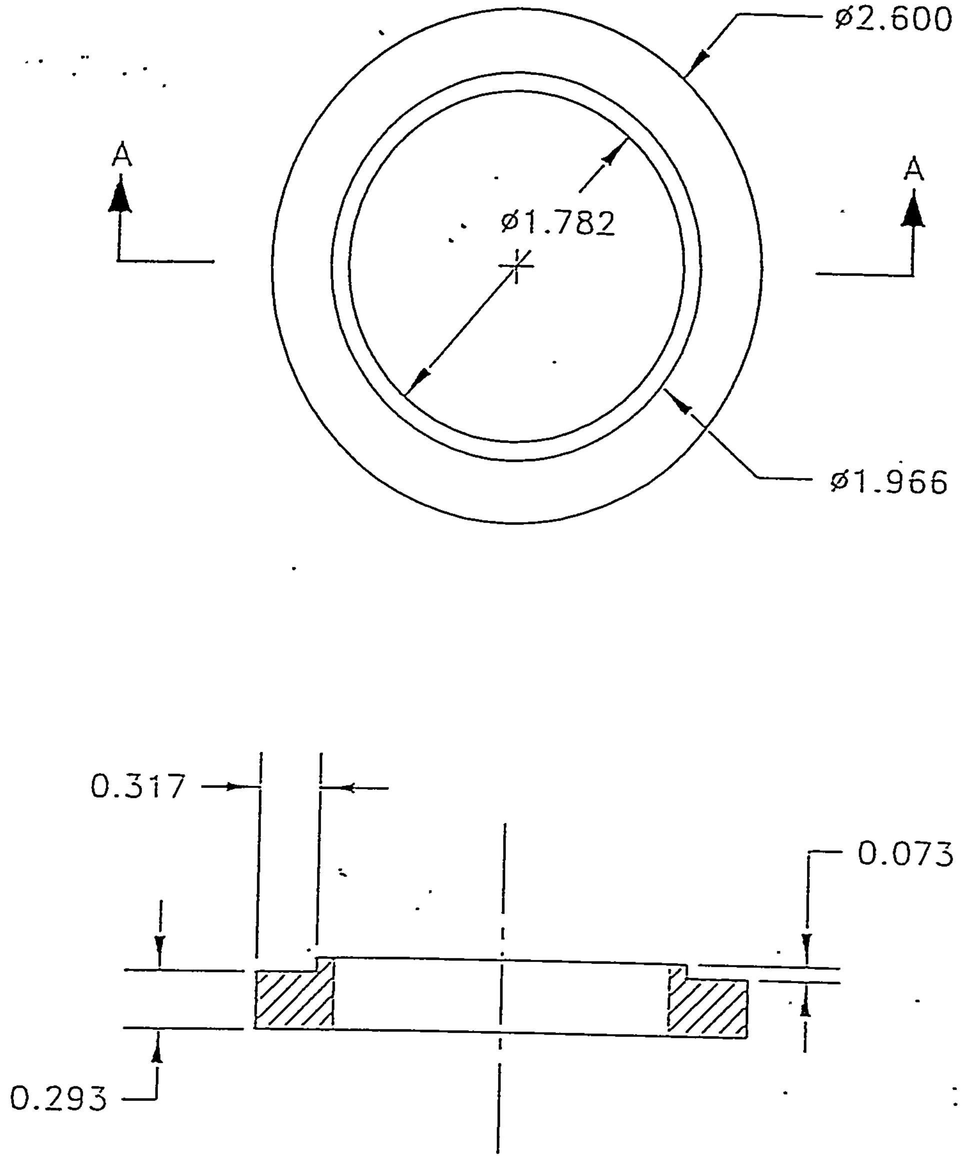
Southern Research Institute Power Systems Development Facility P.O. Box 1069	High–Temperature Impactor	Dwg. No: M7252–074 Revision: A Scale: Full	A



Material: Haynes Alloy 556

Figure 6

Southern Research Institute Power Systems Development Facility P.O. Box 1069 Wilsonville, AL 35186	High-Temperature Impactor Stage Retainer Cup	Dwg. No: M7252-075 Revision: A Scale: 1:1.1 Date: 3/23/96	A



View A–A

Material: Haynes Alloy 556

Figure 7

Southern Research Institute
Power Systems Development Facility
P.O. Box 1069

High–Temperature Impactor
Internal Spacer

Dwg. No: M7252–075
Revision: A
Scale: Full

Recycle Gas Booster Compressor Pressure Profile for Commissioning Run

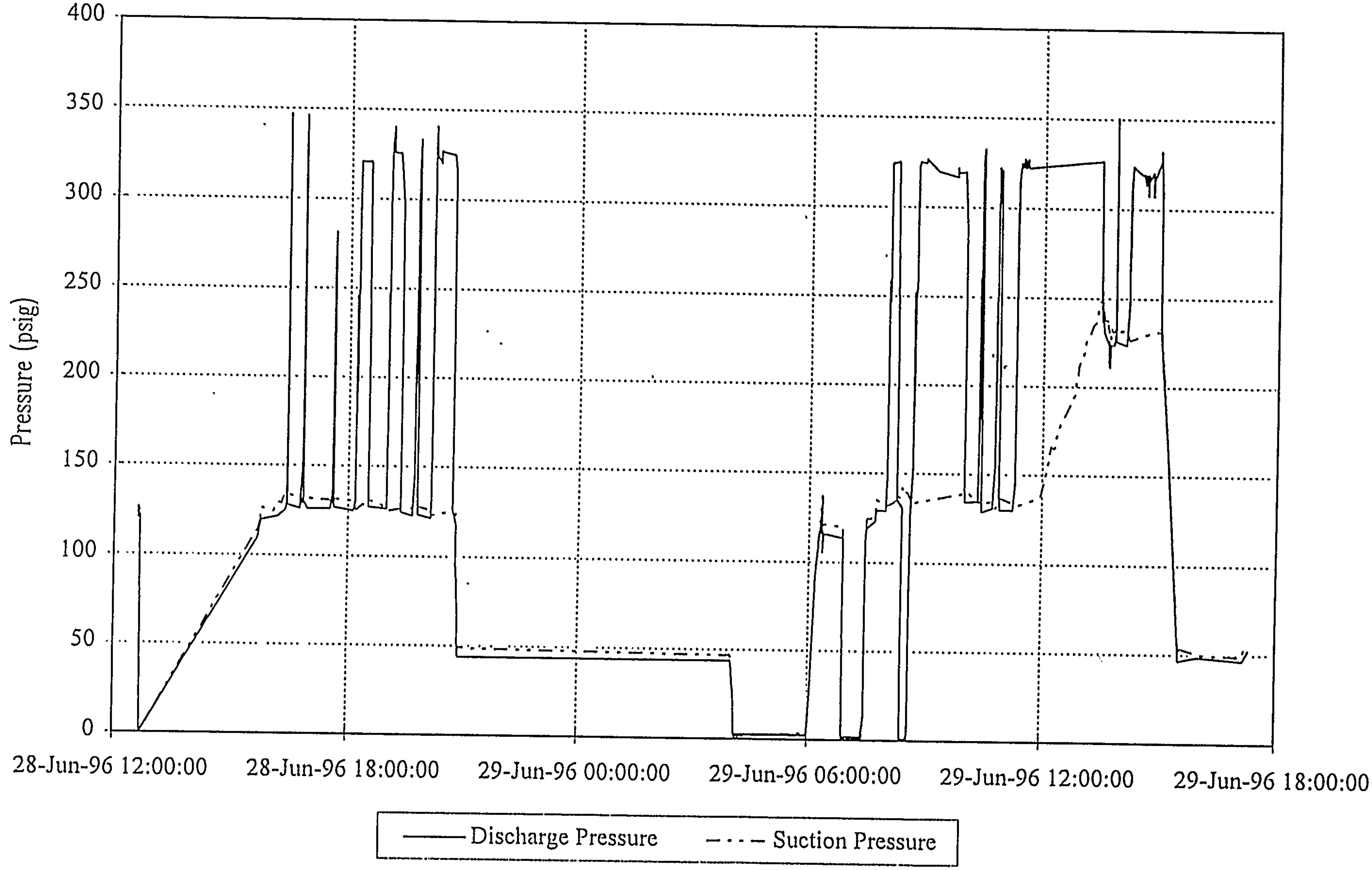
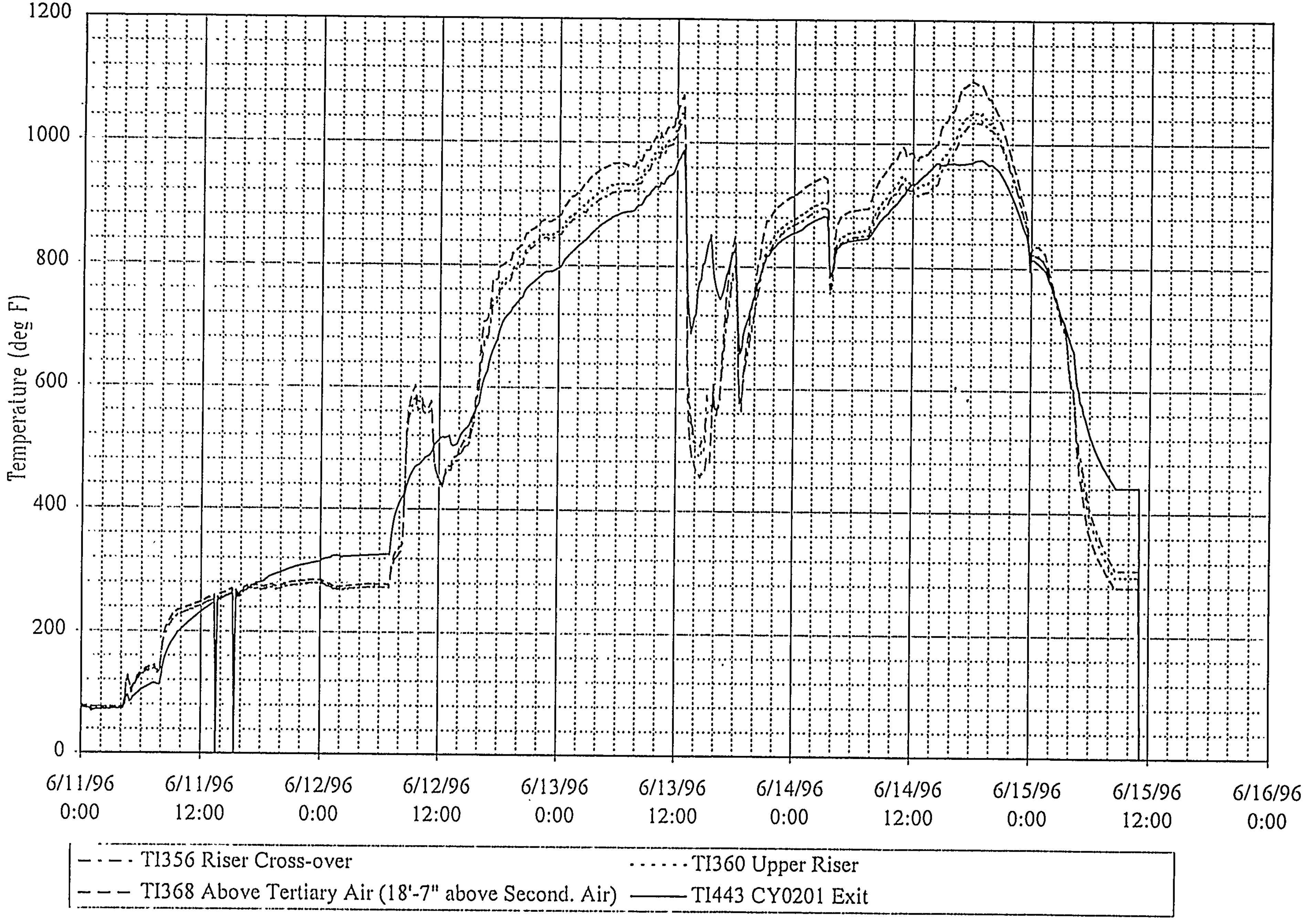


Figure 8

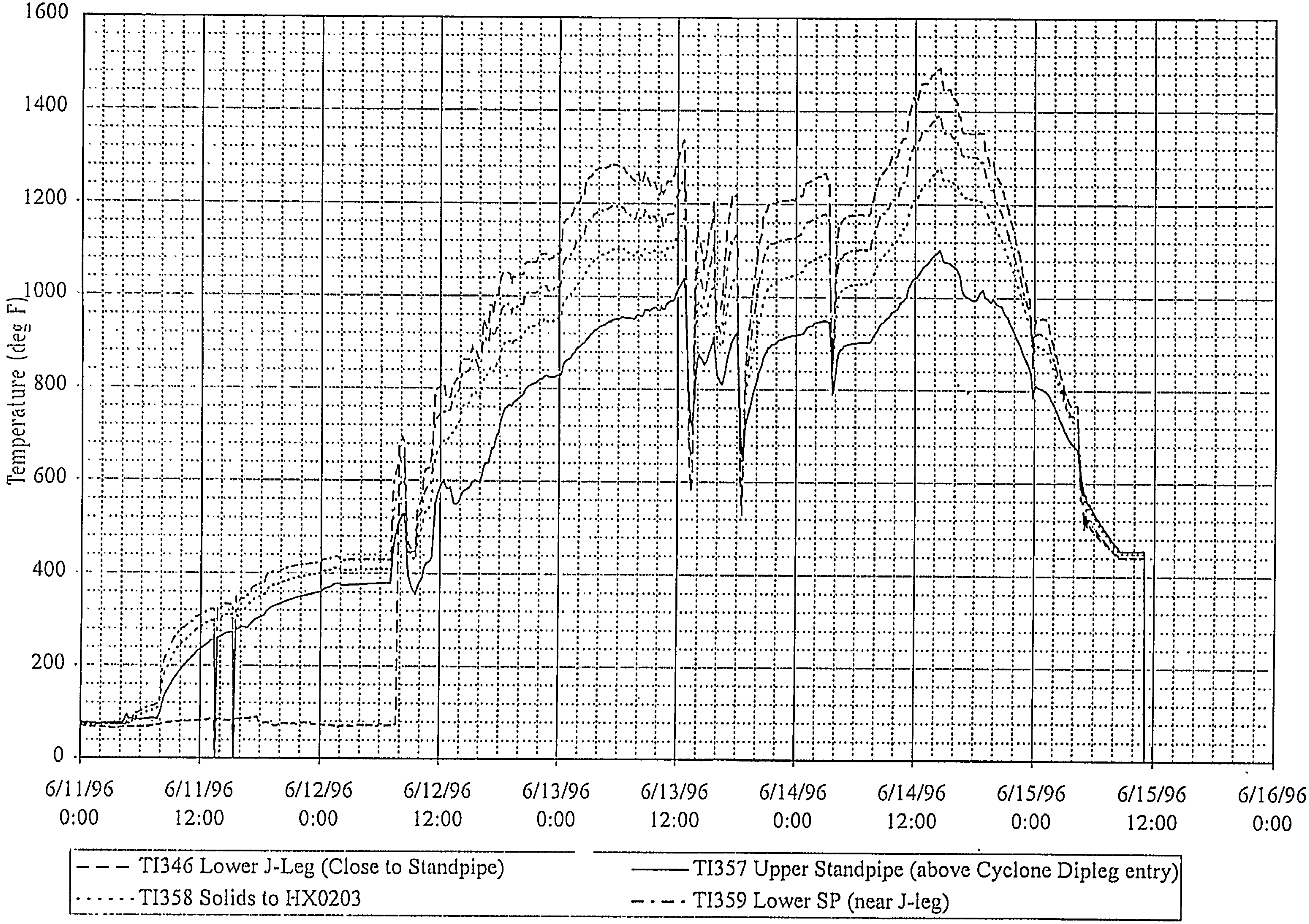
Riser, Cyclone Exit Temperature Profiles



SOUTHERN COMPANY SERVICES INC.

8/2/96
Figure 9

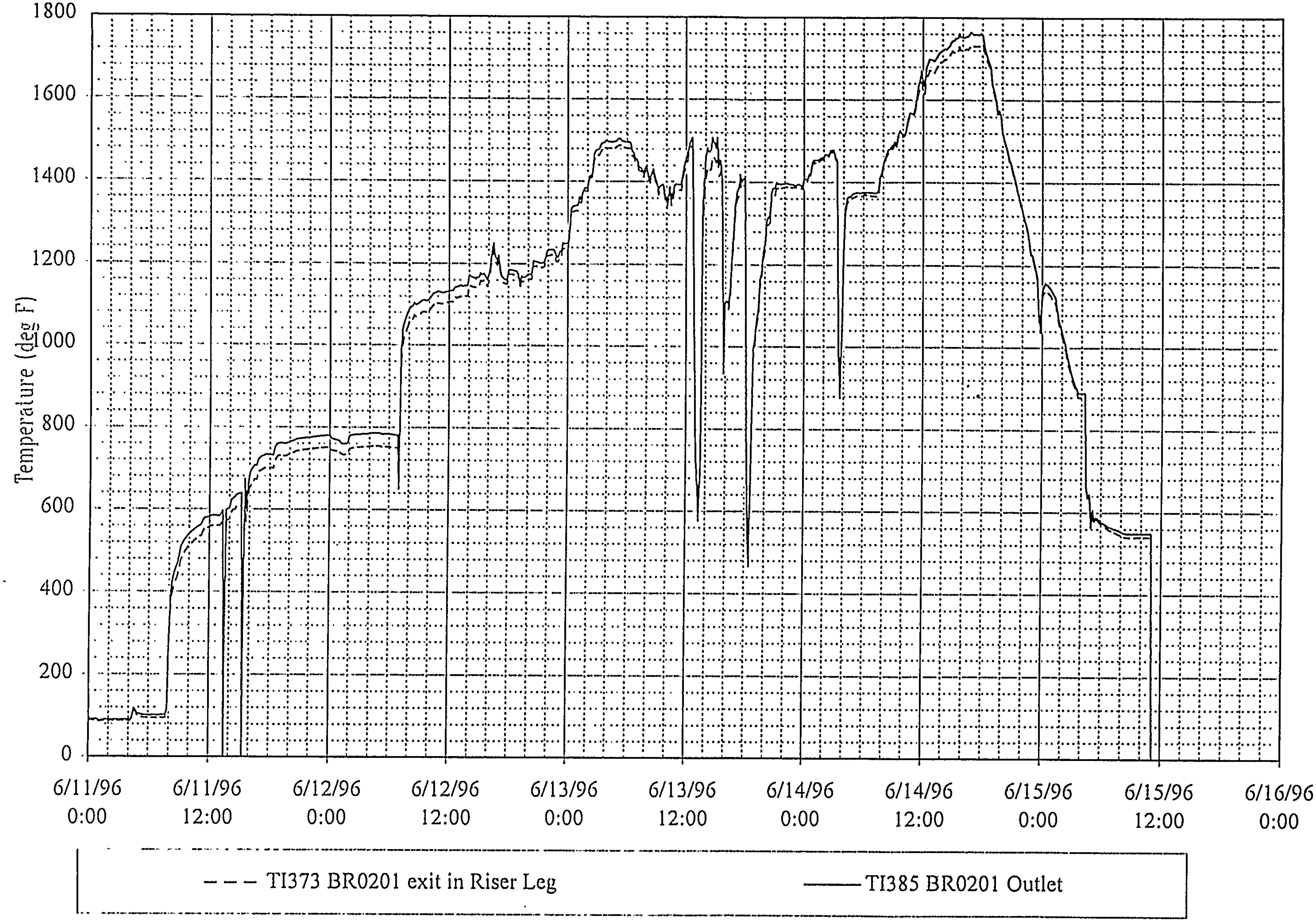
Standpipe Temperature Profiles



SOUTHERN COMPANY SERVICES INC.

8/2/96
Figure 10

Burner Exit Temperature Profiles



SOUTHERN COMPANY SERVICES INC.

8/2/96
Figure 11.

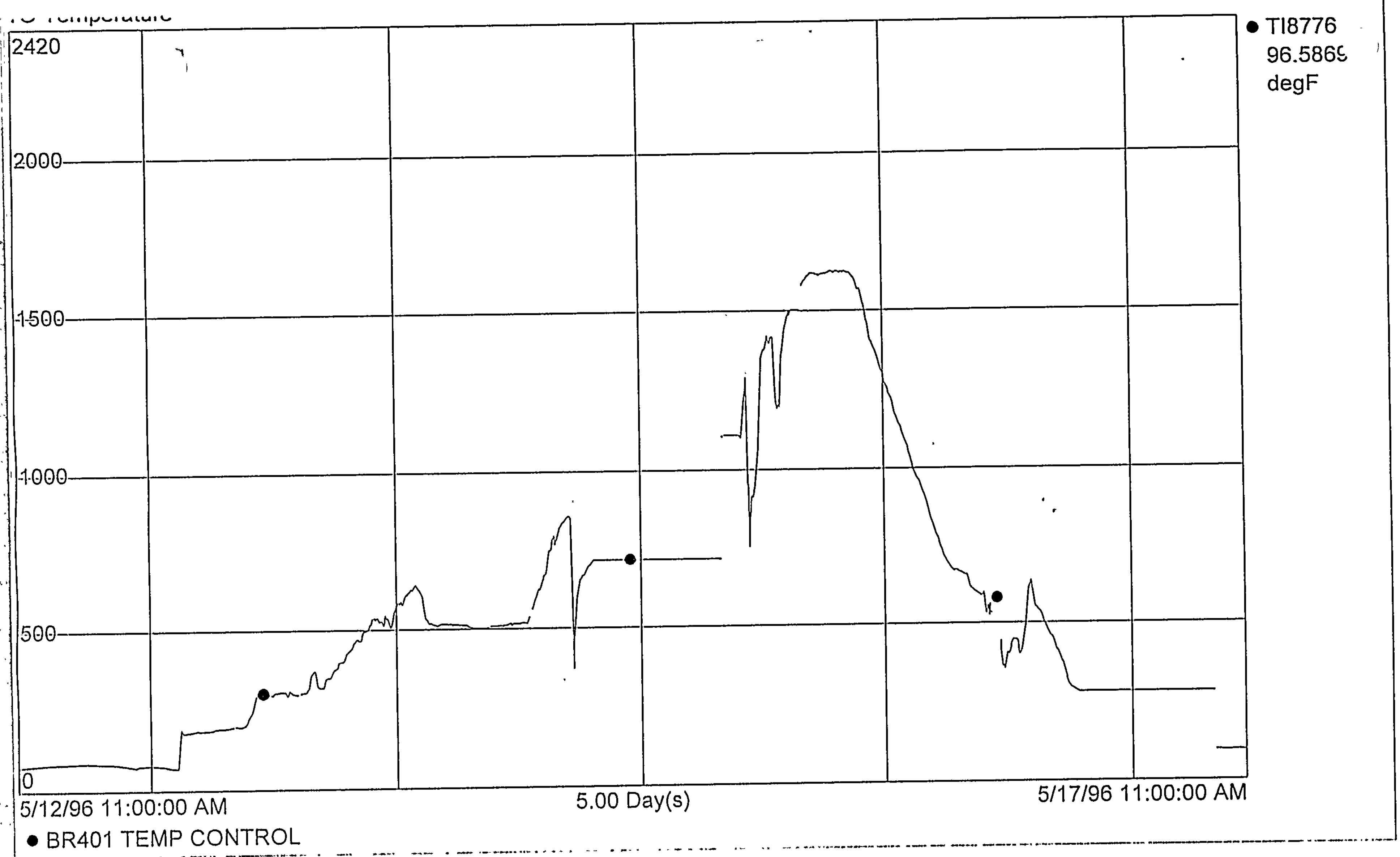

2420
2000
1500
1000
500
0
5/12/96 11:00:00 AM
5.00 Day(s)
5/17/96 11:00:00 AM
● BR401 TEMP CONTROL
● TI8776
96.5869
degF

Figure 12