

1 of 3

PFBC HGCU Test Facility
Technical Progress Report

First Quarter, CY 1994

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I. INTRODUCTION

This is the eighteenth Technical Progress Report submitted to the Department of Energy (DOE) in connection with the cooperative agreement between the DOE and Ohio Power Company for the Tidd PFBC Hot Gas Clean Up Test Facility. This report covers the period of work completed during the First Quarter of CY 1994.

During this quarter, the Tidd Hot Gas Clean Up System operated for 835 hours during six separate test runs. The system was starting into a seventh run at the end of the quarter. Table I summarizes all test runs since initial operation. Highlights of this period are summarized below:

- Operated HGCU for 835 hours (850 including beginning of the seventh test run)
- Longest run during the quarter was approximately 333 hours.
- Filter pressure drop was stable during all test runs this quarter using spoiling air to the primary cyclone upstream of the Advanced Particle Filter (APF).
- The tempering air system was commissioned this quarter which enabled the unit to operate at full load conditions while limiting the gas temperature in the APF to 1400F.
- During a portion of the one run, the tempering air was removed and the filter operated without problems up to 1450F.
- Ash sampling was performed by Battelle personnel upstream and

downstream of the APF and ash loading and particle size distribution data were obtained.

- A hot area on the APF head was successfully repaired in service.
- A hot spot on the top of an expansion joint was successfully repaired by drilling holes from the inside of the pipe and pumping in refractory insulation.
- A corrosion inspection program for the HGCU system was issued giving recommendations for points to inspect.
- Filter internal inspections following test runs 13 and 17 revealed a light coating (up to 1/4" thick) of residual ash on the candles and some ash bridging between the dust sheds and inner rows of candles. No candle breaks were observed.

On March 31, 1994, we presented a summary of the results of APF testing during this quarter to the Department of Energy (DOE) at Morgantown, WV.

II. WORK ACCOMPLISHED DURING THE REPORTING PERIOD

2.1 Detailed Design and Engineering

In addition to monitoring and evaluating the performance of the HGCU system during testing, engineering effort was devoted to the following other activities:

- Developing a corrosion inspection program for the HGCU system
- Developing a procedure for repairing a hot spot on expansion joint No. 7 and following the field repair of the joint
- Developing a procedure for repairing a hot spot on the APF head
- Recommending a means to heat trace and insulate the flow instrument (Annubar) to prevent corrosion
- Analyzing flow rate data and concluding that the data from certain test runs is invalid

Two incidents during testing this quarter focused attention to corrosion potential in the HGCU system. The first incident occurred during test run 13 when two pipe plugs in the Annubar head began leaking at the threads. Following the run, the plugs were removed and found to be corroded. The threads in the Annubar were in good condition. The 304 stainless steel pipe plugs were replaced with Hastelloy C276 material. (The Annubar head is Hastelloy.) The second incident occurred during the test run No. 14 when the unit

had to be shut down due to a leak in a 1" nipple connected to the HGCU pipe. Upon removal and inspection, the Hastelloy C276 nipple was found to be corroded internally from condensed flue gas. The line was not in service so the nipple was relatively cool and below the dew point of the flue gas. It will be replaced by a heavy wall (0.4") nipple made from Hastelloy C22, and it will be heat traced and insulated to maintain it above the dew point.

Following test run No. 15, the Annubar was removed from the pipe nozzle for inspection. During this inspection, the Hastelloy C22 liner in the 6" pipe nozzle also exhibited some pitting corrosion. As a result, we developed recommendations for heat tracing the Annubar flanges and instrumenting the pipe nozzle to monitor its temperature. This change was implemented between runs No. 15 and No. 16.

As a result of the corrosion issues noted above, a comprehensive review was made of the HGCU system to locate potential areas of corrosion. Following this review, a corrosion inspection program was submitted to the plant giving a prioritized list of areas to inspect in the system.

The second major engineering activity this quarter involved developing a repair procedure to eliminate a hot spot on the top of the bellows of expansion joint No. 7. During run No. 13, the top of the bellows of expansion joint No. 7 exhibited elevated temperatures (up to 700F) and it was necessary to remove insulation to reduce the temperature to below 700F. The hot spot was believed to be due to hot gas migrating to the bellows. In order to eliminate the problem, a repair was made during the outage between runs No.

13 and No. 14. One tee was removed from the HGCU system in order to gain access to the inside of the expansion joint. Two rows of six holes each were drilled into the cavities near the inner and outer bellows (see Figure 1). Then refractory insulation was pumped through the holes. A total of 13 gallons were pumped in. This repair was successful as seen in the following runs where the top of this expansion joint was reduced to 500 - 525F. It should be noted that the repair could not be made by drilling from the outside without penetrating the Hastelloy liner inside the pipe spool.

A similar repair was made on line to a hot area on the head of the APF during run No. 15 as discussed in a subsequent section.

The gas flow rate measured during runs No. 13, 14, and 15 seemed to be unusually high (over 141,000 lb/hr in some cases). The data from past runs and runs No. 16 and No. 17 were compared using the venturi flows as somewhat indicative of the relative gas flows. Based on this analysis and the discovery that the instrument tubing at the flow meter was found to be leaking and containing condensed liquid after test run No. 15, it was concluded that the Annubar flow rate data from runs No. 13, No. 14 and No. 15 was unreliable. Between runs No. 15 and No. 16, the tubing was replaced and sloped to prevent condensation from collecting in the lines. Also, as noted above, the Annubar flanges were heat traced and insulated which should prevent condensation of the flue gas near the tubing connections on the Annubar.

As discussed in the last quarterly report, a system was designed to enable the primary cyclone upstream of the APF to be rendered totally ineffective. This modification would greatly increase and quantity

and mean particle size of the ash entering the APF. A second emergency ash removal line that would be required for this system was also engineered. Materials for this system were purchased and delivered. However, there are presently no plans to install this system since the APF appears to be functioning properly with the existing cyclone detuning system. The system could be installed at a later date if the APF DP stability becomes an issue during testing above 1450F.

2.3 Westinghouse Engineering and Design

See Appendix 1.

5.0 Testing

During the first quarter of 1994 a total of six test runs were completed. The test durations ranged from 19 to 333 hours of coal fire. In general, testing of the APF went smoothly with no major problems. Only one unit shutdown was caused by the HGCU system and that was due to a leak in a 1" sampling line nipple. The following is a discussion of each of the test runs.

Test run 12 - 1/10 to 1/11/94

This test run was terminated after 19 hours of coal fire when several primary cyclones became plugged. Due to the brevity of this run and lack of steady state operation near design conditions, it will not be discussed further.

Test Run 13 - 1/15 to 1/29/94

During Run 13, the unit was operated for 333 hours on coal fire burning Pittsburgh No. 8 coal and Plum run Greenfield dolomite. The primary objective of this run was to assess the performance of the APF while operating with the primary cyclone ahead of the filter detuned to produce a coarser ash and higher ash loading. The tempering air system was commissioned during this run and functioned without any problems.

During the run, ash sampling was performed upstream and downstream of the APF using specially designed sampling probes. The results showed that by detuning the primary cyclone, the ash loading to the filter increased from a design value of 600 ppm to about 3400 ppm, and the mean particle size of the ash increased from about 3 to 7 microns. Refer to Appendix 2 for detail results of the ash sampling. The higher ash concentration resulted in significantly higher ash loading. Despite the higher ash loading, the filter performed very well.

Figure 2 shows a graph of filter pressure drop and temperature for Run 13. The unit load was reduced at about 200 and 250 hours into the run due to bed sintering problems, which accounts for the dips in temperature, and DP during these periods. During the remaining periods of this run, the filter pressure drop remained quite stable and exhibited the usual trend of following gas temperature. During the last 50 to 75 hours of the run, the unit bed height was increased to the maximum (142 inches). During this period, the filter DP increased somewhat due to higher gas flow and dust loading.

Following shutdown of the unit, the filter was inspected via nine 3-in. nozzles on the side of the vessel. In general, the candles looked in good condition with very little residual ash accumulation. However, some ash bridging was seen between the bottoms of the inner rows of candles and the dust sheds on the plenum support pipes.

Prior to Run 14 additional insulation was pumped into the APF head insulation from the inside of the APF. However, this did not prove to be entirely successful, and additional insulation had to be pumped in from the outside during Run No. 15 as discussed below.

Test Run 14 - 2/17 to 2/18/94

This test run was terminated after 23 hours of coal fire when a 1" nipple on the HGCU piping developed a leak that could not be repaired in service as previously discussed. A plot of filter DP and temperature versus time for Run 14 is shown in Figure 3.

Test Run 15 - 2/19 to 2/25/94

This run was a hot restart of the previous run. Overall, the APF performed without any major problems during this run. Some minor problems, however, arose. Shortly after startup, the APF dome exhibited elevated temperatures (up to 730F) near the gas outlet nozzle. The gas temperature was held to the 1250F range in order to keep the hot areas below 750F. On 2/21 an on-line repair was successfully made which reduced the hot areas to below 300F in some areas and to below 400F in others. The repair involved drilling and tapping three 1/4" holes in the outlet nozzle near the head and pumping in 45 gallons of pumpable insulation. Following this repair

the unit was brought up to full bed height (142"). Tempering air was again used to limit the gas temperature in the APF to 1400F. Figure 4 shows a graph of APF DP and temperature versus time for this run. The unit load was reduced about 110 hours into the run when a coal pasted pump stopped working. After the bed again stabilized, the unit was returned to full load. The HGCU system functioned without further problems from this point until the unit tripped due to loss of the sorbent booster compressor.

Test Run 16 - 3/3 to 3/9/94

Most of this test run was conducted at 142" and 150" bed levels. As is the previous run, tempering air was used to limit the filter gas temperature to 1400F. This run was smoothest so far the HGCU system. The system operated for over 145 hours without any major problems. Figure 5 shows a plot of APF DP and temperature during Run 16. Figure 6 shows DP and flow rate. The APF DP exhibited a gradual decline throughout this run. This reason for this is unknown. The test conditions throughout Run 16 were the most steady of all the runs so far. Therefore, data from this run should be considered a good baseline reference for APF operation at 1400F. This run was terminated when the unit tripped due to the loss of two coal paste pumps.

Test Run 17 - 3/16 to 3/23/94

Prior to this test run, the screw cooler hydraulic motor seals leaked hydraulic fluid which contaminated the lube oil system on the screw cooler. The hydraulic motor was replaced with a spare, and the lube oil system was drained and cleaned before start-up.

This was another relatively uneventful run on the HGCU system. The unit operated for approximately 164 hours on coal fire. Most of the run was conducted at 128" bed level, with portions at 142" and 115". Due to bed sintering problems, the bed level could not be maintained at 142". The tempering air was turned off during this run which allowed the APF to operate up to 1450F. The filter pressure differential was relatively stable throughout the run as shown in Figures 7 and 8. During this run additional insulation was pumped into the APF head to lower the surface temperature in one area from 550F to 400F. The unit tripped due to a low oil pressure indication on the gas turbine.

The APF internals were again inspected through the nine instrument nozzles following Test Run 17. No broken candles were observed. The residual ash layer on the candles was somewhat thicker than seen following Test Run 13 and appeared to be about 1/8" to 1/4" thick. The ash coating was uniform from candle to candle but also very rough looking on all the candles. The ash bridging previously seen between the dust sheds and the inner rows of candles was still evident, but not obviously worse than before. The amount of ash accumulation on the dust sheds varied considerably (1/2" to 4") among the six dust sheds. No candle-to-candle bridging was seen.

It should be noted that all of the testing done during this quarter utilized spoiling air to the primary cyclone upstream of the APF. The beneficial effects of the spoiling are apparent in the stability of the filter DP in all of these runs. As noted previously, the coarser ash particles result in an ash cake that is easier to remove from the candles than the ash cake obtained without spoiling air in

service. In addition, removal of the ash from the APF hopper has not been a problem since the spoiling air has been in service. The spoiling air also reduces the temperature of the gas from the cyclone approximately 90F at full load conditions.

7.0 Hazardous Air Pollutants

The special HGCU sampling hardware was shipped to Tidd Plant this quarter. Testing is scheduled for the second quarter of 1994.

III. MANPOWER REPORT AND COST DATA

As of March 31, 1994, the AEPSC Engineering, Design and Project Support cumulative work-hours were 69,435 or 100.0% of the total 69,097 revised work-hours projected for the project. Figure 9 compares the actual work-hours expended versus the current estimate. For the reporting period, a total of 1,069 hours were charged to the project by AEPSC personnel.

The actual DOE's cost expenditure during the First Quarter 1994 were \$935,663. As of March 31, 1994, the cumulative DOE's cost expenditures were \$18,213,505. Figure 10 depicts the cumulative expenditure forecast for the project which includes Westinghouse cost share. During the First Quarter 1994, Westinghouse was paid a total of \$329,884. Total payments to Westinghouse through March 31, 1994 were \$6,559,735. Major contractual commitments during this reporting period totalled \$183,636 and are summarized as follows:

<u>Contract Purchase Order</u>	<u>Description (Contractor)</u>	<u>Contracted Costs</u>
09964-071-3	Refractron SiC Ceramic Candles	\$ 183,636

Table I
TIDD HGCU RUNS - SUMMARY

<u>RUN NO.</u>	<u>COAL FIRE DATE</u>	<u>COAL FIRE TIME</u>	<u>UNIT TRIP DATE</u>	<u>UNIT TRIP TIME</u>	<u>COAL FIRE TIME HRS:MIN</u>	<u>NOTES</u>
0*	05/21/92	20:26	05/23/92	07:41	35:14*	Bypass mode. Unit trip due to XJ-4 failure.
1	10/28/92	18:10	11/01/92	23:32	101:22	Unit trip due to HGCU ash lockhopper pluggage.
2	11/17/92	09:33	11/17/92	10:50	1:17	Unit trip due to plugged primary cyclones.
3	11/21/92	18:41	11/24/92	22:50	76:09	Unit trip due to coal paste problems.
4	11/25/92	12:11	12/07/92	09:56	285:45	Warm start-up. Unit trip due to XJ-7 failure. 21 candles found broken during outage.
5	06/30/93	17:28	07/03/93	05:04	59:36	Shutdown to change G.T. telemetry instrumentation.
6	07/05/93	00:35	07/05/93	17:17	16:42	Completed G.T. testing.
7	07/18/93	18:20	08/05/93	12:22	426:02	Shutdown due to ash buildup on APF liner.
8	08/09/93	10:18	08/09/93	11:37	1:19	G.T. trip due to bearing vibration.
9	08/10/93	22:29	08/14/93	05:27	78:58	Warm start-up. Shutdown due to low O ₂ resulting from high coal paste excursion.
10	08/19/93	17:48	08/24/93	13:28	115:40	Manual combustor trip due to deteriorating bed and evaporator conditions after switching to limestone.
11	08/29/93	23:31	09/23/93	20:12	596:41	Combustor trip due to leak in sorbent transport pipe. 62 candles found broken during outage.
12	01/10/94	06:41	01/11/94	01:36	18:55	Manual combustor trip due to plugged primary cyclone.
13	01/15/94	23:42	01/29/94	20:31	332:49	Manual combustor trip due to boiler tube leak.
14	02/17/94	14:58	02/18/94	14:14	23:16	Manual combustor trip due to leak in HGCU gas sample connection.
15	02/19/94	06:12	02/25/94	13:09	150:57	Manual combustor trip due to loss of sorbent air compressor.
16	03/03/94	10:22	03/09/94	11:30	145:08	Manual combustor trip due to loss of two paste pumps.
17	03/16/94	14:48	03/23/94	10:50	164:02	G.T. trip due to low lube oil pressure.
Total Coal Fire Time* (Hrs:Min)					2594.38	

*During Run 0, HGCU system was in bypass mode, time not included in total.

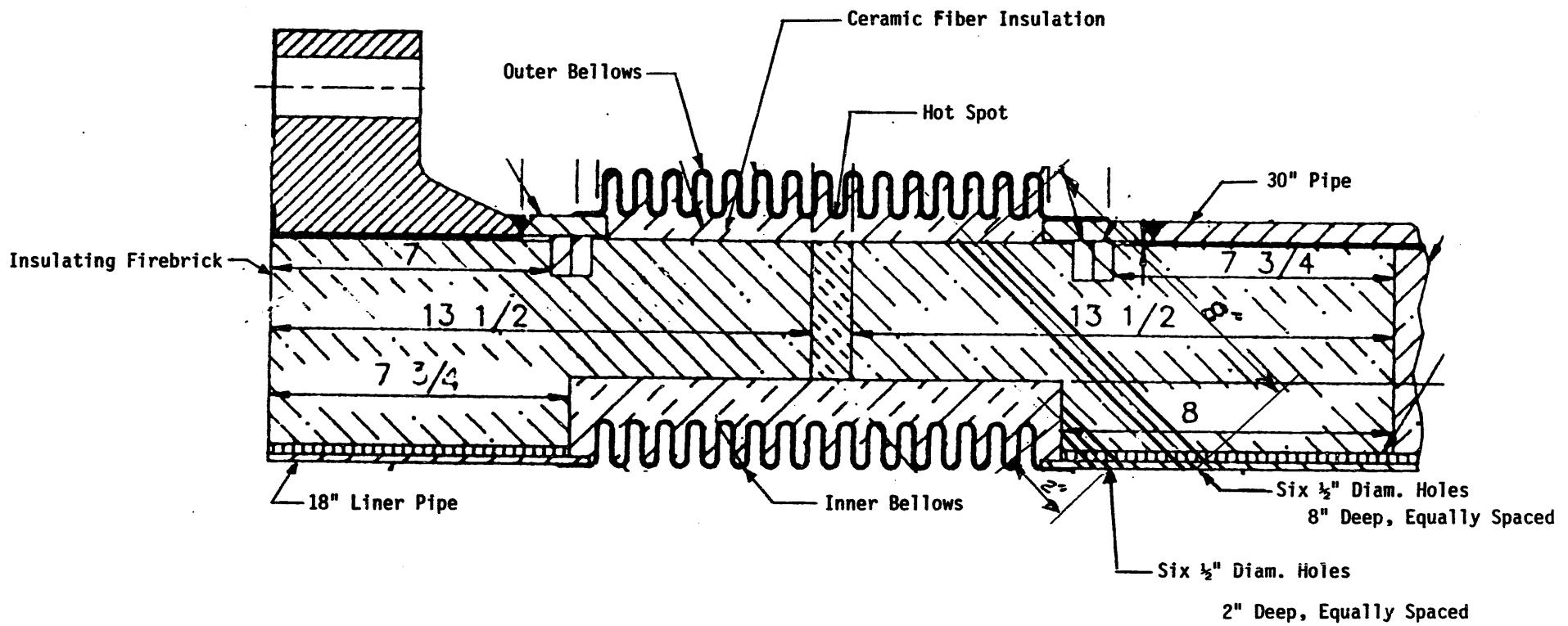
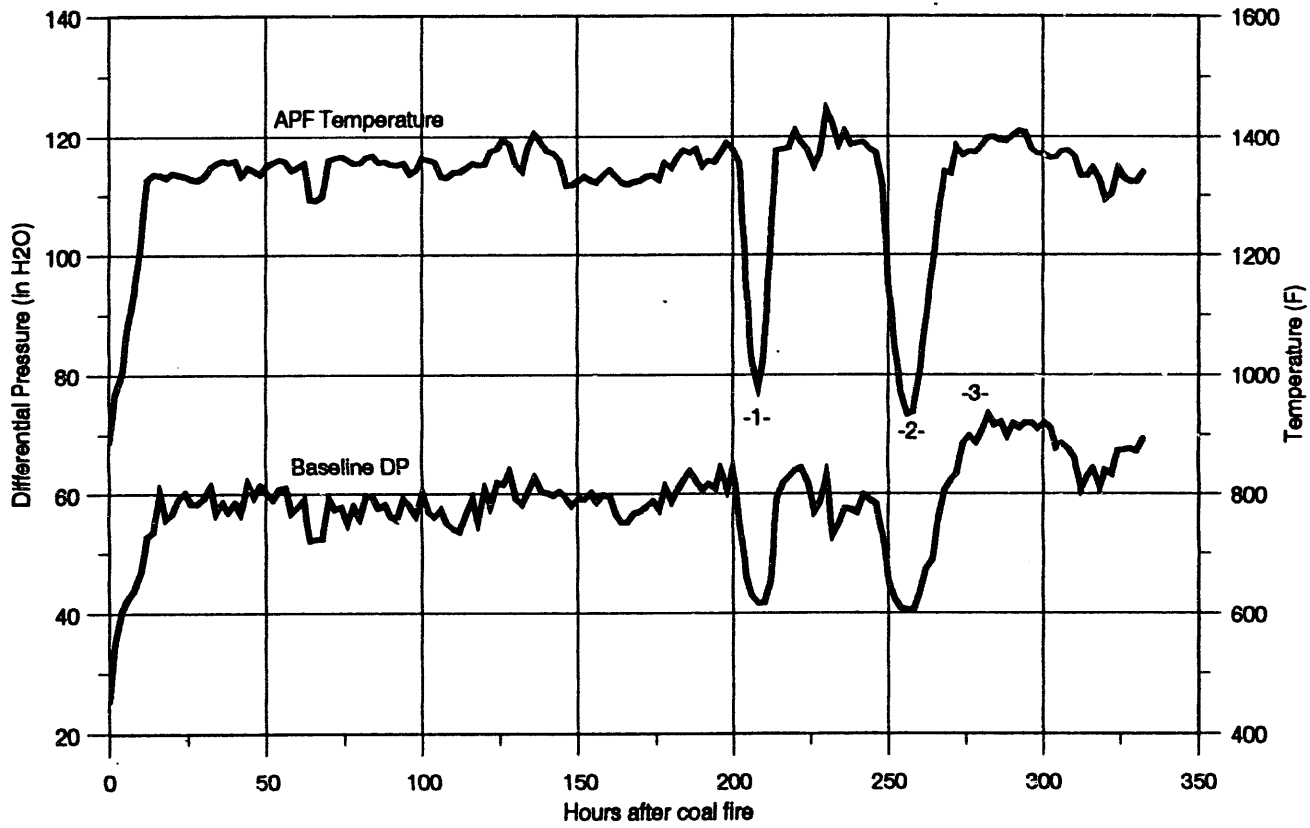


Figure 1

Location of Holes Drilled into Expansion Joint No. 7
for

FILTER DP AND TEMPERATURE DURING TEST RUN 13

January 15.- 29, 1994



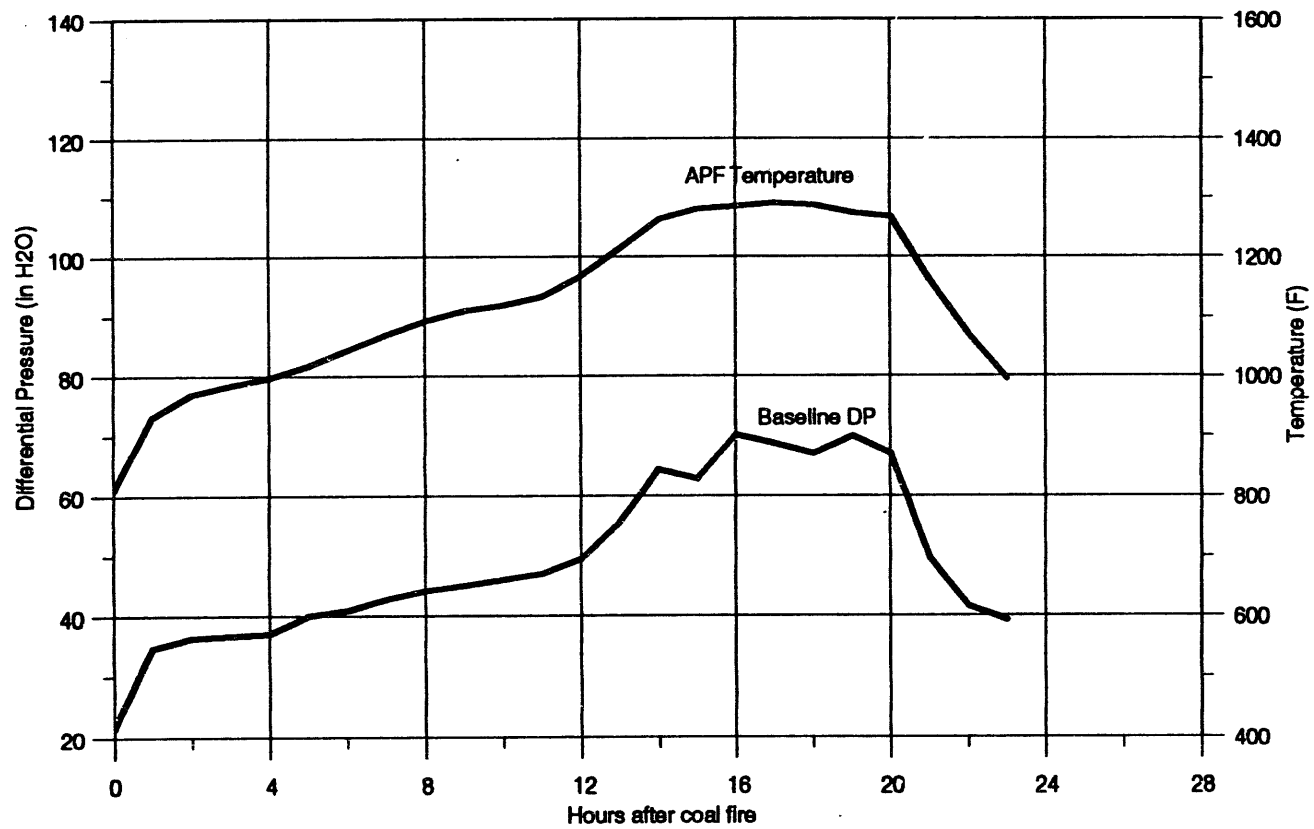
- 1. Reduced unit load.
- 2. Reduced unit load.
- 3. Increased load, Tempering air on.

Note: Temperature based on 2 hour averages, DP based on minimum value over 2 hour periods.

Figure 2

FILTER DP AND TEMPERATURE DURING TEST RUN 14

February 17-18, 1994

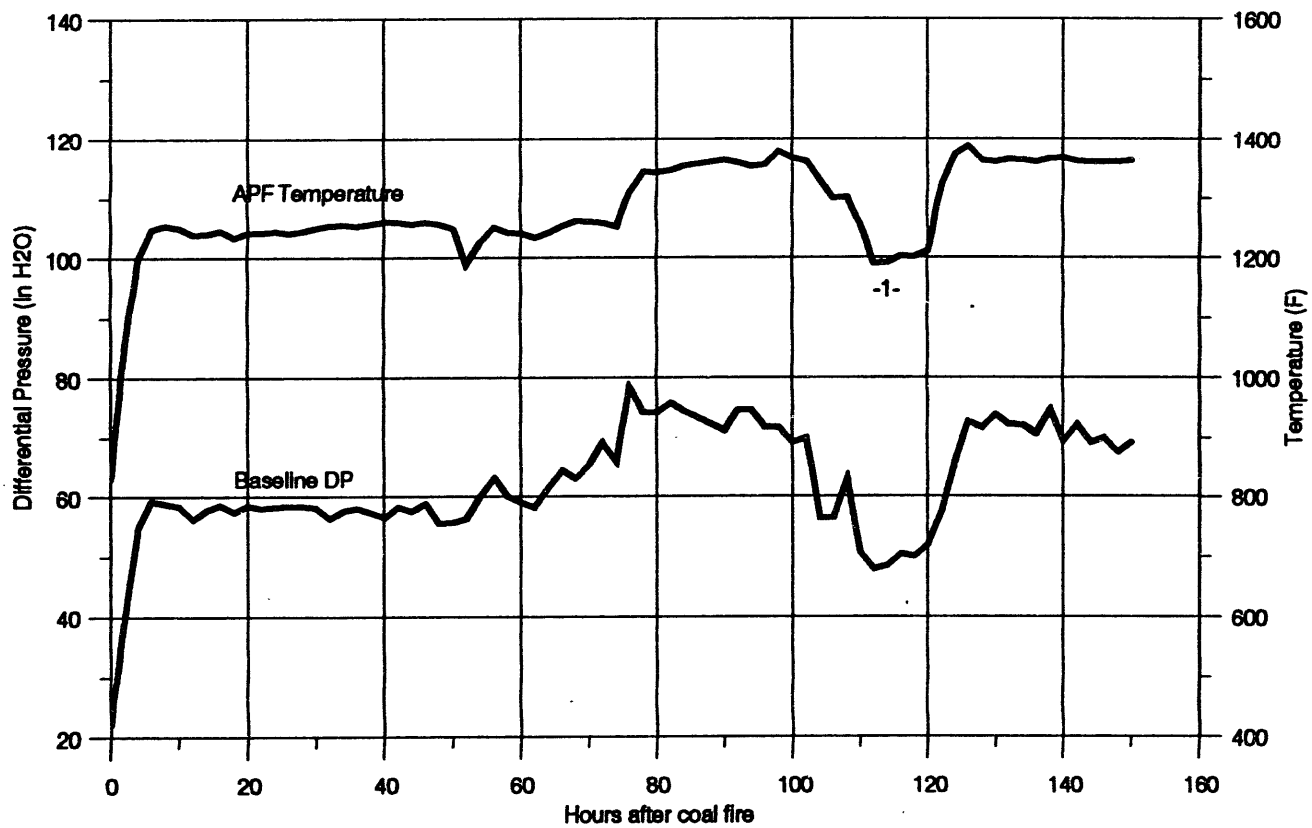


Note: Temperature based on 1 hour averages, DP's based on minimum value over 1 hour period.

Figure 3

FILTER DP AND TEMPERATURE DURING TEST RUN 15

February 19 - 25, 1994

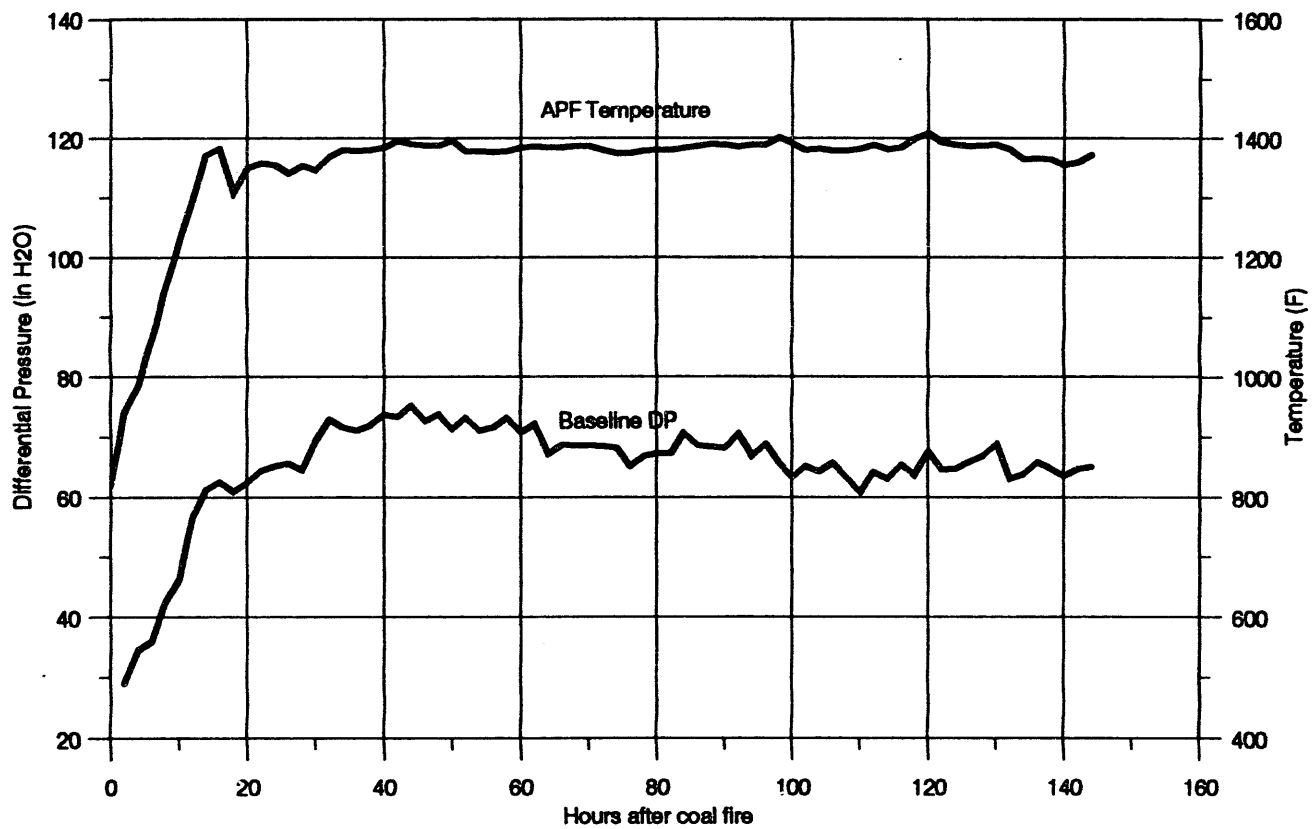


Note: Temperature based on 2 hour averages, DP based on minimum value over 2 hour periods.

Figure 4

FILTER DP AND TEMPERATURE DURING TEST RUN 16

March 3 - 9, 1994

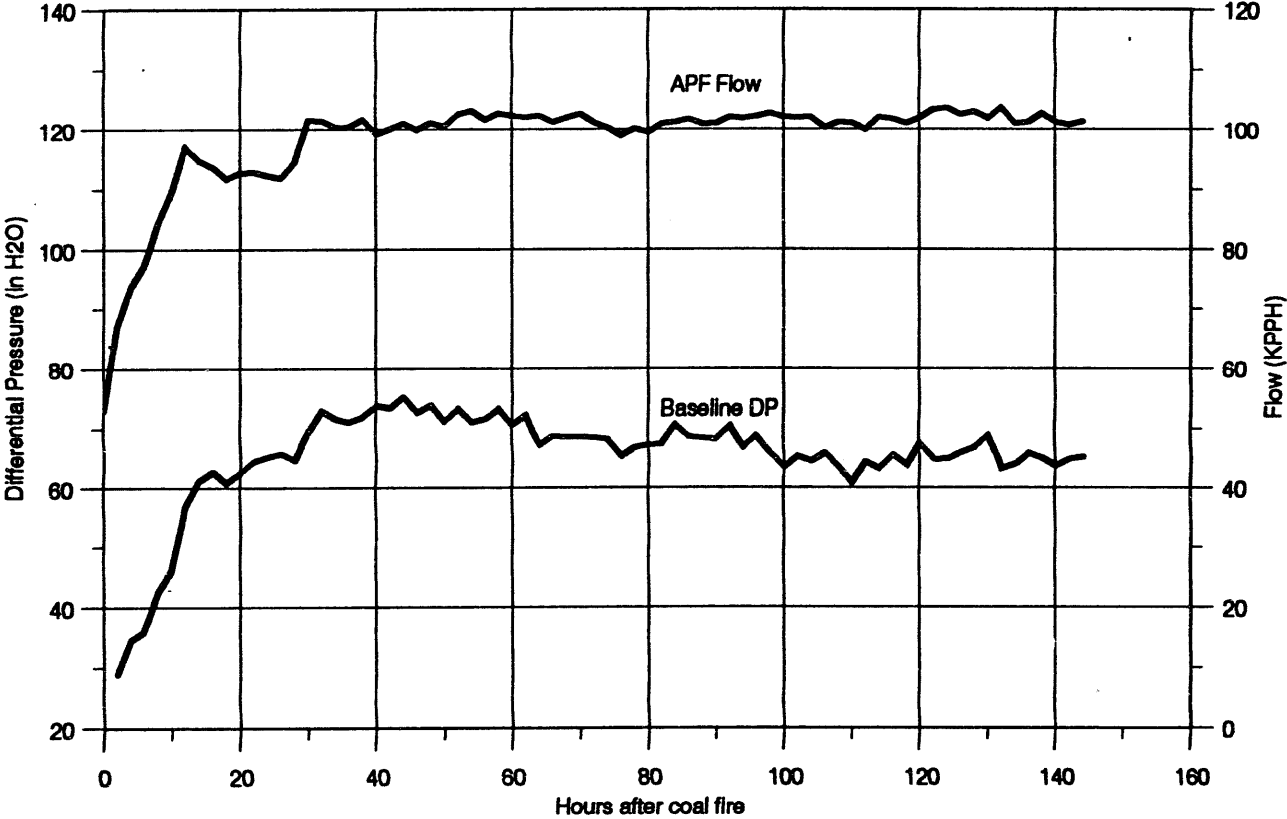


Note: Temperature based on 2 hour averages, DP's based on minimum value over 2 hour period.

Figure 5

FILTER DP AND FLOW DURING TEST RUN 16

March 3 - 9, 1994

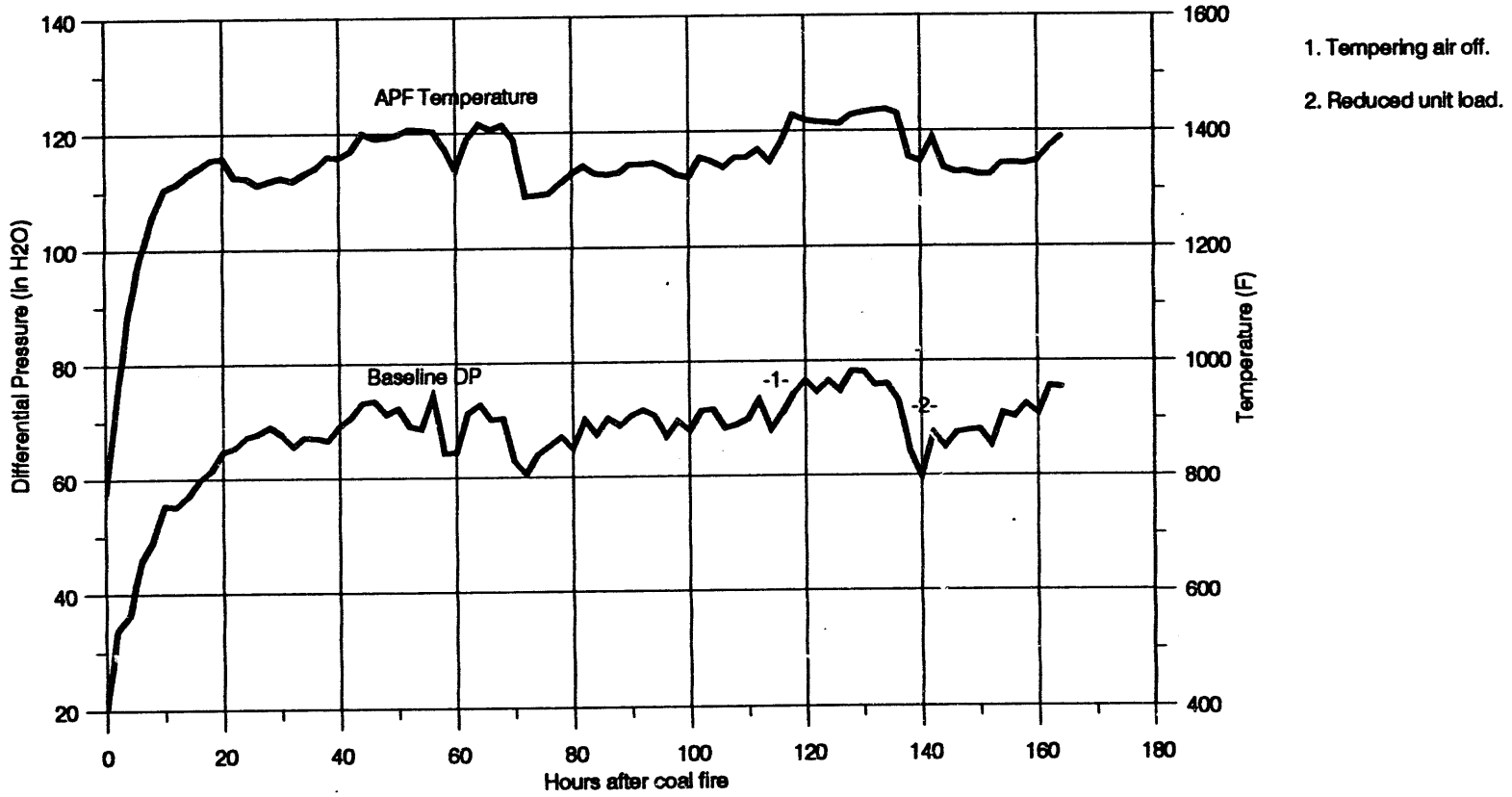


Note: Flow based on 2 hour averages, DP based on minimum value over 2 hour periods.

Figure 6

FILTER DP AND TEMPERATURE DURING TEST RUN 17

March 16 - 23, 1994

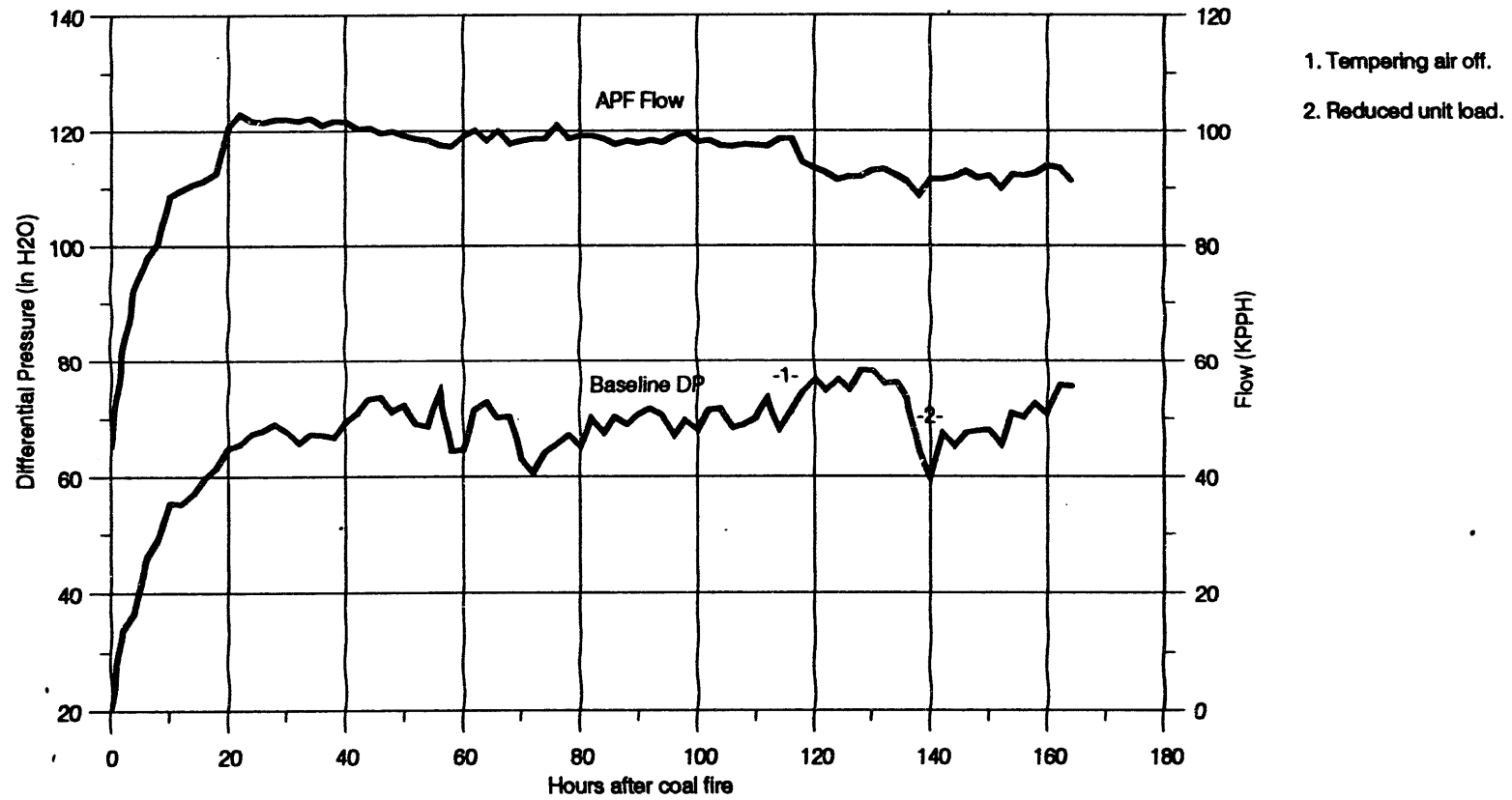


Note: Temperature based on 2 hour averages, DP based on minimum value over 2 hour periods.

Figure 7

FILTER DP AND FLOW DURING TEST RUN 17

March 16 - 23, 1994

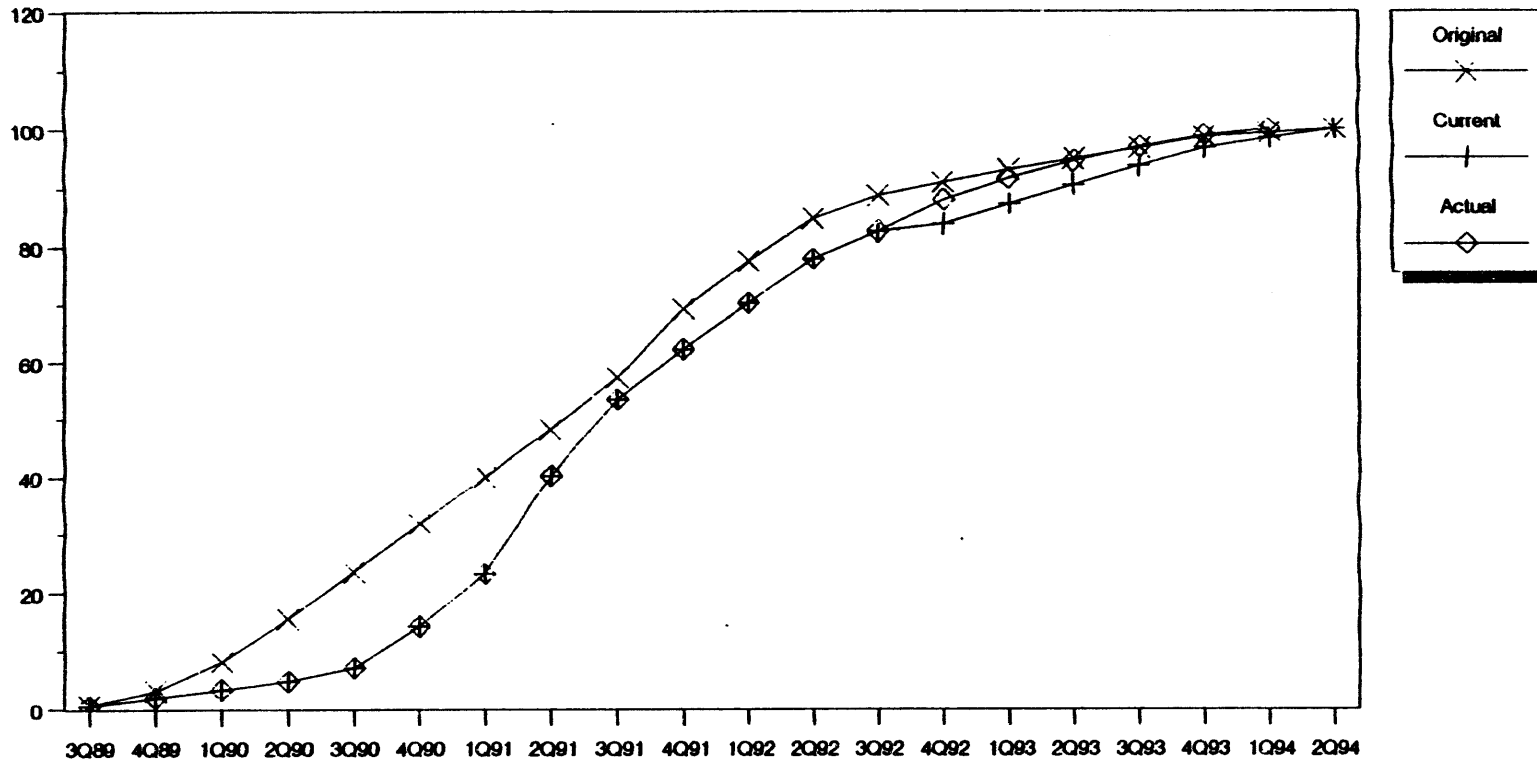


Note: Flow based on 2 hour averages, DP based on minimum value over 2 hour periods.

Figure 8

**PFBC Hot Gas Clean-Up Test Program
 AEPSC Eng., Design & Project Support Work-Hours
 Budget Versus Actual**

Cumulative %

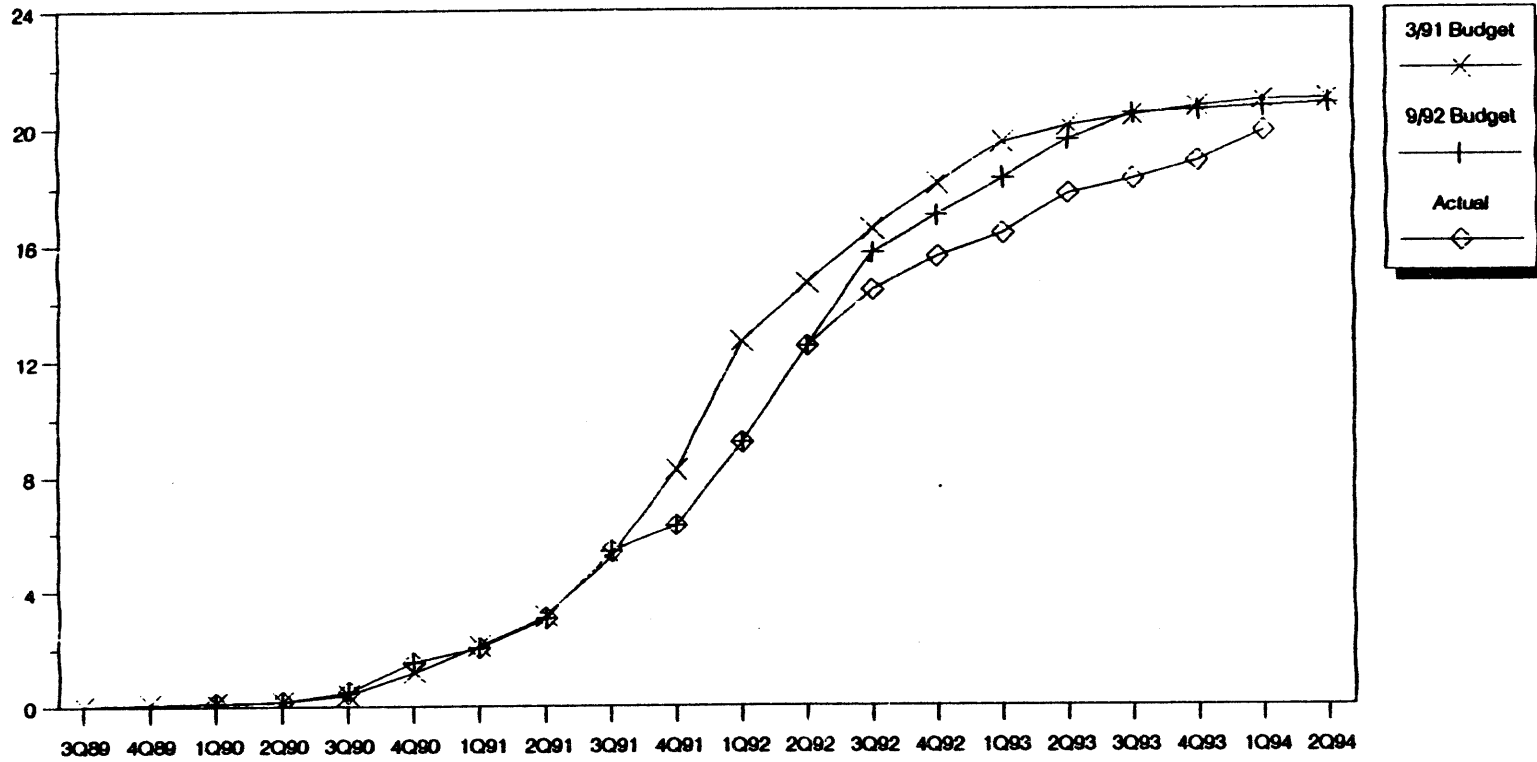


	3Q89	4Q89	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92	1Q93	2Q93	3Q93	4Q93	1Q94	2Q94
Original	0.8	3.2	8.1	15.6	23.6	31.8	40.0	48.2	57.3	69.2	77.4	84.7	88.6	90.9	93.1	94.9	96.7	98.6	99.3	100.0
Current	0.6	2.0	3.4	4.8	7.1	14.3	23.3	40.2	53.4	62.2	70.2	77.8	82.5	83.8	87.2	90.5	93.7	96.7	98.4	100.0
Actual	0.6	2.0	3.4	4.8	7.1	14.3	23.3	40.2	53.4	62.2	70.2	77.8	82.5	87.9	91.6	94.5	96.9	98.9	100.0	

Figure 9

**PFBC Hot Gas Clean-Up Test Program
Cumulative Expenditures
Budget Versus Actual**

(in Thousands)



	(\$000)																			
	3Q89	4Q89	1Q90	2Q90	3Q90	4Q90	1Q91	2Q91	3Q91	4Q91	1Q92	2Q92	3Q92	4Q92	1Q93	2Q93	3Q93	4Q93	1Q94	2Q94
3/91 Budget	18.7	70.1	106.3	152.3	383.1	1142.4	2108.4	3120.3	5213.0	8220.2	12683.5	14656.2	16524.3	18106.5	19483.3	20039.8	20372.3	20672.6	20898.9	20955.5
9/92 Budget			90.5	146.7	477.6	1531.3	2040.6	3059.1	5387.9	6280.4	9162.2	12522.0	15711.7	16998.3	18284.9	19571.4	20453.8	20567.8	20681.8	20796.5
Actual			90.5	146.7	477.6	1531.3	2040.6	3059.1	5387.9	6280.4	9162.2	12522.0	14397.6	15569.3	16362.4	17753.2	18254.2	18835.3	19853.4	

Figure 10

SUMMARY REPORT

on

**PARTICULATE SAMPLING (INLET/OUTLET)
OF AEP'S PFBC AT THE TIDD PLANT**

to

**AMERICAN ELECTRIC POWER
Columbus, OH**

April 13, 1994

by

Robert D. Litt and Paul R. Webb

**BATTELLE
505 King Avenue
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SUMMARY

Battelle measured the particulate mass loading and particle size distribution of the hot-gas (ceramic) filter inlet and outlet streams of AEP's PFBC at the Tidd plant in Brilliant, Ohio. These samples were collected on January 20-21, 1994. For these samples, the primary cyclone was detuned (by re-entraining particulate back into the cyclone exit gas stream) with the idea of challenging the hot-gas filter with larger and more concentrated solids emissions. The PFBC samples were taken with a specially designed sampling probe. A typical Method 5 protocol was employed. Particle size was also determined using an Andersen MARK III cascade impactor.

At the request of AEP, samples collected at the Tidd plant were sent to Southern Research Institute for further particle classification. A letter report showing the analytical results is included in Appendix A.

The following table summarizes the results:

	Inlet	Outlet
Mass Loading		
Grain/DSCF	1.85	0.021
lb/hr	400	4.6
ppm, wt basis	3489	39.2
Mean Particle Size, μm	7.0	

TABLE OF CONTENTS

	<u>Page</u>
SUMMARY	i
Introduction	1
Background	1
Objective	2
Approach	2
Technical Discussion	2
Probe Design	3
Isolation Valve	7
Holding Chamber	7
Air Cooled Probe	7
Method 5 Sampling Train	13
Andersen Impactor	13
Test Procedure	13
Velocity Profile	13
Mass Loading	15
Particle Size Distribution	16
Test Results	16
Conclusions and Recommendations	20

APPENDIX A SAMPLE ANALYSES FROM SOUTHERN RESEARCH INSTITUTE

LIST OF TABLES

	<u>Page</u>
TABLE 1. VELOCITY TRAVERSE	17
TABLE 2. AEP/TIDD PARTICULATE LOADING DATA	18
TABLE 3. RUN #4 - INLET PARTICLE SIZE DISTRIBUTION	19

LIST OF FIGURES

Figure 1. Sample Temperature in Probe	4
Figure 2. Sample Probe, AEP	5
Figure 3. AEP Inlet Probe Assembly	6
Figure 4. Heat Shield	8
Figure 5. Holding Chamber	9
Figure 6. Experimental Probe Seal	10
Figure 7. Photograph of Sampling Nozzle	11
Figure 8. Photograph of Outlet Mechanical Assembly	12
Figure 9. Pressure Vessel for Andersen Impactor	14

Introduction

Background

American Electric Power has taken a leadership role in developing Pressurized Fluidized Bed Combustion (PFBC) as a Clean Coal Technology. The 70 MW demonstration facility at the Tidd Plant is the first commercial-scale implementation in the U.S. This facility provides significant opportunities to further develop and evaluate the PFBC technology.

Hot Gas Cleanup for particulate is a key component for PFBC application, reliability, and efficiency improvements. AEP and DOE are testing advanced HGCU techniques on 1/7 scale to evaluate design integrity through long-term testing at Tidd. The Tidd Hot Gas Clean Up Test Facility has a design goal of less than 15 ppm particulate in the outlet gas stream. The mean particle size is expected to be less than 3 microns with substantial submicron particles. Measuring these particle loadings and particle size distribution at 1650 F and 185 psig is the challenge.

The initial HGCU technology to be tested at Tidd is a porous ceramic candle filter as described in presentations from AEP and Westinghouse.^(1,2) Measuring the inlet and outlet particulate loadings to this HGCU device, hence the particulate collection efficiency, is the objective of this work. The total mass loading, inlet and outlet, is required for an overall efficiency determination. A particle size distribution for both the inlet and outlet streams establishes a graded particle capture efficiency and better characterizes each stream.

Safety and data reliability are key challenges in conducting high-temperature and high-pressure particulate measurements at the Tidd plant. Battelle applied relevant experience to modify standard test equipment for this high temperature and high pressure sampling. The sampling system was assembled and pressure tested prior to use at Tidd as a safety precaution. Replicate tests are recommended as a quality assurance technique to establish the data reliability.

Isolation Valve

A 6-inch diameter, 300 psi rated, carbon steel plug valve was selected initially to isolate the sampling system from the process conditions. This selection was based on the initial plan that testing would be a short term duration after which the sampling equipment would be removed. The 6-inch valves were installed during an outage but several delays occurred and the valves corroded to an inoperable condition. They were replaced with more reliable 4-inch stainless steel ball valves.

A heat shield was provided to reduce the surface area and angle of incidence for radiant heat to the isolation valve. This was initially intended for the 6-inch plug valves and was retained for the 4-inch ball valves. Figure 4 illustrates the heat shield which was constructed of 310 stainless steel and HS Kaowool® insulation.

Holding Chamber

A holding chamber, see Figure 5, was constructed from 3-inch schedule 80 pipe to seal the sampling probe for insertion through the isolation valve. A 2-inch experimental probe seal was attached to the 2-inch coupling on the holding chamber to provide a pressure tight fitting around the 2-inch sample probe. Two Swagelok fittings were assembled as shown in Figure 6 to minimize leakage of hot process gas. An air purge was used between the two fittings as an additional safety precaution.

Air Cooled Probe

The air cooled probe, shown previously in Figure 2, was constructed of 310 stainless steel tubing. The actual nozzle, shown in Figure 7, was replaceable by using a Hastelloy union to join the nozzle to the sampling probe/tube. A pitot tube was used to measure gas flow (velocity) and a type K thermocouple measured the gas temperature. Special mechanical drive assemblies, as shown in Figures 3 and 8, were used to push the sample

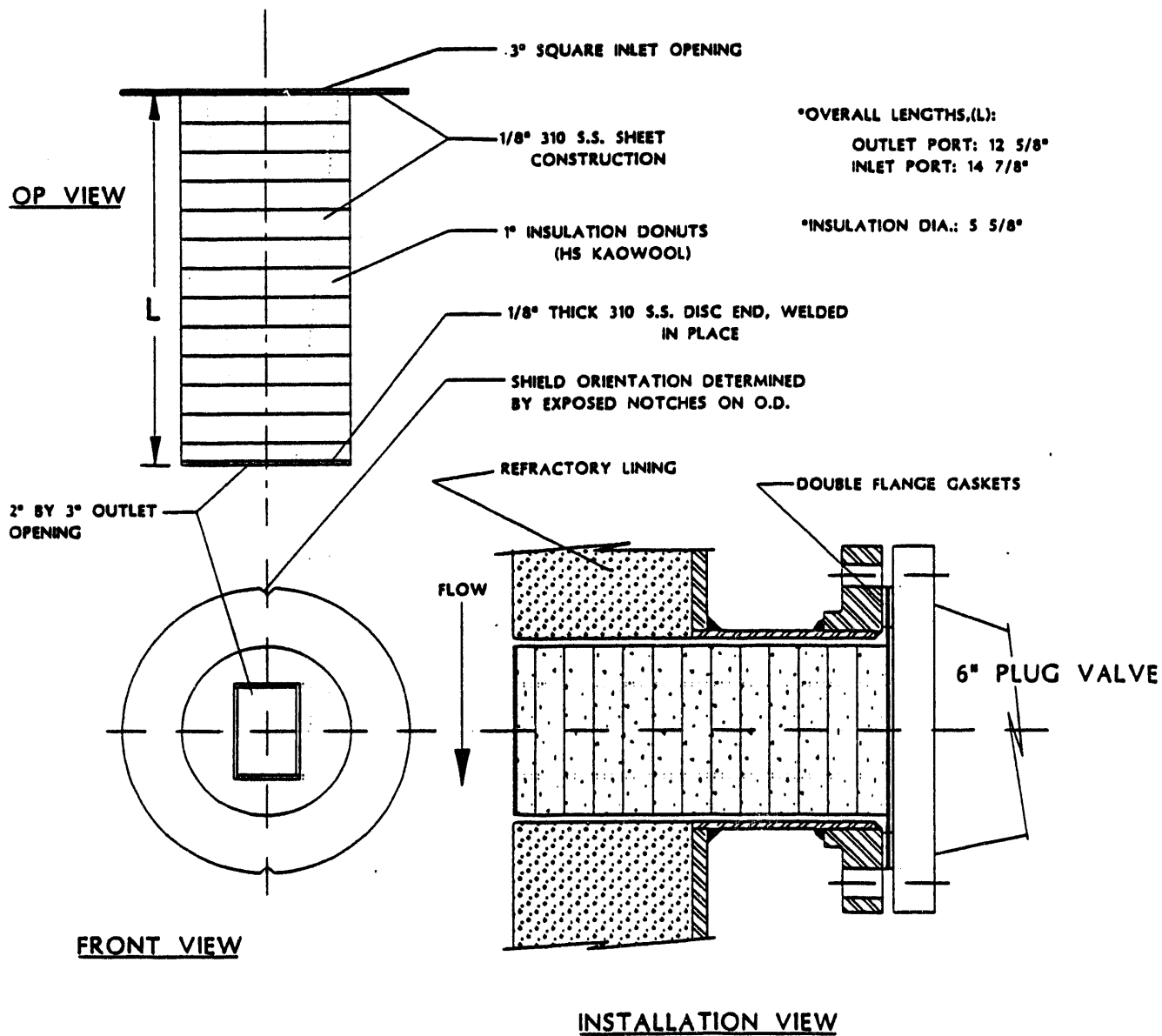


Figure 4. Heat Shield

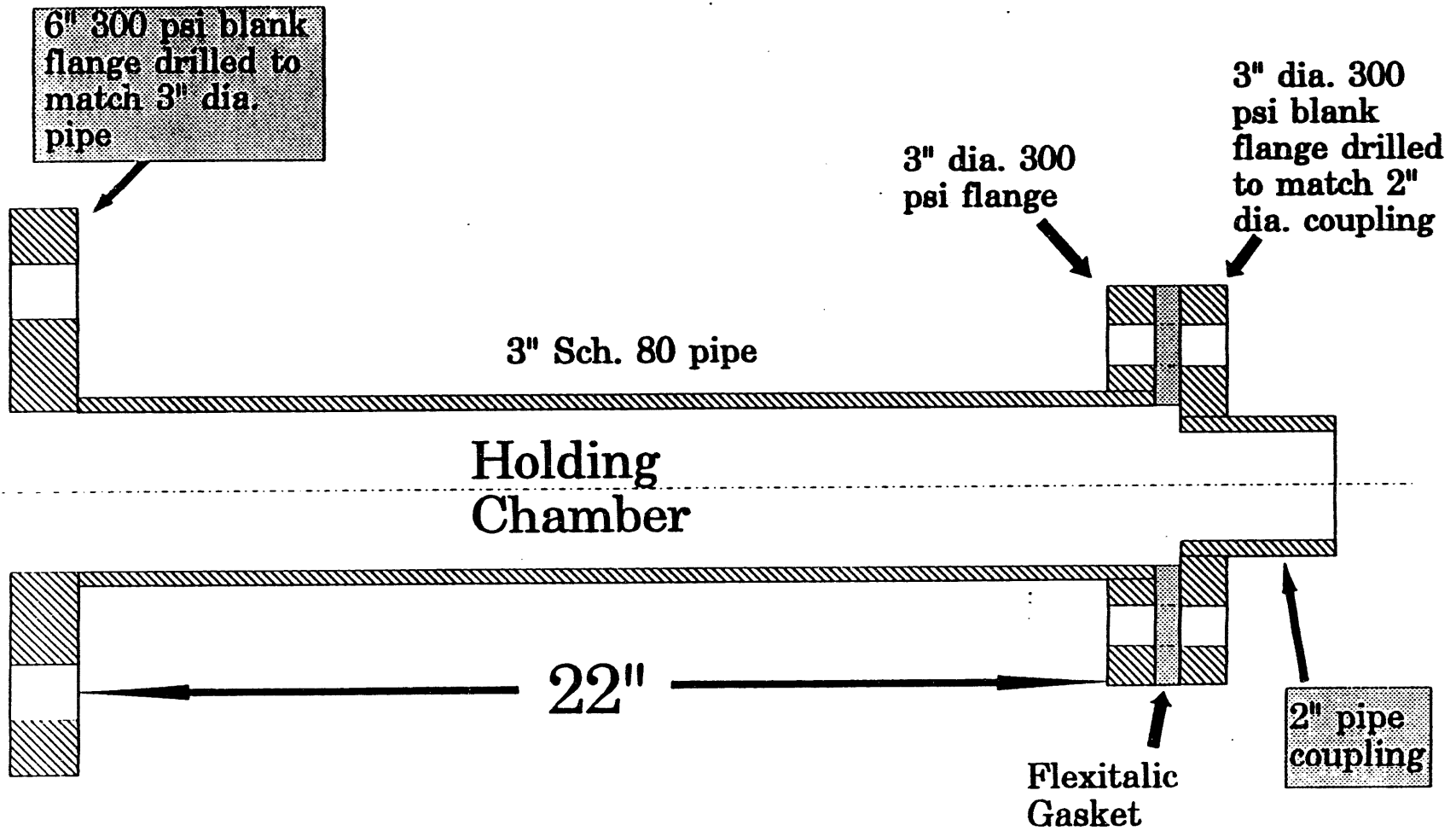


Figure 5. Holding Chamber

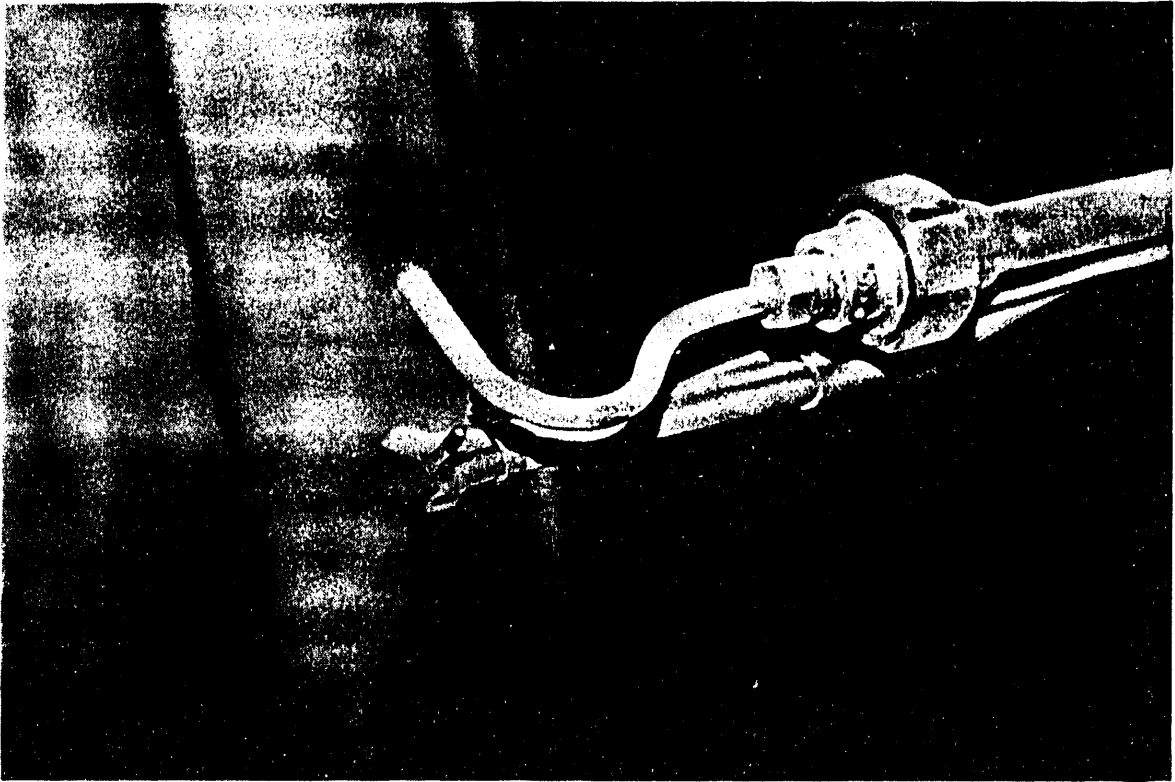


Figure 7. Photograph of Sampling Nozzle

probe(s) into the pressurized line. These assemblies also helped to stabilize and align the sample probe while being inserted or withdrawn.

Method 5 Sampling Train

A Nutech Model 2010 Method 5 stack sampling system was purchased to collect the particulate mass loading samples. The control console monitored temperature, pressure, and flow. An alundum® thimble filter, with a nominal pore size of 5 μm , was used upstream of the flow/pressure control valve to catch the particulate on the inlet stream. The Method 5 filter (0.3 μm nominal pore size) was retained for the inlet sample and used exclusively at the outlet. The gas was then cooled through an ice bath to measure water concentration by condensation and absorption through a silica gel desiccant. A dry gas meter measured the gas flow rate.

Andersen Impactor

An Andersen Mark III Cascade Impactor was purchased for determining particle size distribution. A pressure enclosure, shown in Figure 9, was assembled to use the impactor at high pressure. Sample flow was controlled with an exit valve. A small orifice is provided to equalize pressure within the pressure enclosure and to preheat and avoid condensation on the impactor stages. The impactor classifies particulate into 10 aerodynamic size ranges (including preseparator and backup filter).

Test Procedure

Velocity Profile

A velocity profile was measured using the pitot tube on the sampling probe. A manahelic gage measured the differential pressure of the upstream and downstream ports from the pitot tube. The intended traverse was to measure the velocity (differential pressure)

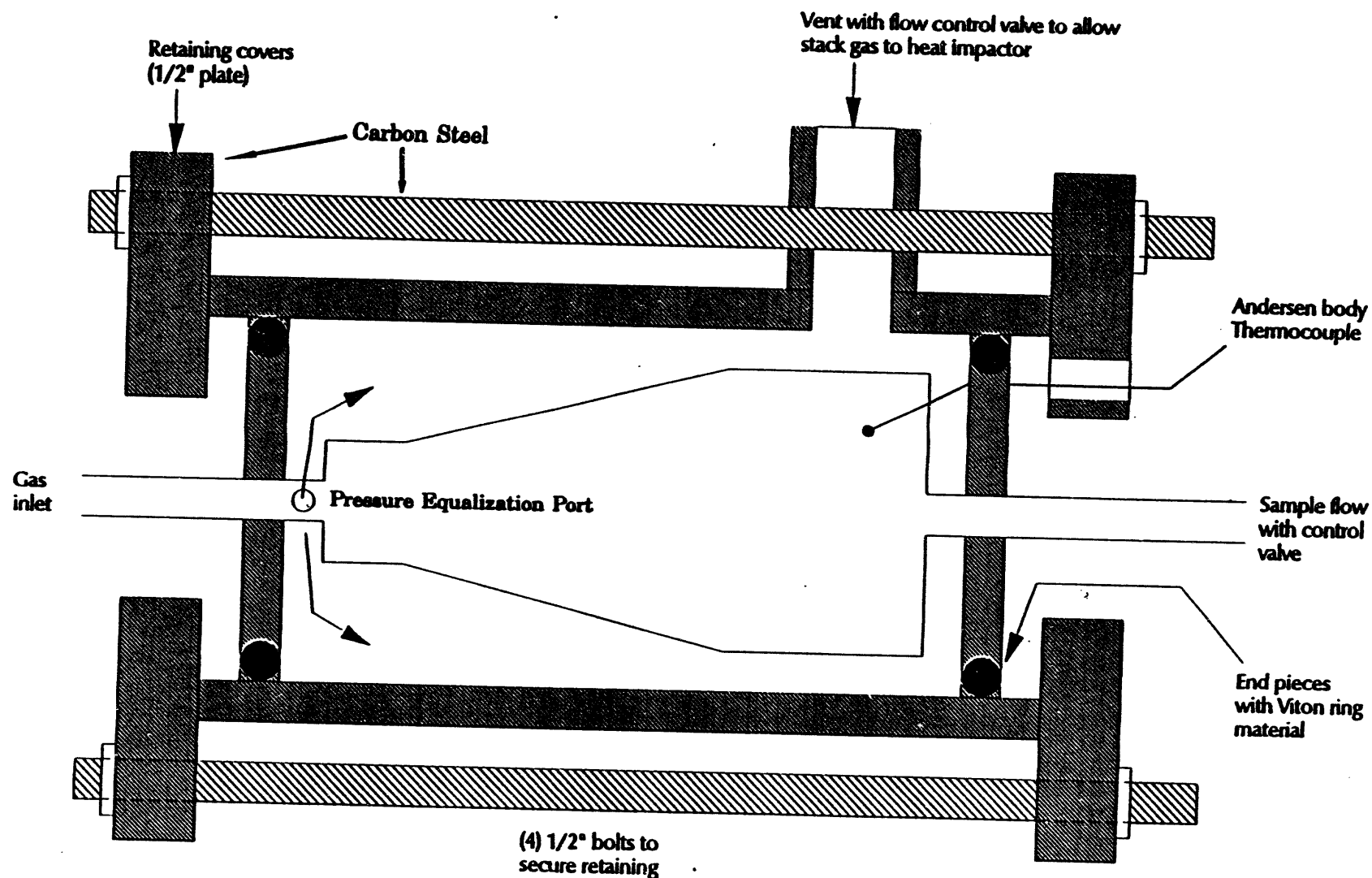


Figure 9. Pressure Vessel for Andersen Impactor
 (dimensions to be taken from existing vessel)

at six radial positions as an indication of the flow/velocity profile. Fully turbulent flow would have constant differential pressure readings or a "flat" velocity profile.

Mass Loading

The test procedure was to assemble the specially designed air-cooled probe and the associated Swagelok seals. The probe was then inserted into the holding chamber with the nozzle orientation pointing into the gas flow. After attaching the support and pushing mechanisms, the Method 5 sampling system was connected to the probe outlet. The 4-inch ball valve was then opened slowly to pressurize the holding chamber. The Swagelok seals were checked for leaks and tightened as necessary. At the appropriate time, the mechanical drive assembly was used to push the probe into the system until the first sampling point was reached. The Method 5 sampling system flow control valve was adjusted to match the velocity, as indicated by the Magnehelic differential pressure gage. A computer program, which had been written to compute sample flow rates, was used to determine sampling gas flows as a function of gas temperatures, velocity (pressure differentials), and static pressures. The sampling system was operated at this location for five minutes. Subsequently, the probe was pushed to five additional sample point locations and was sampled isokinetically for a 5-minute period at each location. An additional 5 minutes was taken at each location as the probe was pushed out of the pipe. Total sample time for the Method 5 runs was 60 minutes.

At the end of the 60 minute sampling period, the screw pushing mechanism was reversed to remove the probe. After the probe was removed, it was allowed to cool to room temperature and then was cleaned with acetone. The probe wash residue and the filter catch comprised the material which was used to determine the solids concentration.

Particle Size Distribution

The sampling system for particle size determination was the same 310 stainless steel air-cooled probe used for the particulate loading tests. The particles were sampled from the system at an isokinetic rate to capture a representative sample at the sampling point. A single sample point was used because the velocity profile was nearly constant and this avoided changing isokinetic conditions. However, there is some uncertainty about how representative the sample is of the entire stream. The gas temperature was approximately 1400 F at a pressure of 140 psig. The Andersen impactor, which was enclosed in a pressure chamber, was connected to the outlet of the sample probe. The chamber allowed the impactor to operate at system pressure. This arrangement placed the flow/pressure control valve downstream of the impactor avoiding attrition or agglomeration when the particles pass through the valve at relatively high velocities.

Test Results

The velocity traverse for the APF inlet and outlet sample points are presented in Table 1. Only a partial traverse was completed because of physical restrictions; these were not resolved as it was decided to proceed with initial testing to demonstrate that the sampling system could provide the necessary data. The differential pressure is generally constant which is the basis for the generally "flat" velocity profile.

Table 2 summarizes the data for 3 EPA Method 5 runs. Run No. 1 was completed with minimal problems and the data show a particulate loading of 1.855 gr/dscf at the APF inlet.

Due to the high system pressure, 140 psig, it was necessary to restrict flow through the sampling system to achieve isokinetic sampling. Under some conditions it is possible to obtain positive pressure between the impinger and the sample vacuum pump, causing the impingers to open and to vent sample gas to the atmosphere. Such a condition occurred

TABLE 1. VELOCITY TRAVERSE

Inlet (19.5" ID)		
Point #1	3.6" H ₂ O ΔP	1293 F
2	5.5" H ₂ O ΔP	1300 F
3	6.2" H ₂ O ΔP	1329 F
4	5.5" H ₂ O ΔP	1334 F
5	5.4" H ₂ O ΔP	1334 F
6	Unable to get complete traverse due to double Swagelok seal.	
Outlet (17.5" ID)		
1	6.5" H ₂ O ΔP	1315 F
2	9.0" H ₂ O ΔP	1320 F
3	8.8" H ₂ O ΔP	1316 F
4	7.8" H ₂ O ΔP	1320 F
5	Not able to get complete traverse do to "apparent obstruction" in pipe!	
6		

TABLE 2. AEP/TIDD PARTICULATE LOADING DATA

Run No.	Inlet			Outlet
	1	2	2A	3
Test Date	1/20	1/21	1/21	1/21
Volume of Gas Sampled, DSCF	52.0	49.9	71.4	95.0
Moisture Fraction Volume, percent	7.8	7.0	5.0	6.2
Average Stack Temperature, F	1,320	1,351	1,351	1,320
Stack Volumetric Flow Rate, DSCFM	25,299	26,911	27,372	26,270
Stack Volumetric Flow Rate, ACFM	8,781	9,420	9,380	8,958
Isokinetic Rate, percent	90.7	75.0	105.4	78.3
Excess Air, percent	31.0	30.9	30.9	30.9
Particulate Mass--Probe, Cyc, Filter Catch, MG	6,270.0	8,774.0	8,774.0	127.0
Particulate Loading, GR/DSCF	1.855	2.706	1.894	0.021
Particulate Loading, GR/ACF	5.341	7.725	5.521	0.060
Particulate Emissions, Lb/Hr	402.3	624.1	444.2	4.6

during Run #2 when some silica gel from the No. 4 impinger carried over into the check valve. This caused a significant pressure drop at the check valve and caused flow control problems. Therefore, the actual sample volume for Run #2 is uncertain; the actual measured flow is reported for Run #2 but it is suspected to be low because of the leakage. The results reported as Run 2A are an attempt to correct the results based on an estimate of the possible sample volume for Run #2.

Run #3 shows the data from a single run at the outlet of the APF. The data show a particulate loading of 0.021 gr/dscf. Minimal problems were experienced during the outlet run.

Table 3, Run #4 shows the Andersen impactor results at the APF inlet. The particle size data need to be qualified to some extent due to the relative location of the impactor. Some skewing of the data may have occurred because of particulate settling within the sample probe ahead of the impactor.

TABLE 3. RUN #4 - INLET PARTICLE SIZE DISTRIBUTION

Stage	% Collected in size range	Cumulative % < size range	Size Range, μm	Effective Cut dia., μm
Pre Collector	30.6	69.4	> 16.0	16.0
1	7.7	61.7	11.0 - 16.0	11.0
2	10.8	50.9	7.2 - 11.0	7.2
3	13.7	37.2	4.6 - 7.2	4.6
4	13.5	23.7	2.3 - 4.6	2.3
Filter	23.7	0	0 - 2.3	--

Some particle size distribution alteration can occur from thermal deposition in the sample probe as the gas cools from 1400 F to approximately 250 F at the impactor. At the request of American Electric Power, material which had been rinsed from the probe and

preimpactor was analyzed by Southern Research Institute. The Southern Research data show a mass mean diameter (MMD) of approximately $6 \mu\text{m}$ for both the probe and the preseparator. For the velocities encountered during the Andersen run, the preseparator cut-off size is approximately $16 \mu\text{m}$ and greater. It is possible that some thermal deposition was occurring in the preseparator, causing an apparent smaller MMD.

Conclusions and Recommendations

It has been demonstrated that particle loading can be measured from a PFBC using specialized Method 5 protocol.

It is recommended that additional tests be performed on the Tidd PFBC using the special sampling system developed in this study. The data collected initially are only a first step in determining particle size and emission loading. At least three runs should be made at both the inlet and the outlet to determine a statistical average. These runs should be made during a period when the plant is operating stably allowing the sample team to test under reasonably controlled conditions.

Possible improvements to the particle size measurements could involve increasing the sample temperature or decreasing the sample tube diameter. The initial test (Run #4) was conducted at similar conditions to the Method 5 mass loading tests. The cooled gas temperature at the Andersen Impactor was approximately 250 F but this could be increased to 1000 F based on the manufacturers specifications. Increasing the temperature could have two possible benefits; (1) the gas velocity through the sample probe the would be higher with less sedimentation and (2) thermal deposition could be decreased. Possible disadvantages are: 1) the need to cool the gas stream downstream of the impactor to accurately measure the dry gas flow and 2) possible distortion of the sample probe and impactor if temperature control is difficult.

Changing the 5/8-inch diameter sample tube to a smaller tube would increase the gas velocity through it and would decrease the particle sedimentation within the sample probe. This change could improve the overall classification although additional samples need to be collected to determine if such a change is necessary.

APPENDIX A

SAMPLE ANALYSES FROM
SOUTHERN RESEARCH INSTITUTE



Southern Research Institute

February 14, 1994

Mr. John D. Hoffman
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

Dear Mr. Hoffman:

We recently received a variety of ash samples from the Advanced Particulate Filter at Tidd (APF) that were obtained by Battelle in January. These samples are described in Table 1.

Table 1
Samples Obtained by Battelle and sent to Southern Research Institute for Analysis

SID #	location	date	description of sample
4031	inlet	1-21-94	Anderson impactor precutter catch
4032	inlet	1-21-94	Anderson impactor stage 0 catch
4033	inlet	1-21-94	Anderson impactor stage 1 catch
4034	inlet	1-21-94	Anderson impactor stage 2 catch
4035	inlet	1-21-94	Anderson impactor stage 3 catch
4036	inlet	1-21-94	Anderson impactor stage 4 catch
4037	inlet	1-21-94	Anderson impactor stage 5 catch
4038	inlet	1-21-94	Anderson impactor stage 6 catch
4039	inlet	1-21-94	Anderson impactor stage 7 catch
4040	inlet	1-21-94	Anderson impactor stage 8 catch
4041	inlet	1-21-94	Anderson impactor filter catch
4042	inlet	1-20-94	run 1 Method 5 thimble catch
4043	inlet	1-20-94	run 1 Method 5 probe wash
4044	inlet	1-20-94	run 2 Method 5 thimble and thimble catch
4045	inlet	1-20-94	run 2 Method 5 probe wash
4046	inlet	1-20-94	run 2 Method 5 thimble bypass (on 63 mm filter)
4047	outlet	1-20-94	Method 5 filter catch and 63 mm filter
4048	outlet	1-20-94	Method 5 probe wash

Southern Research Institute

Mr. John D. Hoffman

February 14, 1994

Page 2

Each inlet run probe wash sample that was collected (SID #'s 4043 and 4045) contained 80 % or more of the total sample collected during the run. This indicates extensive deposition of ash in the probe during sampling. The outlet run probe wash sample (SID # 4048) contained almost all of the sample that was collected during this run. This sample comprises mostly large flakes that appear to have been formed from condensation and/or corrosion in the sampling probe. Consequently, the inclusion of the mass of this sample in any assessment of the performance of the APF would probably be unwarranted.

We noted that there were several large deposits present on the outlet run filter (SID # 4047) that looked more like "nozzle scrapings" than entrained particulate matter. These deposits account for about 4.1 mg of the total mass collected on this filter. Since we do not know the weight of the clean filter prior to the outlet run, we cannot assess how much the weight of the deposits we found on the this filter would affect the calculated efficiency of the APF. As with the large flakes found in SID # 4048, the inclusion of the mass of these deposits in the assessment of the performance of the APF would probably be inadvisable. I have sent a copy of this letter to Paul Webb at Battelle so he can adjust the outlet run data, if he so chooses. Because of the apparent problems with the two samples from the outlet Method 5 run, and because of the limited amount of ash in the outlet run filter catch, we did not perform any chemical or size analyses of the outlet samples.

We selected three of the samples (SID # 4031, 4042, and 4043) taken at the inlet to the APF for size analyses. The results of these analyses are summarized in Table 2 and in Figures 1, 2 and 3. Microscopic examination of the precutter catch sample (SID # 4031) revealed that much of this sample comprises relatively thin flakes that were up to 300 μm across. From their appearance, they were probably formed from some kind of condensation within, or upstream of, the precutter assembly. These flakes were not soluble in water (used as the suspending fluid in our size analyses), but because of their flat shapes, they appeared to have relatively small diameters.

Southern Research Institute

Mr. John D. Hoffman

February 14, 1994

Page 3

Table 2
Size Distribution of Tidd Ashes

Size limits of channel, μm			% mass in channel		
upper limit	lower limit	channel median	4031	4042	4043
42.2	31.6	36.5	1.1	2.5	2.8
31.6	23.7	27.4	1.4	3.4	3.7
23.7	17.8	20.5	2.0	4.4	4.8
17.8	13.3	15.4	2.6	6.0	6.6
13.3	10.0	11.5	5.1	7.8	13
10.0	7.50	8.66	8.2	13	19
7.50	5.62	6.49	19	16	19
5.62	4.22	4.87	32	22	17
4.22	3.16	3.65	11	7.4	4.6
3.16	2.37	2.74	7.0	6.0	3.5
2.37	1.78	2.05	4.4	3.9	2.0
1.78	1.33	1.54	3.5	3.1	1.8
1.33	1.00	1.15	1.9	1.8	0.70
1.00	0.75	0.866	0.70	0.97	0.40
0.75	0.562	0.649	0.15	0.47	--
0.562	0.422	0.487	0.15	--	--

The Stokes' MMD's of samples 4031, 4042, and 4043 were 5.9, 5.1 and 7.6 μm , respectively. The size distributions we measured for these samples are only slightly larger than distributions we measured for samples collected from the APF on September 30, 1993. (Stokes' MMD's for these earlier samples ranged from 3.0 to 5.9 μm . The complete distributions for these samples can be found in the topical report we prepared for Thomas P. Dorchak at DOE/METC: *Assessments of Ash Characteristics from Gas Stream Cleanup Facilities - October 1992 - September 1993*.) Provided that the sampling procedures used during these recent impactor and Method 5 runs accurately collected the entrained particles from the APF inlet duct, it appears that detuning the cyclone may be introducing only slightly larger size distributions of entrained particles into the APF.

Southern Research Institute

Mr. John D. Hoffman

February 14, 1994

Page 4

If I can be of further assistance with this matter, please don't hesitate to call me at (205) 581-2606 or Duane Pontius at (205) 581-2268 (Fax: (205) 581-2448).

Sincerely,



Todd R. Snyder
Research Environmental Engineer

Approved by



Duane H. Pontius Director, Particulate Sciences Department

c: Thomas P. Dorchak - DOE/METC
Richard Dennis - DOE/METC

Paul Webb - Battelle

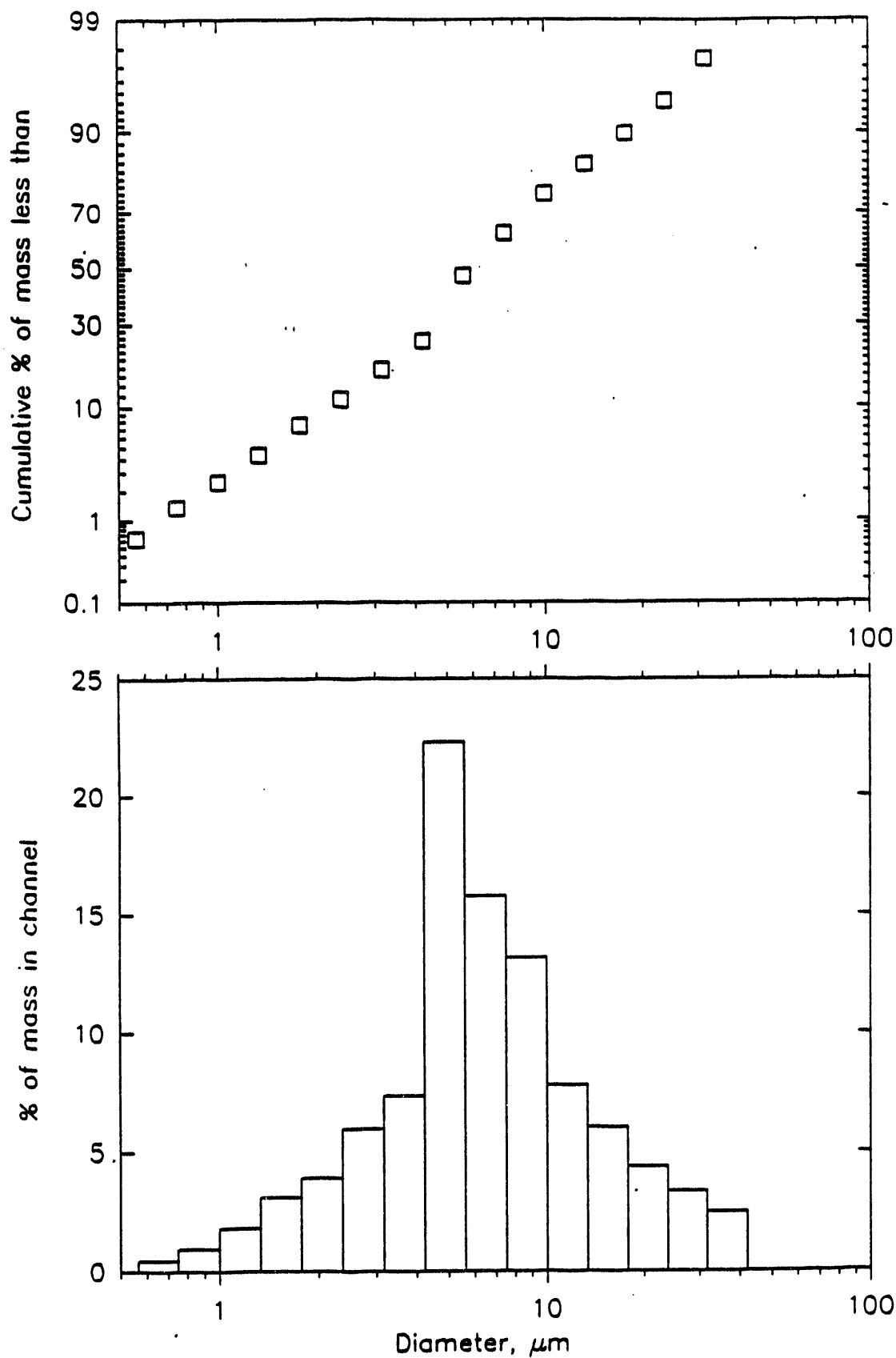


Figure 1. Size distribution of the Anderson impactor precutter catch ash collected from the inlet to the Tidd APF January 21, 1994. These data were measured with a Shimadzu SA-CP4 Centrifugal Particle Size Analyzer.

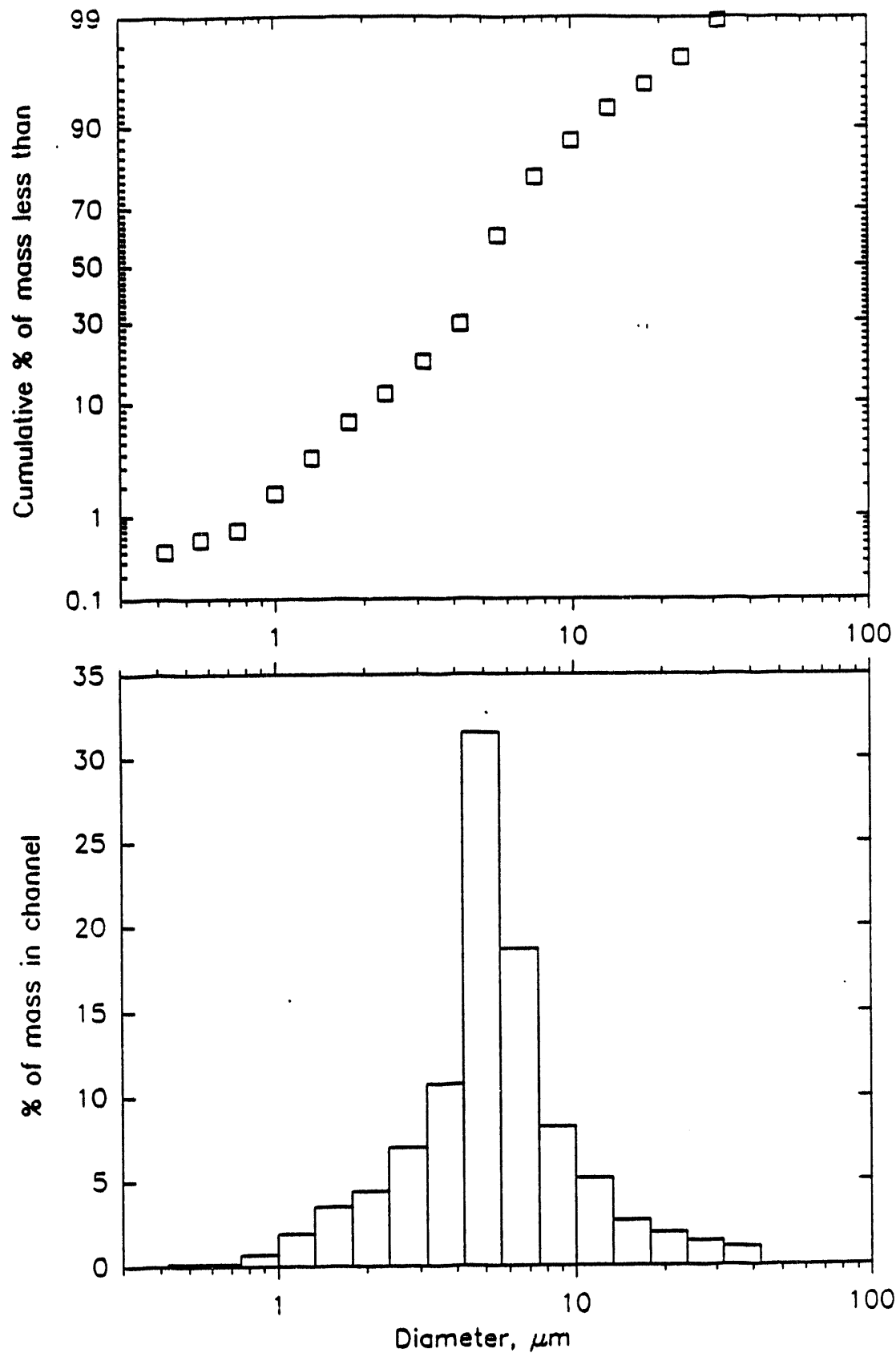


Figure 2. Size distribution of the Method 5 thimble catch ash collected from the inlet to the Tidd APF January 20, 1994. These data were measured with a Shimadzu SA-CP4 Centrifugal Particle Size Analyzer.

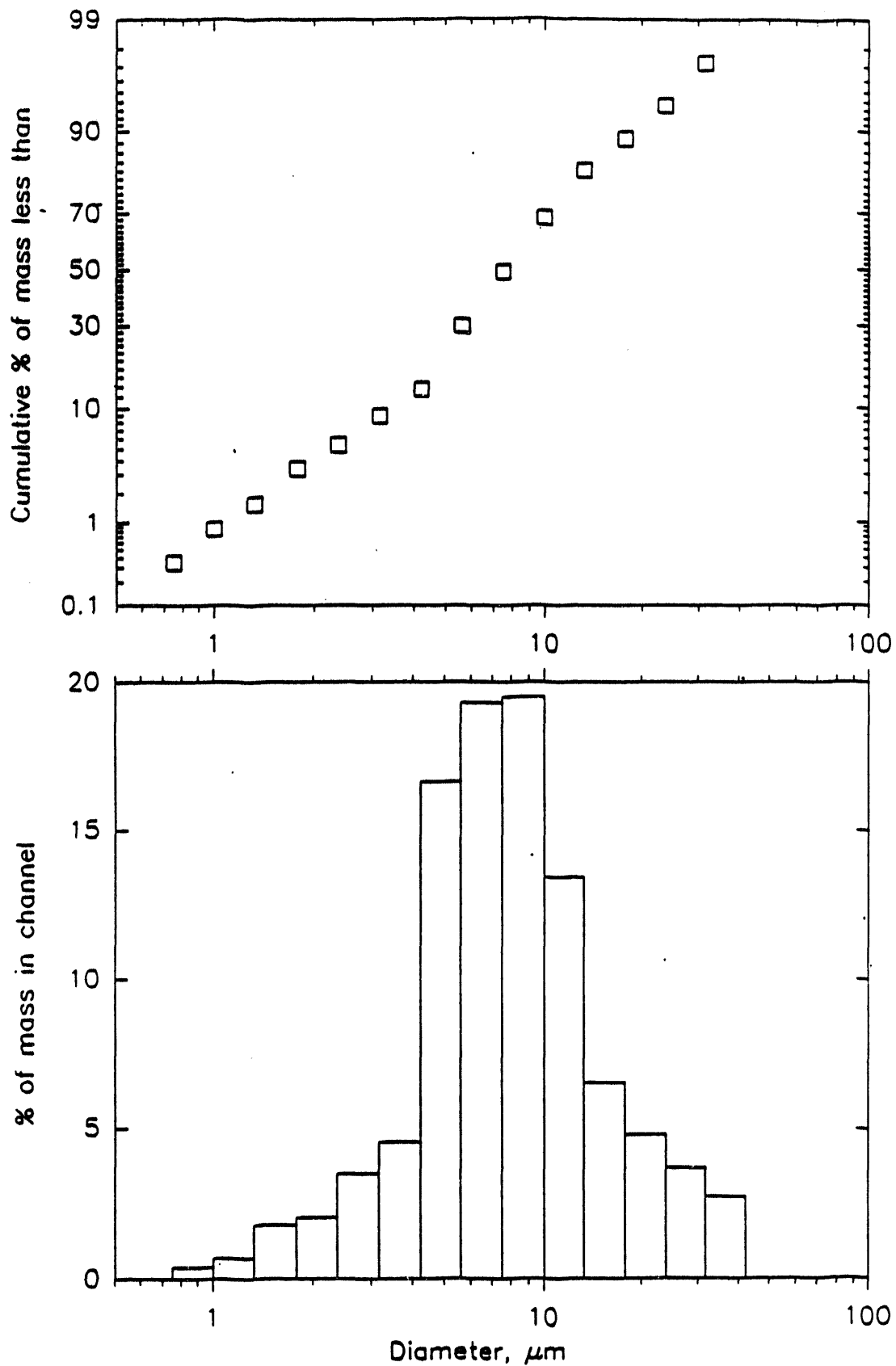


Figure 3. Size distribution of the Method 5 probe wash ash collected from the inlet to the Tidd APF January 20, 1994. These data were measured with a Shimadzu SA-CP4 Centrifugal Particle Size Analyzer.

ADVANCED PARTICLE FILTER

**Technical Progress Report No. 15
January through March 1994**

Prepared by

**Westinghouse Science and Technology Center
Pittsburgh, Pennsylvania**

For

**American Electric Power Service Corporation
Columbus, Ohio**

AEPSC Contract No. C8014

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TIDD ADVANCED PARTICLE FILTER

1.0 INTRODUCTION

Tidd was restarted on January 10, 1994 (on coal @ 6:41 a.m.). Spoiling air was utilized to detune the primary cyclone ahead of the APF. The system was tripped on January 11, 1994 due to pluggage of No. 13 cyclone. Restart occurred on January 15, 1994. The system was tripped on January 29, 1994 due to overheating of No. 14 evaporator tube. The first filter inspection of this period occurred February 1, 1994.

Tidd was again restarted on February 16, 1994. Nonfilter related issues caused a brief shutdown and hot restart on February 18, 1994. Notable overheating of the APF head was analyzed by J. Hoffman. While still in service, technicians drilled holes in the APF outlet nozzle, pumped over 20 gallons of insulation into the region of overheating, and brought APF head temperatures under control. A combustor trip occurred on February 25, 1994 due to a sorbent booster compressor surge. Warm restart occurred on March 2, 1994. Another trip occurred on March 9, 1994 due to problems with two paste pumps. Restart occurred on March 16, 1994. The unit was tripped on March 23 due to indication of gas turbine lube oil system failure. The second filter inspection of this period occurred on March 25, 1994.

The two filter inspections of this quarter are summarized in Section 2.0. Continuing analysis of ceramic filter performance is described in Appendices A and B. A memo evaluating the location of complete mixing of tempering air is provided in Appendix C. Notes from a meeting with R. Banks (consultant) to discuss flow distribution, entrainment and cake formation are included in Appendix D. Tidd operational data is provided in Appendix E.

2.0 FILTER INSPECTIONS

2.1 February 1, 1994 APF Inspection (After 355 hour operation this quarter)

2.1.1 APF Head

Discoloration of the Tempalarm paint was noted extending from pulse nozzle penetrations in the APF head to the clean gas outlet nozzle and up along most of the neck of the outlet nozzle. The maximum temperature reported during service was 630° F. The observed overheating was solved as described previously.

2.1.2 Candle Filters

A thin layer of ash approximately 1/16 to 1/8 inch thick was noted to cover candles viewed from inspection nozzles. Occasional ash lumps approximately 1/4 inch thick and 1/4 x 3/4 inch dimension were also noted on many candles. Modest bridging was discerned behind some candles. These bridges extended to the cluster's metal support tube structure. No bridging was noted between candles in the three bottommost plenums.

Limited air lancing and mechanical dislodging of ash was accomplished from the six ash sheds.

2.2 March 25, 1994 APF Inspection (After 835 hour operation this quarter)

Ridges of ash were noted extending in a downward orientation on dust sheds below candles of the top plenums. Approximately 1/4 to 1/2 inch of ash was observed on the candle surfaces.

Considerable ash buildup (as much as 3 or 4 inches) was noted on dust sheds below candles of the middle plenums. It is speculated that some ash bridges may have occurred to the innermost row of candles, but no bridging was observed to the outer rows of candles or between candles.

Bottom plenum candles showed a mottled (bumpy) coverage of ash up to 1/4 inch thick. No bridges between candles were observed. The bumps of ash ranged in geometry from 1/2 inch diameter to approximately 1/2 inch wide by 3 inches long.

All candles appeared to be plumb and straight. No missing or broken candles were noted. Limited mechanical dislodging of ash was accomplished from the six ash sheds.

KARHULA PARTICLE FILTER TESTING

Inspection of the Westinghouse advanced particle filter at the Hans Ahlstrom Laboratory in Karhula, Finland was performed March 21 through 25, 1994. Observations have been summarized and submitted in a previous letter report to DOE, AEP and Westinghouse dated March 28, 1994. Candle material analysis from this testing is provided in Appendix A.

APPENDIX A

**CHARACTERIZATION OF THE VITROPORE 442T
CLAY BONDED SILICON CARBIDE CANDLE FILTERS
AFTER 512 HOURS OF EXPOSURE TO CFBC GAS CONDITIONS**

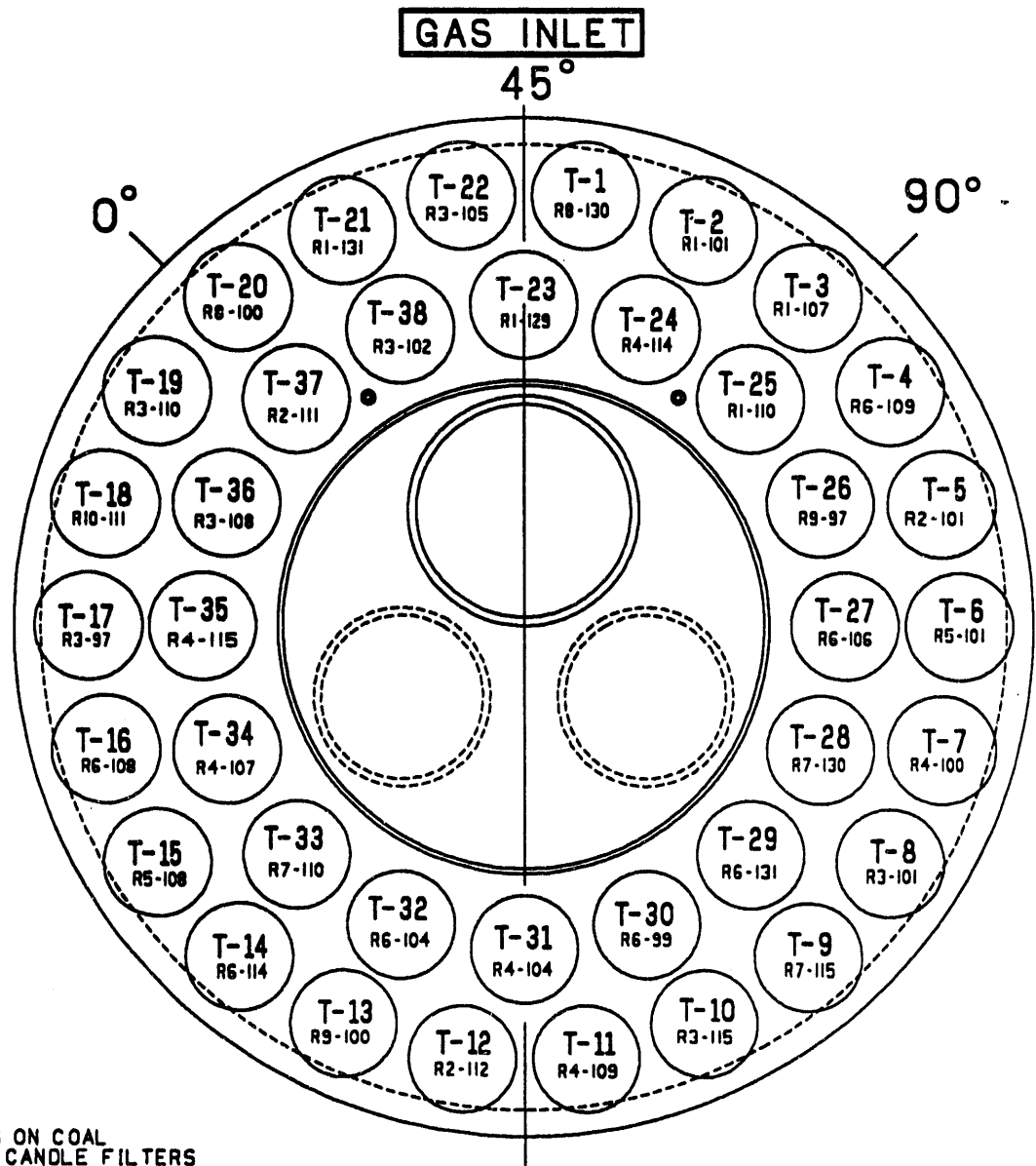
CHARACTERIZATION OF THE VITROPORE 442T
CLAY BONDED SILICON CARBIDE CANDLE FILTERS
AFTER 512 HOURS OF EXPOSURE TO CFBC GAS CONDITIONS

M. A. Alvin
April 1, 1994

Candle Filter Identification Numbers and Locations

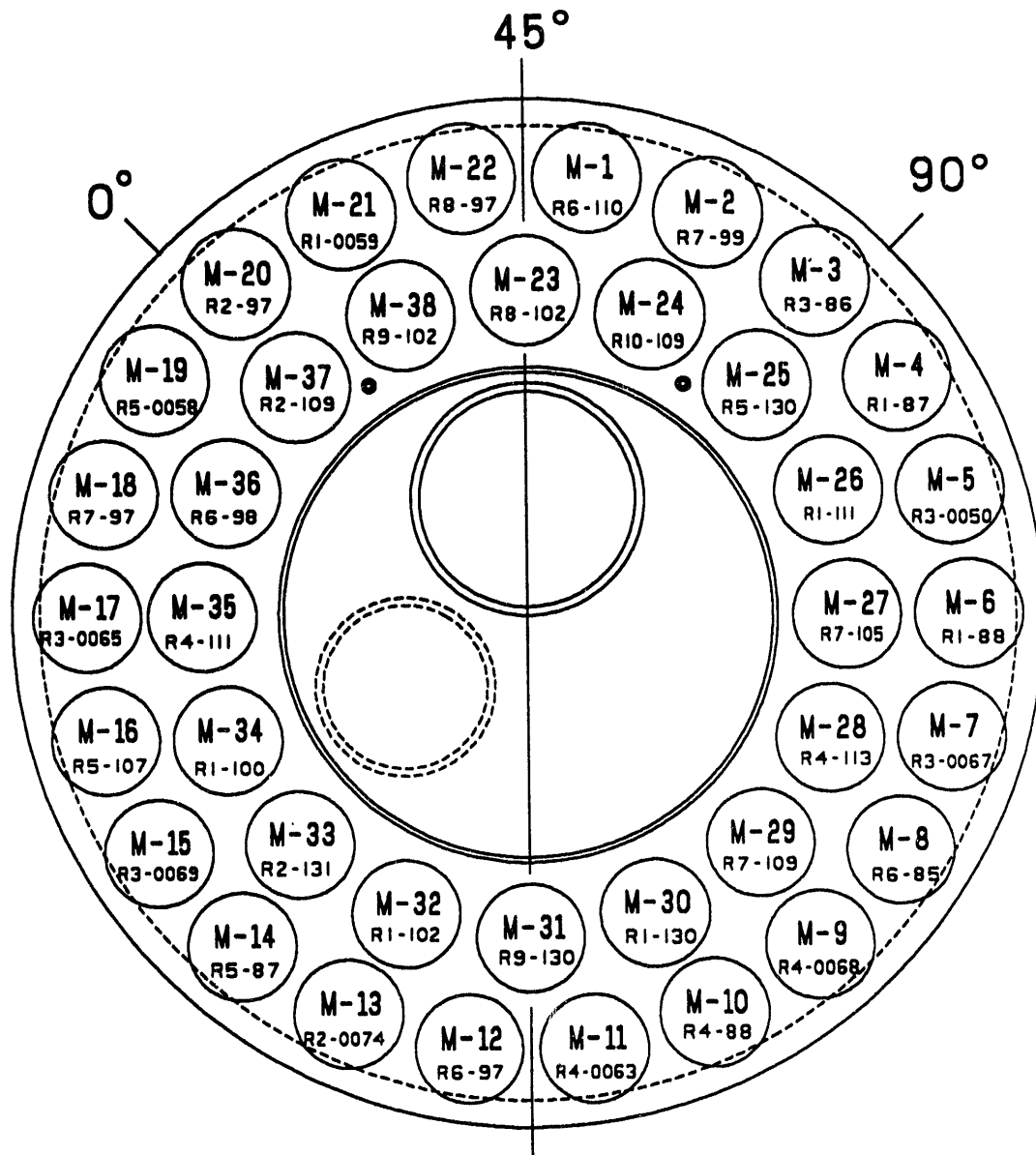
One hundred and twenty-eight (128) 1.5 m Vitropore 442T candle filters which were fabricated during September through November 1993, were installed in the Westinghouse Advanced Particulate Filtration (APF) vessel at the Ahlstrom, Finland circulating fluidized-bed combustion (CFBC) test facility. Figure 1 provides a template detailing the candle filter identification numbers and their respective locations in the top, middle, and bottom plenums during the 512 hour CFBC test which was conducted between November 1 and December 17, 1993 (Test Segment 2).

Two different coals were used during Test Segment 2. These included Illinois No. 6 and Black Thunder coal. Iowa Industrial No. 1 limestone was utilized as the sulfur sorbent with both coal feedstock materials. During the first 221 hours of CFBC operation with Illinois No. 6 coal and Iowa No. 1 Industrial limestone, the temperature in the W-APF vessel was maintained at 800-828°C (1470-1522°F). This was followed by a test period of 116 hours during which time the CFBC was operated with Black Thunder coal and Iowa No. 1 Industrial limestone. The W-APF vessel temperature during this segment of testing was 723-809°C (1333-1488°F). The final 174 hours of CFBC testing in Test Segment 2 utilized only Black Thunder coal without the addition of a sulfur sorbent. W-APF temperature of 800-821°C (1471-1509°F) was maintained during this segment of filter operation.



KARHULA
TOP PLENUM
 (WEEK 344-350. NOV.1-DEC.17.1993)

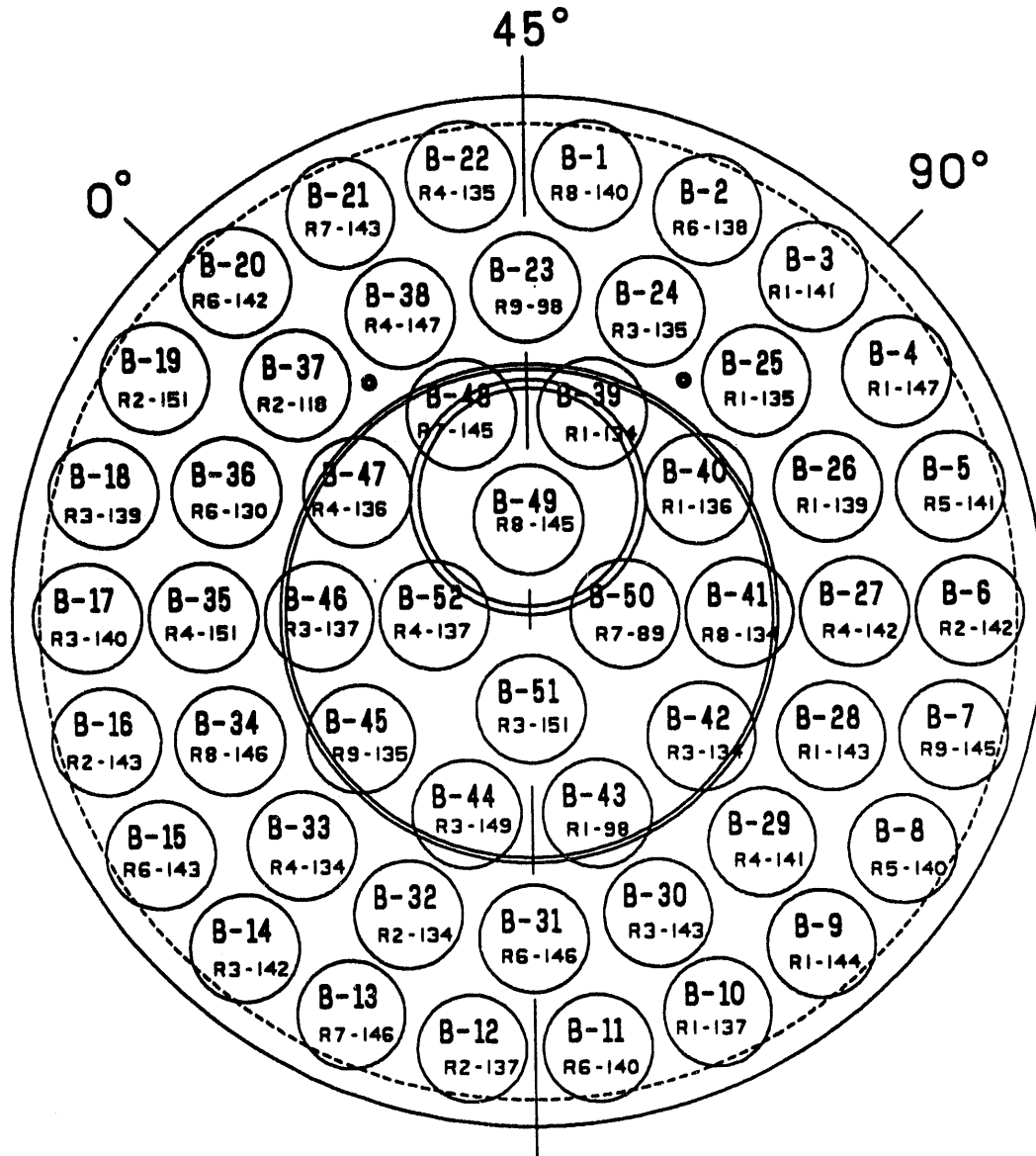
Figure 1a - Candle Filter Identification Numbers And Locations
In The Westinghouse APF Vessel Between November 8 And
December 17, 1993 (Top Array)



KARHULA MIDDLE PLENUM

(WEEK 344-350. NOV.1-DEC.17.1993)

**Figure 1b - Candle Filter Identification Numbers And Locations
In The Westinghouse APF Vessel Between November 6 And
December 17, 1993 (Middle Array)**



**KARHULA
BOTTOM PLENUM
(WEEK 344-350, NOV.1-DEC.17.1993)**

**Figure 1c - Candle Filter Identification Numbers And Locations
In The Westinghouse APF Vessel Between November 6 And
December 17, 1993 (Bottom Array)**

Inspection of the filter unit after 512 hours of operation indicated that all candles were intact. Each candle was covered with a residual ash layer which averaged ~1 cm in thickness. No signs of bridging between candles and/or the support structure were evident.

After 512 hours of APF operation at nominal CFBC temperatures of 830°C, five (5) candles were removed and sent to Westinghouse. These included:

- R1-147 located in position B-4
- R2-143 located in position B-16
- R2-142 located in position B-6
- R1-137 located in position B-10
- R4-135 located in position B-22.

Five additional candles were removed for characterization by Ahlstrom. These included:

- R8-140 located in position B-1
- R5-141 located in position B-5
- R6-140 located in position B-11
- R3-140 located in position B-17
- R3-139 located in position B-18.

During shipment to Westinghouse, three of the five candles fractured. As shown in Figure 2, a common fracture location was approximately midway along the length of the candle filters. Bowing of the Vitropore 442T candles was readily evident after the dust cake had been removed. Candle R1-137 had been shipped to Pall Advanced Separations Systems for re-inspection of the candle filter dimensional tolerances, as well as, additional material characterization. As indicated by Pall, candle R1-137 was bowed by 5.3 mm (0.21 in) at a position of 520.7 mm (20.5 in) from the flange top. When checked for perpendicularity, the candle was seen to be almost 50.8 mm (2 in) out of

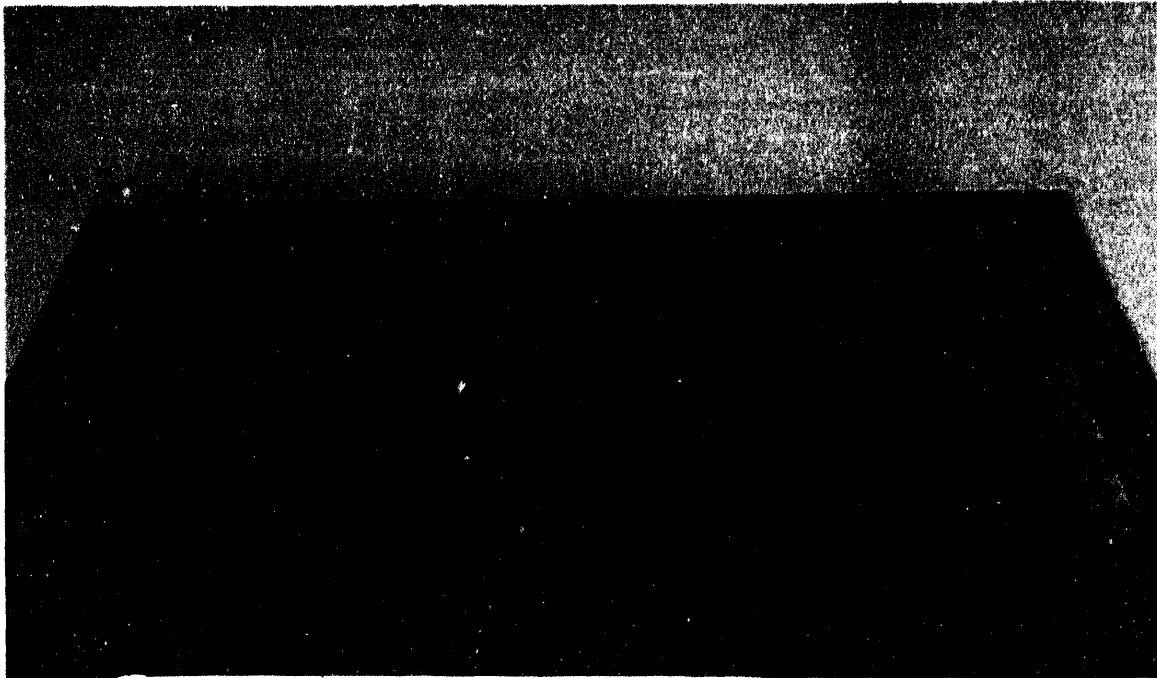


Figure 2 - Vitropore 442T Candles Received At Westinghouse After 512 Hours Of Hot Gas Filtration in the ~830°C CFBC Gas Environment

tolerance. Deviation from the perpendicularity tolerance appeared to be due to a bend in the candle starting $\sim 1/3$ of the length from the flange top. The apparent bow in the Vitropore 442T candles which was evident after removal of the candles from the CFBC Karhula test facility, was also evident in the Vitropore 442T candle filters that were removed from the pressurized fluidized-bed combustion (PFBC) test facility at Foster Wheeler. Note ash bridging was not evident during CFBC filter operation, and is not considered to be the cause of candle bowing at this time.

Figure 3 indicates that the mid-body fracture of candle R2-142 (B-6) was a fresh fracture as seen by the general absence of dust fines along the fractured surface. Note that there is a relatively large "gouge" along the candle filter body wall directly above the fracture line. The "gouged" area was covered with ash, which implies that either the candle may have been operated in-service in this fashion, or that ash was caked along this surface during handling and/or shipment. Notably the ID surface of candle R2-142 was relatively clean, indicating that fines had not been carried through the filter matrix, or pulsed back into the filters during hot gas cleaning cycles. The gasket used to seal candle R2-142 was also relatively clean after 512 hours of operation (Figure 4).

Candle R2-143 (B-16), however, had a noticeable dust cake layer along its ID surface (Figure 5). The top gasket sealing surface also indicated the presence of fines concentrated along both the OD and ID edges of the gasket (Figure 6). As shown in Figure 7, the area along the gasket sleeve just below the top gasket of candle filter R2-143 (B-16), as well as the bottom gasket were also coated with ash fines. Candle R2-143 (B-16) had fractured into four sections during shipment to Westinghouse. Photos of the fractured surfaces of candle R2-143 (B-16) are shown in Figures 8 and 9. A heavy dust layer is noted along the ID surface of this candle. Although the fractured surfaces generally

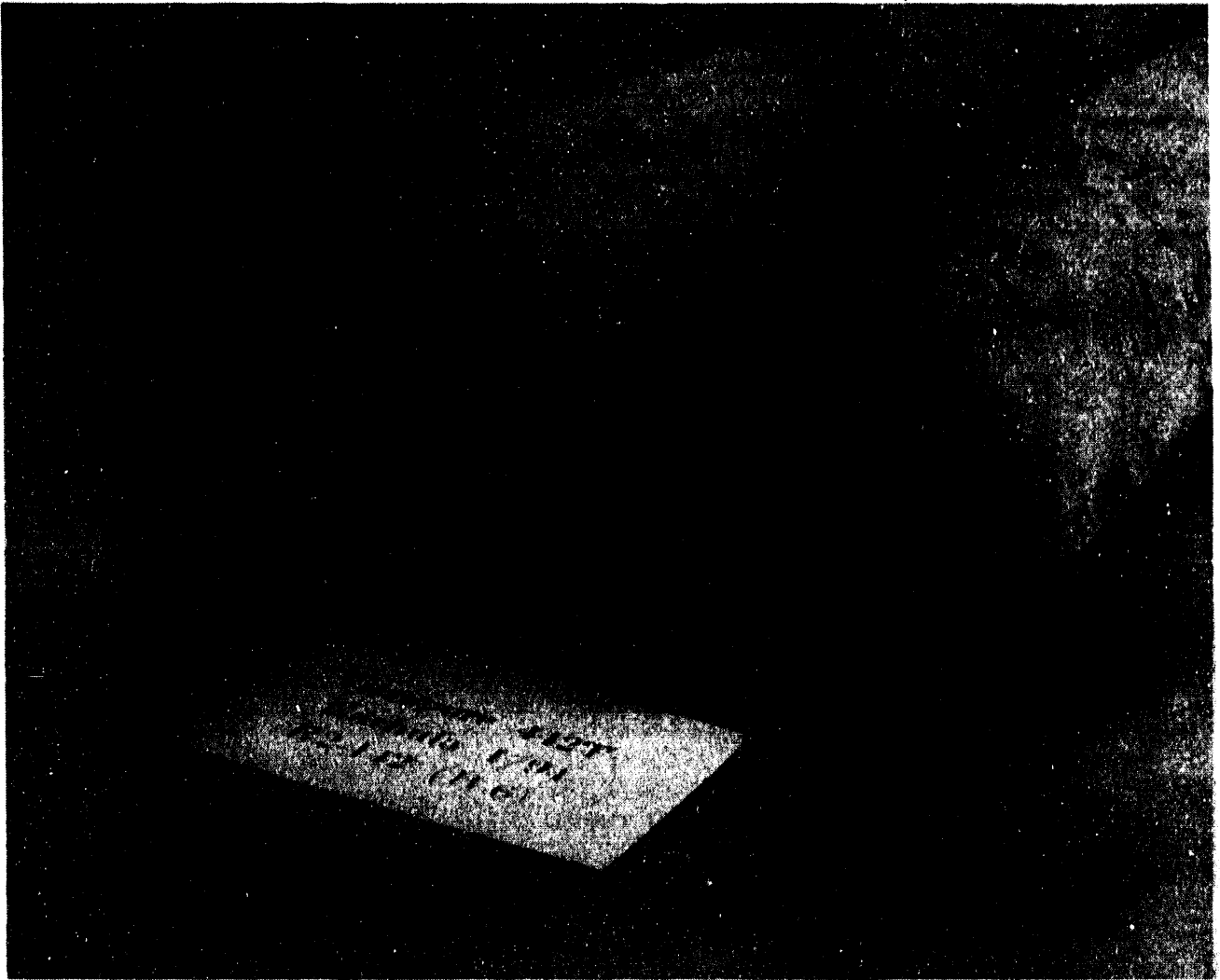


Figure 3 - Fractured Surfaces Of Vitropore Candle R2-142 (B-6)



Figure 4 - Top Gasket Seal of Vitropore 442T Candle R2-142 (B-6)

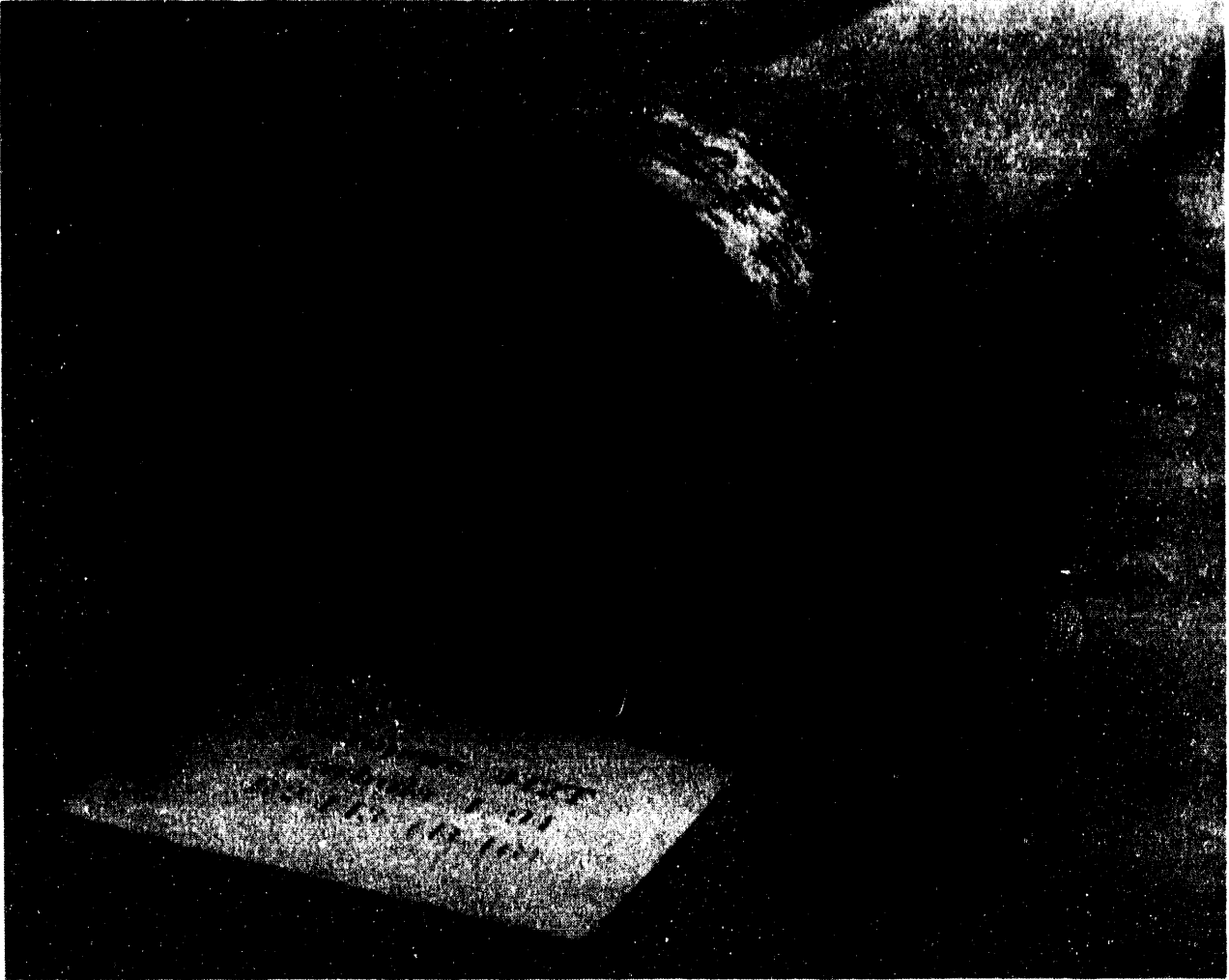


Figure 5 - Candle Filter R2-143 (B-16)

This page contains Westinghouse proprietary information.



Figure 6 - Top Gasket Seal Of Vitropore 442T Candle R2-143 (B-16)

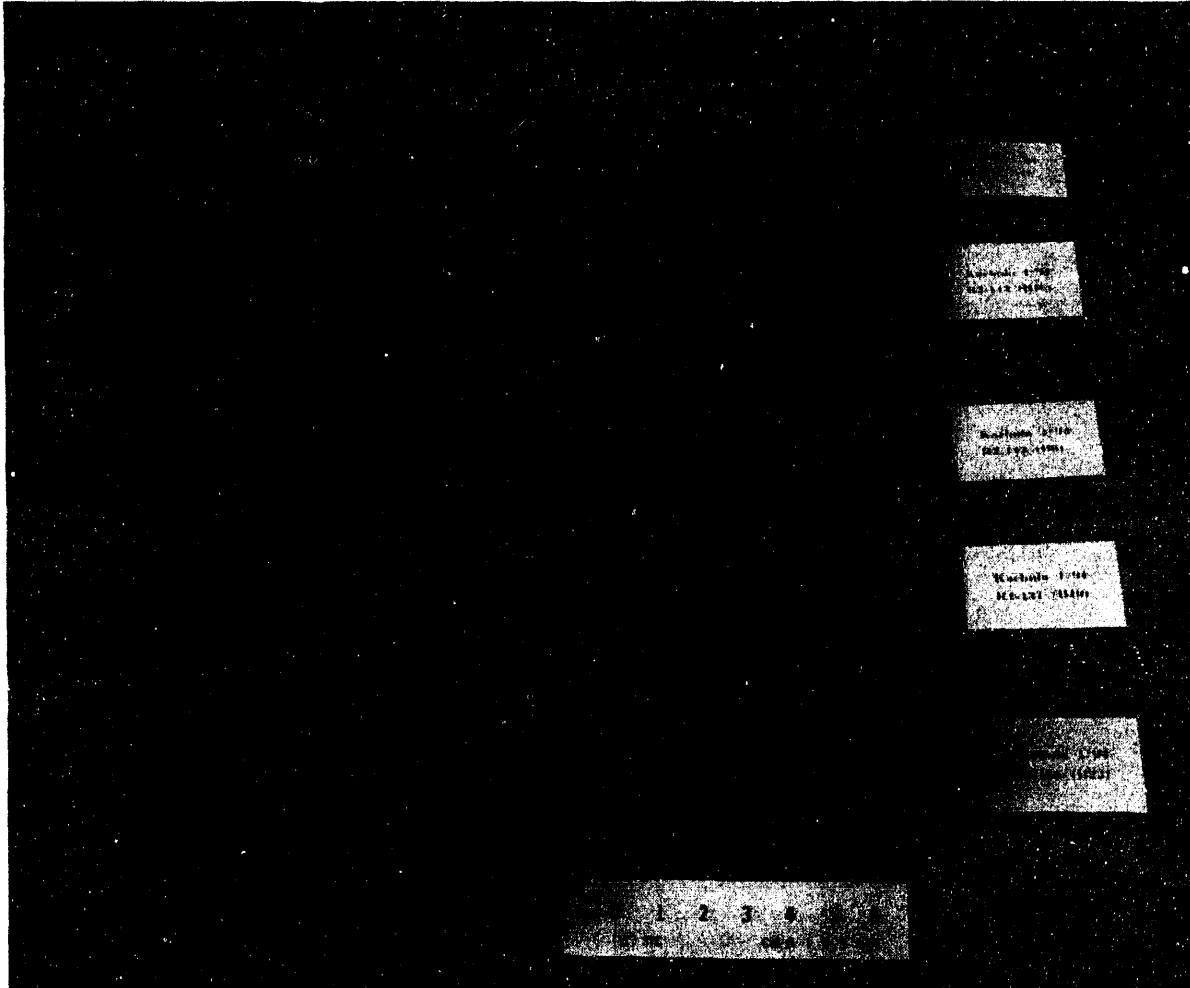


Figure 7 - Photograph Of All Five Vitropore 442T Candles Which Were Shipped To Westinghouse in January 1994. Sleeve And Bottom Gaskets Illustrate That Effective Sealing Had Been Maintained During 512 Hours Of Hot Gas Filtration In The CFBC Gas Environment.

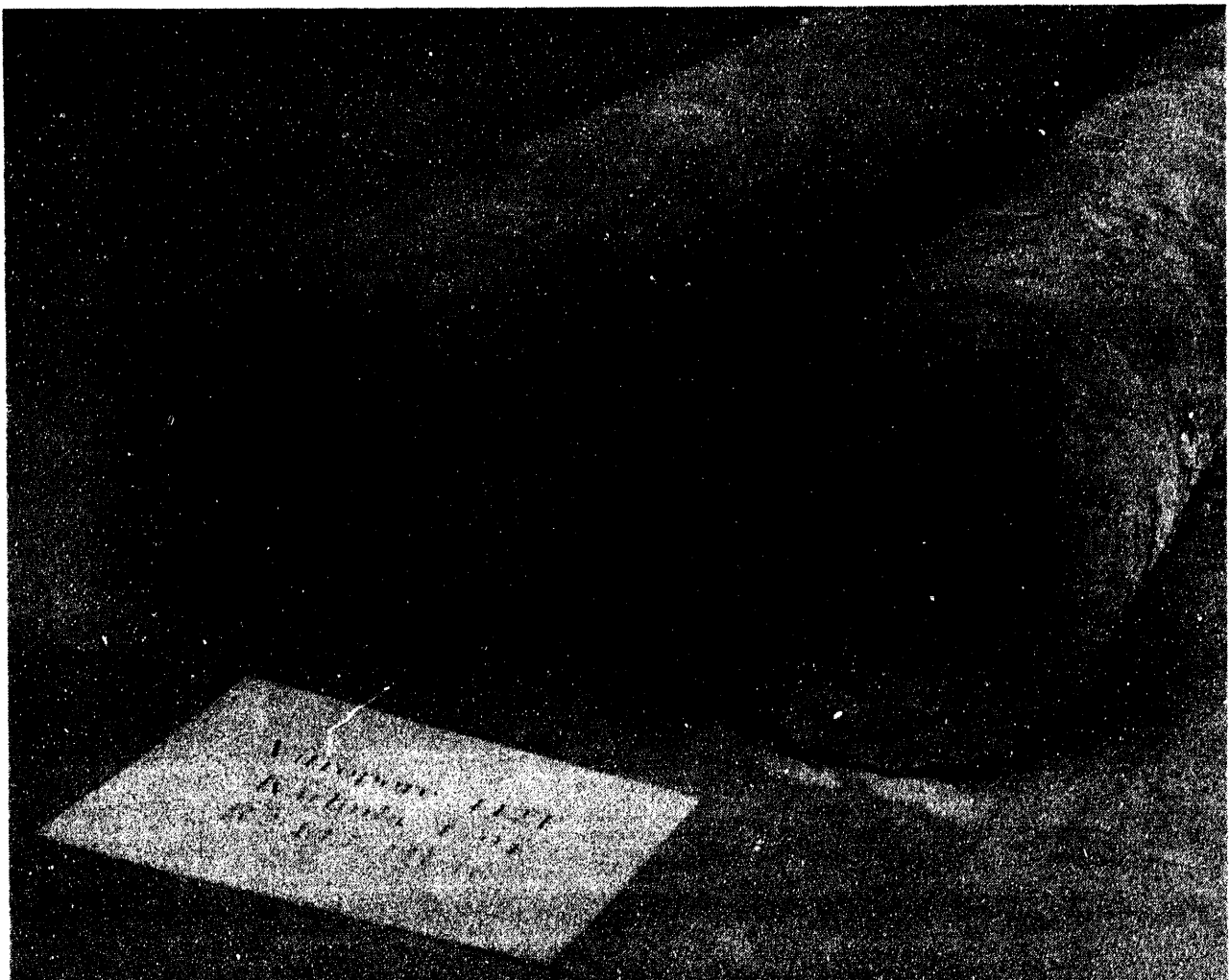


Figure 8 - Fractured Surface Of Candle Filter R2-143 (B-16)

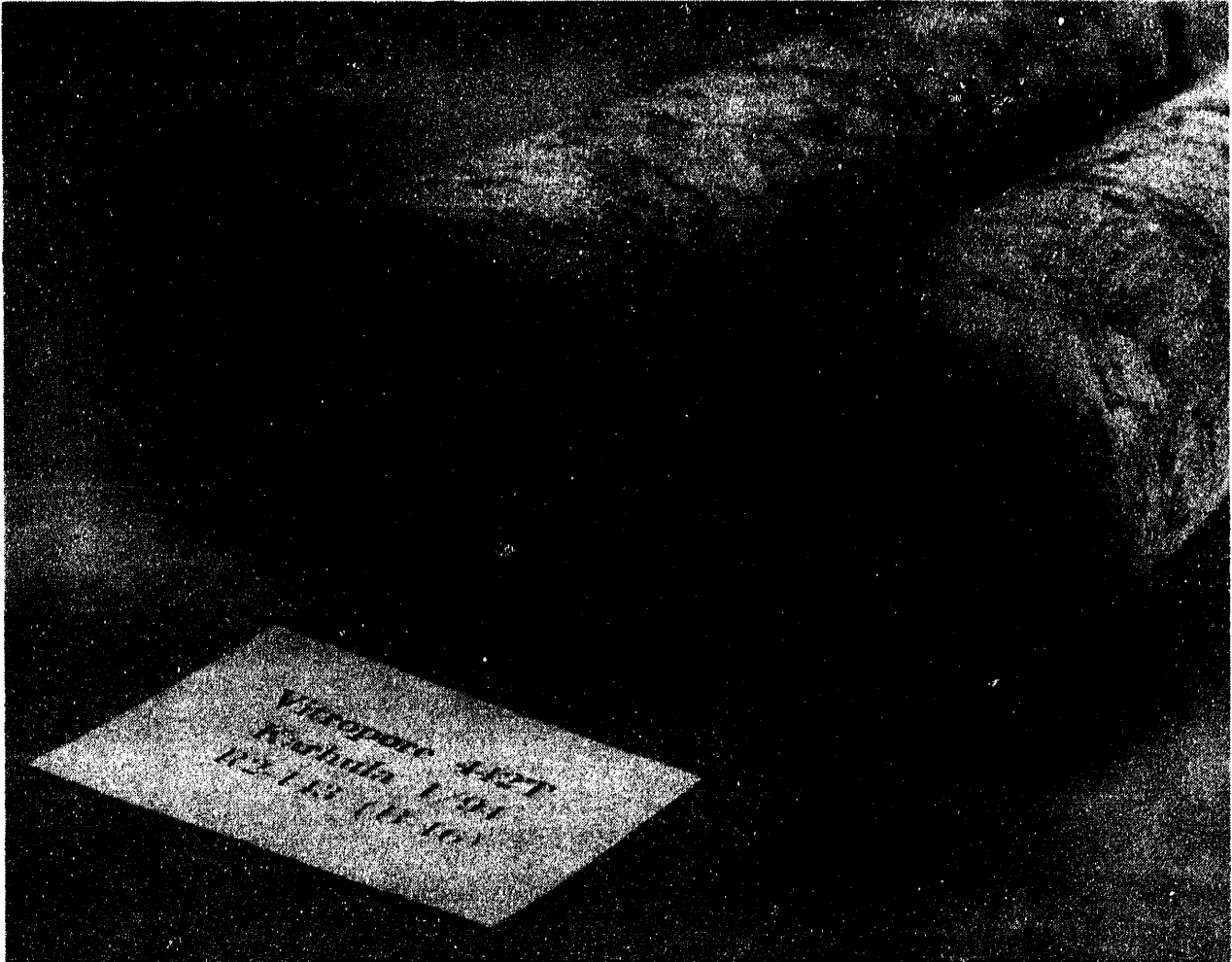


Figure 9 - Fractured Surface Of Candle Filter R2-143 (B-16)

appear to be free of dust, a relatively heavy surface coating of dust is evident along one section of the fractured candle filter surface shown in Figure 9.

The top gaskets used to seal candles R1-137 (B-10), R1-147 (B-4), and R4-135 (B-22) are shown in Figures 10 through 12. Each of these gaskets are relatively clean, indicating that a good dust seal had been maintained during the 512 hours of CFBC hot gas filtration.

In an attempt to illustrate the bond formation along the end cap plug of the Vitropore 442T candles, one candle was cut longitudinally through the candle filter body and nonporous, inserted plug. Figures 13 and 14 illustrate the discontinuity along the ceramic bond which seals the plug into the filter body. Irrespective of the discontinuous internal bond, the ceramic bonding material coats the bottom of the candle and plug, forming what appears to be a continuous outer seal.

Of the five CFBC-exposed Vitropore 442T candles which were returned to Westinghouse, candle R1-147 (B-4) clearly had cracked areas present at the base and at ~25.4 mm (~1 in) below the flange of the candle (Figure 15). The cracks were a series of four circumferential 12.7-25.4 mm (0.5-1 in) cracks which appeared to penetrate the candle filter OD membrane. Attempts to measure the actual depth of crack penetration using x-ray microfocus techniques estimated that three of the four cracks were 1.49, 2.99, and 3.15 mm (0.058, 0.118, and 0.124 in) deep through the 10 mm (0.394 in) candle filter wall. The fourth crack was superficial. A higher magnification photograph of the cracked areas is shown in Figure 16.

Sections were also removed from the crack candle filter area. These sections were vacuum infiltrated with epoxy and ground down to where the crack appeared to be initiated. Figures 17 and 18 show an optical photomicrograph montage through the cross-sectioned Vitropore 442T clay bonded silicon carbide filter wall. Discontinuity is detected

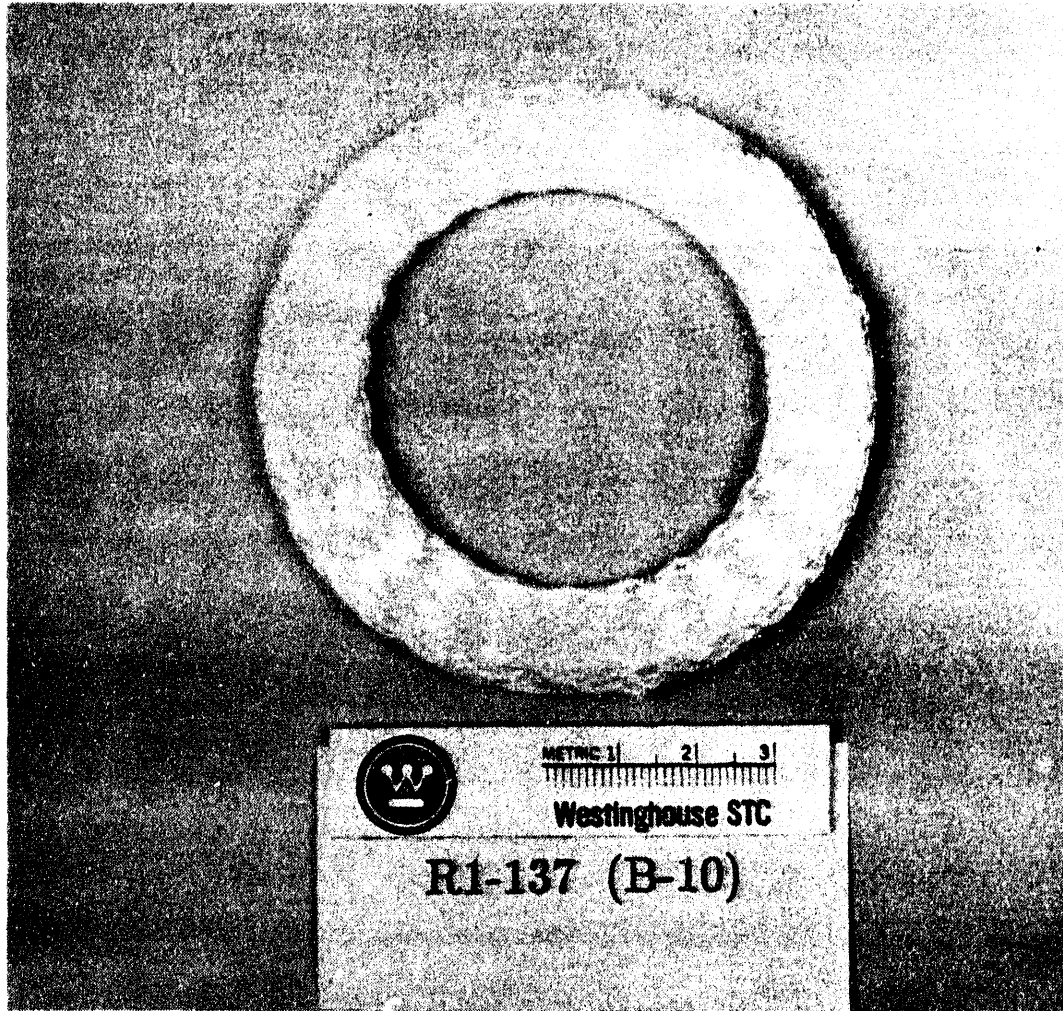


Figure 10 - Top Gasket Seal Of Vitropore Candle R1-137 (B-10)

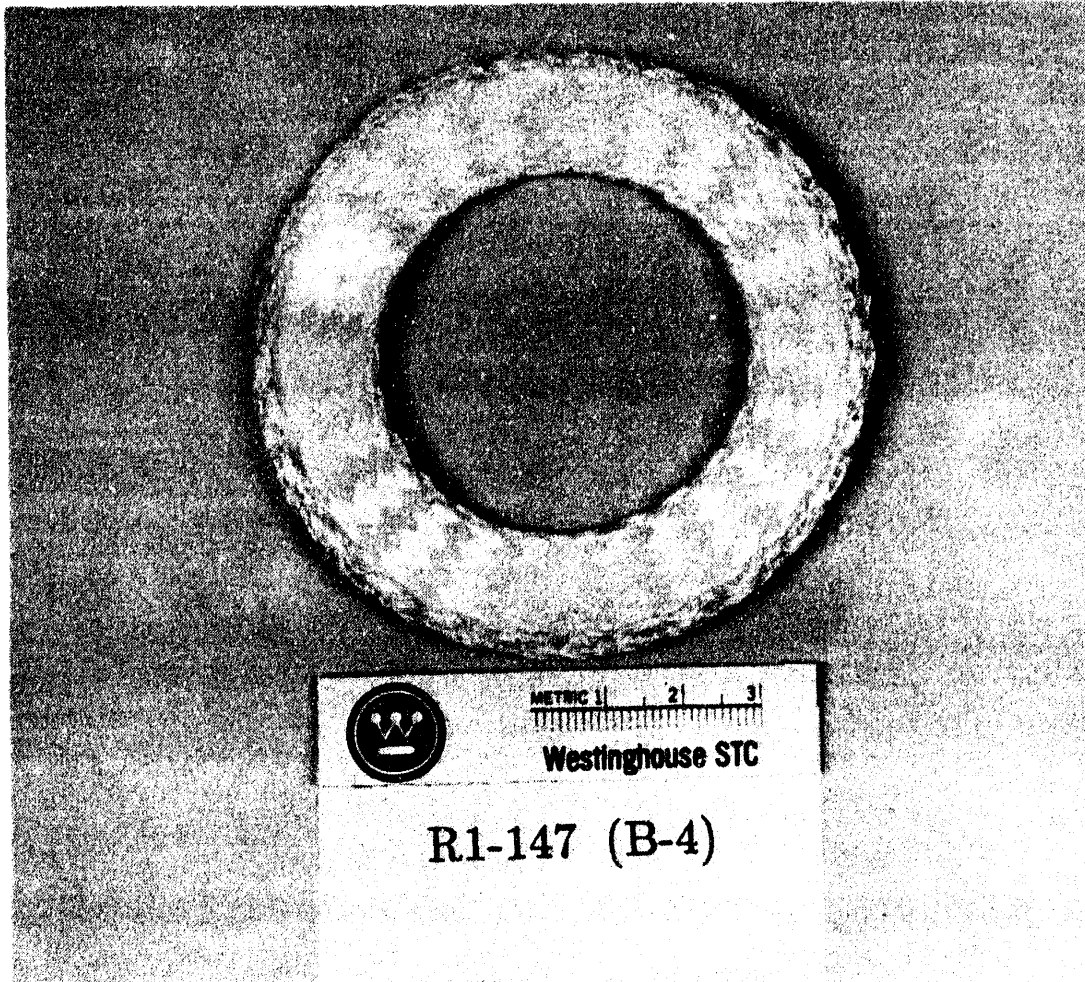


Figure 11 - Top Gasket Seal Of Vitropore Candle R1-147 (B-4)

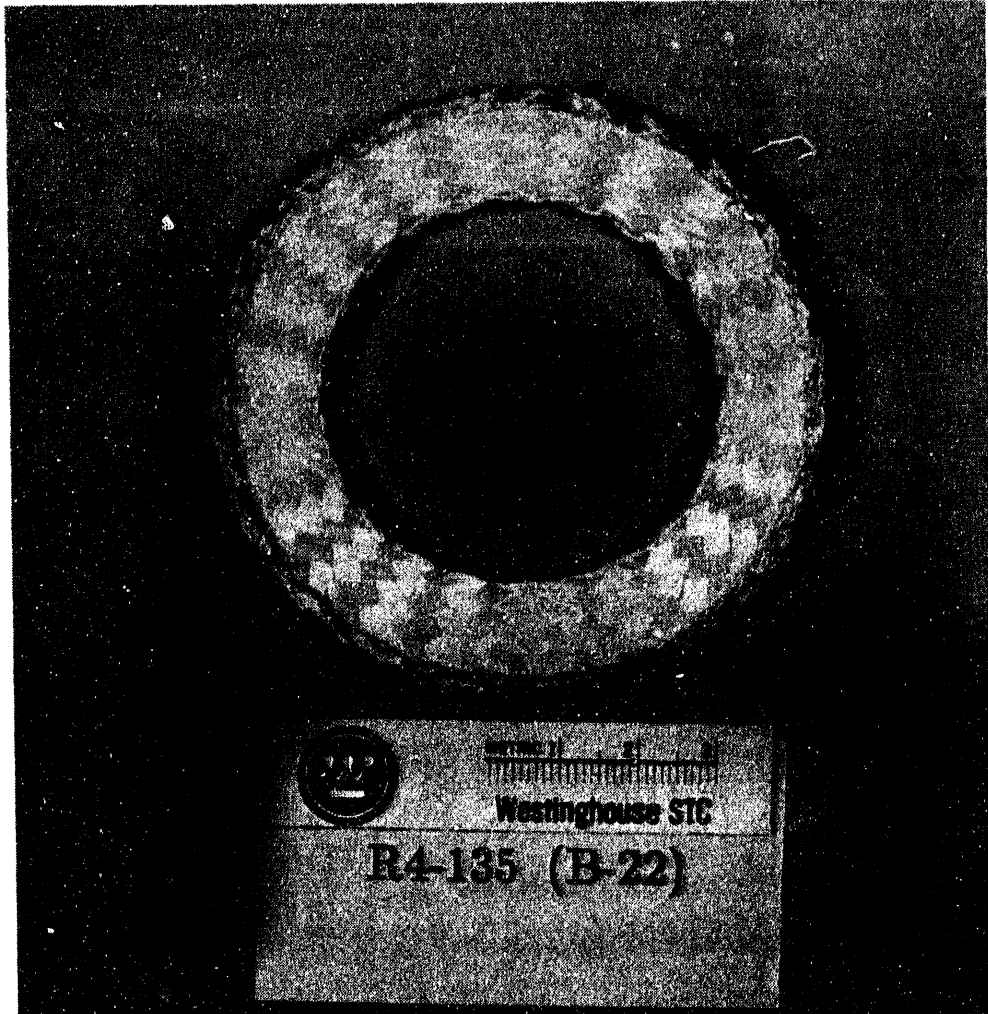
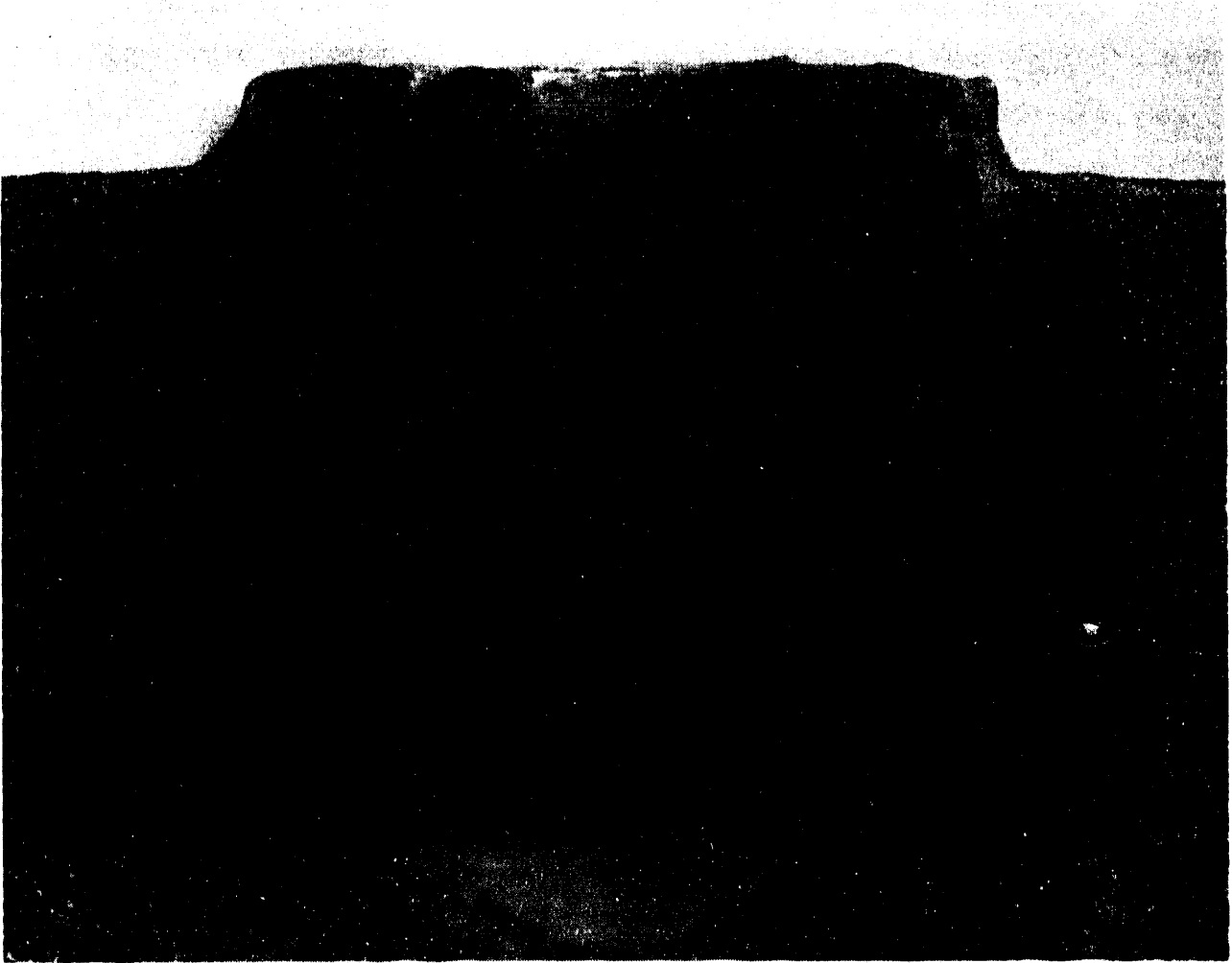


Figure 12 - Top Gasket Seal Of Vitropore Candle R4-135 (B-22)



Figure 13 - Cross-Sectioned Bottom End Cap Of The Vitropore 442T Candle Filter

Figure 14 - Cross-Sectioned Bottom End Cap Of The Vitropore 442T Candle
Filter (Mating Surface To Figure 13)



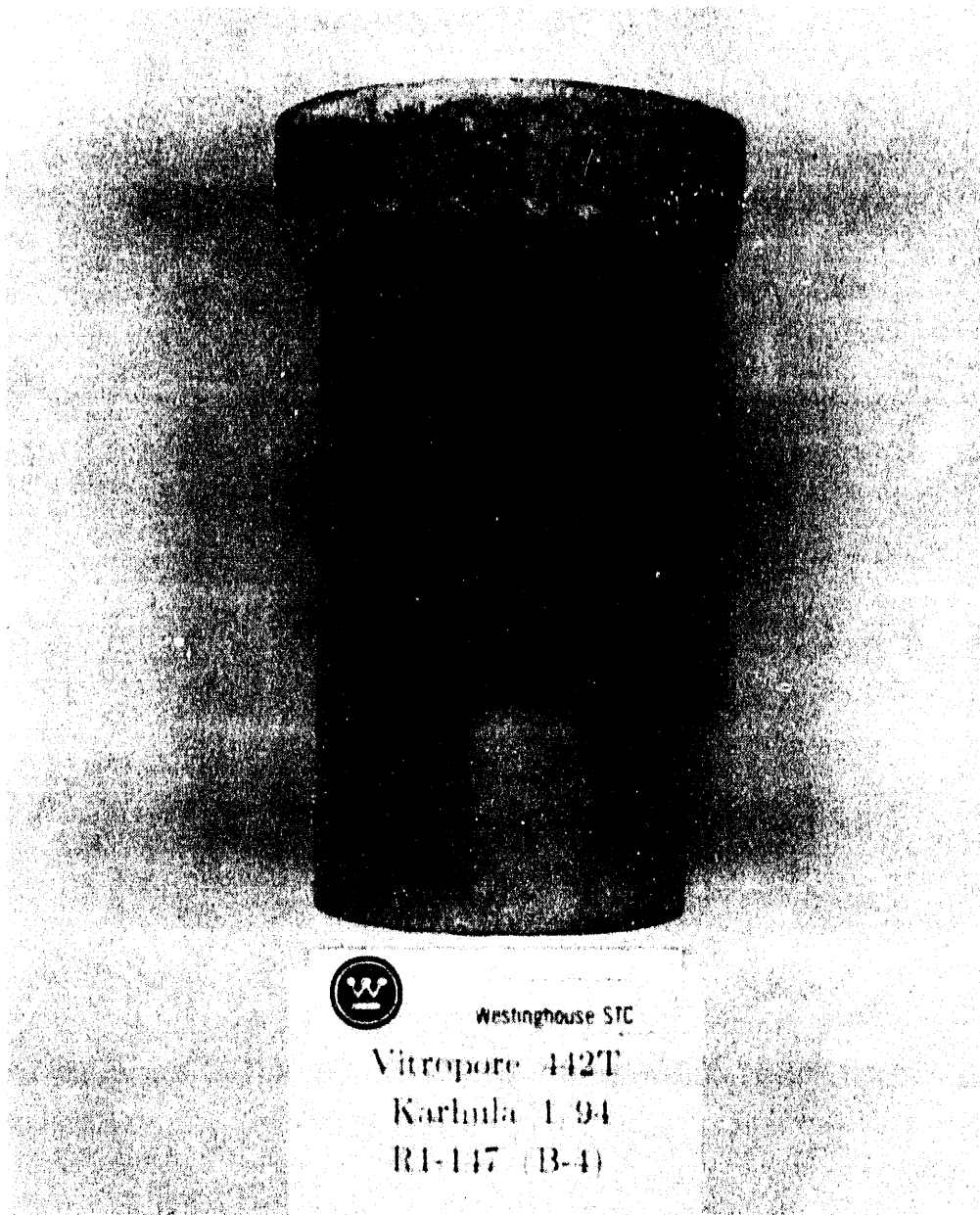


Figure 15 - Cracked Areas Evident Below The Flange Of Candle Filter
R1-147 (B-4)

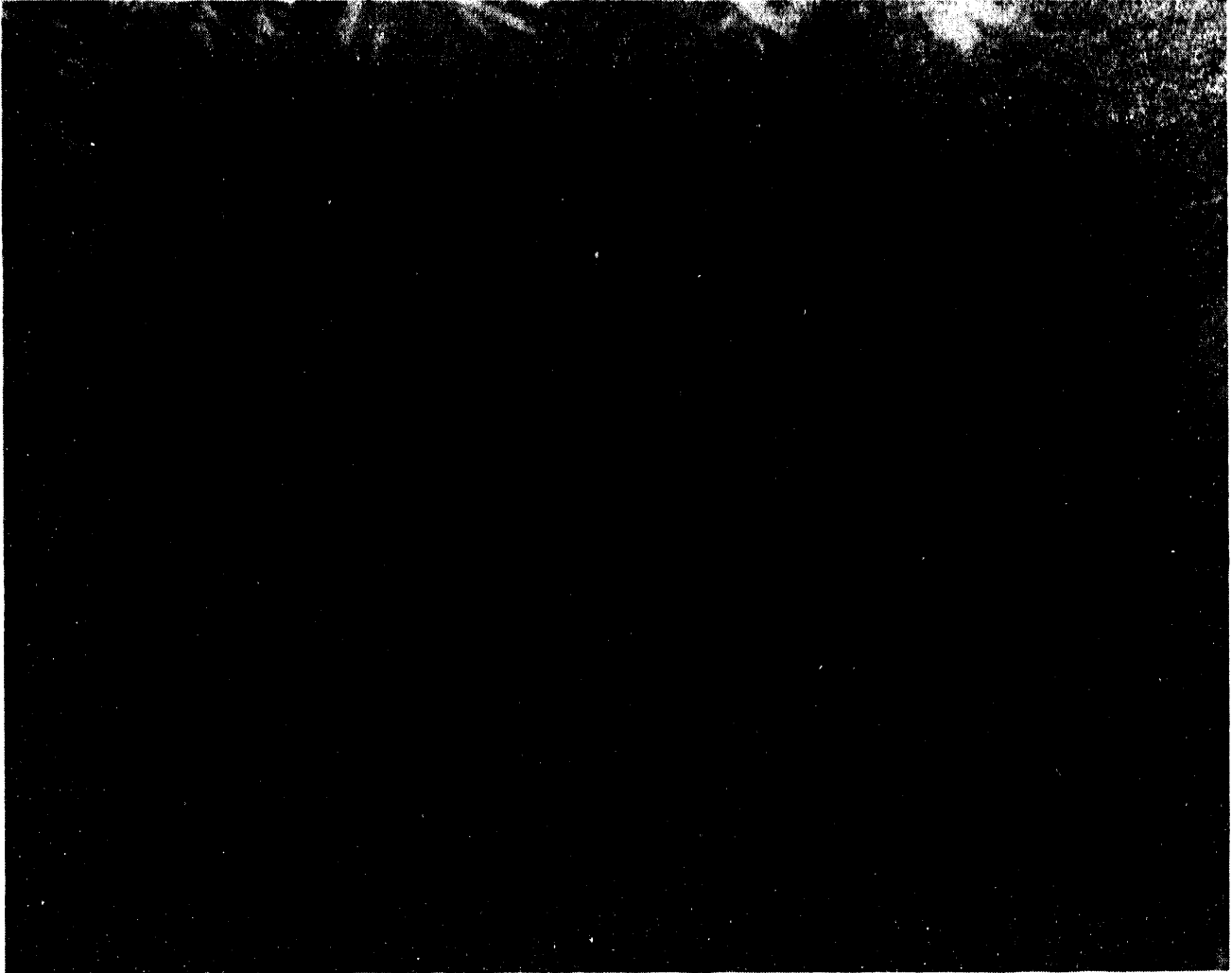


Figure 16 - Higher Magnification Of The Cracked Area Below The Flange
Of Candle Filter R1-147 (B-4)

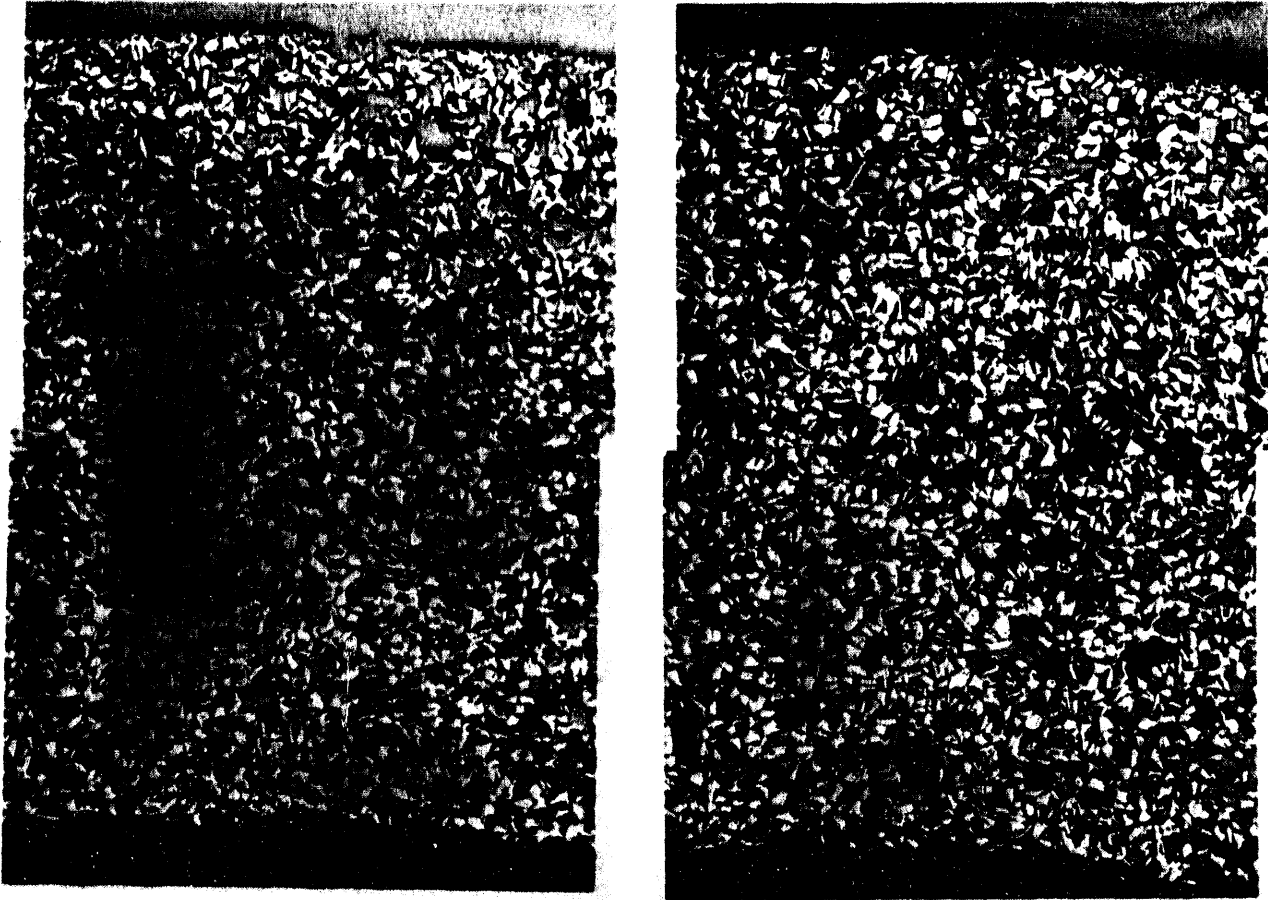


Figure 17 - Lower Magnification Optical Photomicrograph Montage Of The Cross-Sectioned Filter Wall At The Cracked Area Below The Flange Of Candle R1-147 (B-4)

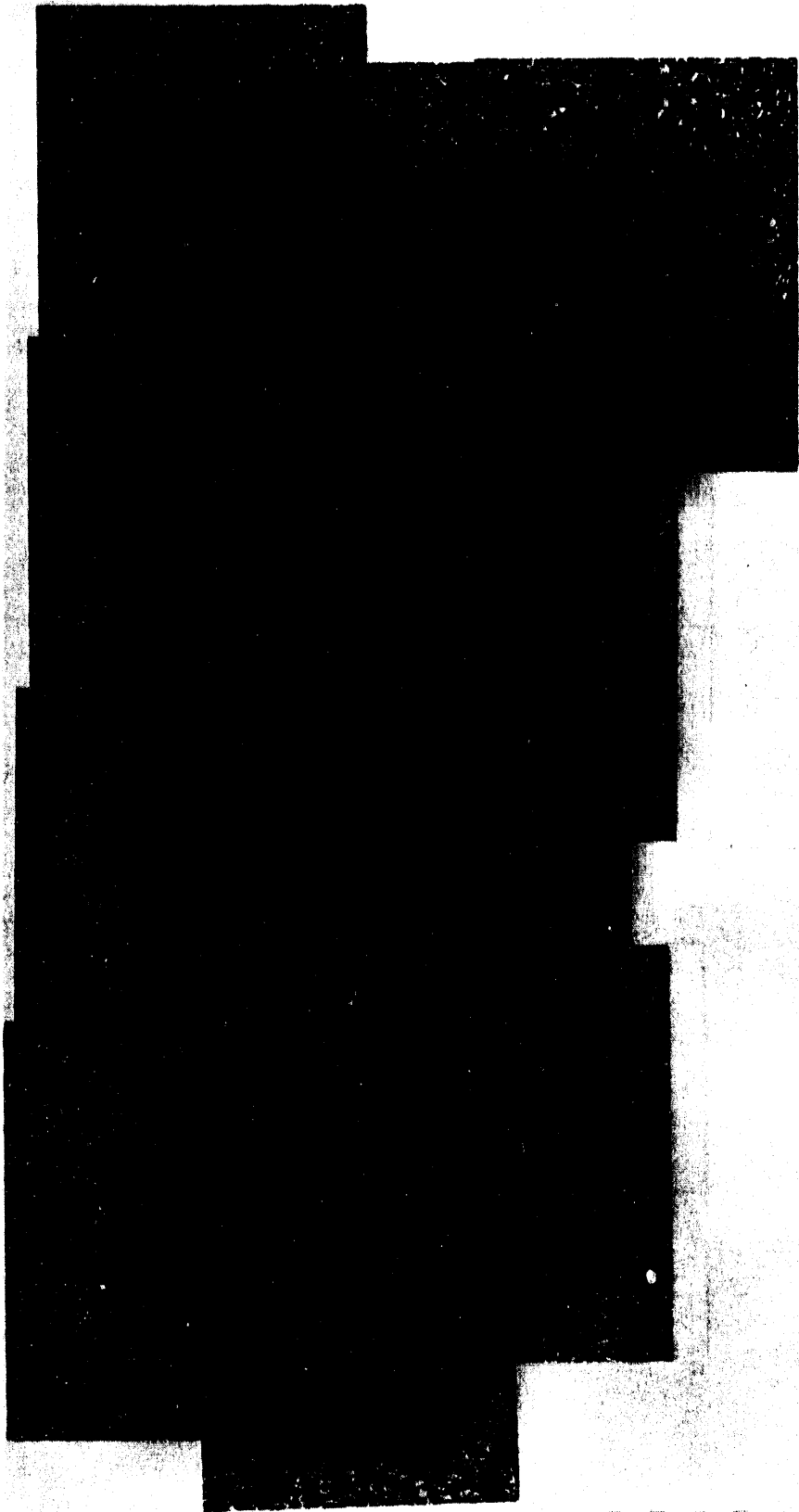


Figure 18 - Lower Magnification Optical Photomicrograph Montage Of The Cross-Sectioned Filter Wall At An Alternate Location Below The Cracked Area Of Candle R1-147 (B-4)

along the membrane coating in the affected area, but due to the relatively high porosity of the filter matrix, tracing a crack path through this material is extremely difficult.

From the apparent direction of the candle filter bow, the cracked section along the flange of candle R1-147 (B-4) was placed in tension during hot gas filtration. The depth of the crack obviously involves at least the membrane, and may actually extend 3 mm (0.118 in) into the 10 mm (0.394 in) candle filter wall.

Dust Cake Formation

Portions of the dust cake layer remained along the Vitropore 442T candles that were shipped to Westinghouse in January 1994 (Figure 19). Notably the OD surface of the dust cake layer had an orangish-yellow appearance. When an area of the dust cake layer was removed from the filter OD surface, the ID surface of the cake (i.e., surface adjacent to the candle filter wall) had a reddish appearance. During Test Segment 2, the filter system had been operated for 221 hours with Illinois No. 6 coal and Iowa Industrial No. 1 limestone, and was followed by 291 hours of operation with Black Thunder coal and Iowa Industrial No. 1 limestone as the sulfur sorbent material. Operation with the Illinois coal resulted in deposition of the reddish ash layer, while the use of Black Thunder resulted in the deposition of the orangish-yellow layer.

A section of the ash cake layer was removed from the candle filter surface. Its thickness was determined to be 2.1 mm. Both the outer orangish-yellow dust cake OD surface, cross-section, and reddish ID surface were characterized using scanning electron microscopy and energy dispersive x-ray analyses (SEM/EDAX). The composition of the reddish Illinois ash-Iowa limestone cake layer was determined by EDAX to include the following elements (i.e., semi-quantitative atomic percent basis):

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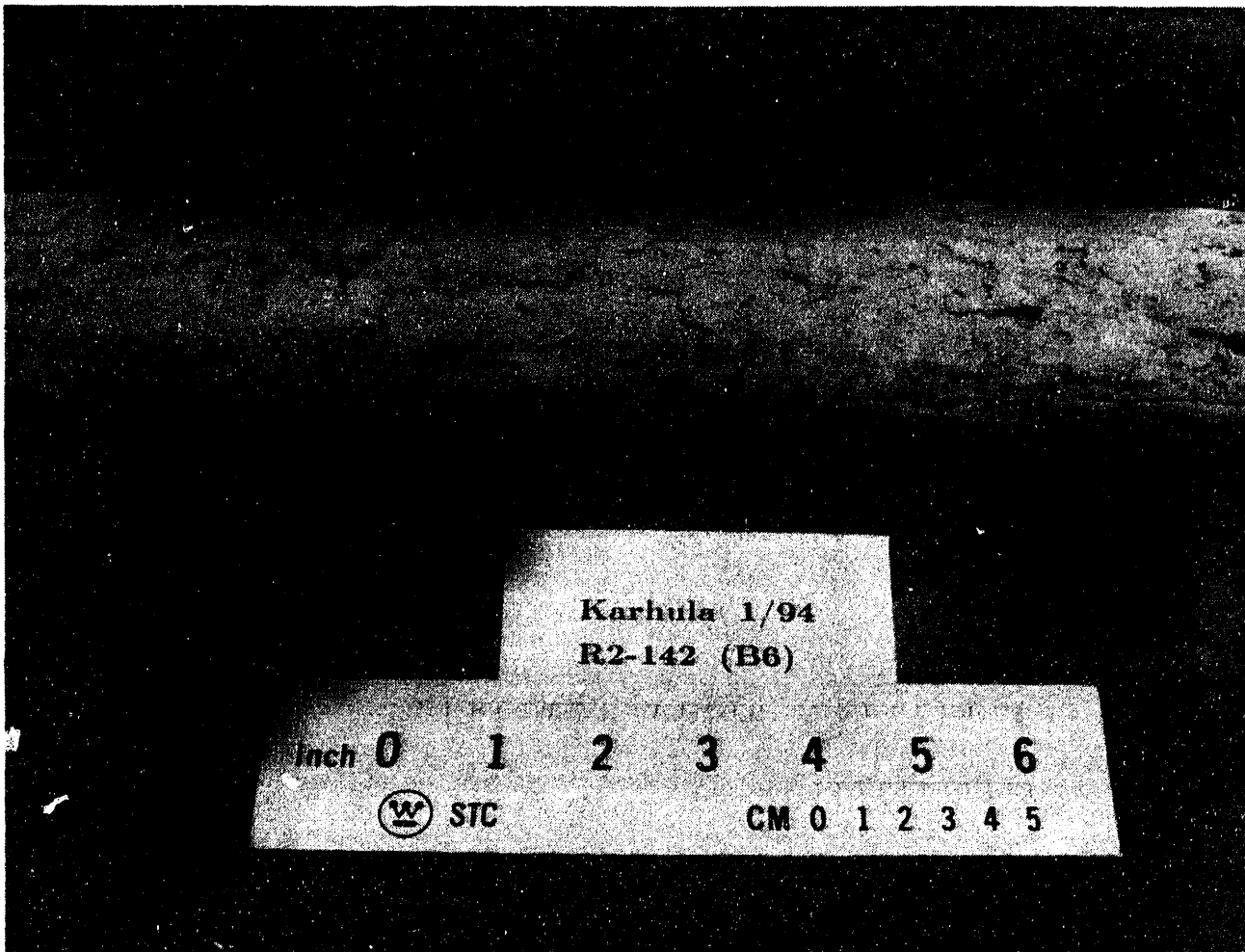


Figure 19 - Dust Cake Formation Along The Vitropore 442T Candles After 512 Hours Of Operation In The CFBC Gas Environment

Element	Area 1	Area 2	Area 3
O	64.66	69.62	70.38
Si	14.82	12.66	12.42
Fe	5.65	2.65	2.71
Al	5.12	5.20	4.65
Ca	4.02	3.39	3.39
Na	3.86	3.85	3.51
S	1.50	2.25	2.51
K	0.37	0.20	0.25
Ti	----	0.19	0.17

Moving 0.2 mm from the ID surface of the dust cake layer (i.e., into and possibly through the reddish Illinois ash-Iowa limestone layer), the composition of the ash cake was identified by EDAX to consist of 71.66% O, 7.82% Si, 6.23% Ca, 5.01% S, 3.95% Al, 2.09% Na, 1.60% Mg, 1.19% Fe, 0.22% K, and 0.22% Ti. At 0.6 mm from the ID surface of the dust cake, the composition of the ash was identified to include 71.95% O, 7.07% Ca, 6.17% Si, 5.67% S, 4.88% Al, 1.59% Na, 1.26% Mg, 0.96% Fe, 0.24% Ti, and 0.19% K (i.e., possibly into the Black Thunder ash-Iowa limestone cake layer based on the lower Si, but higher Ca content in relation to that of the Illinois ash fines).

At 1.0 mm from the ID surface of the dust cake layer, the ash composition was identified to include 65.13% O, 13.13% Ca, 6.24% S, 5.26% Si, 4.06% Al, 3.52% Fe, 0.91% Na, 0.71% Mg, 0.56% K, and 0.49% Ti. At 1.4 mm from the ID surface of the dust cake (0.7 mm from the OD surface) the composition included 71.06% O, 8.24% Ca, 6.37% S, 5.42% Si, 4.31% Al, 1.48% Na, 1.38% Mg, 1.33% Fe, 0.25% K, and 0.16% Ti.

The following elemental concentrations were identified along the orangish-yellow Black Thunder OD ash cake layer:

<u>Element</u>	<u>Area 1</u>	<u>Area 2</u>	<u>Area 3</u>
O	72.07	72.28	73.03
Si	5.37	5.46	5.16
Fe	1.05	0.93	1.12
Al	4.70	4.83	4.19
Ca	7.14	6.78	6.89
Na	1.11	1.17	1.27
S	6.42	6.20	6.22
K	0.17	0.30	0.17
Ti	0.34	0.21	0.31
Mg	1.62	1.84	1.63

Progression through the dust cake layer indicates that a higher silicon containing ash formed initially along the candle filter surface (i.e., Illinois ash and Iowa limestone fines), while extended operation resulted in the accumulation of a dust cake layer which had a lower silicon but higher calcium and sulfur content (i.e., Black Thunder ash and Iowa limestone fines). The above EDAX analyses do not appear to differentiate between deposition of the Black Thunder-Iowa limestone dust cake layer along the Vitropore 442T candle filters during the 116 hours of CFBC test operation, and the final 174 hours of CFBC operation with only Black Thunder coal.

Figure 20 provides a series of scanning electron micrographs (SEM) which illustrates the morphology of the orangish-yellow dust cake outer surface (i.e., Black Thunder ash and Iowa limestone fines). A rather open or porous structure is evident in the OD surface of the dust cake layer. Less than 5 μm -sized particles are frequently identified to fuse into a larger ash network (Figure 20a). Often <1-2 μm fines are attached to the surface of an underlying larger particle. Note the rounded nature of the micron-sized fines that form the outer shell of the 10-15 μm agglomerated ash structures shown in Figure 20b.

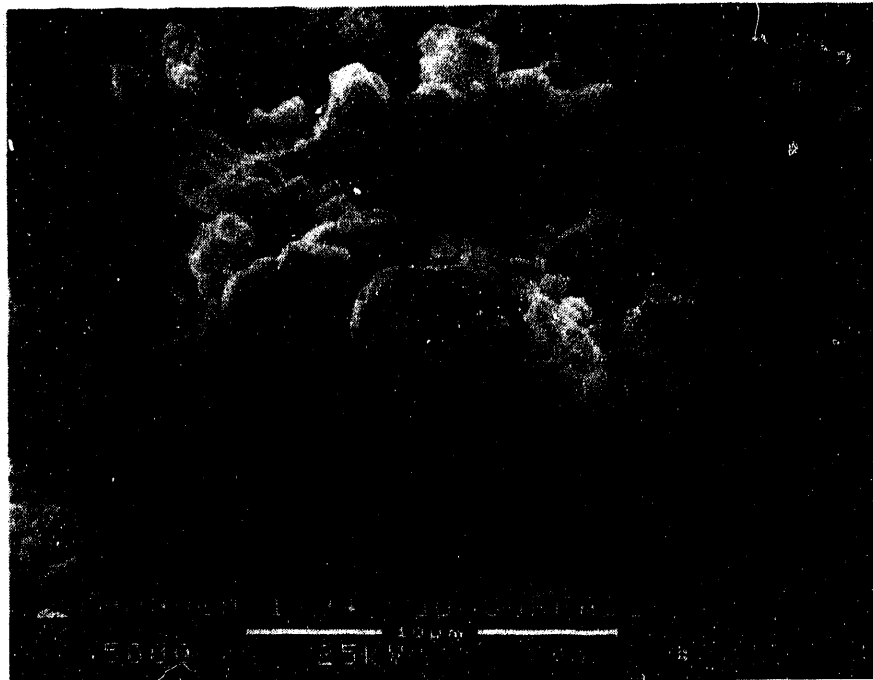
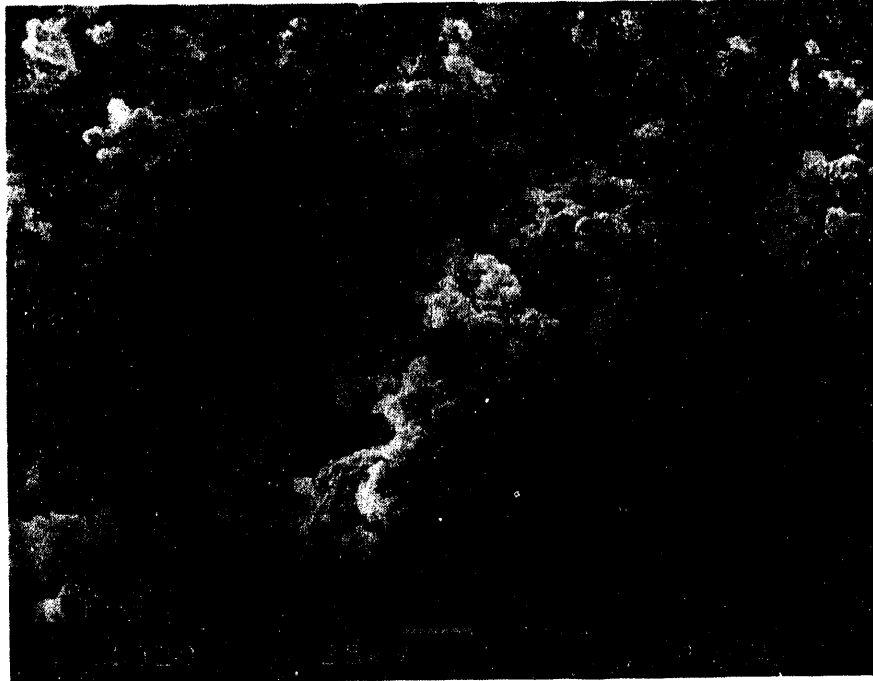


Figure 20a - Scanning Electron Micrographs Illustrating The Morphology Of The OD Surface Of The Ash Cake Layer Formed Along The Vitropore 442T Candle Filters. The Orangish-Yellow Colored Ash Is Indicative Of Black Thunder Ash And Possibly Iowa Limestone Fines

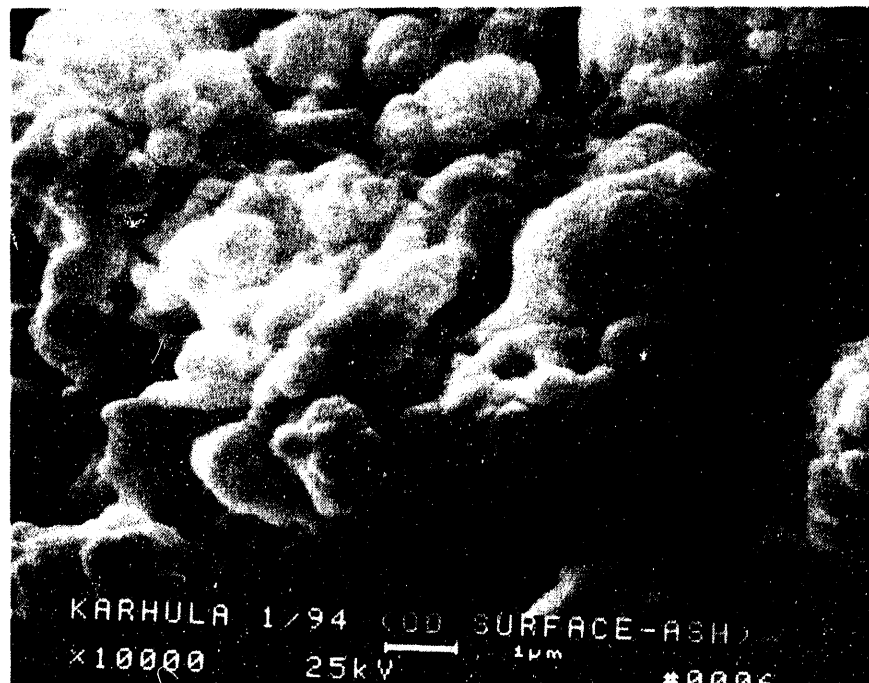
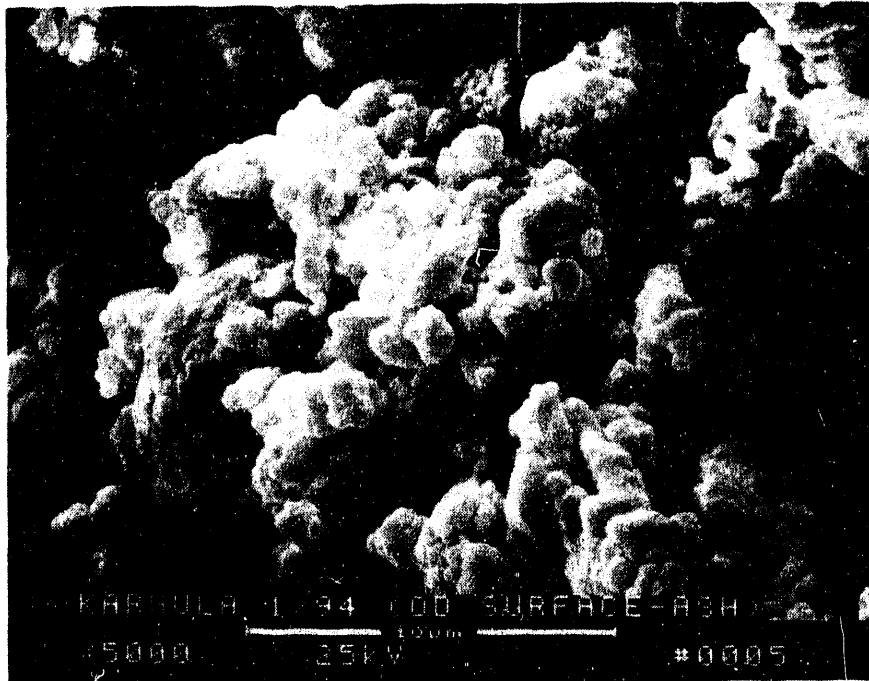


Figure 20b - Fused Ash Fines Forming 10-15 μm -Sized Agglomerates

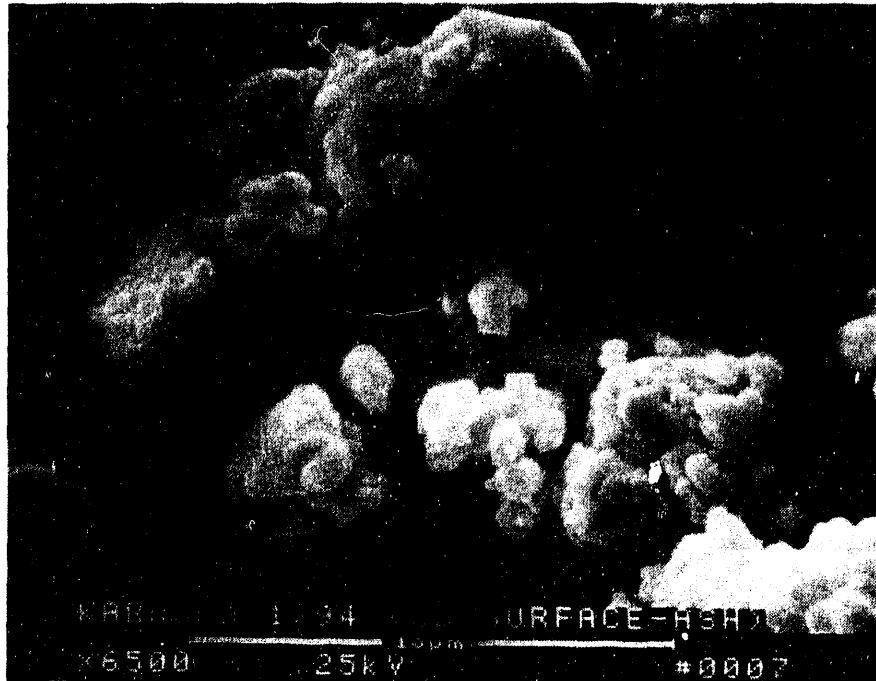


Figure 20c - Scanning Electron Micrograph Illustrating The Attachment Of Fines To 10 μ m-Sized Particles Which Have A Smooth Almost Molten Surface Appearance

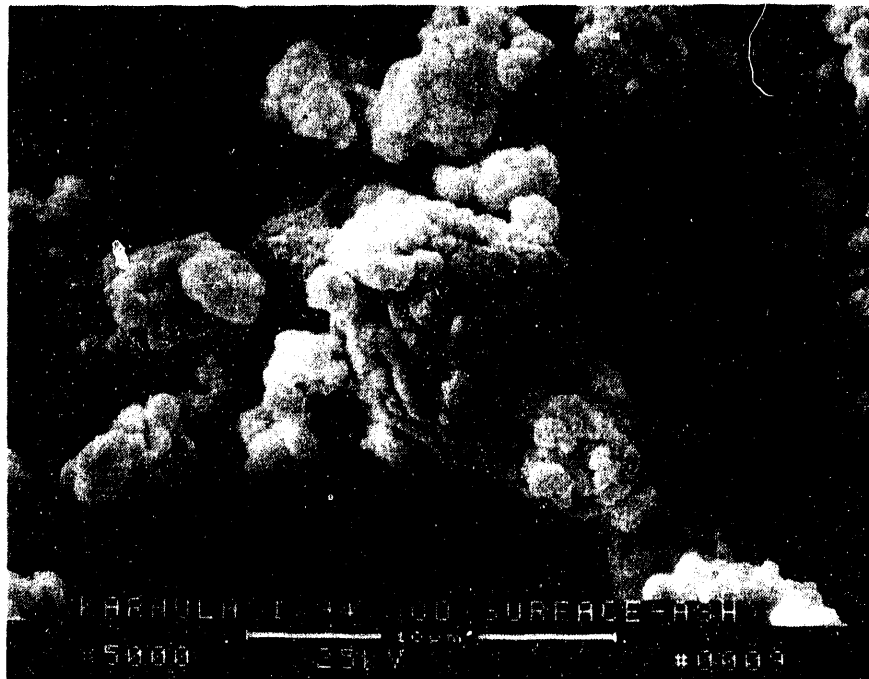
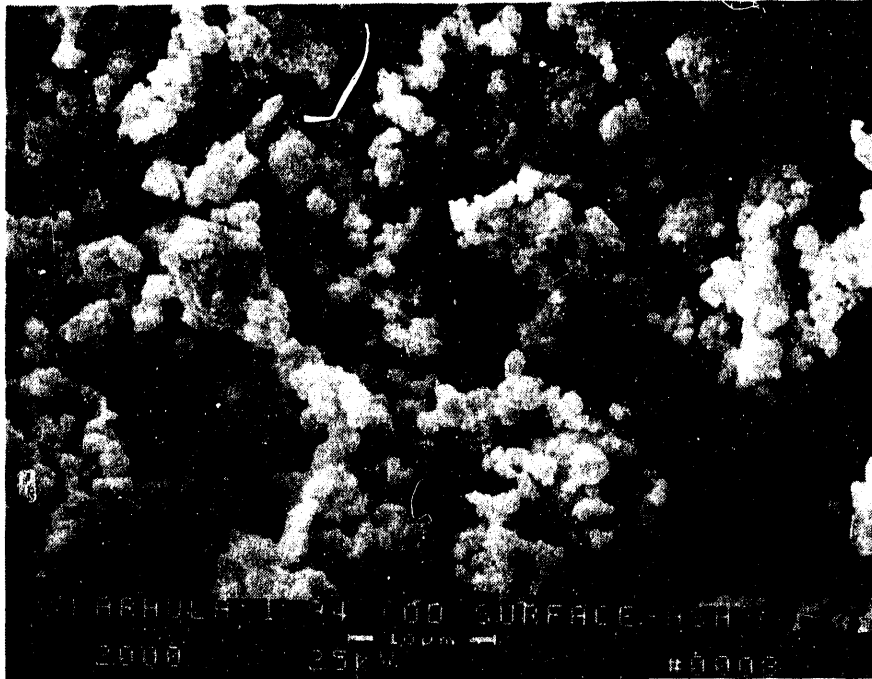


Figure 20d - Geodesic Surface Features Of The 5-15 μm -Sized Particles Formed From Deposition Of Black Thunder Ash And Possibly Iowa Limestone Fines

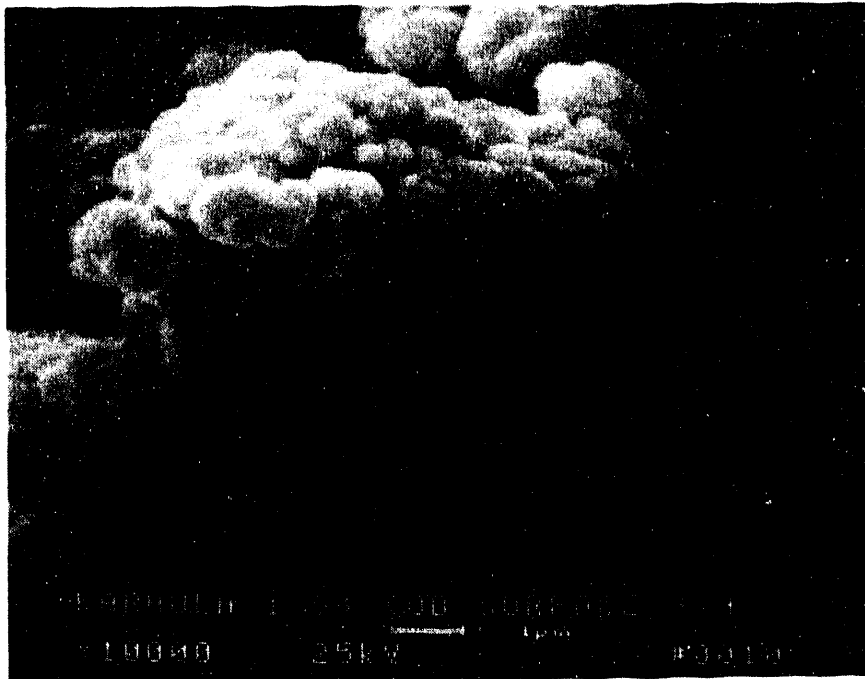


Figure 20e - High Magnification Of The 5-10 μm -Sized Black Thunder Ash
And Possibly Iowa Limestone Fines

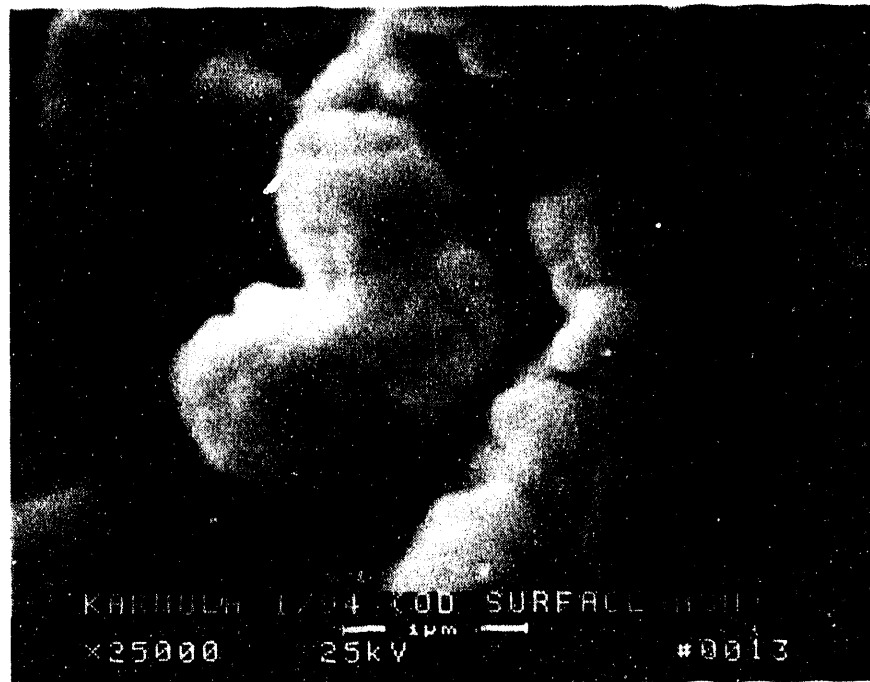
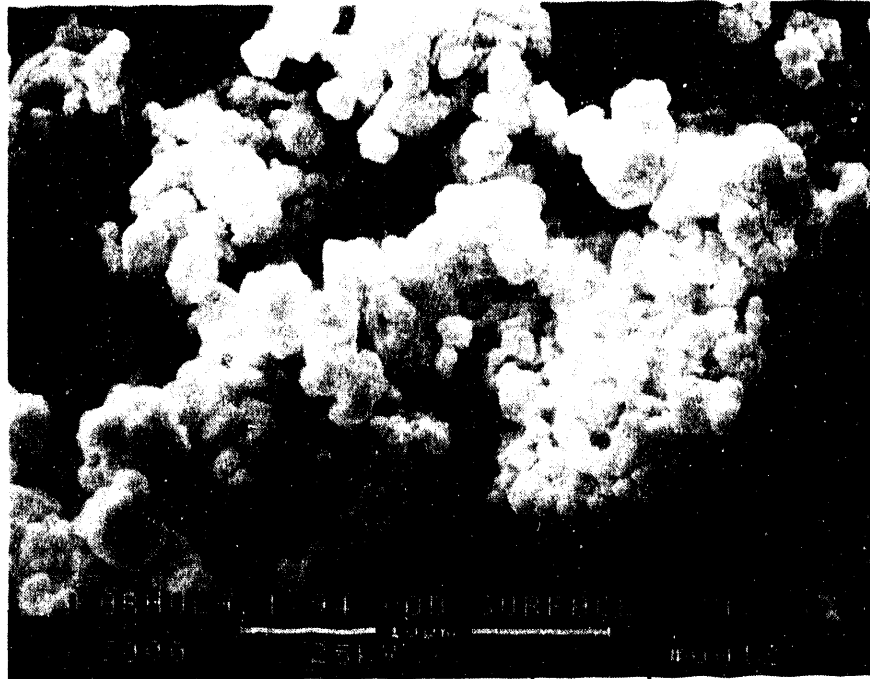


Figure 20f - Morphology Of The Micron And Submicron Fines Which Are Present Along The Surface Of The Larger Particulates In The Black Thunder Ash And Iowa Limestone Dust Cake Layer

Figure 208 - Morphology Of The Micron And Submicron Agglomerates



Frequently 10 μm particulates which appear to have smooth "molten" surfaces serve as substrates for the attachment of micron-sized particle formations (Figure 20c). Alternately 5-15 μm particles which have geodesic surface features are readily evident along the orangish-yellow OD surface of the Black Thunder ash and possibly Iowa limestone dust cake layer. Again these particles serve as substrates for the adherence of smaller particulates.

Figure 20e shows the relatively extensive network of perhaps a crystalline phase that forms the geodesic or "patch-work" OD surface of the ash particle. Figures 20f and 20g illustrate the morphology of the micron and submicron fines that are present along the surface of the larger particulates of the Black Thunder ash and Iowa limestone dust cake layer.

Figure 21 presents a series of micrographs through the 2.1 mm cross-sectioned ash dust cake layer. Here we encounter a somewhat denser packing of the ash. The relatively large 10-20 μm , smooth surface particles are readily evident in Photo 18, Figure 21a. At higher magnification (Photo 19, Figure 21a; Photo 20, Figure 21b) micron and submicron-sized particles are identified to be attached (i.e., sintered, fused, bonded or grain growth) to the surface of the underlying 10-20 μm larger ash particles.

Figures 21c through 21e illustrate the morphology of the ash cake layer that was formed 0.7 mm below the OD surface of the dust cake. Flat, smooth surface, plate-like 10-20 μm particles are evident in this area. These particles serve as substrates for adherence of micron and submicron fines. The relative open porosity in this area may be somewhat higher than in the previous series of micrographs.

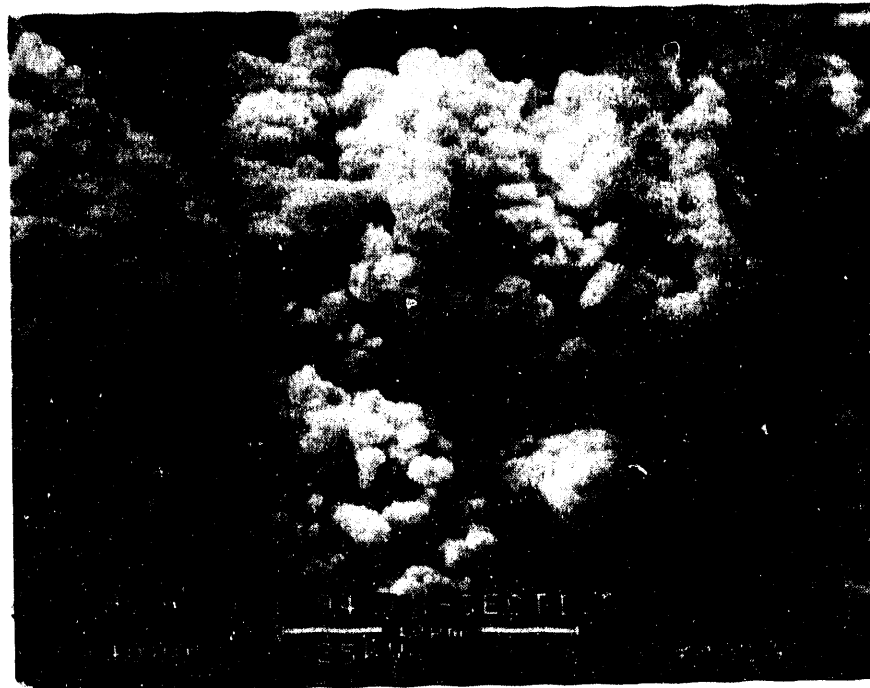


Figure 21a - Cross-Section Of The 2.1 mm Dust Cake Layer Formed Along The Vitropore 442T Candle Filters. Location Of This Area Is 0.2 mm Below The OD Surface Of The Dust Cake Layer



Figure 21b - Higher Magnification Micrograph Illustrating The Formation Of Micron And Submicron Ash Fines Which Are Frequently Attached To The Underlying Smooth Surface 10-20 μm -Sized Black Thunder Ash And Iowa Limestone Fines

2 of 3

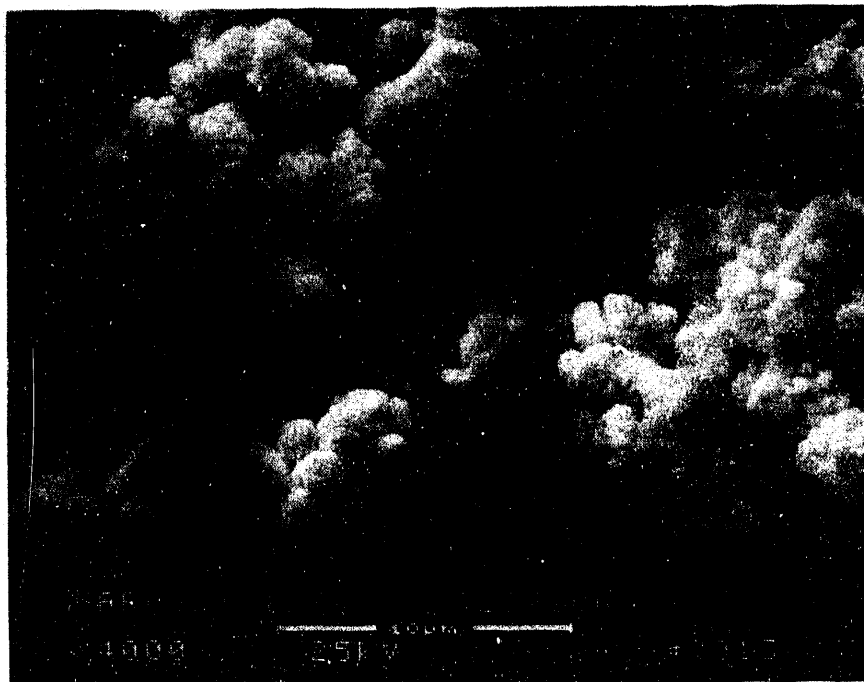


Figure 21c - Cross-Section Of The 2.1 mm Dust Cake Layer Formed Along The Vitropore 442T Candle Filters. Location Of This Area Is 0.7 mm Below The OD Surface Of The Dust Cake Layer. Flat, Plate-Like, Smooth Surface 10-20 μm Particles Serve As Substrates For The Adherence Of Micron And Submicron Particles.

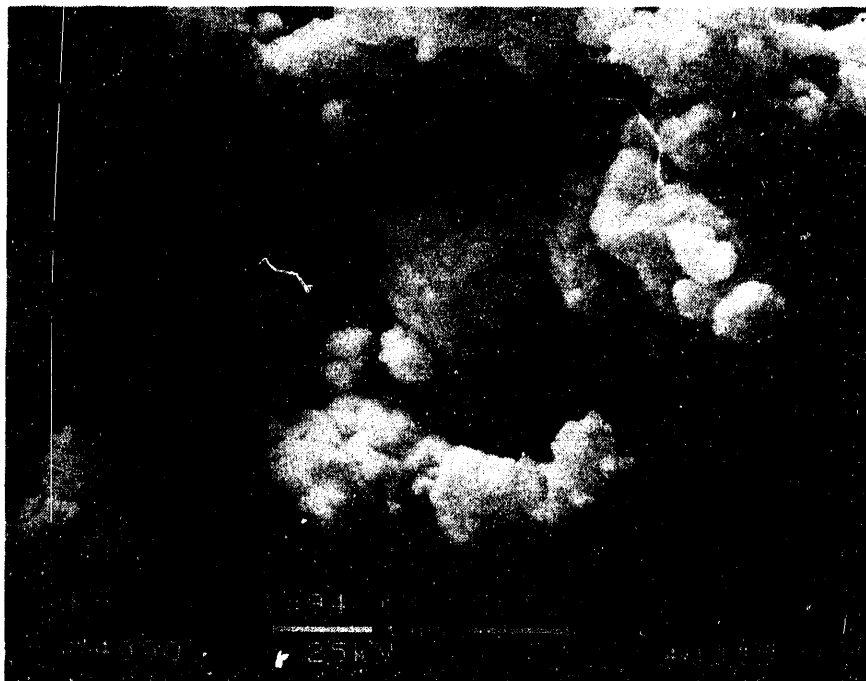


Figure 21d - Additional Micrographs Illustrating The Adherence Of Micron AND Submicron-Sized Particles Along The Surface Of Smooth, Plate-Like $>10 \mu\text{m}$ Particles. Note The Geodesic Formation Of Several Of The Fines.



**Figure 21e - High Magnification Of The Geodesic Particles In The Ash
Dust Cake Layer**

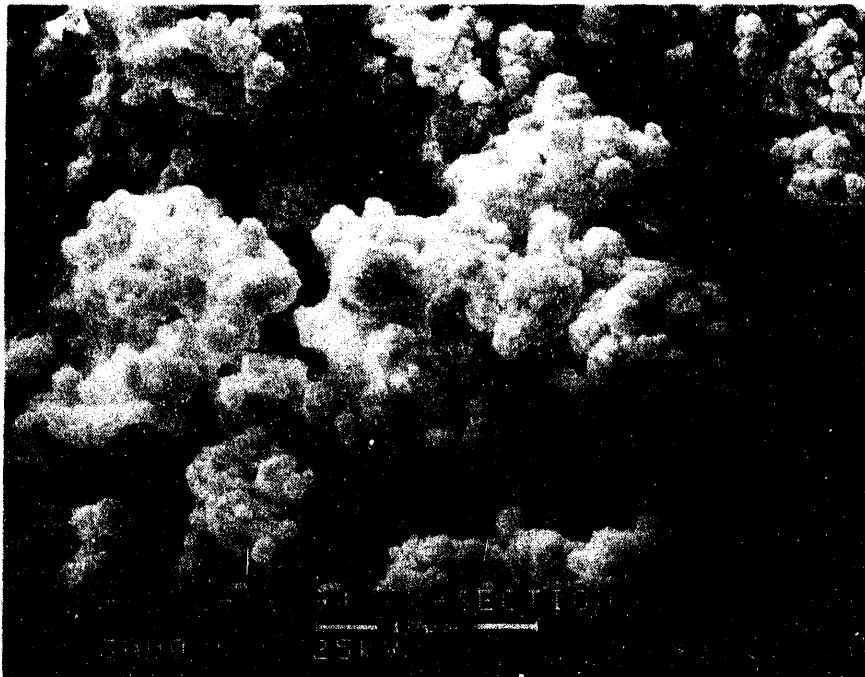


Figure 21f - Cross-Section Of The 2.1 mm Dust Cake Layer Formed Along The Vitropore 442T Candle Filters. Location Of This Area Is ~1.0 mm Below The OD Surface Of The Dust Cake Layer (Midway Through The Cross-Sectioned Ash Cake Layer).

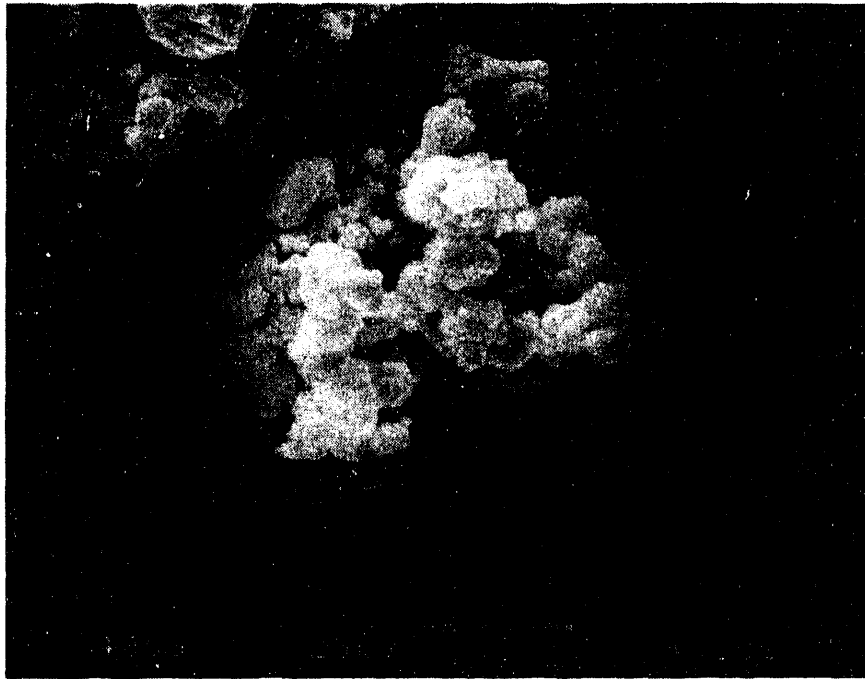


Figure 21g - Agglomeration Of Fines Detected At 1.5 mm Below The OD Surface Of The Dust Cake Layer

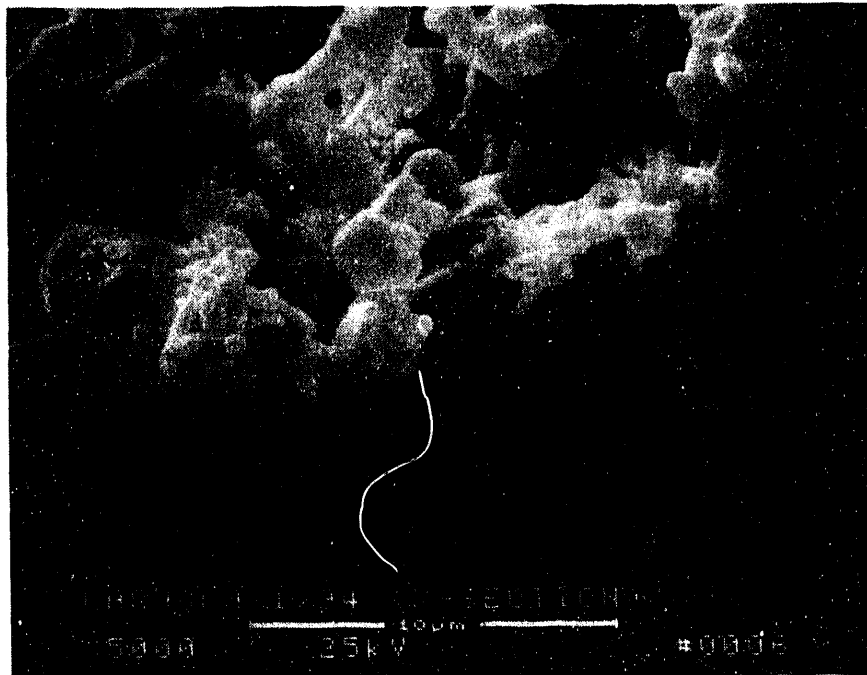
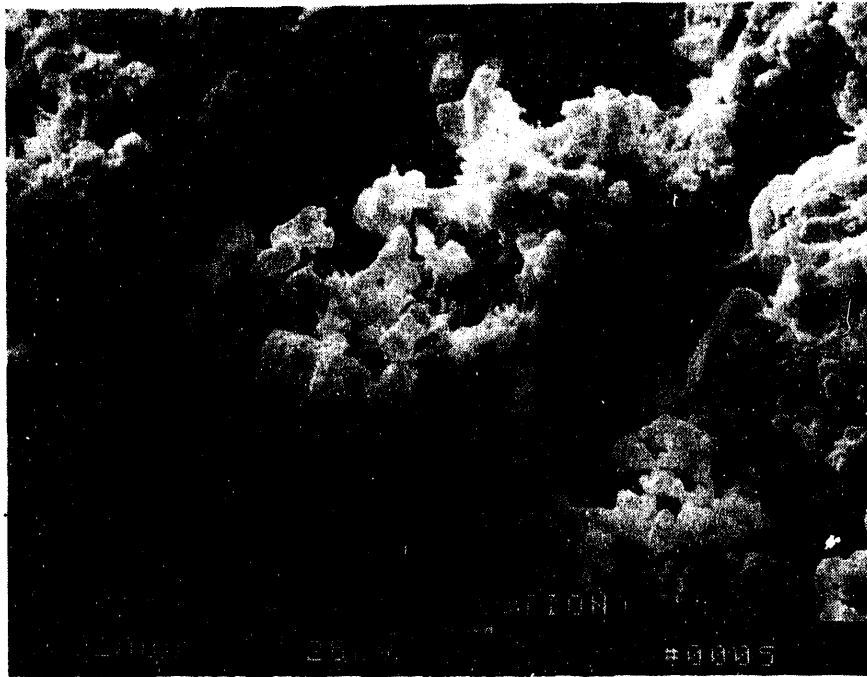


Figure 21h - Cross-Section Of The 2.1 mm Dust Cake Layer Formed Along The Vitropore 442T Candle Filters. Location Of This Area Is 1.9 mm Below The OD Surface Of The Dust Cake Layer. Angular Smooth Surface Fines Support Grain Growth (i.e., CaSO_4) In This Area.

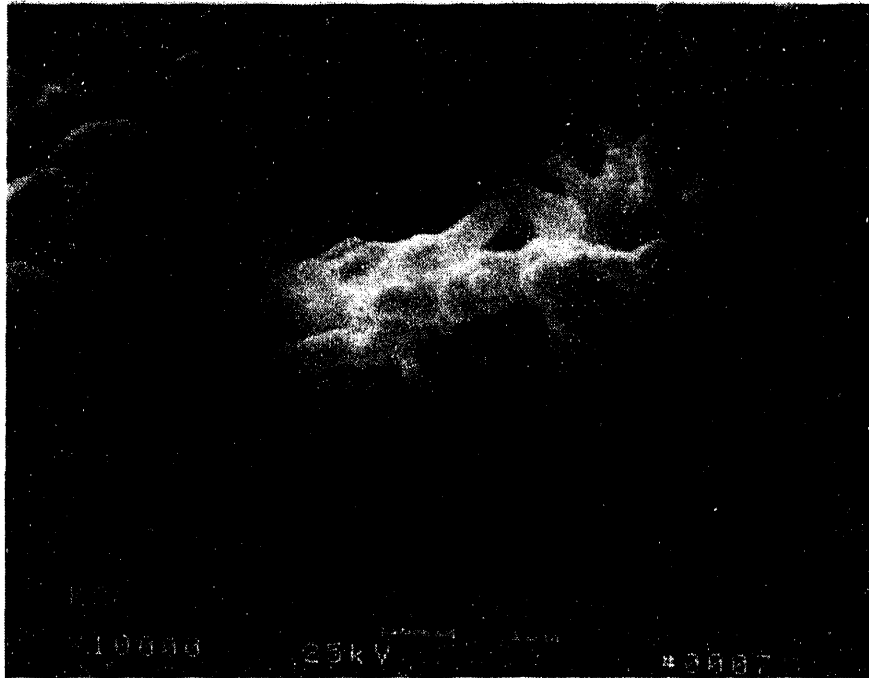


Figure 21i - High Magnification Of Grain Growth Along Ash Particulates

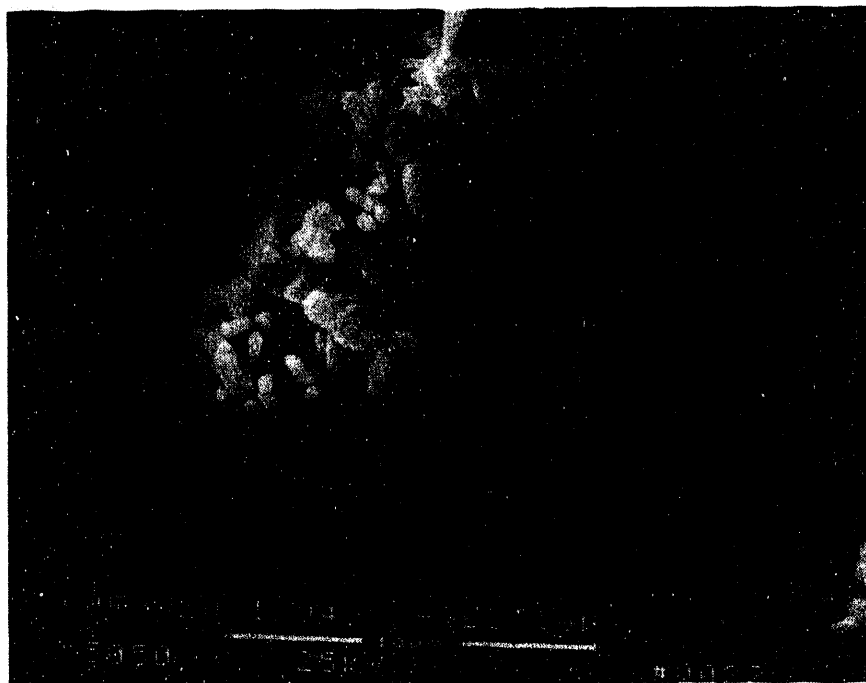


Figure 21j - Micrographs At An Alternate Location Illustrating Grain Growth



Figure 21k - Higher Magnification Of The Particles Supporting Grain Growth

Figure 211 - Morphology Of The Ash Fines Formed Near The ID Surface Of The Ash Cake Layer

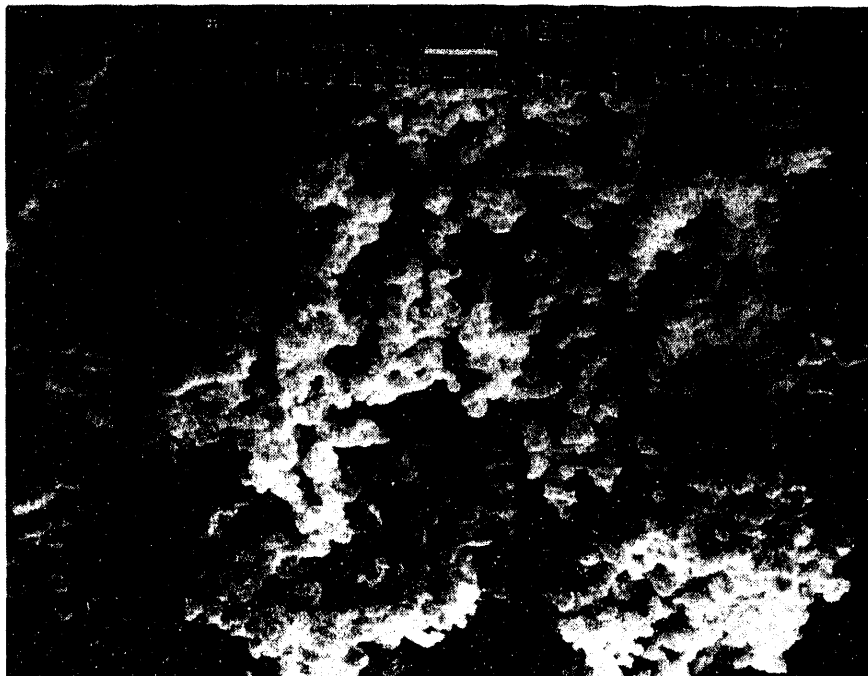
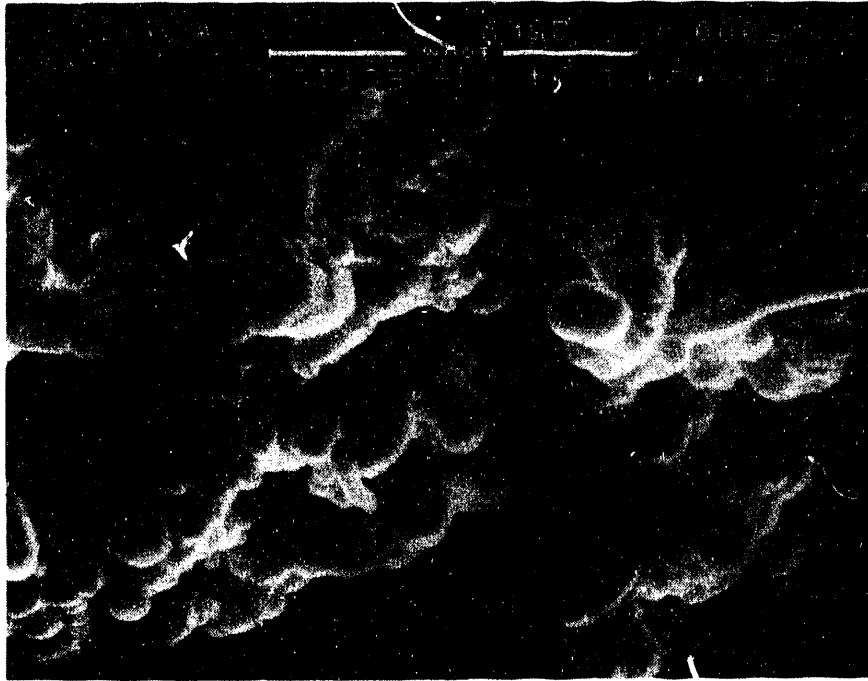




Figure 21m - Higher Magnification Of The Fines Formed Near The ID Surface Of The Ash Cake Layer

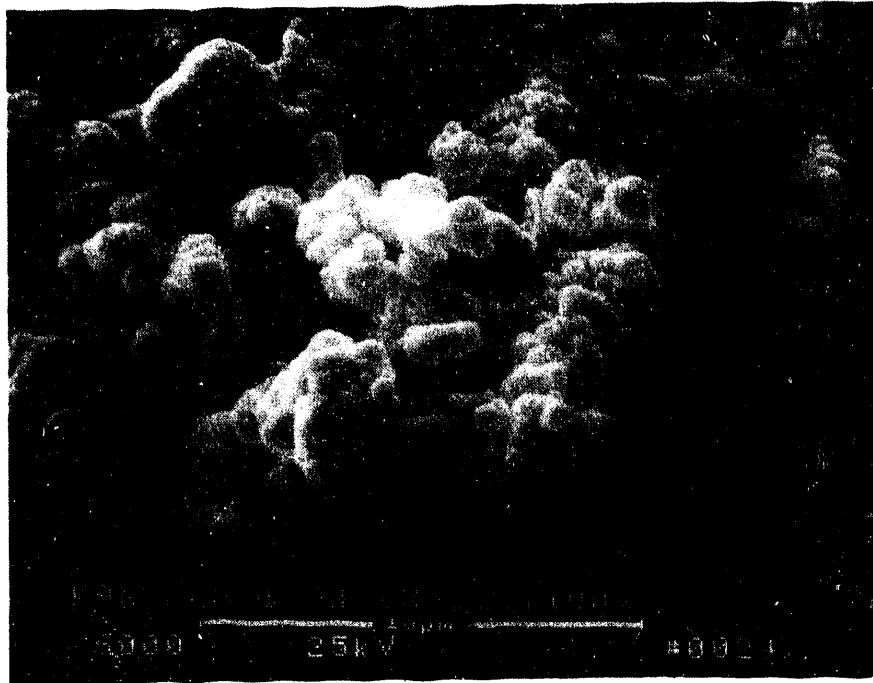


Figure 21n - Additional Micrographs Along The ID Surface Of The Ash
Cake Layer

At approximately midway through the ash cake layer, 10-20 μm -sized agglomerate formations are evident. These agglomerates consist of 1-5 μm -sized fines (Figure 21f). The appearance of the flatter, smooth surface, plate-like substrate particles, and/or geodesic particles is not evident in this area of the ash cake layer. Similar agglomeration of fines is readily evident at 1.5 mm below the OD surface of the dust cake layer (Figure 21g).

At ~ 0.2 mm from the ID surface of the ash cake layer (1.9 mm from the OD surface of the dust cake), protrusions or grain growth (i.e., rod-like features) are apparent along the surface of the ash agglomerates (Figures 21h through 21k). These are expected to be growth of calcium sulfate from the underlying fused ash grains. Note the angularity of the fused ash grains which are typically 3-4 μm on an edge. The angular features are somewhat similar to the fused geodesic particles formed nearer to the OD ash cake surface.

Figures 21l and 21m illustrate the morphology of the ash cake layer along the cross-sectioned ID ash cake layer. The protrusions or spike-like features shown in Figures 21h through 21k are somewhat "stubbier" near the ID ash cake surface (Figures 21l through 21m). The agglomerates tend to contain fused micron and submicron fines. Note the relatively open structure that is again present in the dust cake layer that is formed directly adjacent to the candle filter OD surface. What is also apparent in this area is the absence of the large 10-20 μm smooth surface particles which serve as substrates for the accumulation of smaller fines (Figure 21l). The surface morphology of the ash fines present at the filter OD surface is relatively uniform consisting of 1-4 μm grains which fuse together, and which possibly have flat surface features, but rounded contoured edges (Figure 21m). Agglomerates of these particles form the open porosity ash network along the filter OD surface (Figure 21n). This area is expected to consist of Illinois ash and Iowa limestone sorbent fines that were initially deposited along the candle filter OD surface.

Figure 22 presents a series of micrographs detailing the morphology of the ash cake layer that was in contact with the filter surface. Note that the $<1-3 \mu\text{m}$ fines fuse into a relatively open ash network, and frequently accumulate along the surface of $5-7 \mu\text{m}$ flat-faced particles (Figures 22a and 22b). Frequently rectangular flat-faced particles are evident in the ID ash cake layer (Figure 22c and 22d). Alternate fused micron and submicron particles which form agglomerates are evident in this layer (Figures 22e through 22j).

Filter Material Characterization

Two series of SEM characterizations were conducted on the 512 hour CFBC-exposed Vitropore 442T clay bonded silicon carbide candle filter matrix. Initially a section from candle filter R1-147 was removed and coated with carbon to determine not only the morphology of the matrix, but also the elemental composition of the material (Figure 23). Since sulfur was not detected within the Vitropore 442T matrix, a second section of the candle was removed from filter R1-147 and coated with gold to provide a more distinct series of micrographs which illustrate sharper details of the binder coated silicon carbide grains (Figure 24).

Figure 23a illustrates the morphology along the cross-sectioned Vitropore 442T clay bonded silicon carbide candle filter matrix at the membrane-coarse support structure interface. The OD membrane is located along the left-hand side of Photos 2 and 3 in this figure. What is apparent in the two micrographs shown in Figure 23a are the "bubbles" and voids within the binder ligament areas. Ash fines do not appear to have penetrated through the OD membrane surface into the underlying coarse support grain structure of the Vitropore 442T filter.

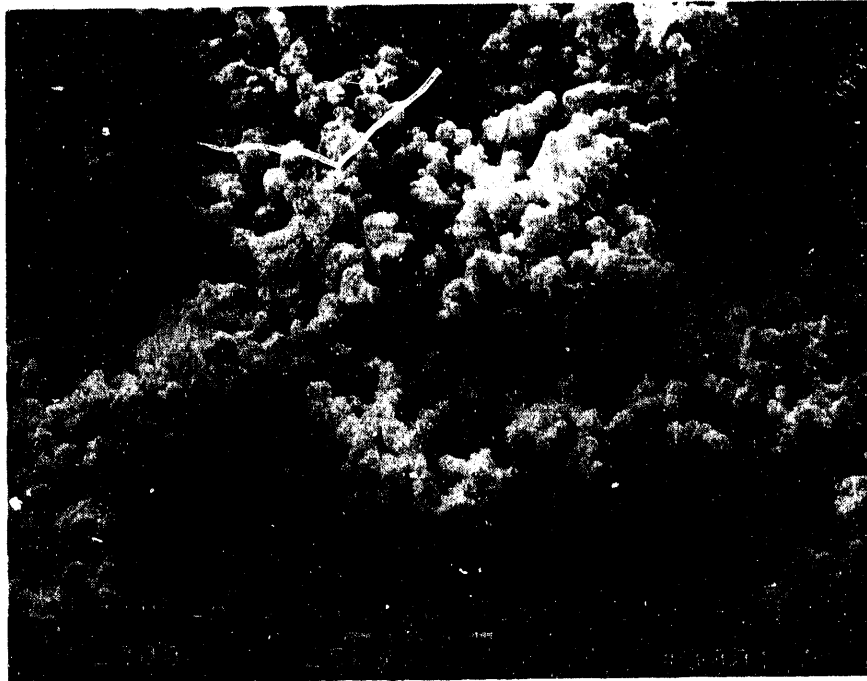


Figure 22a - Morphology Of The ID Surface Of The Ash Cake Layer That Was Formed Directly Adjacent To The Candle Filter OD Surface. Dust Contains Predominantly Illinois Ash And Iowa Limestone Fines.

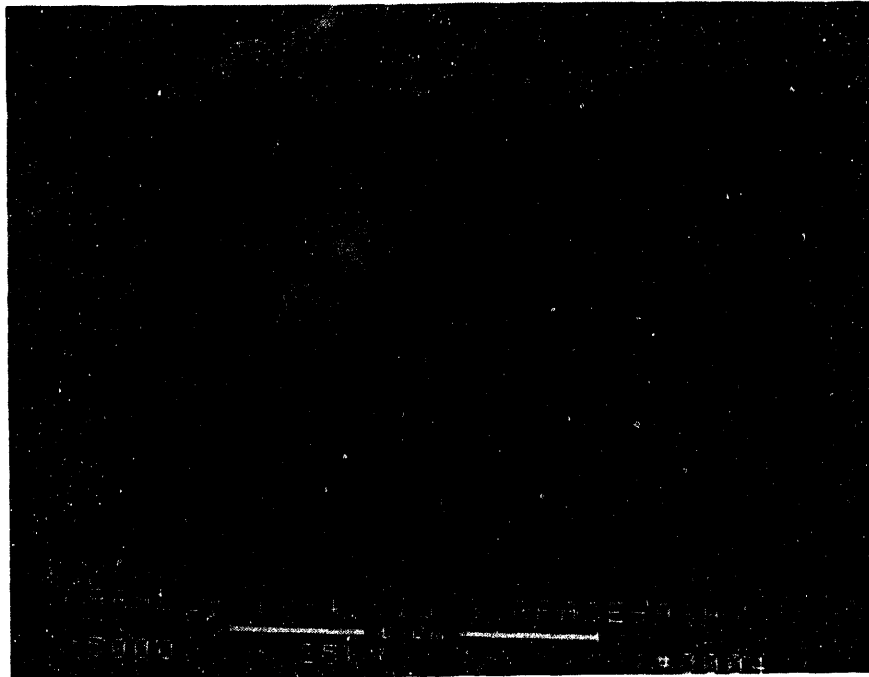


Figure 22b - Higher Magnification Of The Dust Cake ID Surface Layer

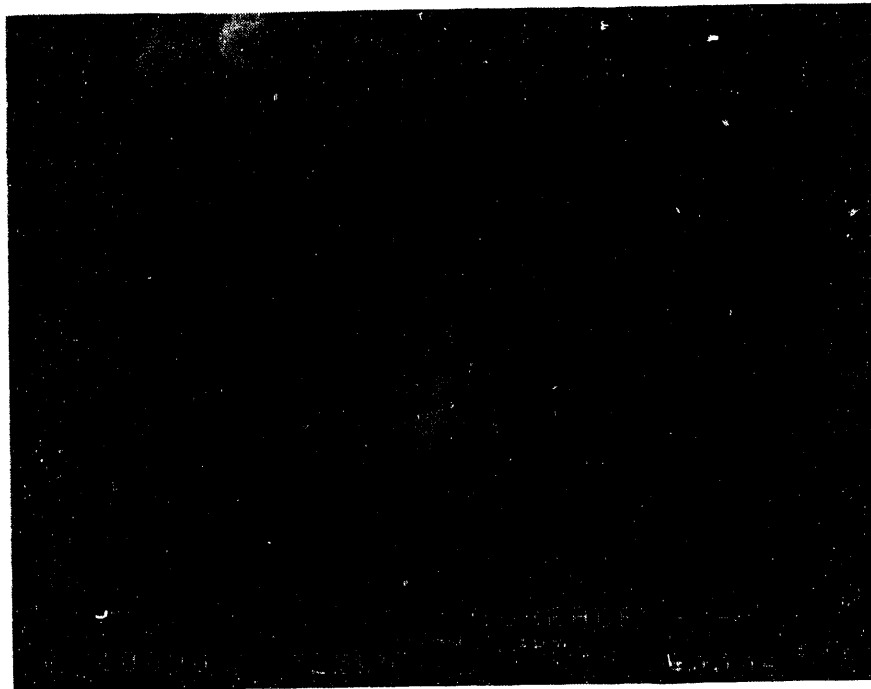
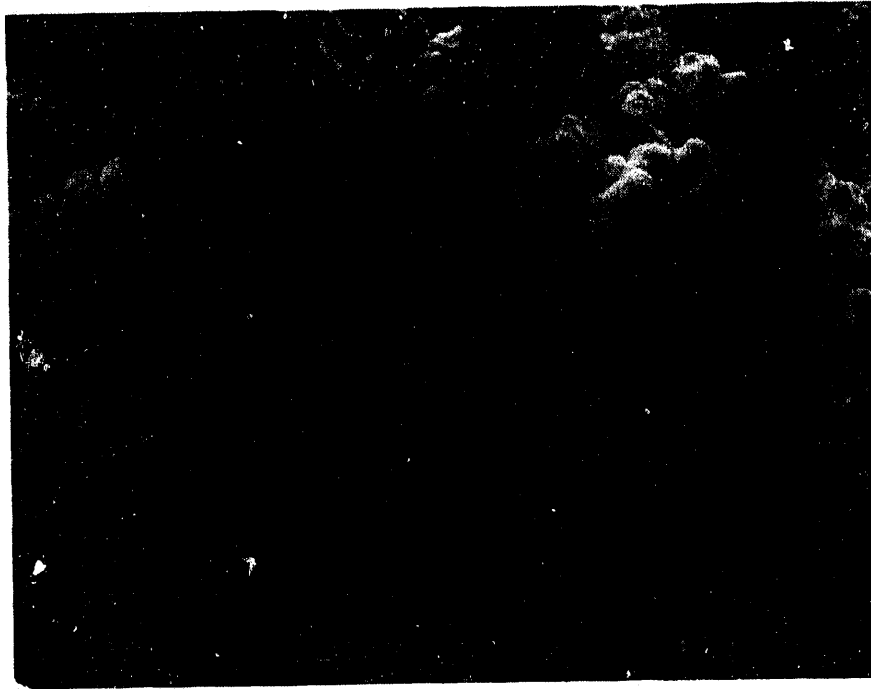


Figure 22c - Flat Plate-Like 5-7 μm Fines Present In The Ash Cake Layer

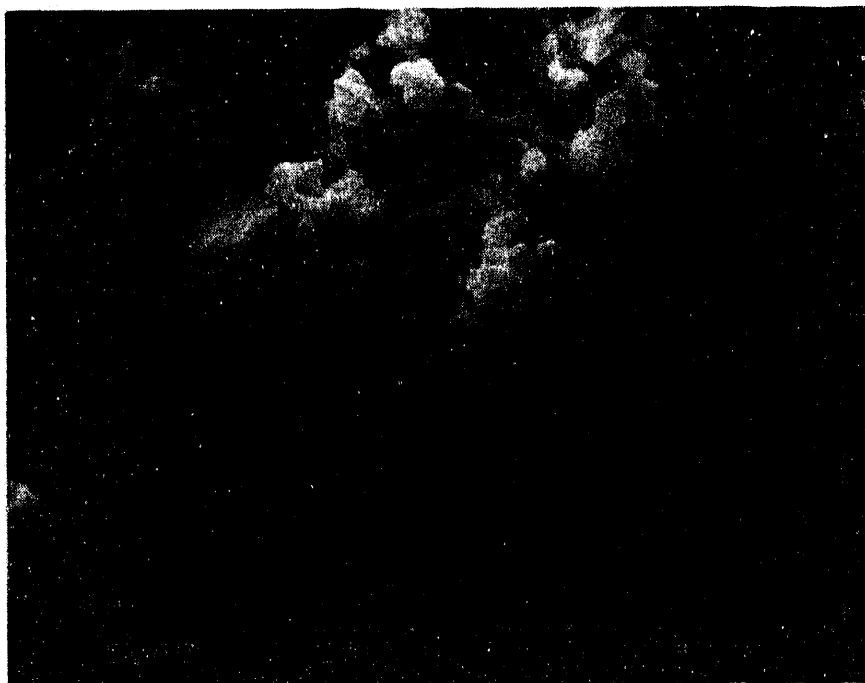
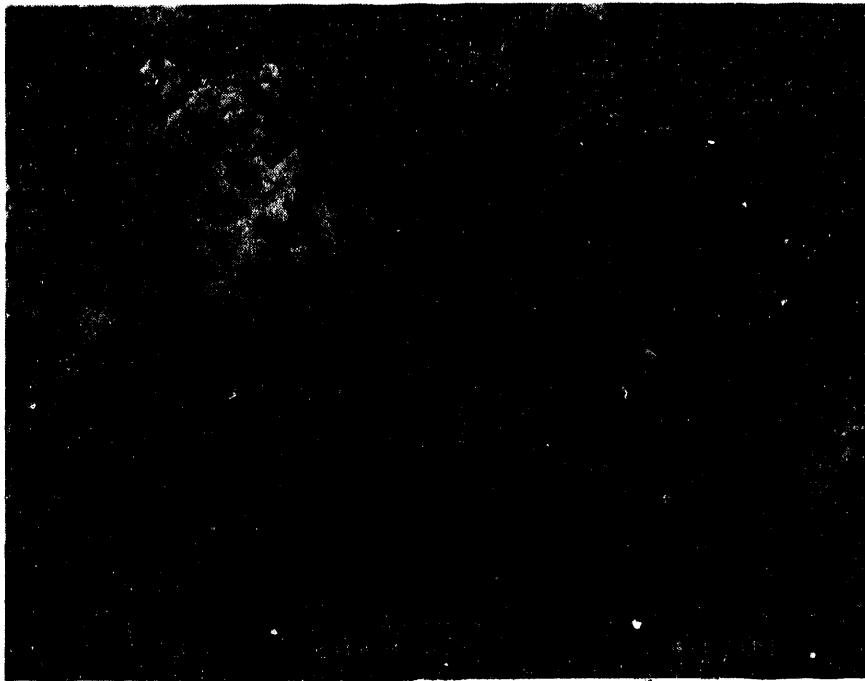


Figure 22d - Micrographs Illustrating The Open Porosity In The Ash Cake Layer That Formed Directly On The Candle Filter OD Surface. Flat Plate-Like Particles Are Evident In This Layer. These Particles Serve To Form The Interconnecting Porosity With Adjacent Smaller, Somewhat More Rounded Fines.

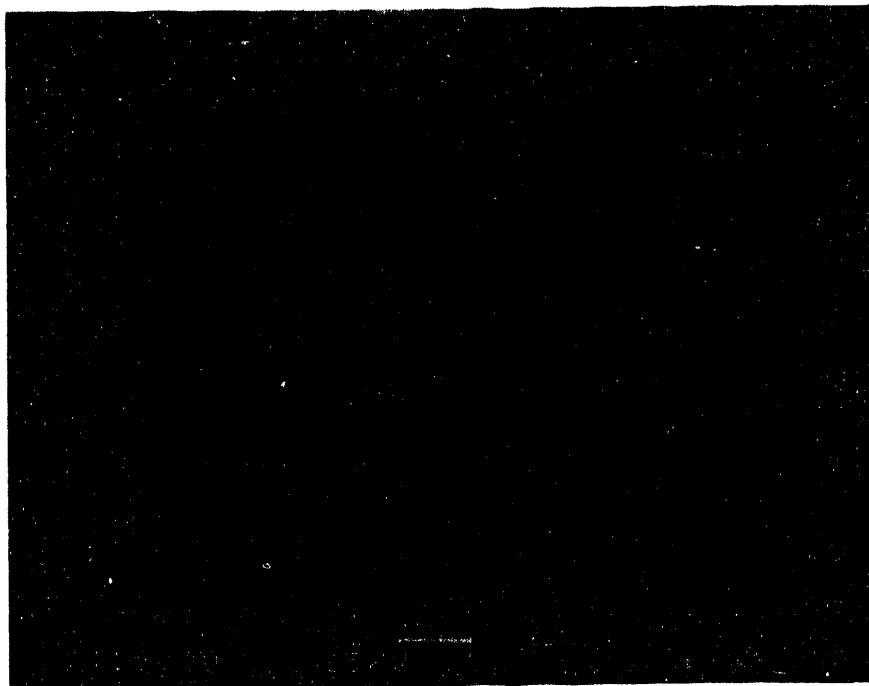


Figure 22e - Micron And Submicron Particles Fused To Form Agglomerates

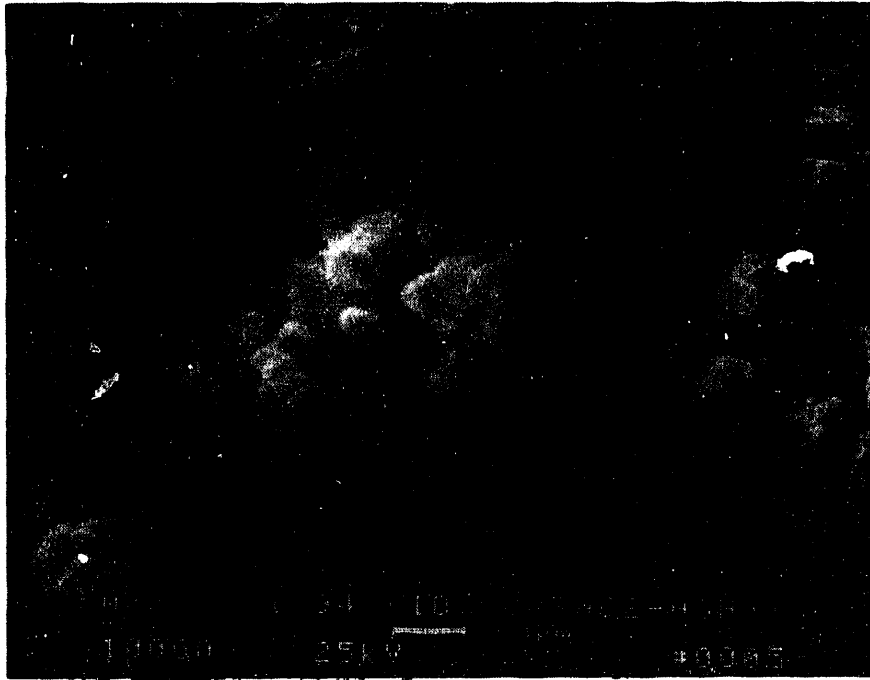


Figure 22f - Higher Magnification Of The Micron And Submicron Fused Particle Agglomerates

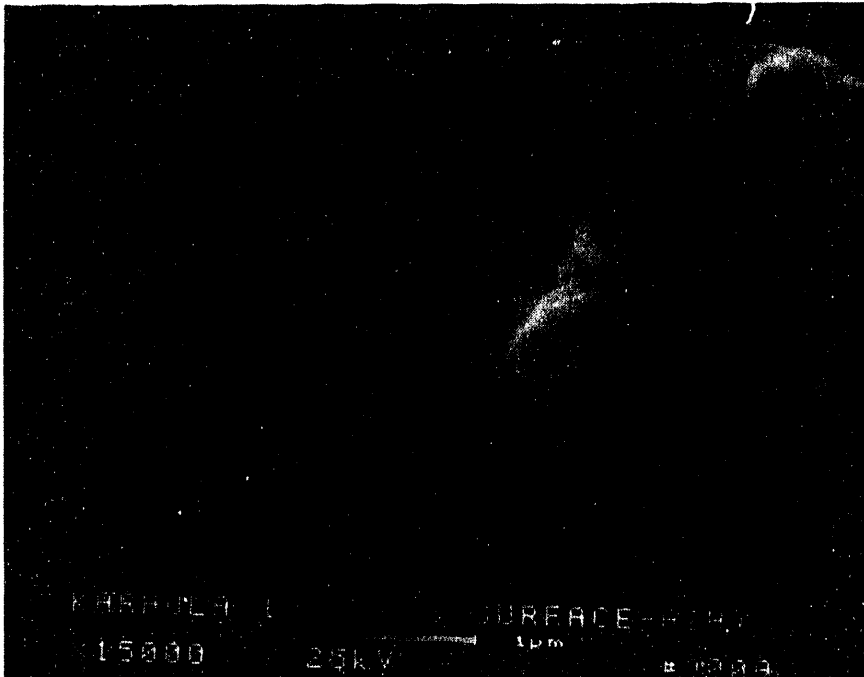
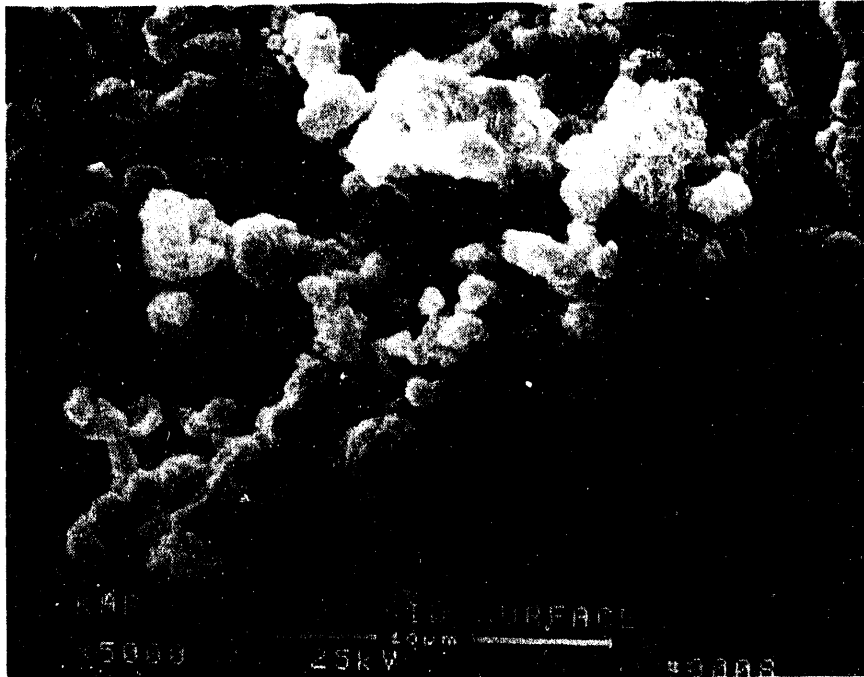


Figure 22g - Additional Micrographs Illustrating Porosity Within The Fused Submicron Agglomerated Network

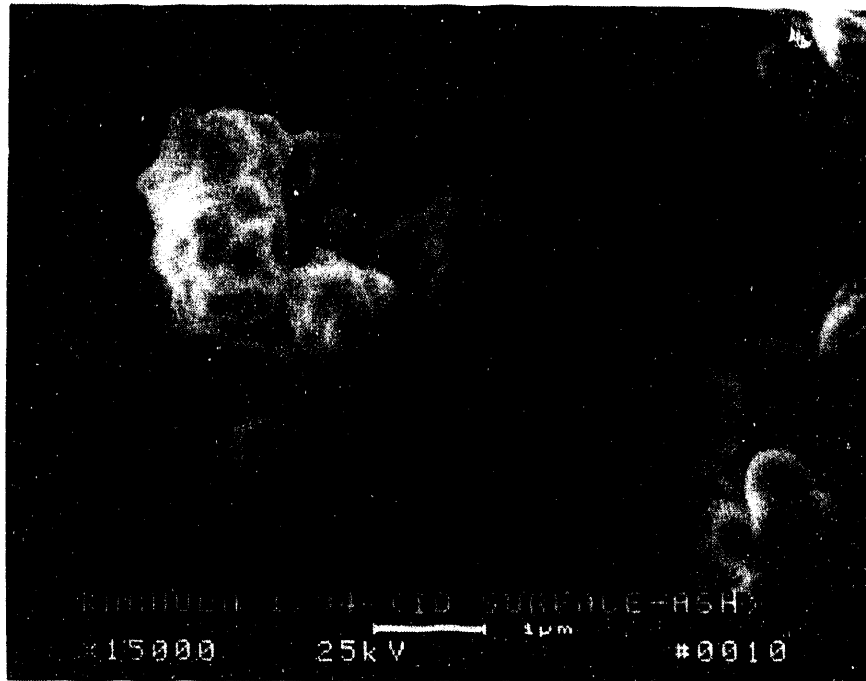


Figure 22h - Micrograph Illustrating The Morphology Of Ash Agglomerates

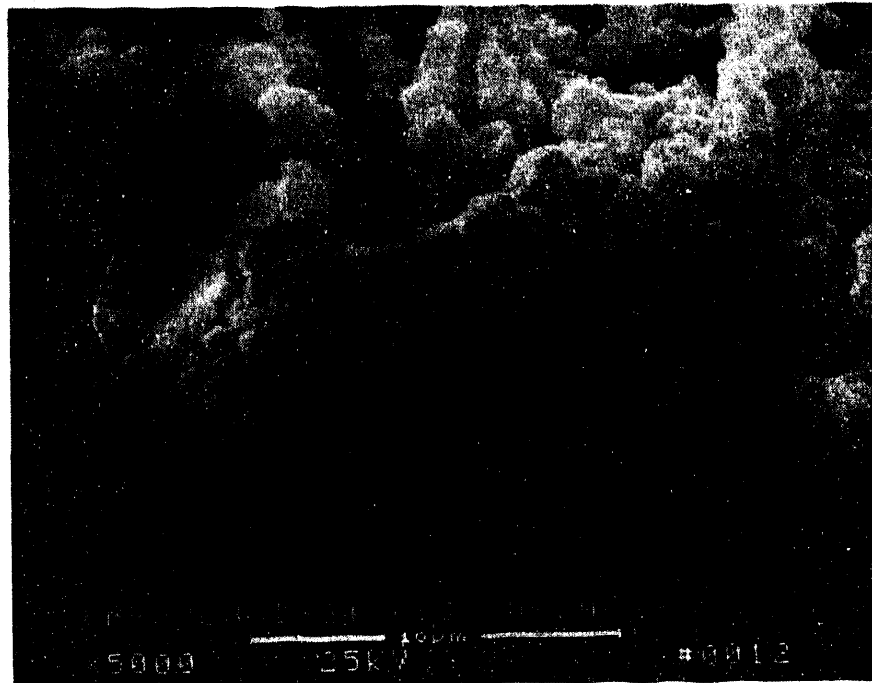


Figure 22i - Morphology Of An $\sim 10 \mu\text{m}$ Dense Particle Which Is Present Amidst The Micron And Submicron Fused Agglomerated Fines

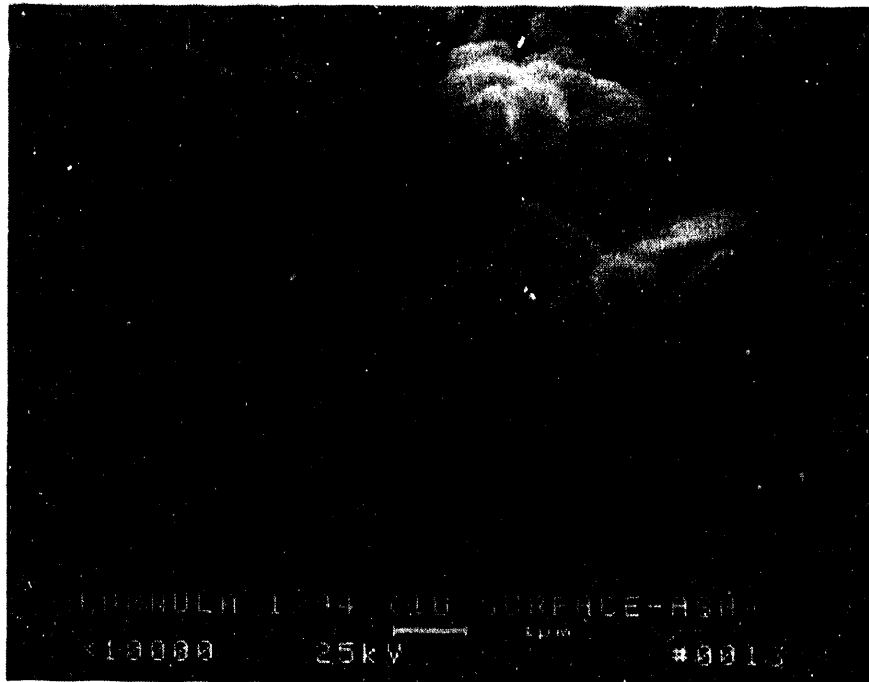


Figure 22j - High Magnification Micrograph Illustrating The Fused Nature Of The Micron-Sized Fines In The Ash/Sorbent Agglomerate Formed Along The Candle Filter OD Surface

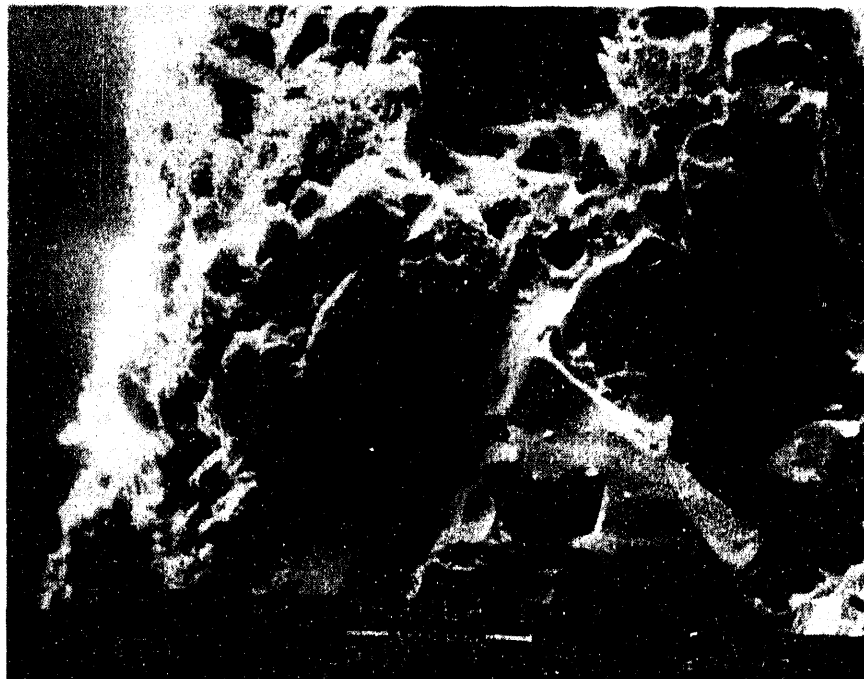
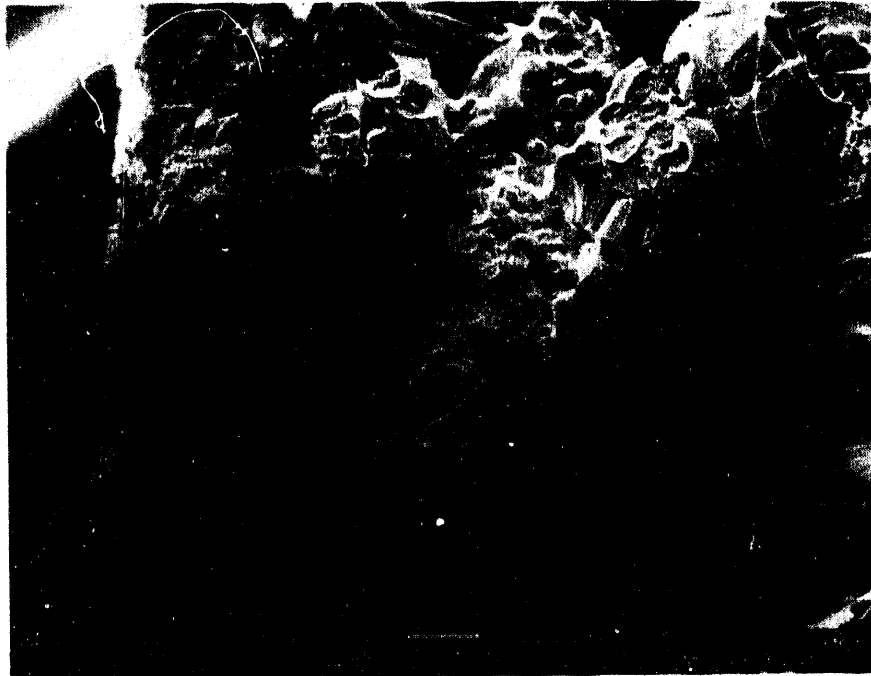


Figure 23a - Scanning Electron Micrographs Illustrating The Morphology Of The 512 Hour CFBC-Exposed Vitropore 442T Clay Bonded Silicon Carbide Candle Filter Matrix. Penetration Of Fines Through The OD Filter Membrane Is Not Readily Apparent. Bubbles And Voids Are Evident Within The Binder Ligaments.

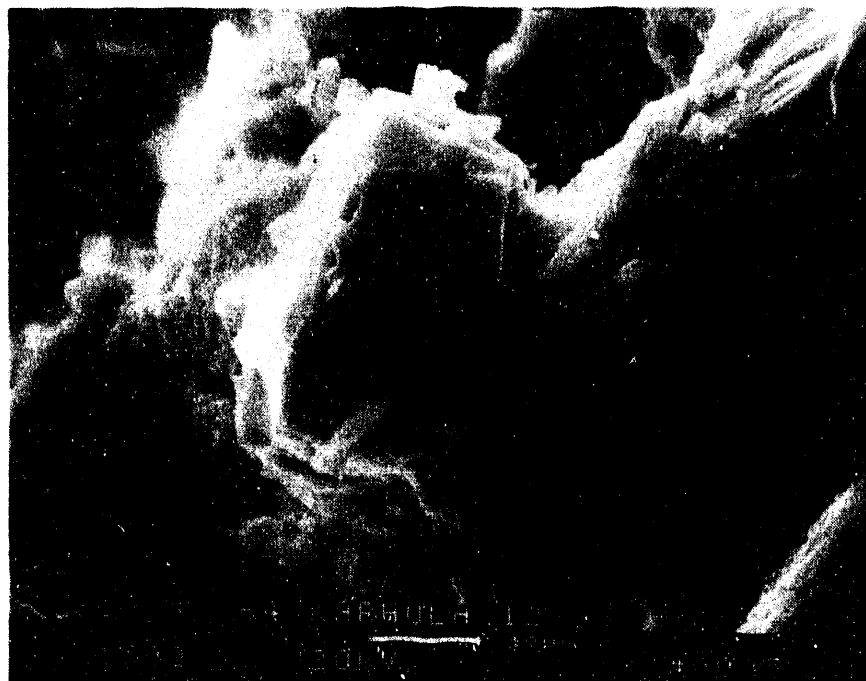
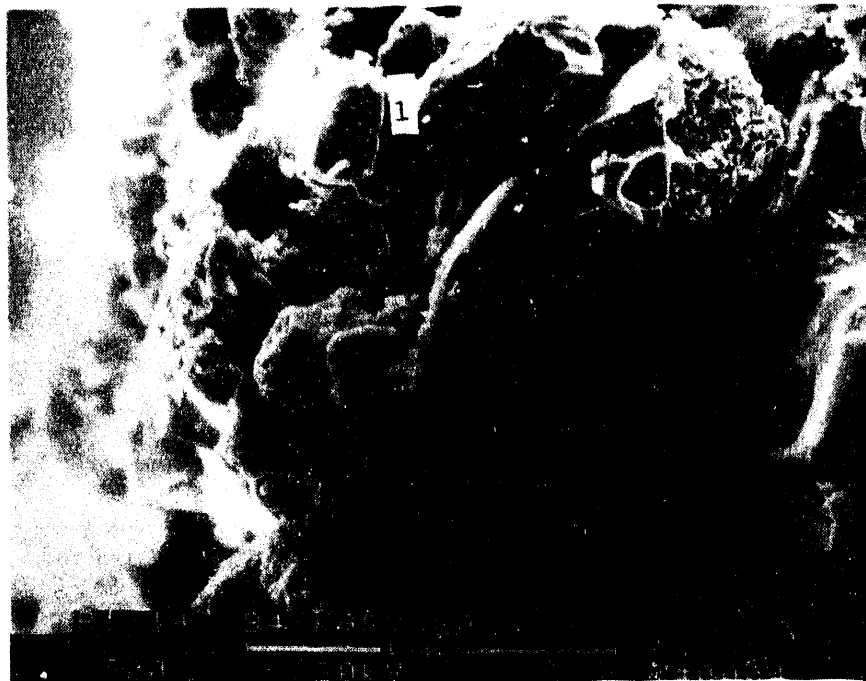


Figure 23b - Scanning Electron Micrographs Illustrating The Binder Coated Silicon Carbide Grains In The OD Membrane Of The Vitropore 442T Matrix After 512 Hours Of Exposure To The CFBC Gas Environment



Figure 23c - High Magnification Micrographs Illustrating The Coalescence And Formation Of SiO₂ Along The Surface Of The Membrane Coated Silicon Carbide Grains. A Thin Oxide Layer Is Detected At The Grain Surface.



Figure 23d - Morphology Of The Binder Coating Along The Surface Of The First Coarse Grain Layer Directly Below The Candle Filter OD Membrane

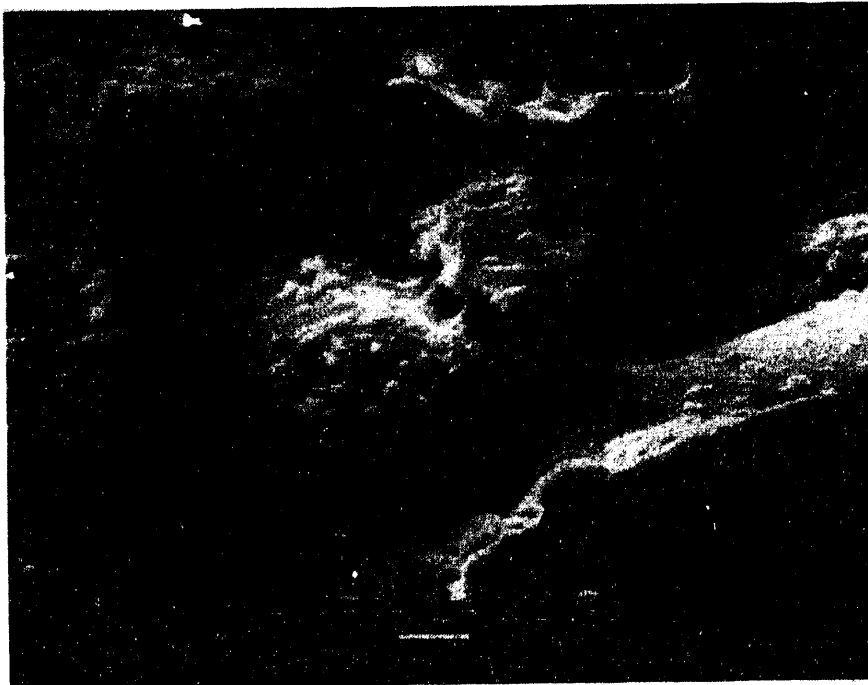


Figure 23e - Morphology Of The Binder Coated Silicon Carbide Grains Near
The Candle Filter ID Surface

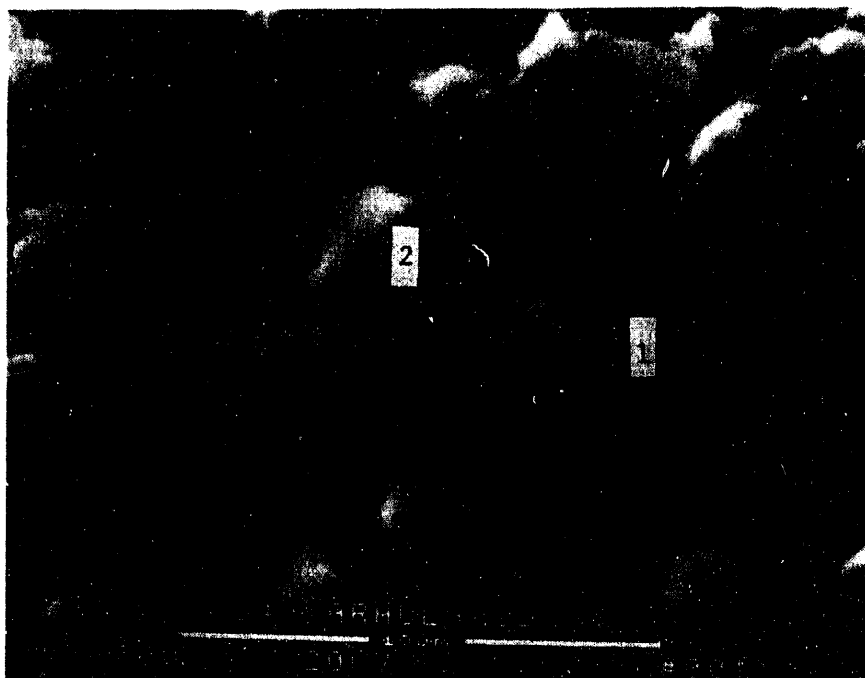


Figure 23f - Higher Magnification Micrograph Illustrating The Morphology Of The Binder Coated Silicon Carbide Grains Along The ID Surface Of Candle R1-147 Which Was Exposed For 512 Hours To The CFBC Gas Environment

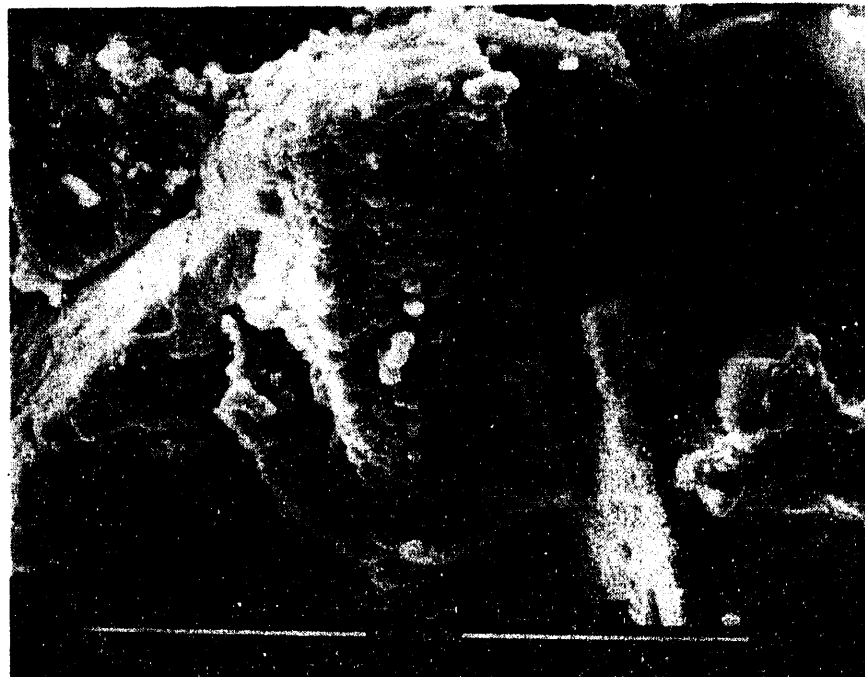


Figure 24a - Micrographs Illustrating Phase Crystallization Along The Binder Coated Silicon Carbide Grains In The OD Membrane Of The Vitropore 442T Candle That Was Exposed For 512 Hours To The CFBC Gas Environment

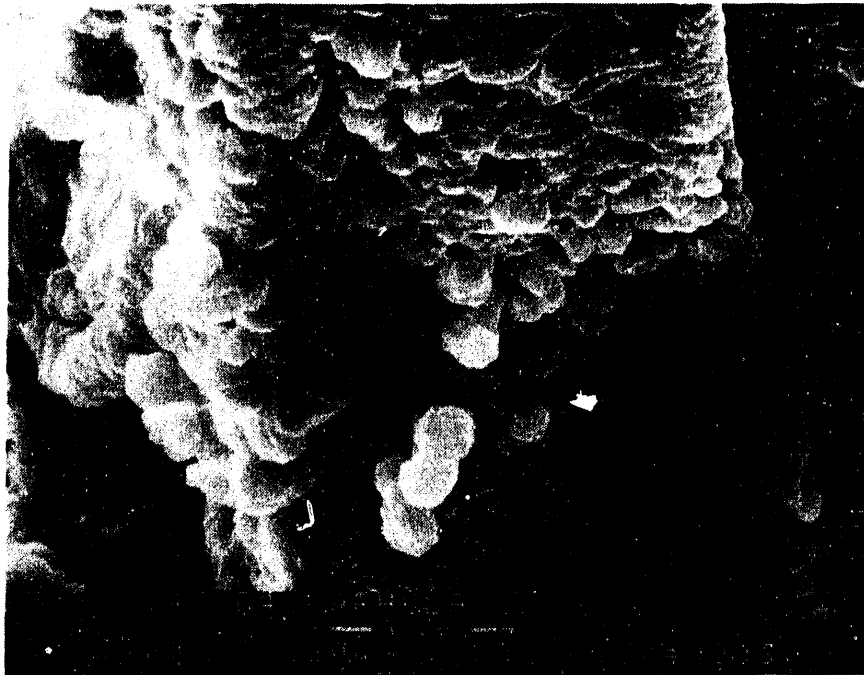


Figure 24b - High Magnification Micrographs Illustrating The Morphology Of The Crystalline Silica Phase Formation Along The Surface Of The OD Membrane Silicon Carbide Grains In The Vitropore 442T Candle Filter Matrix



**Figure 24c - Bubble And Blister-Like Formations Along The Binder
Ligament Crevices Formed Between Adjacent Silicon Carbide
Grains. Cracks Are Infrequently Evident In These Areas.**

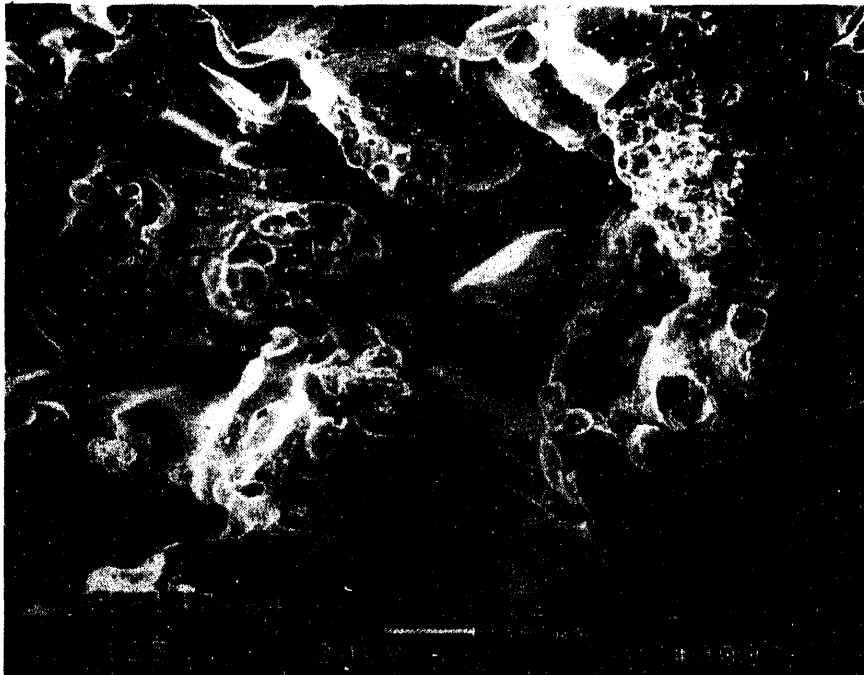


Figure 24d - Morphology Of The Coarse Binder Coated Silicon Carbide Grains Near The Candle Filter OD Surface

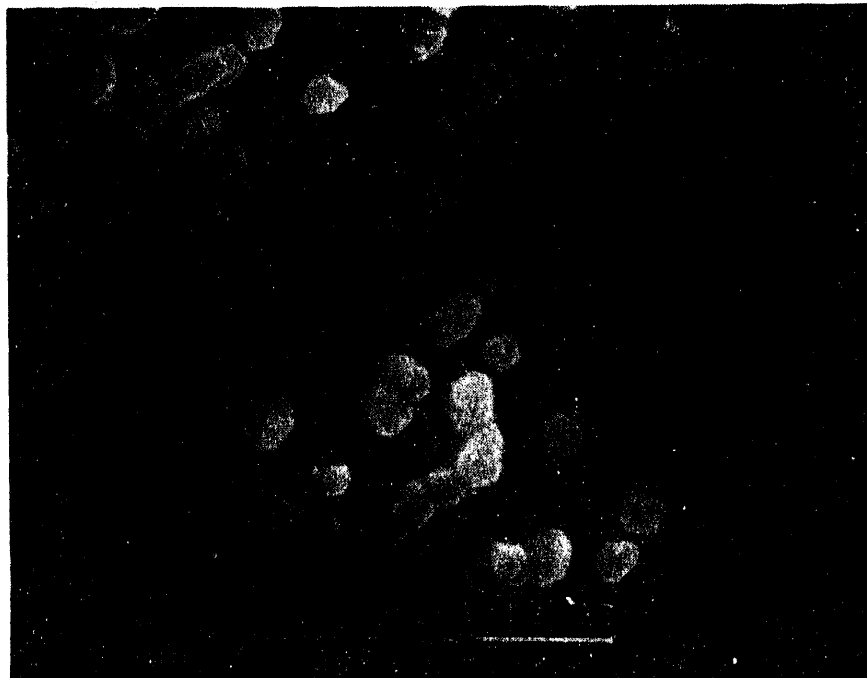


Figure 24e - Higher Magnification Of The Binder Coating Surface

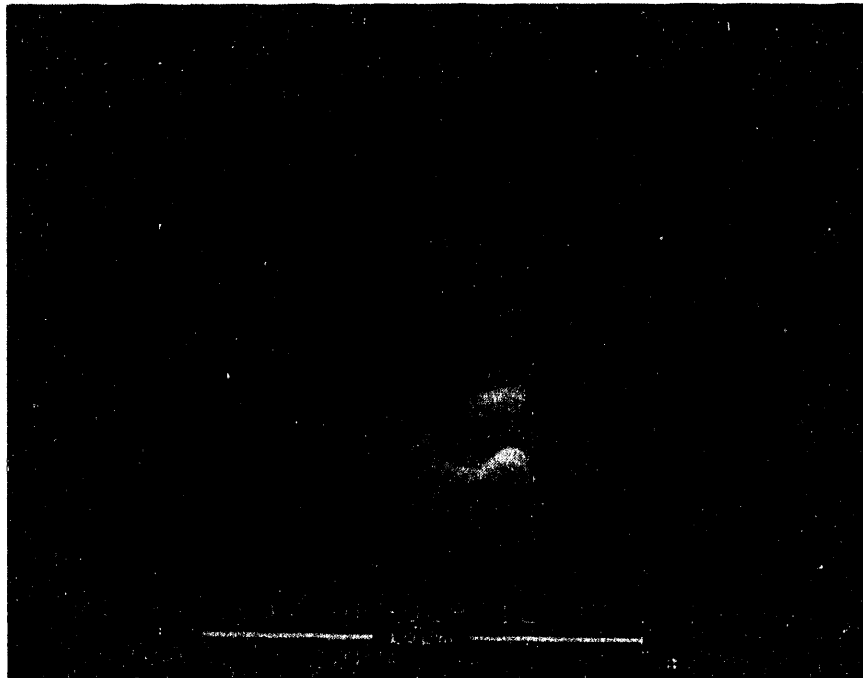


Figure 24f - Morphology Of The Coarse Silicon Carbide Grains Near The OD Membrane Of The 512 Hour CFBC-Exposed Vitropore 442T Candle Filter Matrix. Phase Crystallization Of The Binder Results In An Aluminosilicate-Rare Earth-Enriched Crystalline Phase.



Figure 24g - Surface Crystallization Of The Binder Phase Along Another Silicon Carbide Grain Near The OD Membrane Surface Of The Vitropore 442T Candle Filter

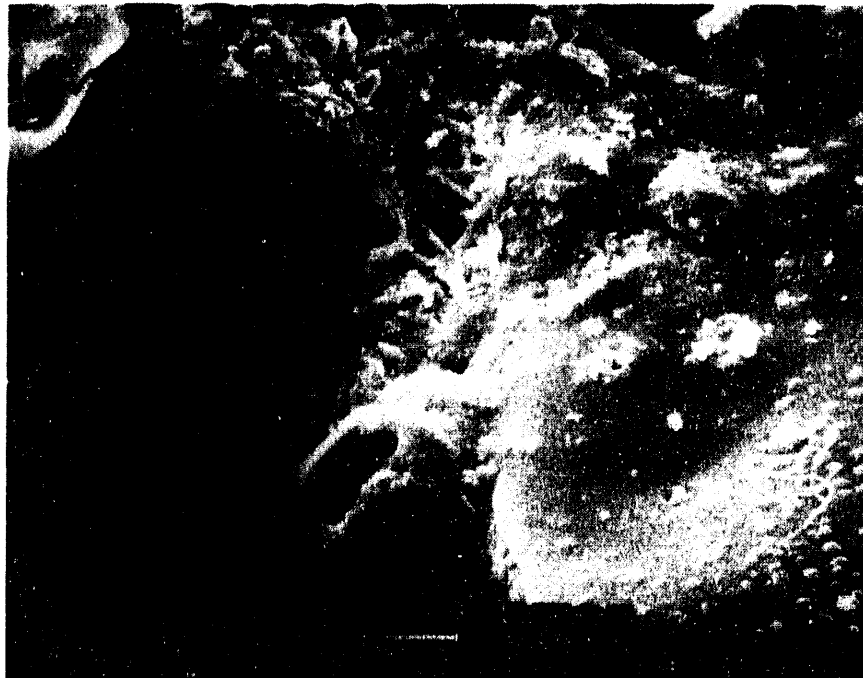


Figure 24h - Phase Changes Along The Binder Coated Grains That Are Several Layers Below The OD Membrane Of The Vitropore 442T Candle Filter

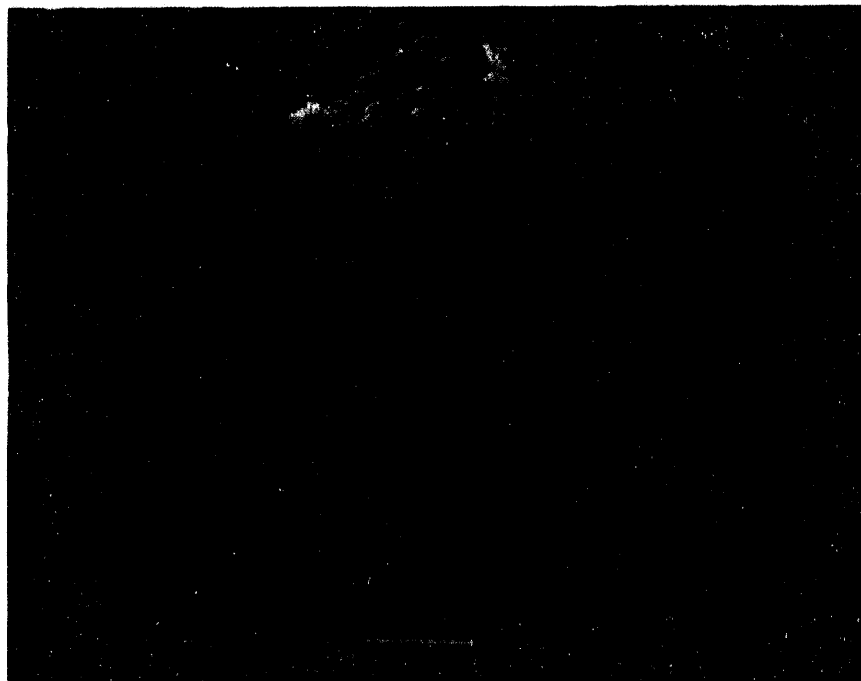


Figure 24i - Top Micrograph Illustrates The Morphology Of The Crystallized Binder Phase Which Results Along The Ligament Crevices Between Adjacent Silicon Carbide Grains. Outgassing Of The Substrate Is Evident In The Raised Blistered Areas Of The Binder. Bottom Micrograph Illustrates Phase Crystallization Along The Surface Of The Silicon Carbide Grains. Coalescence Of The Binder Forming Nodules And Pitted Areas Is Evident.

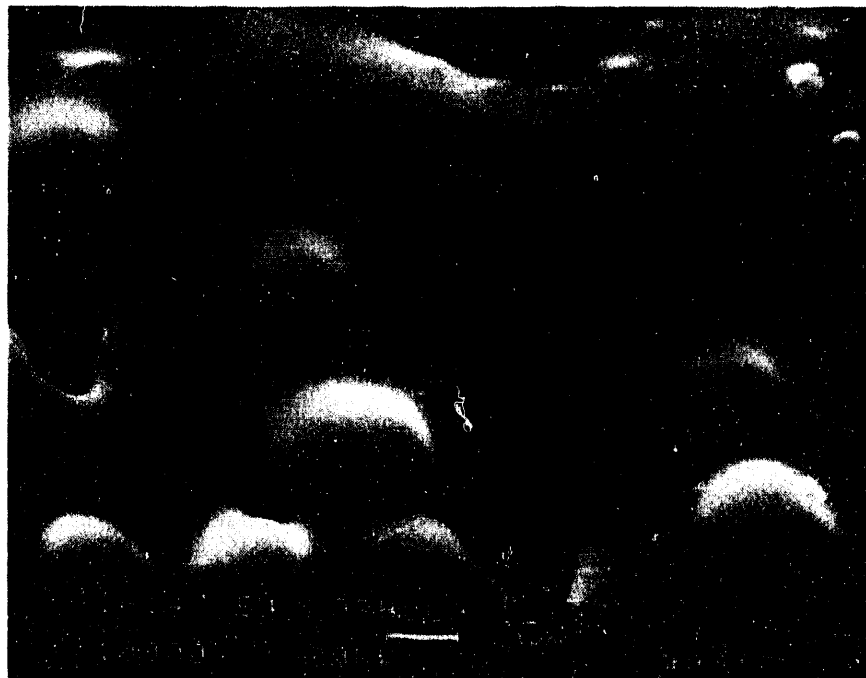


Figure 24j - Higher Magnification Of The Coalesced Binder Coating Along
The Coarse Silicon Carbide Grains

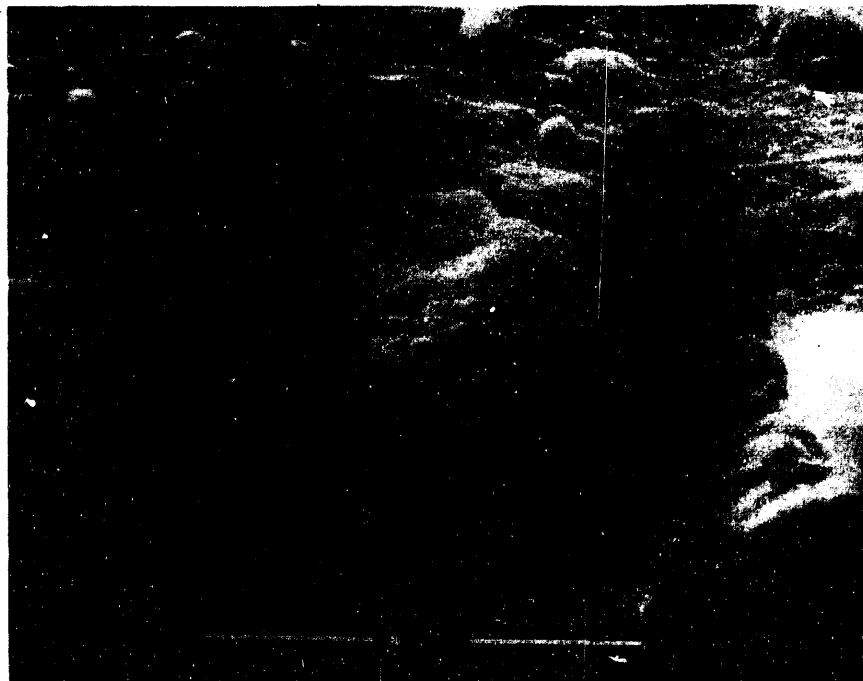
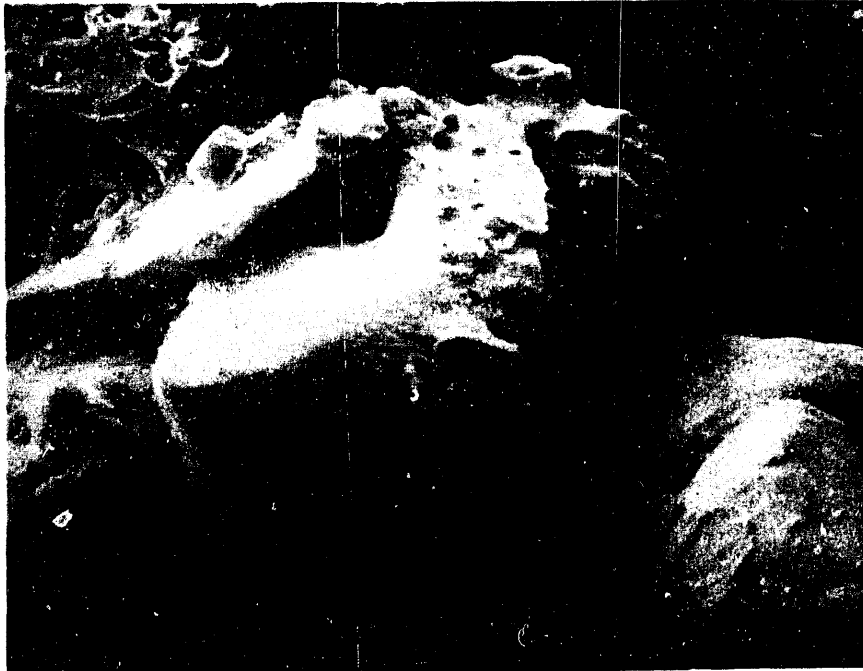


Figure 24k - Scanning Electron Micrographs Illustrating The Morphology Of The Phase Changes That Resulted Throughout The 512 Hour CFBC-Exposed Vitropore 442T Candle Filter Matrix

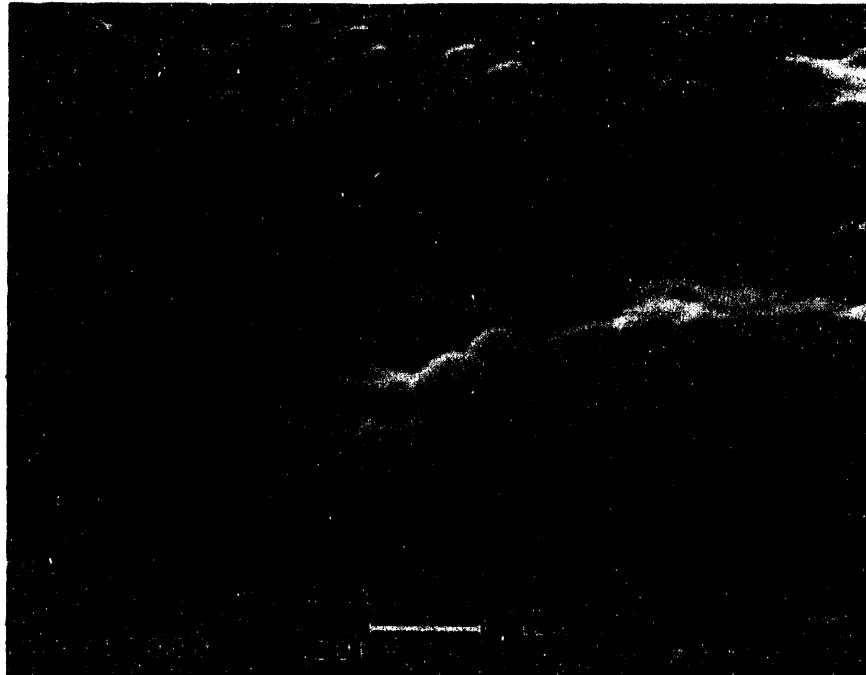


Figure 241 - Higher Magnification Micrograph Illustrating The Raised Nodular Formations Along The Binder Coated Surface Of The Silicon Carbide Grains In The 512 Hour CFBC-Exposed Vitropore 442T Candle Filter Matrix

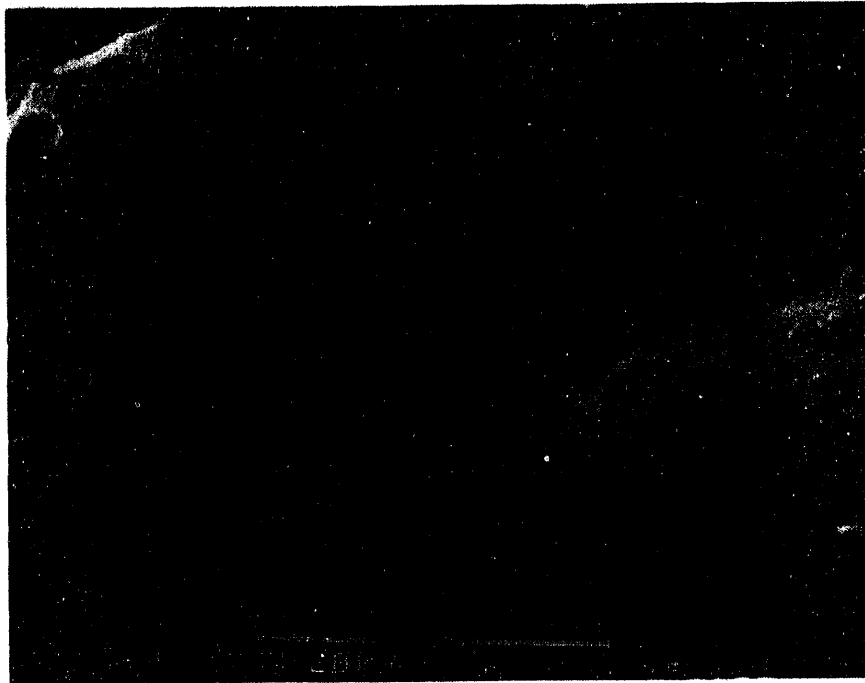
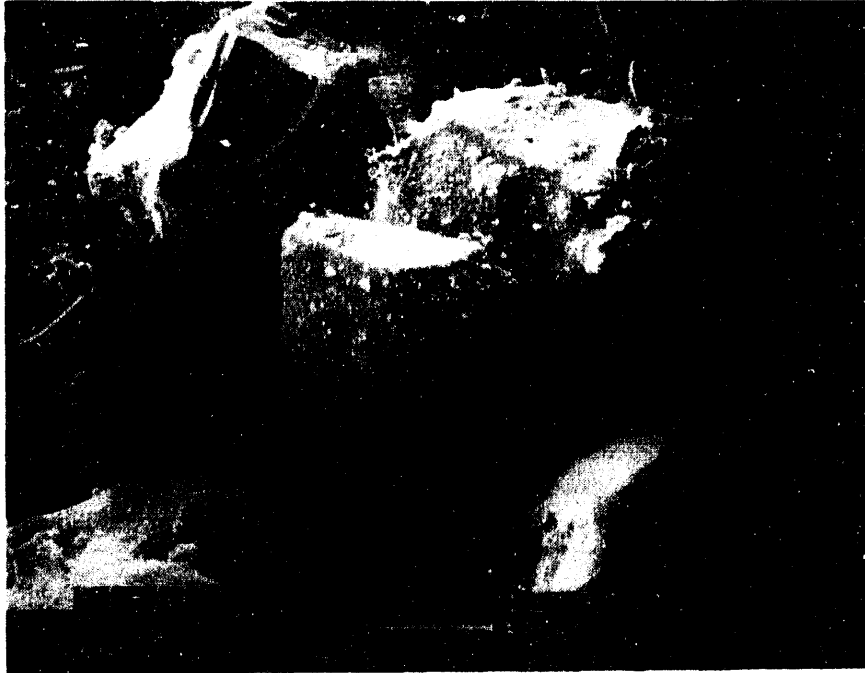


Figure 24m - Micrographs Illustrating The Morphology Of The Binder Coated Silicon Carbide Grains Along The ID Surface Of The Vitropore 442T Matrix

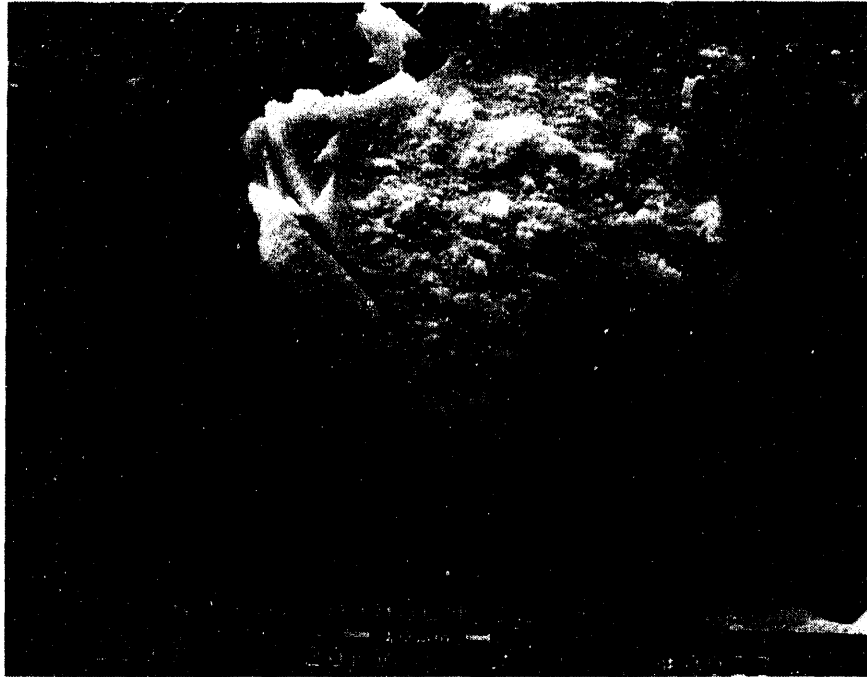


Figure 24n - Binder Phase Coating Along The Silicon Carbide Grains That Are Present Along The ID Surface Of The Vitropore 442T Matrix. Note The Scale-Like Characteristics Of The Binder Phase Along The Silicon Carbide Grain.

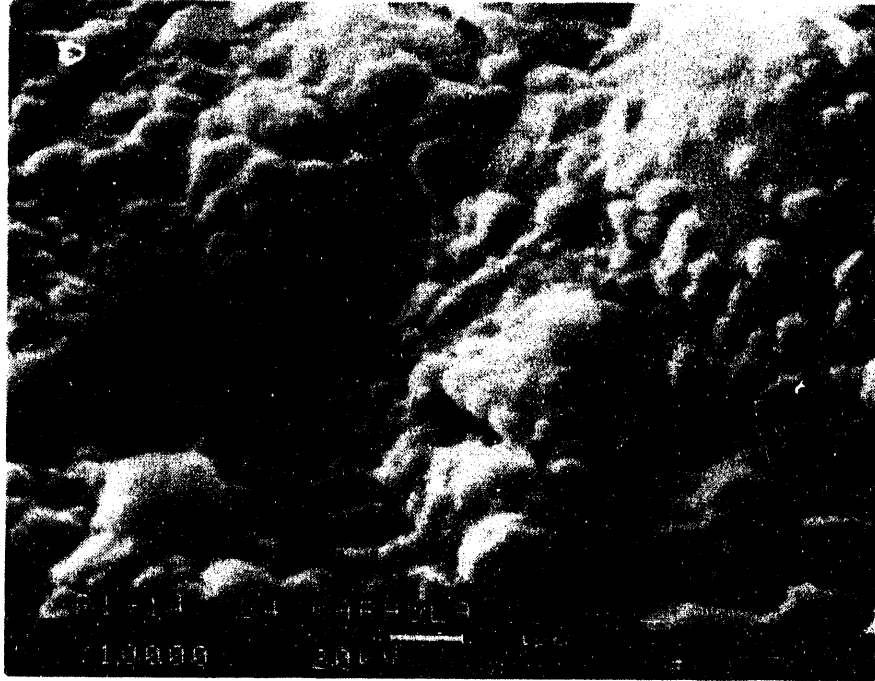


Figure 24c - High Magnification Micrograph Illustrating Extensive Crystallization Along The Binder Surface Of The Vitropore 442T Candle Filter Matrix

The micrographs shown in Figure 23b are at a higher magnification than the micrographs shown in Figure 23a. Area 1 in Photo 4, Figure 23a is the central grain in Photo 5, Figure 23b, and Photos 6 and 7, Figure 23c. The relatively small grain size (10 x 20 μm) is indicative of the membrane coating along the OD surface of the Vitropore 442T candle filters. Notably the silicon carbide grain is covered by a very mottled coating after 512 hours of hot gas filtration at temperatures of $\sim 830^\circ\text{C}$. Area 1, Photo 7, Figure 23c consists of 63.36% O, 35.67% Si, 0.55% Na, and 0.41% Al (i.e., atomic percent basis). This composition implies possible crystallization of the binder phase, forming SiO_2 along the silicon carbide grains that are present in the filter membrane. The substrate or less "mottled" surface features shown in Area 2, Photo 7, consists of 41.30% O, 58.40% Si, 0.25% Na, and 0.04% Al, indicative perhaps of a thin oxide layer along the silicon carbide grain. Possible flow and separation of the coalesced SiO_2 phase may have occurred within the binder phase at the $\sim 830^\circ\text{C}$ CFBC process operating temperatures, exposing a "debindered" grain. The low concentration of aluminum and sodium which is present implies the existence of the original binder phase, as opposed to complete debinding of the particle followed by oxidation of the silicon carbide grain.

Figure 23d illustrates the morphology at the first coarse silicon carbide grain layer which is directly below the candle filter OD membrane. The rather mottled or "patchy" binder phase coating is again evident along the surface of the silicon carbide grain.

Near the mid-section of the 512 hour CFBC-exposed Vitropore 442T matrix, EDAX analysis of the binder coated silicon carbide grains identified the presence of 68.71% O, 19.58% Si, 7.17% Al, 3.67% Na, 0.50% K, and 0.37% S. Moving closer to the ID surface of the candle filter, the binder coating has a somewhat different appearance in comparison to the binder coating which resulted along the OD surface

silicon carbide grains. As shown in Figure 23e, the binder surface appears somewhat mottled in many areas along the silicon carbide grains, but as shown in Photo 10 where the mottling (i.e., phase change) is extensive, the binder coating appears to be lifted and partially removed from the underlying silicon carbide grain. Note the melt-like features which tend to hold the "scale-like" binder coating to the underlying silicon carbide grain. Also in Photo 10, Figure 23e, the binder ligaments in the lower right-hand side of the micrograph are shown to contain voids. Due to the orientation of the sample, only the somewhat "mottled" or smoother binder surface could be subjected to EDAX characterization. The smooth binder coating shown in Area 2, Photo 11, Figure 23f consists of 66.12% O, 28.98% Si, 2.45% Na, 2.05% Al, 0.28% K, and 0.12% S. The raised nodular feature identified in Area 2, Photo 11, Figure 23f contains 72.91% O, 20.54% Si, 3.63% Al, 2.51% Na, 0.25% K, and 0.16% S.

Since sulfur is present at either negligible concentrations or is not detected within the 512 hour CFBC-expose Vitropore 442T matrix, a second sample was removed from candle filter R1-147 and was coated with gold prior to additional SEM/EDAX analyses. Figure 24 presents another series of micrographs detailing the morphology along the cross-sectioned Vitropore 442T candle filter wall (OD to ID surface) using the gold coated sample.

The highly crystallized surface features of the binder coated grains which form the OD membrane of the Vitropore 442T candle filters are depicted in Photo 2, Figure 24a, and Photos 3 and 4 in Figure 24b. EDAX analysis of the crystalline features indicates the presence of 64.18% O and 35.82% Si (i.e., SiO_2). Bubbles or "blister-like" formations are also evident in several of the ligament crevices that are formed between adjacent silicon carbide grains (Photo 1, Figure 24a). Infrequently the bubbles or "blister-like" formations in the ligament areas are seen to be cracked (Photo 5, Figure 24c), with the cracks continuing to "run" along the binder phase which coats the silicon carbide grains.

Figure 24d illustrates the morphology of the Vitropore 442T matrix at an alternate location near the OD surface of the candle filter. Again note the voids which are present within the ligaments that bond adjacent silicon carbide grains together. Mottled areas are also evident along the binder coated silicon carbide grains in this area. These areas are shown at higher magnification in Photo 9, Figure 24c. EDAX analyses of the raised nodules in this area indicate the presence of 50.85% O, 42.36% Si, 3.73% Al, 2.33% Na, and 0.92% K. Aluminum, sodium, and potassium are constituents that are initially present in the binder coating during production of the filter elements. The background or binder phase consists of 68.04% Si, 28.67% O, 1.83% Al, 1.00% K, and 0.46% Na possibly indicating the presence of a very thin coating of binder along the silicon carbide grain.

The surface morphology along another silicon carbide grain near the OD surface of the Vitropore 442T matrix is shown in Figure 24f. Extensive surface mottling and crystallization is evident in this area. The composition of the crystalline features shown in Photo 11 include 47.72% O, 25.55% Si, 8.90% rare earth, 8.92% Al, 5.63% rare earth, 1.33% Na, 1.04% Ca, and 0.91% K. Instead of silica-rich crystals forming along the binder surface, an aluminosilicate-rare earth phase has formed from the binder in this area. Similar mottling and/or crystallization is apparent along an alternate grain which is immediately below the outer OD membrane (Photo 12, Figure 24g).

Moving a few grains deeper into the matrix, mottling and/or crystallization of the binder coating is again evident (Photos 13 and 14, Figure 24h). The ligament areas between two or three adjacent grains are shown at higher magnification in Photo 14, Figure 24i. Rod-like features are evident within the ligament crevices. Outgassing of the binder substrate is also apparent in the raised blistered areas of the binder. Similarly localized crystallization which forms submicron and micron-sized "raised nodules" along the binder coated grains is

evident. Coalescence of the binder phase has occurred in several areas along the silicon carbide grain, leading to what appears to be a surface void along the binder coating. Figure 24j increases the magnification of the binder coated grain. It is rather interesting to note that a microcrack "runs" from one of the binder void areas along the coated grain, to a location near to an adjacent pit or void. The nature of this microcrack is not expected to have resulted from sample preparation. Silicon, aluminum, and oxygen are detected along the smooth binder phase in Photo 7, Figure 24j.

Rather extensive "mottling" along the binder coated grain surface (Figure 24k and 24l) is evident through the cross-sectioned candle filter matrix. Again voids are evident within the binder interconnecting ligaments. Extensive mottling or phase changes within the binder coating of the silicon carbide grains is evident near the filter ID surface (Figure 24m, 24n, and 24o). The crack which is present along the binder coating of the grain in the lower portion of Photo 21, Figure 24m may have resulted during sample preparation. What is apparent, however, is the crack in the binder "scale-like" coating that remains attached to the semi-debindered grain (Photo 22, Figure 24m). Photo 23, Figure 24m shows a higher magnification micrograph of the microcracked binder coating. Based on area scan EDAX analyses, mottled crystalline surface features shown in Photo 25, Figure 24o consist of 50.47% O, 35.59% Si, 11.51% Al, 1.31% Na, and 1.12% K which reflects the presence of the binder phase.

Note that the rare earth constituents in the binder phase were detected near the OD surface of the clay bonded silicon carbide matrix. One question which therefore arises is the relative homogeneity of the binder composition throughout the filter wall. Another concern is if the rare earth constituents are added homogeneously throughout the candle, why are they preferentially being detected within localized areas of the binder phase?

Material Strength

The room temperature and process temperature strengths of the 512 hour CFBC-exposed Vitropore 442T candle filter matrix were determined via C-ring compression and tension testing. As shown in Figure 25 the strength of the initial as-manufactured Vitropore 442T matrix that was used during this segment of testing (i.e., 512 hours; November 8 through December 17, 1993; Test Segment 2) was somewhat lower than the room temperature and hot strengths of the Vitropore 442T matrix that was used during testing with the Schumacher Dia Schumalith and the Coors alumina/mullite filters (i.e., 227 hours; Week 18-20, Week 21-23, April 1993; Test Segment 1).

Note that the 512 hour CFBC-exposed Vitropore 442T candles were equipped with the Westinghouse regenerator, and were operated at temperatures of 830°C. This is in contrast with the Test Segment 1, 900°C Vitropore-Schumacher-Coors candle filter test effort which did not utilize the Westinghouse regenerator. The two sets of data are therefore kept distinctly separated due to the differences between production lots, the presence or absence of the regenerator, as well as the somewhat lower filter operating temperature in Test Segment 2 (830°C vs 900°C). The data shown in Figure 25, however, indicate that the Vitropore 442T matrix continues to lose strength as a function of time. The question which needs to be addressed at this time is whether the candle filter strength would be lower than that shown in Figure 25, if the regenerator had not been installed in the filter mount.

Table 1 summarizes the percent strength retention for all clay bonded silicon carbide CFBC-exposed candle filters which were characterized by Westinghouse. Both the Schumacher and Pall porous ceramic candle filters lose strength during use in the 830-900°C CFBC hot gas filtration environment. Note that in the 227 hour test segment the Westinghouse regenerator had not been installed above the candle

- CFBC -

Schumacher F-40 (227 Hrs 900°C)

- Compression
- Tension

Pall Vitropore 442T (227 Hrs 900°C)

- Compression
- Tension

Pall Vitropore 442T (512 Hrs 830°C)

- ▲ Compression
- △ Tension

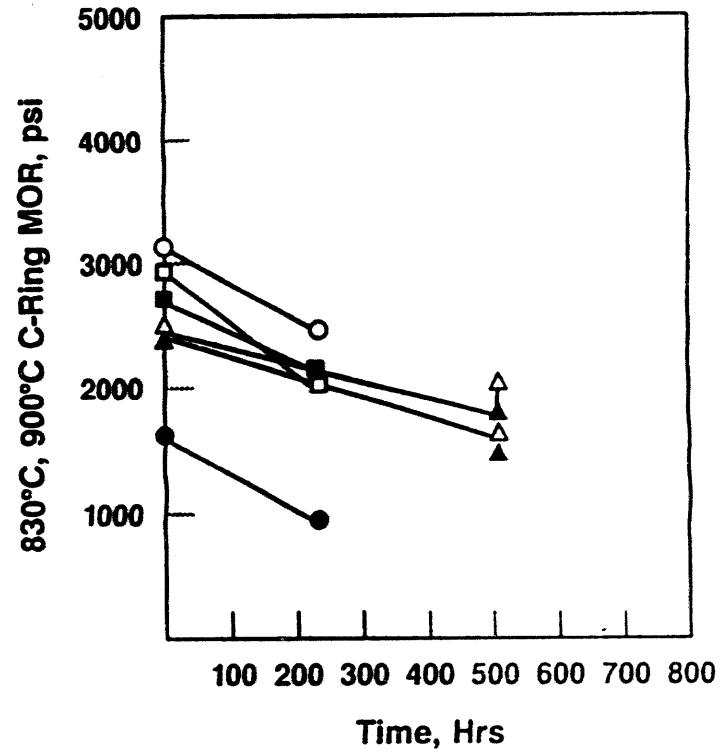
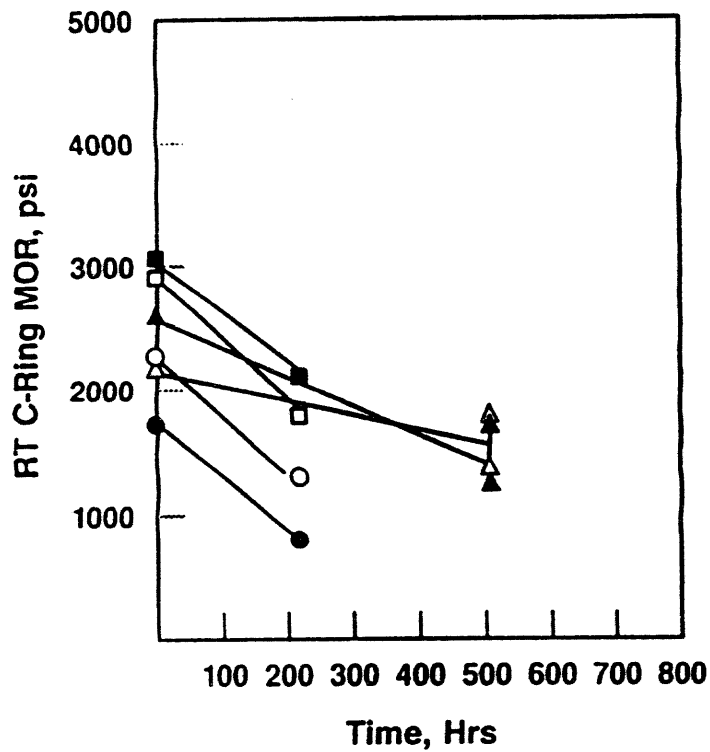


Figure 25 - Residual Strength of the Clay Bonded Silicon Carbide Candle Filters

Table 1
Percent Strength Retention in CFBC-Exposed Clay Bonded Silicon Carbide Candle Filters

Candle ID	Temp., °C	Time, Hrs	Room Temperature C-Ring		Hot Strength, 830°C C-Ring		Hot Strength, 900°C C-Ring	
			Compression	Tension	Compression	Tension	Compression	Tension
S2855/374C (T12)	900	227	46	55	-	-	63	76
R3-0061 (M19)	900	227	71	63	-	-	80	69
R4-135 (B22) *	830	512	72	86	73	80	89	93
R1-147 (B4) **	830	512	52	63	59	66	68	59

* Intact Candle but Bowed

** Candle Broke During Shipment; Cracks on OD Near Flange; Bow Evident

filters. During subsequent testing (Test Segment 2; 512 hours), the Westinghouse regenerator had been installed with the Vitropore 442T candle filters. As shown in Table 1, candle R4-135 which was located in position B-22 and had been fitted with the regenerator, retained a higher room temperature and hot strength along its ID surface in comparison to candle R3-0061 (M-19) which did not have the Westinghouse regenerator installed. Note, however, that the OD strength of both Vitropore 442T candles are nearly identical.

Candle R1-147 which was located in position B-4 was operated with the Westinghouse regenerator. This candle was intact during removal from the Westinghouse APF vessel, but fractured during shipment to Westinghouse. The lower observed strength of the candle is apparent throughout the entire candle body which may have been responsible for its fragile nature during shipment. Note that this candle had visible cracks below its flange, and also had an observable bow.

Figure 26 and Table 2 list the permeability measurements for candles R1-137 (B-10) and R4-135 (B-22) as they were received at Westinghouse prior to any cleaning. Brushing off the ash cake from candle R4-135 (B-22) increases gas permeability through the filter. The dust cake resistance along candle R4-135 (B-22) is estimated at ~3.1 iwc at 843°C (1550°F) with an air flow velocity of ~11 fpm.

Summary

- SEM/EDAX characterization of the dust cake layer formed along the 512 hours CFBC-exposed Vitropore 442T candle filters identifies variations in the morphology and elemental composition of the ash/sorbent fines along the surface of the cake that was in direct contact with the filter element surface (i.e., Illinois No. 6 ash and Iowa Industrial No. 1 limestone fines); throughout the cake layer thickness; and along the OD surface of the dust cake layer (i.e., Black Thunder ash and possibly Iowa Industrial No. 1 limestone fines).

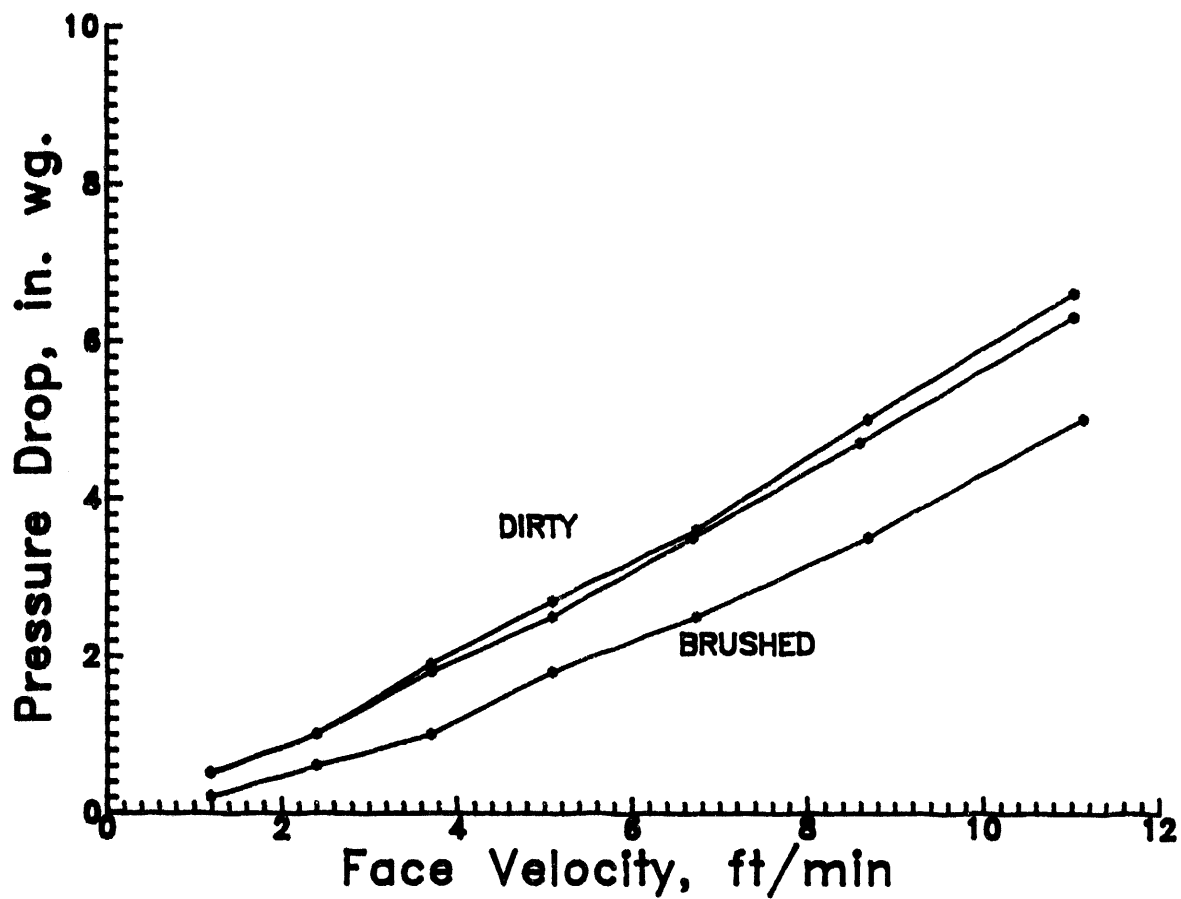


Figure 26 - Pressure Drop Across the Vitropore 442T Candles After 512 Hours of Operation in the CFBC Gas Environment

Table 2
 Permeability of Vitropore 442T Candle Filters
 After 412 Hours of Operation in the CFBC Gas Environment

<u>Identification</u>	<u>Flow %</u>	<u>Flow scfm</u>	<u>Pressure psig</u>	<u>Velocity fpm</u>	<u>Delta P iwc</u>	<u>Delta P @ 1550° iwc</u>
B-10 R1-137	10	3.22	1.5	1.17	0.5	1.36
	20	6.43	2	2.40	1	1.95
	30	9.65	3	3.71	1.8	3.51
	40	12.86	4	5.09	2.5	4.87
	50	16.08	6	6.69	3.5	6.82
	60	19.29	9	8.59	4.7	9.15
	70	22.51	14	11.03	6.3	12.27
B-22 R4-135	10	3.22	1.5	1.18	0.5	0.97
	20	6.43	2	2.40	1	1.95
	30	9.65	3	3.71	1.9	3.70
	40	12.86	4	5.09	2.7	5.26
	50	16.08	6.2	6.73	3.6	7.01
	60	19.29	9.5	8.68	5	9.74
	70	22.51	14	11.03	6.6	12.85
B-22 R4-135 Brushed	10	3.22	1.5	1.18	0.2	0.39
	20	6.43	2	2.40	0.6	1.17
	30	9.65	3	3.71	1	1.95
	40	12.86	4	5.09	1.8	3.51
	50	16.08	6.2	6.73	2.5	4.87
	60	19.29	9.5	8.68	3.5	6.82
	70	22.51	14.5	11.13	5	9.74

- Grain growth (i.e., CaSO_4 crystal formation) is readily evident along the ash ID surface which was in direct contact with the filter OD surface. This layer evidently experienced the entire 512 hours of hot gas filtration in Test Segment 2.
- Small (i.e., $\sim 5 \mu\text{m}$), rounded edge ash particulates appear to have fused, forming the interconnecting porous ash network along the ID ash cake surface (i.e., Illinois No. 6 ash and Iowa Industrial No. 1 limestone fines). Larger particles (i.e., $5\text{-}10 \mu\text{m}$) tend to form as either unique geodesic structures, or as flat, plate-like $10\text{-}20 \mu\text{m}$ smooth surface particulates which serve as substrates for the adherence (i.e., deposition an/or grain growth) of smaller ash fines.
- Voids are evident within the binder ligaments that interconnect adjacent silicon carbide grains in the 512 hour CFBC-exposed Vitropore 442T matrix.
- Extensive surface crystallization of the Vitropore 442T binder phase occurs after 512 hours of CFBC filter operation. SiO_2 forms as a coalesced phase along the surface of the binder coated fine OD membrane grains. An aluminosilicate-rare earth-enriched phase forms in isolated areas along the binder coating of silicon carbide grains in the cross-sectioned 10 mm Vitropore 442T candle filter wall. An alternate aluminosilicate crystalline phase forms along the binder surface of the silicon carbide grains near the filter ID wall.
- Bubble and blister-like features are evident in the binder, particularly at ligament crevices between adjacent silicon carbide grains.

- Infrequently microcracks are identified along the binder coating which encapsulates the silicon carbide grains.
- Room temperature and process temperature strengths of the Vitropore 442T matrix decrease with CFBC process exposure time. Further data are needed to determine whether this trend continues with extended process operating conditions, and whether this trend parallels the formation of additional crystallization or phase changes within the binder and/or grain structure. Similarly the impact of pulse cycling on the stability of the candle filter ID matrix needs to be determined for extended exposure in the CFBC process gas environment.
- Although the data are limited, the use of the Westinghouse regenerator appears to reduce the impact of thermal fatigue along the ID wall of the Vitropore 442T candle filter matrix. Additional data are needed to verify these preliminary results.
- The strength data for the 227 and 512 hours Vitropore 442T candle filters have been kept separated for the following reasons:
 - Two different candle filter production batches/lots which appear to have somewhat different as-manufactured room temperature and process temperature strengths were utilized during Test Segment 1 and Test Segment 2.
 - Test Segment 1 did not include the use of the Westinghouse regenerator, while the regenerator had been included above the candle filters during Test Segment 2. The concept of utilizing the regenerator is to reduce the impact of thermal fatigue along the candle ID surface.
 - The Westinghouse APF vessel operated at temperatures of 900°C in Test Segment 1, while at 830°C in Test Segment 2.

The 70°C difference in temperature in the elevated temperature regime where the binder phase begins to soften and strength is reduced, as well as the possible impact of the Westinghouse regenerator are both expected to contribute to the ultimate residual strength of the Vitropore 442T candle filter matrix during extended exposure in the CFBC gas environment.

- Crack formations below the flange of candle R1-147 reflect the direction of the bow imposed on this filter element. Although ash bridging was not apparent between the candles and/or metal support structure, this surface of the candle had apparently been placed in tension during process operation. Further effort is needed to identify whether changes within the binder coated silicon carbide grains in the OD membrane versus changes within the binder that coated the coarse grain support structure were in part responsible for the bowing of the filter, and possibly OD surface crack formations.

APPENDIX B

**MATERIAL CHARACTERIZATION OF THE CLAY BONDED
SILICON CARBIDE CANDLE FILTERS IN THE
W-APF SYSTEM AFTER 1294 AND 1760 HOURS OF
HOT GAS FILTRATION AT AEP**

MATERIAL CHARACTERIZATION OF THE CLAY BONDED SILICON CARBIDE
CANDLE FILTERS IN THE W-APF SYSTEM
AFTER 1294 AND 1760 HOURS OF HOT GAS FILTRATION AT AEP

M. A. Alvin
April 1, 1994

Testing was initiated in the W-APF system on October 28, 1992. During this phase of testing, 384 1.5 m Schumacher Dia Schumalith F40 clay bonded silicon carbide candles which were manufactured in 1991 were exposed for a period of 466 hours at nominal operating temperatures of 732°C (1350°F) to ash fines generated from pressurized fluidized-bed combustion (PFBC) of Pittsburgh No. 8 coal and Plum Run dolomite. In December 1992, testing was terminated due to failure of the candles as a result of ash bridging principally along the bottom three cluster arrays. The ash provided a sustained bending load on the candle filter body, causing delayed fracture, ultimately failing twenty-one (21) filter elements. Tables 1 through 3 summarize the nominal test conditions which the W-APF experienced throughout the various phases of hot gas filtration testing during the October-December 1992 test segment at the American Electric Power (AEP) Demonstration test facility.

Post-test inspection of the candles indicated that all of the filter elements in both the top and middle arrays remained intact. As a result of failure along the bottom arrays, only the candles in the bottom three clusters were removed and replaced with new filter elements that were manufactured during 1992. The W-APF was then brought back on-line in July 1993 and was operated for an additional period of 1294 hours. Operating conditions of the W-APF during this test period are shown in Table 4. Due to the detection of dust in the off-gases, testing was terminated, and the W-APF system brought off-line, cooled,

Table 1**Summary of Test Run No. 1 (October 28 to November 2, 1992)**

Nominal Conditions	Test Period		
	1	2	3
Plant Load, MW_e	10 - 25	50 - 60	35
APF Flow, KPPH	65 - 70	85 - 90	70
Temperature, °F	1150 - 1200	1350 - 1400	1200 - 1225
Pressure, psig	85 - 90	130 - 135	100
ΔP_{TS}, in wg	25 - 40	65 - 75	50 - 60
Face Velocity	6.1 - 6.4	6.1 - 6.5	5.9
Time at Conditions, Hrs	20	16*	62
Total Hours on Coal	102		
Total Quantity of Ash	4400		
Filtered (Estimated), lbs			

* **Limited By Cyclone/APF Hot Spots**

Table 2
Summary of Test Run No. 2 (November 21 to November 25, 1992)

Nominal Conditions	Test Period		
	1	2	3
Plant Load, MW_e	10 - 25	50 - 60	35
APF Flow, KPPH	60 - 65	85 - 92	50 - 55
Temperature, °F	1000 - 1150	1400 - 1450	1200
Pressure, psig	70 - 87	125 - 135	100
ΔP_{TS}, in wg	40 - 50	65 - 80	140* - 180
Face Velocity	5.5 - 5.9	6.1 - 6.6	4.3 - 4.6
Time at Conditions, Hrs	12	24	30**
Total Hours on Coal	78		
Total Quantity of Ash	3450		
Filtered (Estimated), lbs			

* **Baseline Not Recovered After Loss of Pulse Compressor**

** **Includes 24 Hr Period With No or Very Limited Pulse Cleaning**

Table 3

Summary of Test Run No. 3 (November 25 to December 7, 1992)

Nominal Conditions	Test Period				
	1	2	3	4	5
Plant Load, MW_e	43-48	43-47			
APF Flow, KPPH	90	70	65-55	75-50	75
Temperature, °F	1300-1350	1325-1370	1400-1450	1450-1490	1335-1350
Pressure, psig	130	135	130	130	125
ΔP_{TS}, in wg	45-80	140*-170	**	**	80-120
Face Velocity	6.2-6.4	4.8-5.1	4.4-4.7	4.8-5.7	5.5-5.6
Time at Conditions, Hrs	32	46	27	45	60
Total Hours on Coal	286				
Total Quantity of Ash	12,500				
Filtered (Estimated), lbs					

* **Pulse Compressor Lost, Baseline Not Recovered**

** **Pressure Drop Increasing with Temperature**

Table 4
Summary of Tidd/APF Operation

1993 - OPERATION (July Through September)

	Operating Hours	Cumulative Hours	Operating Temperature	Pressure Drop	Inspection
Runs 5 & 6	75	541	<1400 °F	Stable	No Filter Issues
Run 7	426	967	1150 to 1350 °F	Stable	No Filter Issues
Runs 8 & 9	80	1047	1450 °F	Increasing Δp , Pulse Pressure Increased from 800 to 1000 to 1200 psig	Patchy Cleaning No Ash Bridging
Run 10	116	1163	1450 °F	Slowly Increasing Δp , Pulse Pressure at 1200 psig	Patchy Cleaning No Ash Bridging
Run 11	597	1759	1450 °F 1200 °F	Increasing Δp $\Delta p = 240$ in wg Stable Δp	<ul style="list-style-type: none"> • Minimum Load Cleaning On Line • Outlet Dust First Detected (After 300 Hours) • Significant Ash Bridging, Failed Candles

B-7

and inspected. Ash bridging was evident throughout all nine filter arrays. During the initial site inspection sixty-two (62) filters were known to have failed, with additional candles suspected to be fractured but remained suspended within the bridged ash structure. As previously indicated⁽¹⁾ via the site inspection, with the exception of

- 2 candles along the inner ring of cluster A/M
- 7 candles along the inner ring of cluster B/M
- 10 candles along the outer ring of cluster C/B

all fractured surfaces were clean, indicating that failure of the filter elements may have occurred during cooldown or after the W-APF had been taken off-line. The 19 candles in the A/M, B/M and B/B arrays had evidence of ash along their fractured surfaces, implying that these candles had failed during test operation.

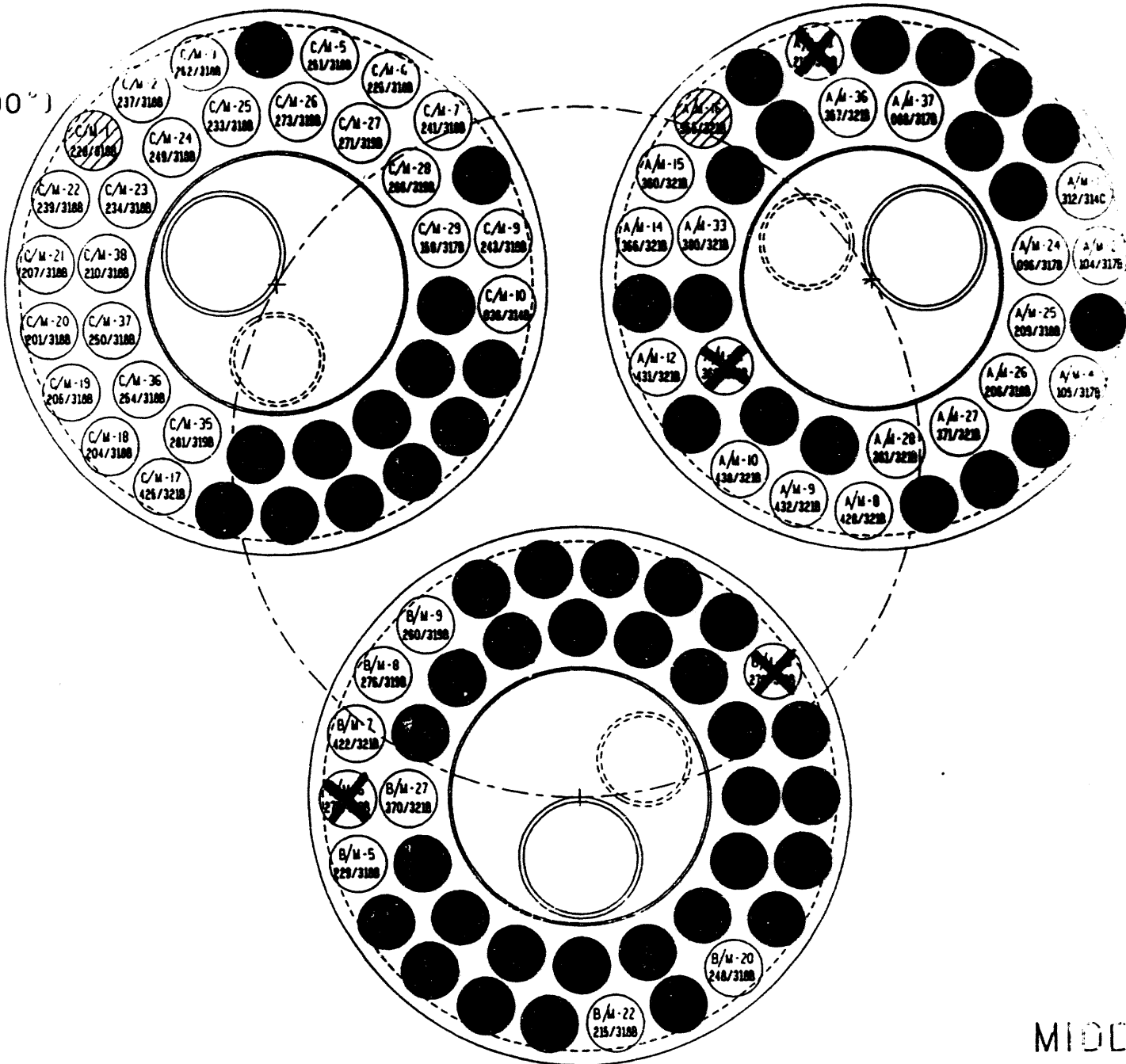
Since all of the candles were removed from the W-APF vessel during the fall of 1993, each candle could be cataloged as to whether it was intact or fractured prior to removal (i.e., during test operation or remained sufficiently tightly held in the ash cake to prevent dust accumulation along the fractured surfaces). As shown in Figure 1, 101 candles had failed prior to or during shutdown of the W-APF system (i.e., prior to removal from the vessel as shown by the completely filled locations in Figure 1). Fourteen (14) candles had broken during disassembly (i.e., crossed-out locations on Figure 1).

The lengths of the failed candles as measured from the top of the flange to the fractured surfaces are listed in Table 5. Note that of the 115 broken candles (101 candles failed prior to test termination, and 14 candles broken during disassembly), only 110 were returned to Westinghouse for dimensional verification and inspection. The majority of the candles had failed at ~76-102 mm (~3-4 in) below the flange, near the fine-to-coarse grain transition section of the candle filter body.

NORTH

C/M (300°)

A/M (160°)



B-10

B/M (180°)

TIDD
MIDDLE PLENUM

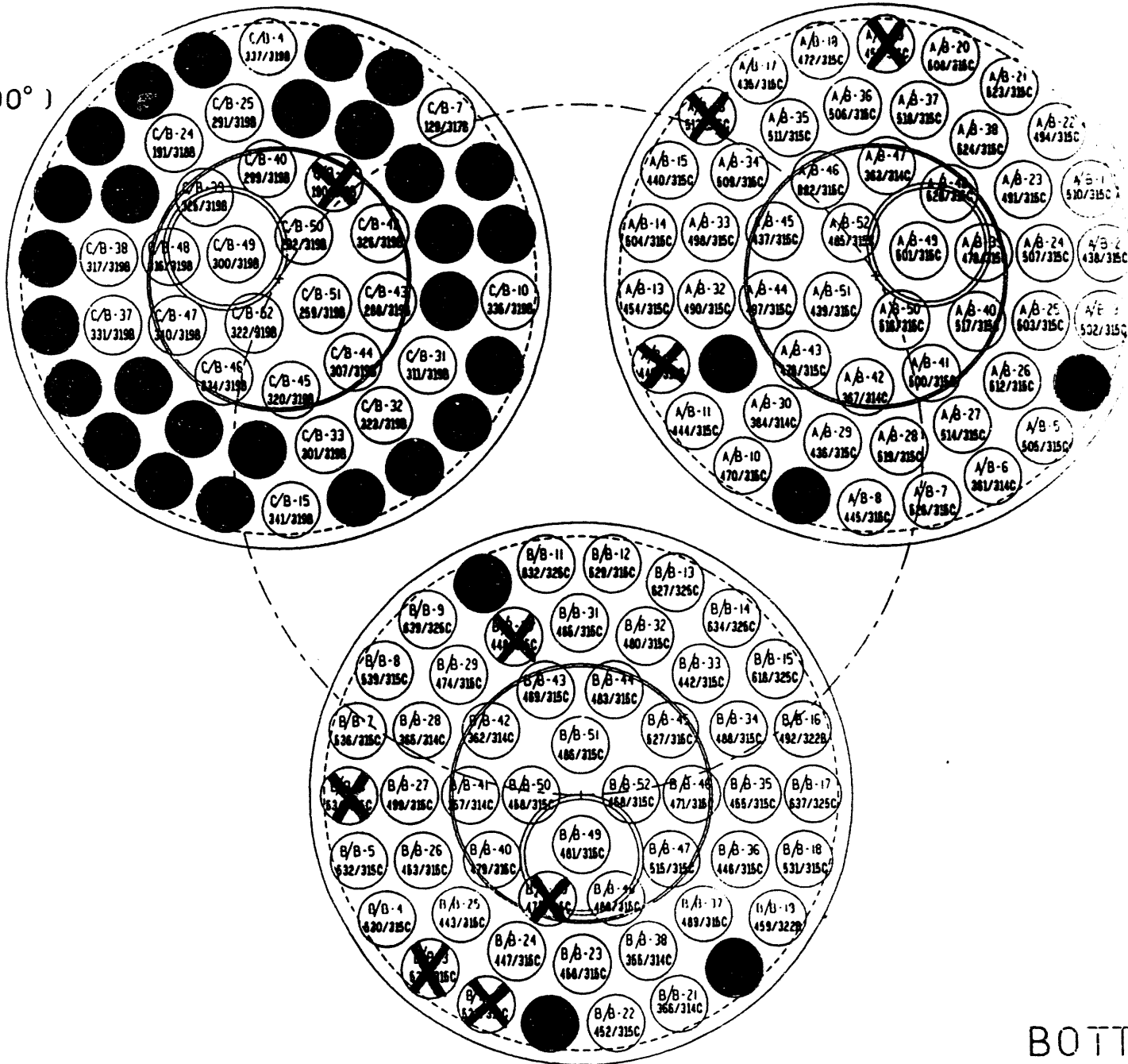
Figure 1b - Fractured Candle Filter Locations Along The Middle Arrays
After The July Through September 1993 Test Segment At AEP

NORTH

C/B (300°)

A/B (60°)

B-11



TIDD
BOTTOM PLENUM

B/B (180°)

Figure 1c - Fractured Candle Filter Locations Along The Bottom Arrays After The July Through September 1993 Test Segment At AEP

Table 5
Fractured Candle Lengths

Candle Location	Candle Id	Length (inches)	Candle Location	Candle Id	Length (inches)
	433/314C	3.5	B/M 33		17.25
A/B 4		3.875	B/M 34		21
A/B 9		4	B/M 35		4.125
A/M 3		3.75	B/M 36		4.375
A/M 5		3.875	B/M 37		18.375
A/M 6		4.25	B/M 38		7.75
A/M 7		4.75	B/T 26		4.125
A/M 11		4.375	B/T 34		15
A/M 13		3.75	C/B 1		3.375
A/M 17		3.875	C/B 2		3.75
A/M 19		4.25	C/B 3		3.25
A/M 20		4.875	C/B 5		4.125
A/M 21		3.75	C/B 6		3.625
A/M 22		3.625	C/B 8		3.5
A/M 23		4.25	C/B 9		3.25
A/M 29		3.875	C/B 11		3.125
A/M 30		27.3125	C/B 12		3.5
A/M 32		4.375	C/B 13		4
A/M 34		3.75	C/B 14		3.875
A/M 35		21	C/B 16		3.5
A/M 38		20.5	C/B 17		3.375
A/T 1		3.375	C/B 18		3.375
A/T 2		3.75	C/B 19		3.5
A/T 3		4	C/B 20		3.375
A/T 4		4	C/B 21		3.625
A/T 19		4.375	C/B 22		3.75
A/T 31	165/317B	4.25	C/B 23		3.125
B/B 1		3.5	C/B 26		3.625
B/B 10		3.625	C/B 27		3.375
B/B 20		3.5	C/B 28		4
B/B 36		3.5	C/B 29		11.75
B/M 1		3.25	C/B 30		17.875
B/M 2	247/318B	4.5	C/B 34		3.875
B/M 4	245/318B	3.75	C/B 35		3.25
B/M 6		4.375	C/B 36		3.5
B/M 10		3.875	C/M 2	237/318B	3.625
B/M 11		4	C/M 8		4.125
B/M 12		4.25	C/M 11		4.25
B/M 13		3.875	C/M 12		4.25
B/M 14		4.125	C/M 13		3.75
B/M 15		3.875	C/M 14		3.875
B/M 16		4	C/M 15		3.875
B/M 17		4.25	C/M 16		4
B/M 18		3.875	C/M 30		19
B/M 19		22	C/M 31		4
B/M 21		4	C/M 32		16.5
B/M 23		3.625	C/M 33		20.375
B/M 24	223/318B	17.125	C/M 34		24.125
B/M 25	242/318B	19.375	C/T 2		3.75
B/M 26		19.375	C/T 12		4.25
B/M 28		4	C/T 15		4
B/M 29		10.5	C/T 20		4.25
B/M 30		4	C/T 21		13.625
B/M 31		18.5625	C/T 30		4.125
B/M 32		19.875	C/T 33		4.625

Attempts were also made to determine the direction of the force applied to the candle body. During disassembly, the majority of the candles were marked to indicate the orientation of the candle body relative to its common plenum. As a result of bending, a shear lip remains along the circumferential fractured section of the candle wall which is indicative of the direction of the applied force. Figure 2 illustrates the direction of the applied force on 95 of the failed candles, two of which had been broken during the disassembly procedures. In the top arrays which had the least number of failures, the direction of force is typically outward from the center of the array. In the middle and bottom arrays, the applied force is multi-directional. Notably, in-service failures had not been experienced along the inner two rows of candle filters in the three bottom arrays.

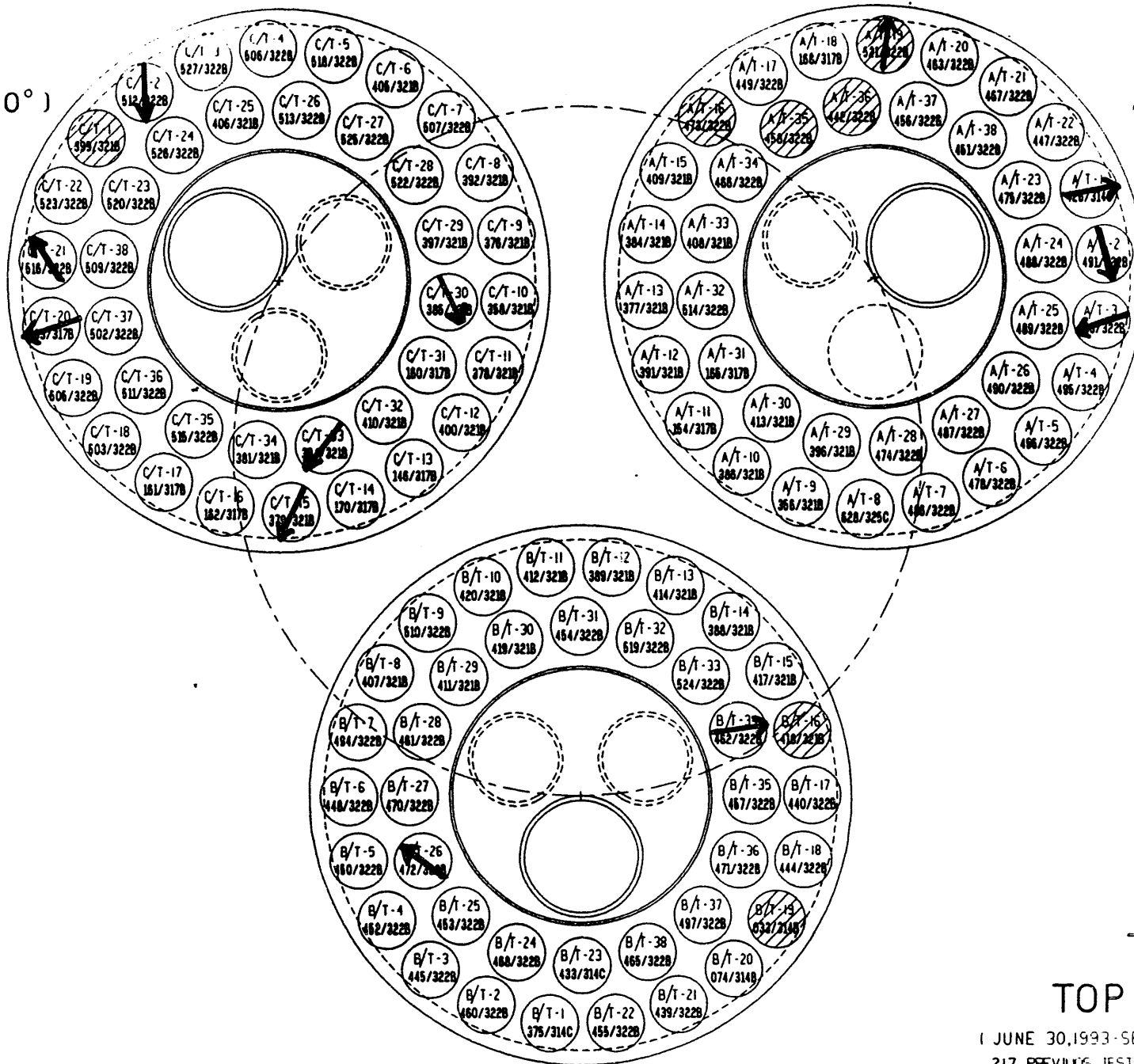
In order to assess changes which have occurred with the clay bonded silicon carbide Schumacher Dia Schumalith F40 candle filter matrix, filters were removed from the various arrays, and were subjected to room temperature and process temperature C-ring compression and tension strength testing. As shown in Figure 3, the 1991 Schumacher Dia Schumalith filters which were originally installed in the W-APF had an apparent lower as-manufactured strength than the 1992 candles which were installed only in the bottom three candle arrays during the July through September 1993 segment of testing. After 1760 hours of exposure in the PFBC gas environment, the average strength of the clay bonded silicon carbide filter matrix appears to be only somewhat reduced along the OD filter surface (i.e., C-ring compression testing), while a greater loss of strength is detected along the ID filter surface (i.e., C-ring tension testing). A similar trend is indicated for the initially stronger 1992 Schumacher Dia Schumalith F40 candle filters which experienced only 1294 hours of operation in the PFBC gas environment. It is interesting to note that the stronger 1992 candles appear to initially lose strength at a faster rate in comparison to the weaker

NORTH

C/T (300°)

A/T (60°)

B-14



B/T (180°)

TIDD
TOP PLENUM

(JUNE 30,1993-SEPTEMBER 23,1993; 1294 HOURS)
217 PREVIOUS TEST CANDLES (F40:1991)
167 NEW CANDLES (F40:1991,1992)

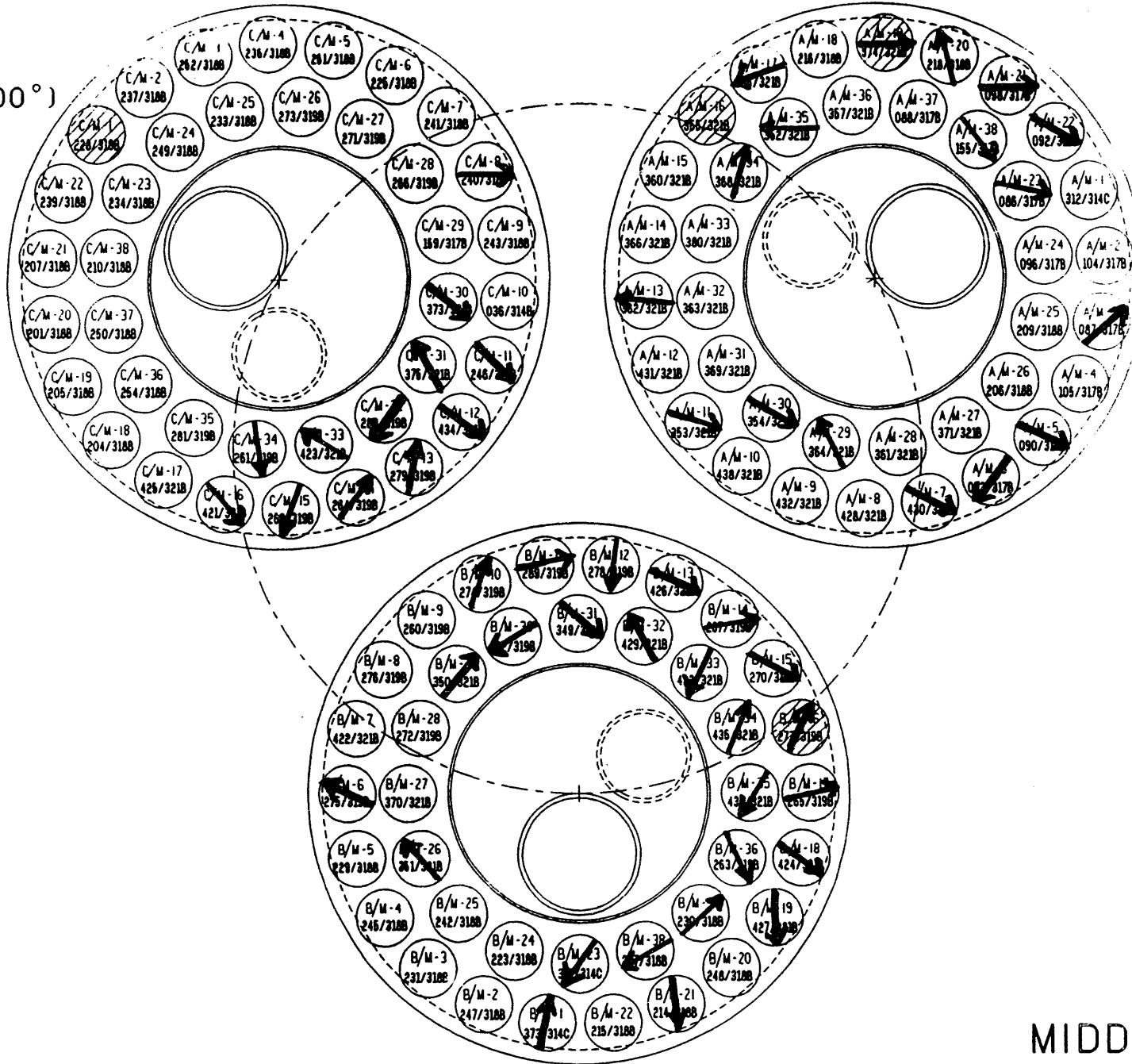
Figure 2a - Direction Of The Applied Force Along The Top Array Of Candles
After The July Through September 1993 Test Segment At AEP

NORTH

C/M (300°)

A/M (60°)

B-15



TIDD
MIDDLE PLENUM

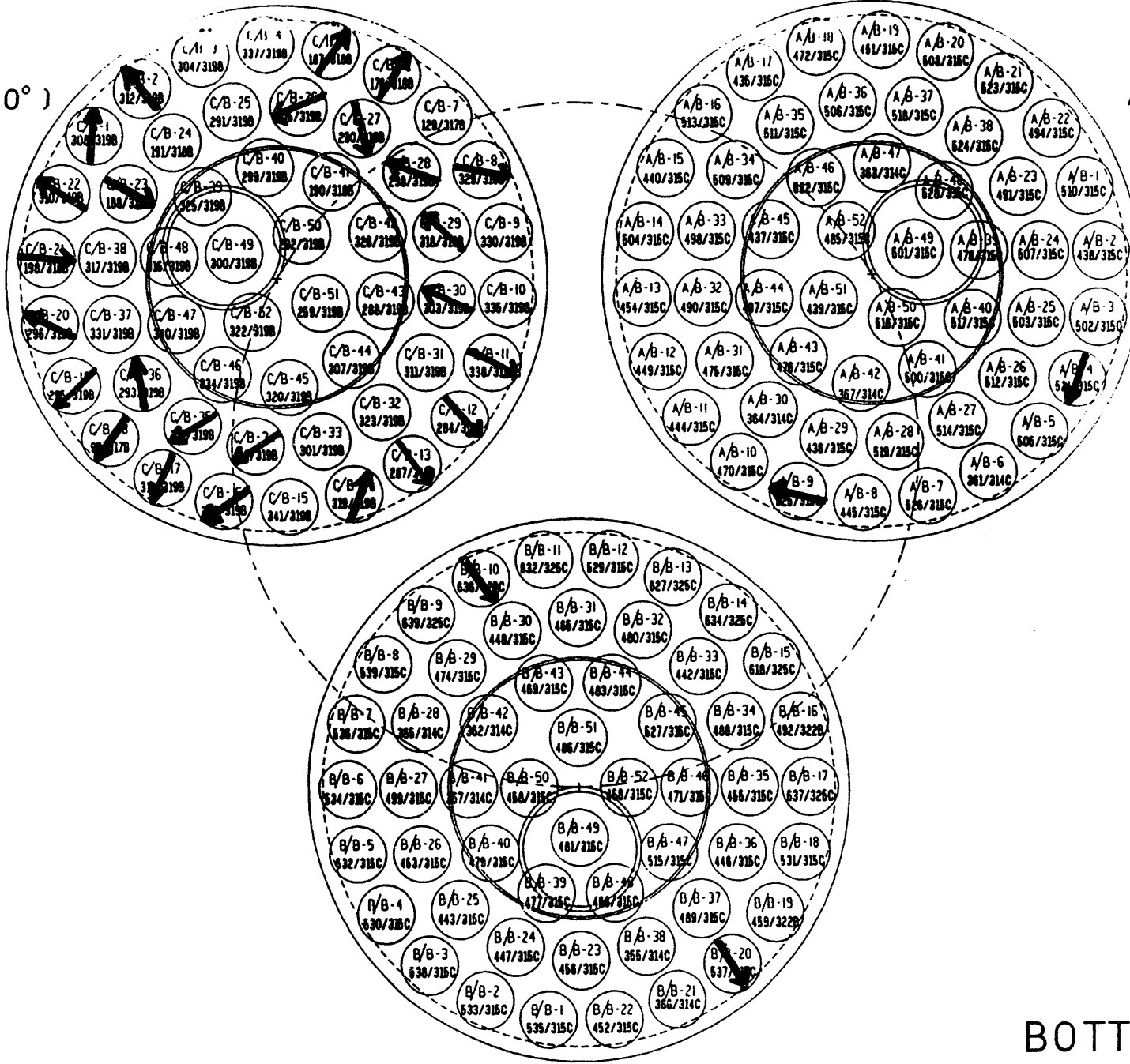
B/M (180°)

Figure 2b - Direction Of The Applied Force Along The Middle Array Of Candles After The July Through September 1993 Test Segment At AEP

NORTH

C/B (300°)

A/B (60°)



B-16

TIDD
BOTTOM PLENUM

B/B (180°)

Figure 2c - Direction Of The Applied Force Along The Bottom Array Of Candles After The July Through September 1993 Test Segment At AEP

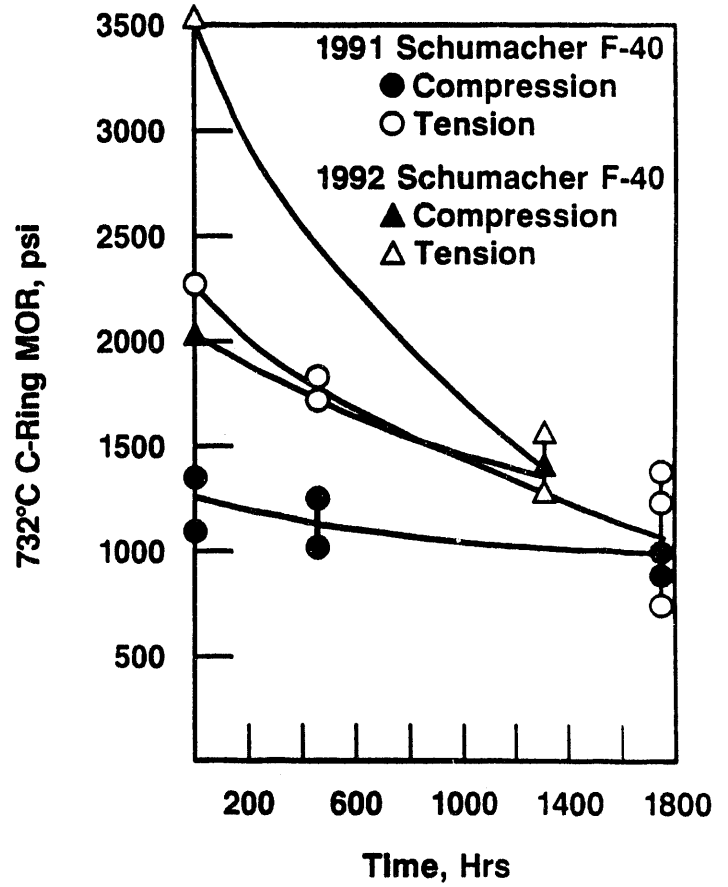
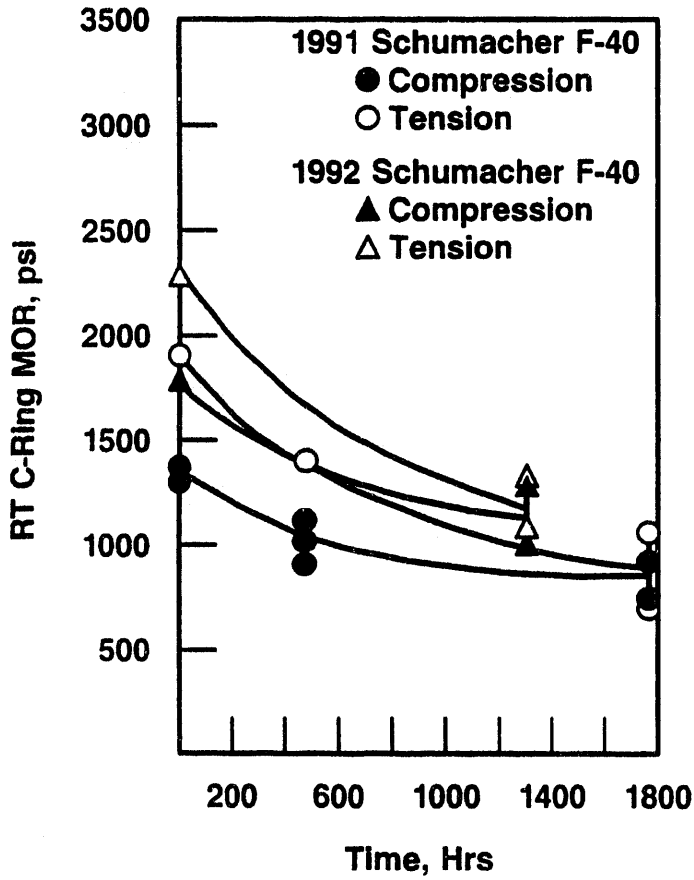


Figure 3 - Residual Strength Of The Clay Bonded Silicon Carbide Schumacher Dia Schumalith F40 Candle Filters As A Function Of Test Operating Time In The AEP PFBC Process Gas Environment

1991 candle filters. Both filter lots do, however, appear to converge at what may be a "steady state" strength during the initial period of exposure (i.e., <2,000 hours) in the high temperature PFBC gas environment, irrespective of the original, as-manufactured strength of the clay bonded silicon carbide matrix.

As shown in Table 6, the greatest retention of material strength is along the OD surface for both the 1991 and 1992 candle filter production lots. The greatest loss in strength is along the candle filter ID surface which may reflect the thermal fatigue characteristics of the clay bonded silicon carbide filter matrix (i.e., the response of the matrix to process temperature and pulse cycling events to achieve dust cake removal).

References

1. Advanced Particle Filter, Technical Progress Report No. 14, October through December 1993, Report Prepared by the Westinghouse Science and Technology Center for the American Electric Power Service Corporation under Contract No. C8014.

Table 6
 Percent Strength Retention in PFBC-Exposed
 Clay Bonded Silicon Carbide Candle Filters

Production Lot	Temp., °C	Time, Hrs	Room Temperature C-Ring		Hot Strength, 732°C C-Ring	
			Compression	Tension	Compression	Tension
F-40 1991	732	464	87	75	94	78
F-40 1991	732	1760	70	56	88	61
F-40 1992	732	1294	71	62	63	46

APPENDIX C

GAS MIXING OF TEMPERING AIR

From: STC, 501-2Y29
 WIN: 236-1984
 Date: January 31, 1994
 Subject: GAS MIXING OF TEMPERING AIR

To: Z. N. Sanjana STC
 T. E. Lippert, STC
 M. D. Carelli, STC

In the AEP system, 20500 lbm/hr of air at 575°F, 169 psia, is mixed with 100700/120840 lbm of flue gas at 1550°F, 164 psia. The flue gas composition is:

Table 1. Flue Gas Properties

	Molecular Weight	Gas Constant ft-lbf/ lbm-°R	Volume Fraction %	Absolute Viscosity lbm/ft-s @1550°F
CO ₂	44.01	35.11	13.49	2.878 x 10 ⁻⁵
H ₂ O	18.02	85.75	10.45	2.525 x 10 ⁻⁵
O ₂	32.00	48.29	3.70	3.540 x 10 ⁻⁵
N ₂	28.02	55.15	72.35	2.898 x 10 ⁻⁵
SO ₂	64.07	24.12	0.20	2.808 x 10 ⁻⁵

The density of the air is given by:

$$\rho_a = \frac{P}{R T} = \frac{(169)(144)}{(53.35)(575+459.69)} = 0.44215 \text{ lbm/ft}^3$$

The air volume flow rate:

$$Q_a = \frac{m_a}{\rho_a} = \frac{(20500/3600)}{0.44215} = 12.879 \text{ ft}^3/\text{sec}$$

The air is injected through a 4 inch schedule 10S stainless steel pipe, with an I.D. of 4.26 inches. The flow area:

$$A_f = \frac{\pi D^2}{4} = \frac{\pi (4.26/12)^2}{4} = 0.09898 \text{ ft}^2$$

The bulk air velocity:

$$V_a = \frac{Q_a}{A_f} = \frac{12.879}{0.09898} = 130.12 \text{ ft/sec}$$

For air at 575°F (575 K) Touloukain (ref. 1) gives an absolute viscosity of $29.49 \times 10^{-6} \text{ N-s/m}^2$. Converting to English units:

$$\mu_a = 29.49 \times 10^{-6} \text{ N-s/m}^2 \times \frac{1 \text{ lbf-s/ft}^2}{47.88164 \text{ N-s/m}^2} \times 32.174 \frac{\text{ft-lbm}}{\text{lbf-s}^2}$$

$$\mu_a = 1.982 \times 10^{-5} \text{ lbm/ft-s}$$

The Reynolds number:

$$Re_a = \frac{\rho_a V_a D}{\mu_a} = \frac{(0.44215)(130.12)(4.26/12)}{1.982 \times 10^{-5}} = 1.030 \times 10^6$$

Since the transition from laminar flow to turbulent flow occurs at Reynolds numbers between 2000 and 8000 the flow is clearly highly turbulent.

For the flue gas the density of the mixture is given by:

$$\rho_m = \frac{P}{T} \left(\frac{x_1}{R_1} + \frac{x_2}{R_2} + \dots + \frac{x_n}{R_n} \right)$$

Where $x_1 - x_n$ are the volume fractions of the components, and $R_1 - R_n$ are the gas constants for the components

$$\rho_m = \frac{(164)(144)}{(1550+459.69)} \left(\frac{0.1349}{35.11} + \frac{0.1045}{85.75} + \frac{0.0370}{48.29} + \frac{0.7235}{55.15} + \frac{0.0020}{24.12} \right)$$

$$\rho_m = 0.2236 \text{ lbm/ft}^3$$

The minimum volume flow rate is:

$$Q_f = \frac{\dot{m}_f}{\rho_m} = \frac{(100700/3600)}{0.2236} = 125.10 \text{ ft}^3/\text{sec}$$

The flue gas flow through a pipe with an I.D. of 19.5 inches. The flow area is:

$$A_f = \frac{\pi (19.5/12)^2}{4} = 2.0739 \text{ ft}^2$$

The bulk fluid velocity is:

$$V_f = \frac{Q_f}{A_f} = \frac{125.10}{2.0739} = 60.32 \text{ ft/sec}$$

The viscosities of the components of the gas mixture from Touloukian's (ref. 1) data are shown in Table 1. Note that the viscosities of these components do not vary significantly from that of the major component, N_2 . Since the mixture is more than 70% N_2 , we would expect the viscosity of the mixture to be very nearly equal to that of N_2 . This was verified by using Wilke's (ref. 2) method of predicting the viscosity of gaseous mixtures.

$$\mu_m = \frac{\mu_1}{1 + (x_2/x_1)^{\phi_{12}}} + \frac{\mu_2}{1 + (x_1/x_2)^{\phi_{21}}}$$

$$\phi_{12} = \frac{[1 + (\mu_1/\mu_2)^{0.25} (M_2/M_1)^{0.5}]}{\sqrt{8} [1 + M_1/M_2]^{0.5}}$$

$$\phi_{21} = \phi_{12} (\mu_2/\mu_1) (M_1/M_2)$$

Where: x_1 = Mol fraction of gas 1
 x_2 = Mol fraction of gas 2
 M_1 = Molecular weight of gas 1
 M_2 = Molecular weight of gas 2
 μ_1 = Absolute viscosity of gas 1
 μ_2 = Absolute viscosity of gas 2

First we estimated the viscosity of the $O_2 - SO_2$ mixture. Next we estimated the viscosity of the $CO_2 - H_2O$ mixture. We then combined these two mixtures, and finally combined them with the N_2 . The predicted value of μ_m was 2.898×10^{-5} lbm/ft-sec. Therefore the Reynolds number is:

$$Re_m = \frac{(0.2236)(60.32)(19.5/12)}{2.898 \times 10^{-5}} = 7.583 \times 10^5$$

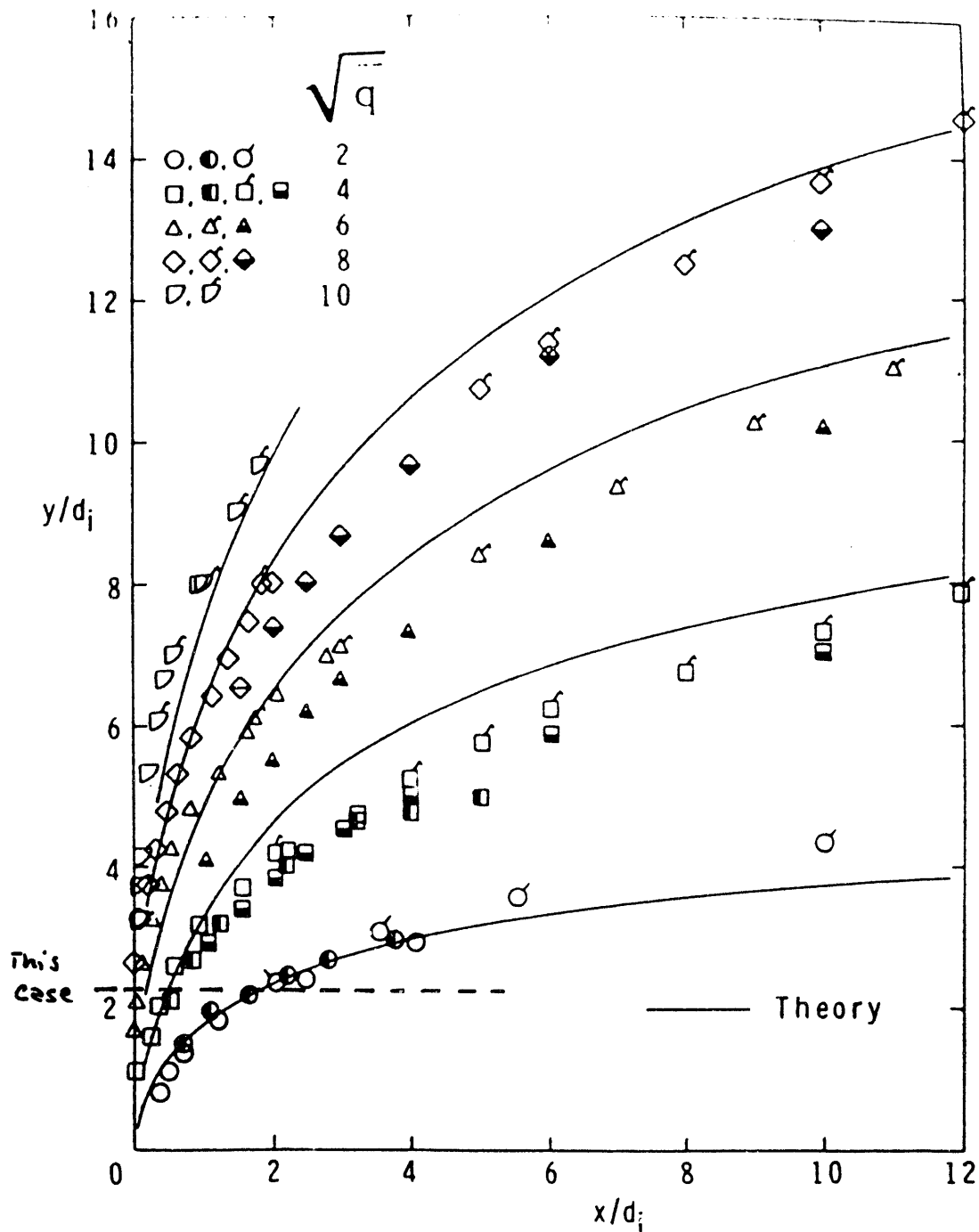
Therefore the flow in the main stream is also highly turbulent and good mixing will occur. This was verified by the correlation of Shetz (ref. 3) for transverse injection of jets into turbulent streams. Shetz plots y/d , the penetration of the jet into the main stream, as a function of x/d , the number of jet diameters downstream from the center of the jet and the parameter $q = \rho_j U_j^2 / \rho_\beta U_\beta^2$ where j denotes the density and velocity of the jet and β denotes the density and velocity of the main stream.

For this case $q = (0.44215)(130.12)^2 / (0.2236)(60.32)^2 = 9.202$. For the center of the jet to reach the center of the main pipe $y/d = (19.5/2)/(4.26) = 2.289$. From Figure 1, we see than this will occur at a value of $x/d < 4.0$. Therefore complete mixing should occur within 17 inches of the jet inlet.

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Trajectories for transverse, $\theta = 90$ deg, air jets into air for various values of the $\bar{q} = \rho_j U_j^2 / \rho_\infty U_\infty^2$.¹⁵⁸

TABLE 178-G(T). RECOMMENDED VISCOSITY VALUES FOR GASEOUS AIR

DISCUSSION

GAS

The literature revealed a rather abundant experimental work on air: 51 sets of data were found. Most of them are in the normal range of temperature close to room temperature. At high temperature the results of Vasilescu [254-5] and Trautz [226, 228, 229, 231] appears the most consistent, while at low temperature, the data of Fortier [66], Johnson [97-8] and of Filipova [62] are in good agreement. At about 20 C, very precise measurements of Bond [17], Bearden [8], Rigden [183], Kellström [104-6] and Majumdar [146-7] were selected, and the curve was forced to fit these data.

The theoretical expression for viscosity:

$$\mu = \frac{K\sqrt{T}}{\sigma^2\Omega} \quad (1)$$

was used to obtain $\sigma^2\Omega$ from the experimental data. A plot of $\sigma^2\Omega$ versus $1/T$ revealed that the equation:

$$\sigma^2\Omega = A + B/T e^{-C/T} \quad (2)$$

proposed by Keyes [121] was able to represent the data, which were least square fitted to such an equation. Values obtained from this equation (2) were used in equation (1) to generate the table of recommended values, which are thought to be accurate to $\pm 2\%$ in the whole range covered.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-6} N s m⁻²]

GAS					
T	μ	T	μ	T	μ
		450	24.93	850	37.83
		460	25.32	860	38.10
		470	25.70	870	38.37
		480	26.07	880	38.64
		490	26.45	890	38.91
80	5.52	500	26.82	900	39.18
90	6.35	510	27.18	910	39.45
		520	27.54	920	39.71
100	7.06	530	27.90	930	39.97
110	7.75	540	28.25	940	40.23
120	8.43	550	28.60	950	40.49
130	9.09	560	28.95	960	40.75
140	9.74	570	29.29	970	41.00
150	10.38	580	29.69	980	41.26
160	11.00	590	29.97	990	41.52
170	11.61	600	30.30	1000	41.77
180	12.20	610	30.63	1050	43.0
190	12.79	620	30.96	1100	44.2
200	13.36	630	31.28	1150	45.4
210	13.92	640	31.61	1200	46.5
220	14.47	650	31.93	1250	47.7
230	15.01	660	32.24	1300	48.8
240	15.54	670	32.56	1350	49.9
250	16.06	680	32.87	1400	50.9
260	16.57	690	33.18	1450	51.9
270	17.07	700	33.49	1500	53.0
280	17.57	710	33.79	1550	54.0
290	18.05	720	34.09	1600	54.9
300	18.53	730	34.39	1650	55.9
310	19.00	740	34.69	1700	56.9
320	19.46	750	34.98	1750	57.8
330	19.92	760	35.28	1800	58.7
340	20.37	770	35.57	1850	59.6
350	20.81	780	35.86	1900	60.5
360	21.25	790	36.15	1950	61.4
370	21.68	800	36.43	2000	62.3
380	22.11	810	36.72		
390	22.52	820	36.99		
400	22.94	830	37.27		
410	23.35	840	37.55		
420	23.75				
430	24.15				
440	24.54				

TABLE 30-G(T). VISCOSITY OF GASEOUS CARBON DIOXIDE

DISCUSSION

GAS

Experimental data for the viscosity of carbon dioxide reported in the literature are twenty eight in number. They cover a temperature range from 175 to 1686 K.

To correlate the data, use was made of the theoretical expression

$$\mu = 266.93 \frac{\sqrt{M T}}{\sigma^2 \Omega(T^*)} f \mu$$

The group $\sigma^2 \Omega(T^*)/f \mu$ was computed from the experimental data and plotted as a function of $1/T$. A table was generated from the smooth curve obtained. Recommended values were computed from the theoretical formula, with the values of $\sigma^2 \Omega(T^*)/f \mu$ interpolated from the table. Previous correlations made by Keyes [121] and a semi-theoretical evaluation made by Andrussow [3] were in good agreement with the present work.

At high temperature, the results of Di Pippo [51] are generally higher than the recommended curve, while experimental values of Vasilescu [254-255], Kompaneetz [127] and Trautz [219, 225, 233] are lower, indicating systematic divergence. The accuracy is about $\pm 2\%$, but may reach $\pm 5\%$ at high temperature.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-6} N s m⁻²]

GAS		GAS		GAS	
T	μ	T	μ	T	μ
		550	25.4	950	38.3
		560	25.7	960	38.6
		570	26.1	970	38.9
		580	26.5	980	39.1
		590	26.8	990	39.4
		600	27.2	1000	39.7
170	8.79	610	27.6	1050	41.1
180	9.26	620	27.9	1100	42.4
190	9.74	630	28.3	1150	43.7
200	10.22	640	28.6	1200	44.9
210	10.71	650	29.0	1250	46.2
220	11.19	660	29.3	1300	47.4
230	11.68	670	29.6	1350	48.6
240	12.16	680	30.0	1400	49.7
250	12.63	690	30.3	1450	50.9
260	13.12	700	30.6	1500	52.0
270	13.59	710	31.0	1550	53.1
280	14.06	720	31.3	1600	54.2
290	14.53	730	31.6	1650	55.2
300	14.99	740	32.0	1700	56.3
310	15.45	750	32.3	1750	57.3
320	15.91	760	32.6	1800	58.3
330	16.36	770	32.9	1850	59.3
340	16.81	780	33.2	1900	60.3
350	17.26	790	33.5	1950	61.2
360	17.70	800	33.9	2000	62.2
370	18.14	810	34.2		
380	18.57	820	34.5		
390	19.00	830	34.8		
400	19.42	840	35.1		
410	19.85	850	35.4		
420	20.26	860	35.7		
430	20.68	870	36.0		
440	21.09	880	36.3		
450	21.50	890	36.6		
460	21.90	900	36.9		
470	22.30	910	37.1		
480	22.69	920	37.4		
490	23.09	930	37.7		
500	23.48	940	38.0		
510	23.9				
520	24.3				
530	24.6				
540	25.0				

TABLE 23-G(T). VISCOSITY OF GASEOUS WATER

DISCUSSION

GAS

The Sixth International Conference on the Properties of Steam charged a panel with the task of producing new tables on transport properties. The result was the recommendation of the equation:

$$\mu = (80.4 + 0.407 t) 10^{-7} \text{ N sec m}^{-2} \quad (t \text{ in } ^\circ\text{C}) \quad (1)$$

which served for the representation of the viscosity of superheated steam in the range 100-700 C, in the International Skeleton table (1964).

This equation is based on Shifrin's [197] results as a primary reference. An excellent discussion on the subject, can be found in a paper by Kestin [118]. The tolerances are $\pm 1\%$ in the range 373-573 K and $\pm 3\%$ in the range 573-973 K.

Several papers presented at the 7th International Conference (Tokyo, 1968) were dealing with the subject. Three of these are based on a unique equation for the representation in the whole p, T, μ domain, instead of 4 equations representing four separate domains (Tanishita [210], Miyabe [156] Rivkin [185]). Another paper, by Bruges [27] which is an extension of a previous work [26] uses several equations characteristic of different domains, and includes the experimental results of Latto [135].

Based on the same primary sources of references the values obtained in the different correlation fall well within the tolerances given by the International Skeleton table (1964). Therefore the recommended values were generated from the above equation (1).

In view of the wide acceptance of our basic equation and the numerous detailed discussion in the technical literature coupled with pressing requirements of time, no departure plot appears.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-6} N s m $^{-2}$]

GAS			
T	μ	T	μ
		650	23.38
		660	23.78
		670	24.19
280	8.32	680	24.60
290	8.73	690	25.01
		700	25.41
300	9.13	710	25.82
310	9.54	720	26.23
320	9.95	730	26.63
330	10.35	740	27.04
340	10.76		
		750	27.45
350	11.17	760	27.85
360	11.57	770	28.25
370	11.98	780	28.67
380	12.39	790	29.08
390	12.80		
		800	29.48
400	13.20	810	29.89
410	13.61	820	30.30
420	14.02	830	30.70
430	14.42	840	31.11
440	14.83		
		850	31.52
450	15.24	860	31.92
460	15.64	870	32.33
470	16.05	880	32.74
480	16.46	890	33.15
490	16.87		
		900	33.55
500	17.27	910	33.96
510	17.68	920	34.37
520	18.09	930	34.77
530	18.49	940	35.18
540	18.90		
		950	35.59
550	19.31	960	35.99
560	19.71	970	36.40
570	20.12	980	36.81
580	20.53	990	37.22
590	20.94		
		1000	37.62
600	21.34		
610	21.75		
620	22.16		
630	22.56		
640	22.97		

TABLE 12-G(T). VISCOSITY OF GASEOUS OXYGEN

DISCUSSION

GAS

There are 20 sets of experimental data available for the viscosity of Oxygen, covering an overall range of temperature from 72 to 2500 K. They are those reported by Trautz and al [222, 227, 232, 233], Johnston [98], Van Itterbeek [243-249], Kestin [109-110], Makita [150], Uchiyama [236], Volker [258], Markowski [152], Raw and Ellis [176], Majumdar [146], Yen [266], Rigden [183], Vogel [257], Wobser and Muller [264] and Bonilla [18]. A previous correlation made by Keyes [121], and a semi-theoretical evaluation by Andrussow [3] both are in good agreement with the present correlation.

At low temperature, the data of Johnston appears smoother than those of Van Itterbeek while Volker's data diverge greatly (about 20%). At room temperature, there is good agreement between Kestin, Rigden, Majumdar and Yen. At high temperature, there are discrepancies between the data of Trautz, Bonilla and of Raw and Ellis. The Johnston data were given more weight at low temperatures.

To correlate the data, use was made of the expression:

$$\mu = 266.93 \frac{\sqrt{MT}}{\sigma^2 \Omega(T^*)} f \mu$$

The group $\sigma^2 \Omega(T^*)/f \mu$ was computed from the experimental data, and plotted as a function of $1/T$. To help smoothing, the curve obtained has been compared with the similar curve obtained for Argon, the resulting curve was chosen so as to match the results of Majumdar, Rigden and Kestin, at room temperature, and a table was generated which was used for computing recommended values.

The accuracy is of the order of ± 2 percent but is better than one percent around room temperature.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-6} N s m⁻²]

GAS					
T	μ	T	μ	T	μ
		450	28.28	850	43.8
		460	28.74	860	44.1
		470	29.20	870	44.4
		480	29.65	880	44.7
		490	30.10	890	45.1
80	6.27				
90	6.98				
100	7.68	500	30.54	900	45.4
110	8.39	510	31.0	910	45.7
120	9.12	520	31.4	920	46.0
130	9.85	530	31.8	930	46.3
140	10.56	540	32.3	940	46.7
150	11.27	550	32.7	950	47.0
160	11.96	560	33.1	960	47.3
170	12.65	570	33.5	970	47.6
180	13.33	580	33.9	980	47.9
190	13.99	590	34.3	990	48.2
200	14.65	600	34.7	1000	48.5
210	15.29	610	35.2	1050	50.0
220	15.93	620	35.5	1100	51.4
230	16.55	630	35.9	1150	52.9
240	17.17	640	36.3	1200	54.2
250	17.77	650	36.7	1250	55.6
260	18.37	660	37.1	1300	56.9
270	18.96	670	37.4	1350	58.2
280	19.54	680	37.8	1400	59.5
290	20.11	690	38.2	1450	60.7
300	20.67	700	38.5	1500	61.9
310	21.23	710	38.9	1550	63.1
320	21.77	720	39.3	1600	64.3
330	22.31	730	39.6	1650	65.5
340	22.84	740	40.0	1700	66.6
350	23.37	750	40.3	1750	67.7
360	23.89	760	40.7	1800	68.8
370	24.40	770	41.1	1850	69.9
380	24.91	780	41.4	1900	71.0
390	25.41	790	41.7	1950	72.1
400	25.89	800	42.1	2000	73.1
410	26.39	810	42.4		
420	26.87	820	42.8		
430	27.35	830	43.1		
440	27.82	840	43.4		

G-112

TABLE 11-G(T). VISCOSITY OF GASEOUS NITROGEN

DISCUSSION

GAS

There are 34 sets of experimental data available for the viscosity of nitrogen [5, 18, 50, 59, 64, 67, 81, 95, 98, 99, 109, 110, 112, 115, 117, 138, 146, 148, 151, 152, 175, 183, 201, 220, 222, 227, 233, 236, 349, 254, 255, 257, 264, 268, 326]. The overall temperature range covered, is from 78 to 2500 K. In general there is a good agreement between the various investigators, although the high temperature results from Di Pippo and Kestin [50], Kestin and Whitelaw [117] on one hand, and those of Vasilescu [254-255], and Bonilla [18] on the other lie on opposite sides of the curve, indicating some systematic deviation, a fact already pointed out by Hanley and Childs [85]. A semi-theoretical evaluation was made by Andrussow [3], and is in good agreement.

To correlate the data, use was made of the theoretical expression:

$$\mu = 266.93 \frac{M\sqrt{T}}{\sigma^2 \Omega(T^*)} f \mu$$

The group $\sigma^2 \Omega(T^*)/f \mu$ was computed from the experimental data and plotted as a function of $1/T$. The curve obtained was smoothed, using the similar curve for argon as a guide, to make the comparison reduction factors used were the ratio of collision diameter and the ratio of Boyle temperature. A table was generated in order to compute recommended values.

The accuracy is thought to be about ± 2 percent.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-4} N s m⁻²]

GAS					
T	μ	T	μ	T	μ
		450	24.08	850	36.55
		460	24.45	860	36.82
		470	24.82	870	37.08
80	5.59	480	25.18	880	37.34
90	6.22	490	25.54	890	37.60
100	6.87	500	25.90	900	37.86
110	7.52	510	26.25	910	38.12
120	8.15	520	26.60	920	38.37
130	8.78	530	26.95	930	38.63
140	9.40	540	27.29	940	38.88
150	10.00	550	27.63	950	39.12
160	10.59	560	27.96	960	39.38
170	11.18	570	28.30	970	39.63
180	11.75	580	28.63	980	39.87
190	12.31	590	28.95	990	40.12
200	12.86	600	29.27	1000	40.36
210	13.40	610	29.59	1010	40.6
220	13.93	620	29.91	1020	40.8
230	14.45	630	30.23	1030	41.1
240	14.96	640	30.54	1040	41.3
250	15.46	650	30.85	1050	41.6
260	15.96	660	31.15	1060	41.8
270	16.45	670	31.46	1070	42.0
280	16.92	680	31.76	1080	42.3
290	17.40	690	32.06	1090	42.5
300	17.86	700	32.35	1100	42.7
310	18.32	710	32.65	1110	43.0
320	18.77	720	32.94	1120	43.2
330	19.21	730	33.23	1130	43.4
340	19.65	740	33.52	1140	43.6
350	20.08	750	33.80	1150	43.9
360	20.50	760	34.09	1160	44.1
370	20.92	770	34.37	1170	44.3
380	21.33	780	34.65	1180	44.5
390	21.74	790	34.93	1190	44.8
400	22.14	800	35.20	1200	45.0
410	22.54	810	35.48	1210	45.2
420	22.93	820	35.75	1220	45.4
430	23.32	830	36.02	1230	45.6
440	23.70	840	36.29	1240	45.8

TABLE 22-G(T). VISCOSITY OF GASEOUS SULFUR DIOXIDE

DISCUSSION

GAS

Twelve sets of experimental data were found in the literature [35, 202, 206, 231, 233, 236, 257, 264, 296, 310, 321, 322]. They show large discrepancies, even at ambient temperature, and at low temperature.

The correlation was made by using the theoretical relation $\mu = K\sqrt{T}/(\sigma^2 \Omega_{22}(T^*)^2)$. From the data $\sigma^2 \Omega$ was computed and plotted as a function of $1/T$. A smooth curve was drawn through the experimental points, and fitted to a quadratic equation, from which recommended values were generated. Values computed by Andrussow [3] with the aid of a semi-theoretical relation are in fair agreement, except at low temperature. The accuracy must be of the order of ± 3 percent.

RECOMMENDED VALUES

[Temperature, T, K; Viscosity, μ , 10^{-6} N s m^{-2}]

GAS

T	μ	T	μ	T	μ
200	8.62	500	21.3	800	32.1
210	9.06	510	21.7	810	32.4
220	9.51	520	22.1	820	32.7
230	9.96	530	22.5	830	33.1
240	10.40	540	22.8	840	33.4
250	10.84	550	23.2	850	33.7
260	11.28	560	23.6	860	34.0
270	11.72	570	24.0	870	34.4
280	12.16	580	24.4	880	34.7
290	12.60	590	24.7	890	35.0
300	13.04	600	25.1	900	35.3
310	13.47	610	25.5	910	35.6
320	13.90	620	25.8	920	35.9
330	14.33	630	26.2	930	36.3
340	14.76	640	26.6	940	36.6
350	15.18	650	26.6	950	36.9
360	15.61	660	27.3	960	37.2
370	16.03	670	27.6	970	37.5
380	16.45	680	28.0	980	37.8
390	16.86	690	28.3	990	38.1
400	17.28	700	28.7	1000	38.4
410	17.69	710	29.1	1050	39.9
420	18.10	720	29.4	1100	41.3
430	18.51	730	29.7	1150	42.8
440	18.91	740	30.1	1200	44.2
450	19.32	750	30.4	1250	45.4
460	19.72	760	30.7		
470	20.12	770	31.1		
480	20.51	780	31.4		
490	20.91	790	31.8		

APPENDIX D

BOB BANKS MEETING

BOB BANKS MEETING ON NOVEMBER 11

Bob Banks, who is an outside consultant in the AEP/APF project, was debriefed on the APF testing conducted late 1993. The purpose was to gain his experience and knowledge relating to ash sintering. The following highlights the discussion points.

1. Discussed cake formation at Tidd along with photos of cake, broken candles.

Bob said it reminded him of a Wheelabrator Fry baghouse at Texas Utilities in Monticello. Used shaker technology to clean bags.

- Experienced severe cake formation. Hypothesis: Formation of gypsum and its hydrated products.
- Suspicion of electrostatic effects. TEL said, "we should measure voltage between candle and vessel." (Tom, should this be an action item for January? Here or at Tidd?)

Shaker technology discussed. No reentrainment problem due to partial shut off of flow during cleaning.

Most relevant experience is with pulse jet baghouse designs. Typical design has dirty gas coming in at high velocity (2-3,000 fpm). That's 30-50 fps typical of what we might use.

Gas enters at the bottom of vessel and slows down. Free space in vessel is designed to reduce gas velocity to 270 ft/min which is 4.5 ft/sec. Apparently there is no entrainment problem in most of these upflow baghouses.

Bob said though that most baghouse designers are cost driven. Downflow would be better for high dust level loadings and some designs have been proposed but cost has been an adverse factor.

We asked him about tangential vs radial entry. He knows of only two round baghouses with tangential entries.

- Donaldson - he sent me a pamphlet. I called and got more info from them.

- Research Cottrell - he also suggested we talk to Ken Cushing, Larry Felix at SRI to tap their experience. They referred me to Duane Pontius. Duane indicated downflow is preferred to avoid entrainment problems. Does not have a strong feeling about tangential vs radial. Does think it is important to avoid dead spots. Does not know if tangential will be effective.

Torit & Day, Division of the Donaldson Company, have a downflow cartridge collector with reverse pulse cleaning, but it is not obvious from their literature why it is a downflow. They claim it aids the cleaning process.

They have a round baghouse with tangential entry which they recommend for very high particle loadings.

APPENDIX E

TIDD APF OPERATION

APF Operation

Tables 1 through 6 summarize the operating conditions of the APF for the following test runs completed during the first quarter of 1994.

Test Run	Time Period (1)	Table No.
12	01/10/94 06:41 - 01/11/94 01:36	1
13	01/15/94 23:42 - 01/29/94 20:31	2
14	02/17/94 14:58 - 02/18/94 11:37	3
15	02/19/94 06:15 - 02/25/94 13:09	4
16	03/03/94 10:13 - 03/09/94 11:30	5
17	03/16/94 14:48 - 03/23/94 10:50	6

Note 1: Beginning with coal fire and ending with a combustor trip.

The flow in the summary tables is the APF outlet gas flow. The temperature is the APF vessel internal temperature at the 0 degree nozzle 8A location. The pressure is the APF outlet pressure. The baseline and trigger delta-p are measured across the APF tubesheet. The initial permeability used to determine the relative permeability is calculated at a 0.4 psi delta-p at a face velocity of 10 ft/min at 1550 F. The ash filtered data in the tables is estimated using an inlet dust loading of 3353 ppm (measured APF inlet loading by Battelle in January 1994).

The flow through the APF was not measured accurately during test runs 12 through 15 due to an instrument problem. The flow data obtained during test runs 12 through 15 was actually too high. For test run 16 and after the instrument problem was corrected. The following formula was used to correct the flow data in tables 1 through 4.

$$114.5 \times \text{FLOW}$$

(Test Run Max Flow in KPPH)

where: 114.5 = Maximum measured flow (in KPPH) during test run 16.

FLOW = Flow (in KPPH) data to be corrected.

Test Run Max Flow in KPPH = Is the maximum incorrect flow for the test run:

Test Run	Max Flow, KPPH
12	111
13	154
14	137
15	133

TABLE 1 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 12 (JANUARY 10 THRU JANUARY 11, 1994)

* Corrected data													RELATIVE		REMARKS
DATE	TIME	HRS	MW	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K0	ASH FILTERED LB	TOTAL ASH LB	REMARKS		
							DP (ts) IN WG	TRIGGER IN WG							
1/10/94	6:00		-1	40	723	43	14	17	4.8	0.36					
1/10/94	6:30	0	-1	44	728	44	14	17	5.2	0.42			* 06:41 coal fire. Pittsburgh No. 8 coal and Plum Greenfield Dolomite sorbent used in test run 12.		
1/10/94	7:00		5	48	834	49	17	22	5.6	0.40	80				
1/10/94	7:30	1	5	52	885	54	17	25	5.9	0.45	88	168			
1/10/94	8:00		7	63	928	71	22	28	6.0	0.34	100	274			
1/10/94	8:30	2	9	78	974	93	25	33	6.1	0.33	131	485			
1/10/94	9:00		10	80	965	94	28	36	6.2	0.29	134	539			
1/10/94	9:30	3	10	81	981	94	28	36	6.3	0.30	135	675			
1/10/94	10:00		11	80	965	94	28	39	6.1	0.28	134	809			
1/10/94	10:30	4	10	81	961	94	28	36	6.2	0.29	136	945			
1/10/94	11:00		11	82	967	94	28	36	6.3	0.30	137	1082			
1/10/94	11:30	5	11	81	971	91	28	36	6.4	0.30	135	1218			
1/10/94	12:00		11	81	974	91	28	39	6.4	0.31	136	1353			
1/10/94	12:30	6	14	74	979	91	28	42	5.9	0.26	123	1477			
1/10/94	13:00		14	78	988	90	28	42	6.3	0.30	131	1607			
1/10/94	13:30	7	17	77	997	89	28	50	6.3	0.30	129	1737			
1/10/94	14:00		16	77	1009	89	29	42	6.4	0.30	129	1806			
1/10/94	14:30	8	17	75	1027	90	28	44	6.2	0.29	125	1991			
1/10/94	15:00		17	76	1050	91	28	44	6.3	0.30	127	2118			
1/10/94	15:30	9	21	78	1070	92	28	50	6.5	0.32	130	2248			
1/10/94	16:00		25	74	1095	93	28	53	6.2	0.29	123	2372			
1/10/94	16:30	10	28	77	1110	93	28	47	6.5	0.32	129	2501			
1/10/94	17:00		30	78	1131	93	30	47	6.7	0.30	130	2631			
1/10/94	17:30	11	34	86	1154	108	30	50	6.6	0.31	145	2776			
1/10/94	18:00		36	87	1175	110	30	58	6.7	0.32	146	2922			
1/10/94	18:30	12	39	88	1202	111	30	58	6.8	0.33	147	3069			
1/10/94	19:00		43	85	1240	112	33	64	6.7	0.28	143	3212			
1/10/94	19:30	13	45	83	1261	113	33	69	6.5	0.27	139	3351			
1/10/94	20:00		47	82	1275	114	33	66	6.5	0.27	138	3489			
1/10/94	20:30	14	50	90	1313	120	33	69	6.9	0.31	151	3639			
1/10/94	21:00		52	102	1324	134	36	75	7.1	0.31	171	3810			
1/10/94	21:30	15	55	98	1321	137	39	69	6.7	0.25	164	3974			
1/10/94	22:00		54	105	1310	137	39	72	7.2	0.28	176	4150			
1/10/94	22:30	16	54	97	1321	136	39	69	6.7	0.25	163	4313			
1/10/94	23:00		54	97	1333	137	39	61	6.7	0.25	162	4475			
1/10/94	23:30	17	55	103	1335	139	42	64	7.0	0.25	172	4647			
1/11/94	0:00		53	95	1339	135	39	69	6.7	0.25	159	4807			
1/11/94	0:30	18	55	100	1334	141	42	69	7.3	0.26	181	4987			
1/11/94	1:00		55	104	1321	142	42	61	6.9	0.24	174	5161			
1/11/94	1:30	19	53	115	1309	142	33	55	7.6	0.42	192	5353	* 01:36 Combustor trip due to a plugged No. 13 cyclone.		

E-4

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 16 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE		REMARKS
DATE	TIME	HRS	MW _o	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K _o	ASH FILTERED LB	TOTAL ASH LB	REMARKS		
							DP (ts) IN WG	TRIGGER IN WG							
1/15/94	21:00		-4	33	613	40			3.8	-					
1/15/94	21:30		-4	35	647	41			4.1	-					
1/15/94	22:00		-3	35	680	42			4.1	-					
1/15/94	22:30		-3	35	703	42			4.2	-					
1/15/94	23:00		-3	35	712	42			4.2	-			* 23:42 coal fire. Pittsburgh No. 8 coal and Plum Run Greenfield Dolomite sorbent used in test run 13.		
1/15/94	23:30	0	-2	34	723	43			4.1	-					

3 of 3

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data

DATE	TIME	HRS	MWe	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K0	ASH FILTERED LB		
1/16/94	0:00		1	37	792	46			4.5	-	63		
1/16/94	0:30	1	3	46	875	58	22	30	5.0	0.24	78	141	
1/16/94	1:00		6	59	940	82			5.0	-	98	239	
1/16/94	1:30	2	8	57	980	88			4.7	-	96	335	
1/16/94	2:00		10	58	960	92			4.5	-	97	432	
1/16/94	2:30	3	11	59	961	92			4.6	-	99	531	
1/16/94	3:00		12	67	969	93	28	80	5.2	0.22	113	644	
1/16/94	3:30	4	13	65	974	94			5.0	-	109	752	
1/16/94	4:00		16	64	976	94			4.9	-	107	859	
1/16/94	4:30	5	17	63	983	94			4.9	-	105	964	
1/16/94	5:00		18	66	1001	102			4.8	-	110	1074	
1/16/94	5:30	6	21	77	1030	112	36	100	5.3	0.17	129	1203	
1/16/94	6:00		26	73	1060	117	33	55	4.9	0.17	122	1328	
1/16/94	6:30	7	28	76	1077	117	33	53	5.2	0.18	128	1453	
1/16/94	7:00		30	63	1090	117	33	58	4.4	0.14	106	1560	
1/16/94	7:30	8	34	76	1101	119	33	53	5.2	0.18	127	1686	
1/16/94	8:00		35	75	1111	120	42	58	5.1	0.14	127	1813	
1/16/94	8:30	9	38	78	1130	121	36	53	5.4	0.18	131	1944	
1/16/94	9:00		40	68	1146	119	36	58	4.7	0.15	113	2057	
1/16/94	9:30	10	42	77	1161	120	36	58	5.4	0.18	129	2186	
1/16/94	10:00		44	73	1175	120	36	55	5.2	0.17	122	2309	
1/16/94	10:30	11	48	75	1202	122	36	58	5.3	0.18	126	2435	
1/16/94	11:00		51	73	1236	125	39	58	5.2	0.16	123	2557	
1/16/94	11:30	12	54	76	1266	128	39	61	5.3	0.17	127	2684	
1/16/94	12:00		57	81	1296	130	39	61	5.7	0.19	136	2820	
1/16/94	12:30	13	61	84	1334	141	42	64	5.7	0.18	141	2961	
1/16/94	13:00		60	82	1332	141	42	77	5.5	0.17	138	3099	
1/16/94	13:30	14	60	85	1336	141	42	61	5.7	0.18	143	3242	
1/16/94	14:00		60	89	1337	142	42	72	6.0	0.19	150	3392	
1/16/94	14:30	15	60	84	1332	142	42	72	5.6	0.17	140	3532	
1/16/94	15:00		58	82	1330	140	42	64	5.5	0.17	138	3670	
1/16/94	15:30	16	59	84	1334	142	42	69	5.6	0.17	141	3811	
1/16/94	16:00		59	67	1339	141	42	69	4.5	0.13	112	3924	
1/16/94	16:30	17	59	89	1333	142	69	72	5.9	0.10	149	4072	
1/16/94	17:00		59	63	1336	139	97	100	4.3	0.05	105	4177	
1/16/94	17:30	18	58	86	1319	142	100	102	5.7	0.06	144	4321	
1/16/94	18:00		58	88	1317	140	44	119	5.9	0.17	147	4469	
1/16/94	18:30	19	57	95	1319	142	44	64	6.3	0.19	159	4628	
1/16/94	19:00		57	80	1328	141	44	68	5.4	0.15	135	4763	
1/16/94	19:30	20	56	92	1326	141	44	66	6.1	0.18	154	4917	
1/16/94	20:00		58	90	1336	142	47	75	6.0	0.16	151	5067	
1/16/94	20:30	21	57	73	1340	142	47	69	4.9	0.12	122	5189	
1/16/94	21:00		54	83	1327	139	47	69	5.6	0.15	139	5328	
1/16/94	21:30	22	56	85	1327	141	47	61	5.7	0.15	142	5470	
1/16/94	22:00		55	90	1326	141	47	66	6.0	0.16	151	5621	
1/16/94	22:30	23	55	91	1318	142	47	66	6.0	0.16	152	5773	
1/16/94	23:00		55	79	1324	141	47	69	5.3	0.14	132	5905	
1/16/94	23:30	24	55	92	1337	142	47	61	6.1	0.17	154	6059	

E-6

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE	
DATE	TIME	HRS	MW _o	FLOW _o KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K _o	ASH FILTERED LB	TOTAL ASH LB	REMARKS	
							DP (ts) IN WG	TRIGGER IN WG						
1/17/94	0:00		55	81	1329	141	47	61	5.4	0.14	135	6194		
1/17/94	0:30	25	55	98	1326	142	47	75	6.5	0.18	164	6358		
1/17/94	1:00		55	88	1323	141	47	64	5.9	0.16	147	6505		
1/17/94	1:30	26	55	91	1322	141	47	64	6.0	0.16	152	6657		
1/17/94	2:00		54	82	1323	141	47	64	5.5	0.14	137	6794		
1/17/94	2:30	27	55	95	1322	142	50	64	6.3	0.16	160	6954		
1/17/94	3:00		53	86	1315	141	47	64	5.7	0.15	144	7098		
1/17/94	3:30	28	53	97	1316	142	50	64	6.4	0.17	162	7260		
1/17/94	4:00		54	92	1315	140	50	64	6.1	0.16	154	7414		
1/17/94	4:30	29	54	96	1314	142	50	61	6.3	0.16	160	7575		
1/17/94	5:00		52	98	1315	141	50	69	6.5	0.17	164	7738		
1/17/94	5:30	30	54	96	1318	142	50	69	6.3	0.16	161	7899		
1/17/94	6:00		51	85	1317	140	50	69	5.7	0.14	143	8042		
1/17/94	6:30	31	53	97	1321	143	50	69	6.4	0.17	162	8204		
1/17/94	7:00		55	88	1320	141	50	64	5.9	0.15	147	8352		
1/17/94	7:30	32	55	98	1322	142	50	64	6.5	0.17	164	8516		
1/17/94	8:00		53	80	1336	141	50	61	5.4	0.13	134	8650		
1/17/94	8:30	33	53	98	1331	143	47	61	6.5	0.19	165	8814		
1/17/94	9:00		53	91	1336	141	50	61	6.1	0.16	152	8967		
1/17/94	9:30	34	54	96	1337	143	50	61	6.4	0.17	161	9128		
1/17/94	10:00		54	94	1343	142	47	61	6.3	0.18	158	9286		
1/17/94	10:30	35	53	93	1341	143	47	61	6.2	0.17	156	9441		
1/17/94	11:00		54	90	1346	142	47	58	6.0	0.17	150	9592		
1/17/94	11:30	36	53	98	1348	143	53	61	6.6	0.16	164	9756		
1/17/94	12:00		54	94	1344	142	47	58	6.3	0.18	158	9914		
1/17/94	12:30	37	52	96	1346	143	47	58	6.5	0.18	162	10076		
1/17/94	13:00		54	89	1353	142	50	58	6.0	0.15	150	10226		
1/17/94	13:30	38	52	95	1346	142	50	58	6.3	0.17	159	10384		
1/17/94	14:00		50	84	1339	140	47	53	5.7	0.15	142	10526		
1/17/94	14:30	39	52	96	1345	143	44	53	6.4	0.20	161	10687		
1/17/94	15:00		52	91	1345	141	44	53	6.1	0.18	152	10839		
1/17/94	15:30	40	52	94	1338	142	44	53	6.3	0.19	157	10996		
1/17/94	16:00		52	84	1334	140	47	53	5.7	0.15	140	11137		
1/17/94	16:30	41	52	95	1338	143	44	55	6.3	0.19	159	11295		
1/17/94	17:00		52	85	1362	142	47	55	5.7	0.15	142	11437		
1/17/94	17:30	42	51	97	1352	142	47	53	6.6	0.19	163	11600		
1/17/94	18:00		49	93	1331	140	44	53	6.3	0.19	155	11755		
1/17/94	18:30	43	49	96	1319	141	47	58	6.4	0.18	162	11917		
1/17/94	19:00		50	88	1318	141	50	64	5.9	0.15	148	12065		
1/17/94	19:30	44	51	95	1319	141	50	66	6.3	0.16	159	12225		
1/17/94	20:00		50	93	1325	140	47	61	6.3	0.17	157	12381		
1/17/94	20:30	45	50	98	1330	143	50	64	6.5	0.17	164	12545		
1/17/94	21:00		52	90	1343	142	50	77	6.1	0.15	151	12696		
1/17/94	21:30	46	52	100	1351	143	50	66	6.7	0.18	168	12864		
1/17/94	22:00		52	92	1345	142	47	72	6.2	0.17	154	13018		
1/17/94	22:30	47	51	100	1345	143	50	66	6.7	0.18	168	13186		
1/17/94	23:00		51	86	1337	141	50	72	5.0	0.14	143	13330		
1/17/94	23:30	48	53	97	1328	142	50	69	6.4	0.17	162	13492		

E-7

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW	FLOW* KPPH	T DEG F	P PSIG	BASELINE DP (ts) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/KØ	ASH FILTERED LB					
1/18/94	0:00		52	87	1325	141	50	69	5.8	0.15	145	13637				
1/18/94	0:30	49	52	95	1327	142	47	64	6.3	0.18	160	13790				
1/18/94	1:00		53	85	1338	141	47	64	5.7	0.15	143	13939				
1/18/94	1:30	50	54	89	1340	141	50	61	6.0	0.15	150	14089				
1/18/94	2:00		53	87	1345	142	47	66	5.8	0.16	145	14234				
1/18/94	2:30	51	55	96	1349	143	47	64	6.4	0.18	162	14396				
1/18/94	3:00		55	87	1353	142	47	66	5.8	0.16	145	14541				
1/18/94	3:30	52	53	94	1351	142	47	61	6.3	0.18	157	14698				
1/18/94	4:00		55	85	1350	142	47	61	5.7	0.15	143	14841				
1/18/94	4:30	53	54	98	1355	143	47	69	6.6	0.19	165	15006				
1/18/94	5:00		54	93	1360	142	47	61	6.3	0.18	156	15162				
1/18/94	5:30	54	55	96	1358	143	47	58	6.5	0.18	161	15324				
1/18/94	6:00		54	91	1361	143	47	58	6.2	0.17	153	15476				
1/18/94	6:30	55	54	98	1366	144	47	69	6.6	0.19	164	15641				
1/18/94	7:00		54	99	1363	143	47	61	6.7	0.20	166	15807				
1/18/94	7:30	56	54	96	1364	144	47	58	6.6	0.19	165	15972				
1/18/94	8:00		55	94	1372	144	47	58	6.3	0.18	157	16129				
1/18/94	8:30	57	53	97	1370	143	47	58	6.6	0.19	163	16292				
1/18/94	9:00		54	92	1357	142	53	55	6.2	0.15	155	16446				
1/18/94	9:30	58	53	97	1349	143	53	55	6.5	0.16	163	16609				
1/18/94	10:00		53	90	1346	143	55	75	6.1	0.14	151	16760				
1/18/94	10:30	59	53	97	1344	144	44	58	6.5	0.20	163	16924				
1/18/94	11:00		52	93	1344	141	44	53	6.2	0.19	155	17079				
1/18/94	11:30	60	53	101	1342	144	44	61	6.7	0.21	169	17248				
1/18/94	12:00		54	94	1345	143	50	58	6.3	0.18	157	17405				
1/18/94	12:30	61	53	98	1343	143	44	58	6.5	0.20	164	17569				
1/18/94	13:00		51	99	1339	142	47	55	6.6	0.19	166	17734				
1/18/94	13:30	62	52	102	1354	143	47	58	6.9	0.20	172	17906				
1/18/94	14:00		52	98	1354	144	47	58	6.6	0.19	165	18071				
1/18/94	14:30	63	53	94	1361	143	47	58	6.3	0.18	158	18228				
1/18/94	15:00		54	97	1365	144	47	58	6.5	0.19	163	18391				
1/18/94	15:30	64	47	87	1334	139	50	55	5.9	0.15	146	18537				
1/18/94	16:00		48	96	1291	141	50	58	6.3	0.16	160	18697				
1/18/94	16:30	65	47	95	1296	140	47	55	6.3	0.17	160	18857				
1/18/94	17:00		46	99	1289	140	44	53	6.6	0.20	167	19024				
1/18/94	17:30	66	45	74	1287	131	44	55	5.2	0.14	124	19148				
1/18/94	18:00		46	87	1285	131	44	55	6.1	0.17	145	19293				
1/18/94	18:30	67	46	94	1289	130	44	64	6.6	0.20	157	19450				
1/18/94	19:00		46	90	1291	132	44	55	6.3	0.18	150	19600				
1/18/94	19:30	68	46	92	1289	131	44	55	6.4	0.19	154	19754				
1/18/94	20:00		46	93	1278	131	44	55	6.5	0.19	155	19909				
1/18/94	20:30	69	45	86	1284	130	44	55	6.1	0.17	145	20054				
1/18/94	21:00		47	96	1285	131	44	55	6.7	0.21	162	20216				
1/18/94	21:30	70	50	90	1308	133	44	58	6.3	0.19	151	20367				
1/18/94	22:00		51	91	1332	134	44	58	6.4	0.19	153	20520				
1/18/94	22:30	71	53	96	1347	134	44	58	6.8	0.21	161	20681				
1/18/94	23:00		52	98	1360	135	44	55	7.0	0.22	164	20845				
1/18/94	23:30	72	53	95	1360	134	44	55	6.8	0.21	159	21004				

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data

DATE	TIME	HRS	MW ₀	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀	ASH FILTERED LB		
1/19/94	0:00		50	97	1351	134	44	55	6.9	0.22	162	21167	
1/19/94	0:30	73	51	91	1347	133	42	55	6.5	0.22	153	21320	
1/19/94	1:00		50	96	1342	134	44	61	6.8	0.21	161	21481	
1/19/94	1:30	74	54	97	1367	135	44	55	6.9	0.22	163	21645	
1/19/94	2:00		52	92	1363	135	44	55	6.5	0.20	154	21799	
1/19/94	2:30	75	52	85	1356	134	44	55	6.1	0.18	142	21941	
1/19/94	3:00		53	82	1353	133	44	55	5.9	0.17	137	22078	
1/19/94	3:30	76	51	94	1351	133	44	55	6.7	0.21	157	22236	
1/19/94	4:00		52	93	1352	134	44	55	6.6	0.20	156	22392	
1/19/94	4:30	77	53	91	1354	134	44	55	6.5	0.20	153	22545	
1/19/94	5:00		53	91	1350	134	44	55	6.4	0.19	152	22697	
1/19/94	5:30	78	52	92	1343	134	44	55	6.5	0.20	155	22852	
1/19/94	6:00		53	92	1339	134	44	64	6.5	0.20	154	23005	
1/19/94	6:30	79	52	96	1339	134	44	55	6.8	0.21	160	23166	
1/19/94	7:00		51	94	1342	134	44	55	6.6	0.20	157	23323	
1/19/94	7:30	80	52	94	1340	134	44	55	6.6	0.20	158	23480	
1/19/94	8:00		53	94	1347	134	44	55	6.7	0.21	158	23638	
1/19/94	8:30	81	50	90	1341	133	44	64	6.4	0.19	151	23789	
1/19/94	9:00		51	95	1330	134	47	55	6.7	0.19	159	23948	
1/19/94	9:30	82	53	93	1338	134	47	55	6.5	0.18	155	24103	
1/19/94	10:00		52	92	1344	134	50	58	6.5	0.17	154	24257	
1/19/94	10:30	83	52	96	1333	133	47	58	6.8	0.19	160	24417	
1/19/94	11:00		53	94	1347	134	47	66	6.6	0.19	157	24574	
1/19/94	11:30	84	54	95	1362	134	47	58	6.8	0.20	159	24734	
1/19/94	12:00		52	96	1353	134	47	55	6.9	0.20	161	24895	
1/19/94	12:30	85	52	95	1349	133	47	58	6.8	0.19	159	25054	
1/19/94	13:00		53	97	1349	134	47	58	6.9	0.20	162	25216	
1/19/94	13:30	86	51	97	1350	133	47	58	7.0	0.20	163	25378	
1/19/94	14:00		51	90	1344	133	47	55	6.4	0.18	151	25530	
1/19/94	14:30	87	52	94	1333	133	47	58	6.6	0.19	157	25687	
1/19/94	15:00		51	95	1337	133	47	58	6.8	0.19	160	25847	
1/19/94	15:30	88	51	91	1337	132	47	58	6.5	0.18	152	25999	
1/19/94	16:00		51	93	1334	132	53	58	6.7	0.16	156	26156	
1/19/94	16:30	89	50	96	1340	131	44	58	6.9	0.22	160	26316	
1/19/94	17:00		53	94	1340	133	47	61	6.7	0.19	158	26474	
1/19/94	17:30	90	51	93	1328	131	47	55	6.6	0.19	155	26629	
1/19/94	18:00		51	94	1333	132	47	58	6.7	0.19	158	26787	
1/19/94	18:30	91	51	91	1337	130	47	58	6.5	0.18	152	26939	
1/19/94	19:00		52	93	1325	133	47	61	6.6	0.19	156	27095	
1/19/94	19:30	92	51	87	1327	130	47	61	6.3	0.17	146	27241	
1/19/94	20:00		52	90	1315	132	47	61	6.4	0.18	151	27392	
1/19/94	20:30	93	53	92	1323	132	47	61	6.6	0.18	155	27547	
1/19/94	21:00		52	93	1328	133	50	61	6.6	0.17	155	27703	
1/19/94	21:30	94	51	88	1341	132	50	61	6.3	0.16	148	27851	
1/19/94	22:00		52	95	1340	133	47	58	6.8	0.20	160	28010	
1/19/94	22:30	95	52	92	1337	132	55	61	6.6	0.15	154	28164	
1/19/94	23:00		52	94	1329	132	50	61	6.6	0.17	157	28321	
1/19/94	23:30	96	50	89	1326	131	50	61	6.4	0.16	149	28471	

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													
DATE	TIME	HRS	MW _o	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K _o	ASH FILTERED LB		
1/20/94	0:00		52	94	1322	132	50	61	6.6	0.17	157	28628	
1/20/94	0:30	97	51	88	1317	131	55	61	6.2	0.14	147	28775	
1/20/94	1:00		51	96	1306	132	50	61	6.7	0.18	160	28935	
1/20/94	1:30	98	51	84	1300	131	50	61	5.9	0.15	141	29076	
1/20/94	2:00		51	94	1312	132	50	61	6.6	0.17	158	29233	
1/20/94	2:30	99	51	83	1314	131	50	61	5.9	0.15	140	29373	
1/20/94	3:00		52	93	1314	132	50	58	6.6	0.17	156	29529	
1/20/94	3:30	100	51	86	1324	132	50	58	6.1	0.15	145	29674	
1/20/94	4:00		51	92	1329	133	50	55	6.5	0.17	155	29829	
1/20/94	4:30	101	51	93	1333	132	50	55	6.6	0.17	156	29985	
1/20/94	5:00		52	94	1339	133	50	53	6.7	0.18	157	30142	
1/20/94	5:30	102	51	88	1338	132	50	55	6.3	0.16	147	30289	
1/20/94	6:00		53	91	1343	133	50	55	6.5	0.17	153	30442	
1/20/94	6:30	103	50	83	1334	132	50	55	6.0	0.15	140	30582	
1/20/94	7:00		51	91	1331	132	50	55	6.5	0.17	153	30735	
1/20/94	7:30	104	52	84	1328	131	50	55	6.0	0.15	140	30875	
1/20/94	8:00		53	90	1334	132	50	64	6.4	0.17	151	31026	
1/20/94	8:30	105	53	85	1334	132	50	58	6.1	0.15	143	31169	
1/20/94	9:00		52	92	1344	132	50	61	6.6	0.17	155	31323	
1/20/94	9:30	106	48	88	1313	130	50	58	6.3	0.16	148	31471	
1/20/94	10:00		49	90	1297	130	50	61	6.3	0.16	150	31621	
1/20/94	10:30	107	50	89	1297	130	50	58	6.3	0.16	149	31771	
1/20/94	11:00		48	95	1301	130	50	66	6.8	0.18	160	31930	
1/20/94	11:30	108	49	87	1309	129	50	64	6.3	0.16	146	32077	
1/20/94	12:00		49	94	1302	128	50	58	6.8	0.18	158	32235	
1/20/94	12:30	109	50	85	1295	127	50	61	6.1	0.15	142	32377	
1/20/94	13:00		49	93	1304	128	50	64	6.7	0.18	157	32534	
1/20/94	13:30	110	49	92	1304	128	47	64	6.7	0.19	154	32687	
1/20/94	14:00		49	92	1301	127	50	64	6.7	0.17	155	32842	
1/20/94	14:30	111	49	92	1310	127	47	64	6.7	0.19	154	32996	
1/20/94	15:00		48	89	1313	126	47	66	6.6	0.18	150	33146	
1/20/94	15:30	112	49	88	1306	126	47	64	6.4	0.17	147	33293	
1/20/94	16:00		49	78	1303	125	47	61	5.7	0.15	130	33423	
1/20/94	16:30	113	48	87	1295	125	47	61	6.3	0.17	145	33568	
1/20/94	17:00		49	89	1313	127	47	64	6.5	0.18	149	33717	
1/20/94	17:30	114	49	83	1320	125	47	64	6.2	0.17	140	33857	
1/20/94	18:00		48	88	1305	125	44	61	6.4	0.19	147	34003	
1/20/94	18:30	115	48	80	1315	125	44	61	5.9	0.17	133	34137	
1/20/94	19:00		49	93	1317	126	44	64	6.8	0.21	156	34292	
1/20/94	19:30	116	49	84	1317	125	44	69	6.3	0.18	141	34434	
1/20/94	20:00		49	88	1326	126	47	61	6.5	0.18	147	34581	
1/20/94	20:30	117	48	85	1317	125	44	61	6.3	0.18	142	34723	
1/20/94	21:00		48	91	1319	126	44	61	6.7	0.20	152	34875	
1/20/94	21:30	118	48	81	1334	125	44	61	6.0	0.17	135	35010	
1/20/94	22:00		49	94	1330	126	44	58	6.9	0.22	157	35167	
1/20/94	22:30	119	47	83	1331	125	44	61	6.2	0.18	138	35305	
1/20/94	23:00		49	89	1322	126	44	58	6.6	0.20	150	35455	
1/20/94	23:30	120	49	83	1315	125	44	58	6.2	0.18	140	35595	

E-10

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													
DATE	TIME	HRS	MW ₀	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀	ASH FILTERED LB		
1/21/94	0:00		47	93	1311	126	44	58	6.8	0.21	155	35751	
1/21/94	0:30	121	49	89	1313	126	44	58	6.6	0.20	150	35901	
1/21/94	1:00		48	92	1328	128	44	61	6.8	0.21	154	36054	
1/21/94	1:30	122	49	85	1327	125	44	61	6.3	0.19	143	36197	
1/21/94	2:00		48	91	1339	127	47	58	6.8	0.19	153	36351	
1/21/94	2:30	123	48	88	1343	126	44	61	6.4	0.19	144	36495	
1/21/94	3:00		49	93	1349	127	44	61	6.9	0.21	155	36650	
1/21/94	3:30	124	48	83	1352	127	47	61	6.2	0.17	140	36798	
1/21/94	4:00		49	92	1326	127	47	64	6.8	0.19	155	36945	
1/21/94	4:30	125	48	77	1333	126	47	66	5.8	0.15	130	37074	
1/21/94	5:00		48	85	1354	127	47	61	6.3	0.17	142	37217	
1/21/94	5:30	126	48	81	1372	127	50	61	6.1	0.15	136	37353	
1/21/94	6:00		50	91	1366	128	50	61	6.8	0.18	153	37505	
1/21/94	6:30	127	48	79	1368	126	50	69	6.0	0.15	133	37638	
1/21/94	7:00		50	92	1373	128	50	61	6.9	0.18	154	37793	
1/21/94	7:30	128	49	86	1360	127	50	61	6.5	0.17	144	37937	
1/21/94	8:00		46	91	1358	128	50	58	6.8	0.18	153	38090	
1/21/94	8:30	129	48	79	1360	128	50	66	5.9	0.15	132	38221	
1/21/94	9:00		48	82	1364	127	53	72	6.2	0.15	138	38359	
1/21/94	9:30	130	48	89	1353	125	53	72	6.7	0.17	150	38509	
1/21/94	10:00		48	90	1342	126	53	72	6.7	0.17	152	38660	
1/21/94	10:30	131	47	83	1333	125	50	69	6.2	0.15	139	38799	
1/21/94	11:00		48	93	1322	126	47	72	6.8	0.19	156	38955	
1/21/94	11:30	132	47	82	1300	124	53	55	6.1	0.14	137	39092	
1/21/94	12:00		47	92	1307	124	47	64	6.8	0.19	155	39246	
1/21/94	12:30	133	47	76	1313	123	50	64	5.7	0.14	127	39373	
1/21/94	13:00		48	89	1313	124	50	61	6.7	0.17	150	39523	
1/21/94	13:30	134	47	85	1311	123	50	64	6.4	0.16	142	39665	
1/21/94	14:00		46	91	1312	123	50	61	6.9	0.18	153	39818	
1/21/94	14:30	135	48	79	1343	122	50	64	6.0	0.15	132	39950	
1/21/94	15:00		48	90	1359	124	50	64	6.9	0.18	151	40101	
1/21/94	15:30	136	48	77	1369	123	50	66	5.9	0.15	129	40230	
1/21/94	16:00		49	92	1362	123	50	66	7.1	0.19	154	40384	
1/21/94	16:30	137	48	88	1365	122	53	64	6.8	0.17	147	40531	
1/21/94	17:00		49	79	1385	123	55	66	6.2	0.14	132	40683	
1/21/94	17:30	138	47	99	1373	121	53	66	7.0	0.17	149	40812	
1/21/94	18:00		50	87	1364	122	53	66	6.8	0.17	146	40958	
1/21/94	18:30	139	49	75	1368	122	55	75	5.8	0.13	126	41083	
1/21/94	19:00		48	88	1348	122	50	66	6.8	0.18	147	41231	
1/21/94	19:30	140	50	85	1346	122	53	69	6.6	0.16	143	41374	
1/21/94	20:00		48	84	1353	121	53	66	6.6	0.16	142	41516	
1/21/94	20:30	141	48	88	1343	122	53	66	6.7	0.16	147	41663	
1/21/94	21:00		48	77	1350	122	53	75	5.9	0.14	128	41791	
1/21/94	21:30	142	48	91	1328	121	53	66	7.0	0.17	152	41943	
1/21/94	22:00		48	88	1326	122	50	66	6.7	0.17	147	42090	
1/21/94	22:30	143	49	91	1320	122	50	66	6.9	0.18	152	42242	
1/21/94	23:00		48	91	1334	121	50	66	7.0	0.19	153	42395	
1/21/94	23:30	144	49	83	1340	123	50	75	6.3	0.16	139	42534	

E-11

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW ₀	FLOW* KPPH	T DEG F	P PSIG	BASELINE DP (t ₀) IN WG		FACE VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB					
1/22/94	0:00		49	86	1347	132	50	75	6.2	0.16	145	42679				
1/22/94	0:30	145	51	93	1340	134	50	66	6.6	0.17	156	42835				
1/22/94	1:00		56	86	1326	133	50	64	6.1	0.15	145	42979				
1/22/94	1:30	146	47	94	1312	132	50	64	6.6	0.17	157	43136				
1/22/94	2:00		49	88	1304	131	50	64	6.2	0.16	148	43284				
1/22/94	2:30	147	47	96	1284	131	50	64	6.7	0.17	161	43445				
1/22/94	3:00		47	100	1279	131	50	64	7.0	0.19	168	43614				
1/22/94	3:30	148	48	100	1280	132	50	64	7.6	0.19	168	43782				
1/22/94	4:00		48	95	1278	131	50	64	6.6	0.17	159	43941				
1/22/94	4:30	149	47	98	1285	132	50	66	6.8	0.18	164	44165				
1/22/94	5:00		47	96	1285	131	50	64	6.7	0.17	161	44266				
1/22/94	5:30	150	47	97	1287	131	50	64	6.8	0.18	162	44428				
1/22/94	6:00		47	96	1284	131	50	64	6.7	0.17	160	44589				
1/22/94	6:30	151	47	92	1290	132	50	64	6.4	0.16	153	44742				
1/22/94	7:00		47	87	1292	131	55	64	6.1	0.13	145	44887				
1/22/94	7:30	152	48	96	1292	132	50	64	6.7	0.18	161	45049				
1/22/94	8:00		47	99	1292	131	50	64	6.9	0.19	166	45215				
1/22/94	8:30	153	48	100	1299	132	50	64	7.0	0.19	168	45383				
1/22/94	9:00		46	85	1310	130	53	66	6.1	0.14	143	45525				
1/22/94	9:30	154	48	97	1293	132	50	61	6.7	0.18	162	45687				
1/22/94	10:00		48	81	1300	131	53	66	5.7	0.13	135	45823				
1/22/94	10:30	155	48	99	1288	132	53	64	6.9	0.17	166	45988				
1/22/94	11:00		48	82	1289	131	53	66	5.7	0.13	137	46126				
1/22/94	11:30	156	48	90	1294	131	53	66	6.3	0.15	151	46276				
1/22/94	12:00		47	86	1290	131	53	66	6.0	0.14	144	46421				
1/22/94	12:30	157	47	96	1289	131	53	66	6.7	0.16	161	46582				
1/22/94	13:00		47	92	1289	131	53	75	6.5	0.16	155	46737				
1/22/94	13:30	158	48	98	1293	131	50	64	6.9	0.18	164	46901				
1/22/94	14:00		47	87	1293	131	53	64	6.1	0.14	146	47047				
1/22/94	14:30	159	47	95	1296	132	53	66	6.6	0.16	159	47206				
1/22/94	15:00		47	91	1300	131	53	64	6.4	0.15	152	47358				
1/22/94	15:30	160	48	98	1304	132	50	64	6.9	0.18	164	47523				
1/22/94	16:00		47	88	1300	131	50	64	6.2	0.16	147	47670				
1/22/94	16:30	161	47	81	1311	130	50	64	5.8	0.14	136	47806				
1/22/94	17:00		46	88	1300	131	50	69	6.2	0.16	148	47954				
1/22/94	17:30	162	46	83	1320	131	47	64	5.9	0.16	139	48093				
1/22/94	18:00		46	88	1297	131	50	61	6.2	0.16	148	48241				
1/22/94	18:30	163	48	94	1302	132	50	64	6.6	0.17	157	48398				
1/22/94	19:00		46	79	1306	130	47	64	5.6	0.15	133	48530				
1/22/94	19:30	164	46	89	1286	131	47	69	6.2	0.17	149	48680				
1/22/94	20:00		46	81	1291	129	47	61	5.7	0.15	135	48815				
1/22/94	20:30	165	47	95	1277	132	50	61	6.6	0.17	160	48975				
1/22/94	21:00		47	85	1288	131	50	61	6.0	0.15	143	49118				
1/22/94	21:30	166	46	94	1292	130	47	61	6.7	0.19	158	49276				
1/22/94	22:00		45	86	1281	130	50	61	6.0	0.15	144	49420				
1/22/94	22:30	167	45	88	1283	130	47	61	6.2	0.17	148	49568				
1/22/94	23:00		46	79	1282	130	50	61	5.5	0.13	133	49701				
1/22/94	23:30	168	46	89	1289	132	50	61	6.2	0.16	150	49851				

E-12

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													
DATE	TIME	HRS	MW _e	FLOW _e			BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS
				T	P	DP (ts) IN WG	TRIGGER IN WG						
1/23/94	0:00		46	86	1292	132	50	61	6.0	0.15	144	49994	
1/23/94	0:30	169	46	92	1289	131	50	64	6.5	0.17	155	50149	
1/23/94	1:00		47	84	1284	132	50	61	5.8	0.14	141	50290	
1/23/94	1:30	170	47	94	1292	132	50	66	6.6	0.17	158	50448	
1/23/94	2:00		47	87	1294	132	50	69	6.1	0.15	145	50593	
1/23/94	2:30	171	47	93	1290	132	50	64	6.5	0.17	155	50748	
1/23/94	3:00		46	90	1288	132	50	64	6.3	0.16	151	50900	
1/23/94	3:30	172	46	88	1289	132	50	64	6.1	0.15	148	51048	
1/23/94	4:00		47	91	1301	133	50	64	6.3	0.16	153	51200	
1/23/94	4:30	173	47	88	1304	132	50	64	6.2	0.16	148	51348	
1/23/94	5:00		46	96	1293	131	50	64	6.7	0.18	161	51509	
1/23/94	5:30	174	47	83	1295	131	50	64	5.8	0.14	139	51648	
1/23/94	6:00		48	82	1302	132	50	64	5.8	0.14	138	51786	
1/23/94	6:30	175	47	96	1301	132	50	64	6.7	0.18	160	51947	
1/23/94	7:00		47	84	1297	132	50	64	5.9	0.15	141	52088	
1/23/94	7:30	176	46	95	1291	131	50	61	6.6	0.17	158	52246	
1/23/94	8:00		45	90	1288	131	50	64	6.3	0.16	152	52398	
1/23/94	8:30	177	46	96	1282	131	50	64	6.7	0.18	161	52559	
1/23/94	9:00		45	82	1285	131	50	64	5.7	0.14	138	52697	
1/23/94	9:30	178	48	95	1302	133	50	64	6.6	0.17	158	52855	
1/23/94	10:00		47	87	1302	132	50	64	6.1	0.15	145	53001	
1/23/94	10:30	179	48	94	1317	133	50	64	6.6	0.17	158	53159	
1/23/94	11:00		46	91	1330	132	50	61	6.5	0.17	152	53311	
1/23/94	11:30	180	46	95	1322	132	50	61	6.7	0.18	159	53471	
1/23/94	12:00		46	90	1310	131	47	64	6.4	0.18	151	53622	
1/23/94	12:30	181	45	93	1301	132	50	61	6.5	0.17	155	53777	
1/23/94	13:00		46	89	1309	132	50	69	6.3	0.16	149	53927	
1/23/94	13:30	182	47	91	1313	132	50	64	6.4	0.16	152	54079	
1/23/94	14:00		47	84	1321	132	50	64	6.0	0.15	141	54220	
1/23/94	14:30	183	46	90	1325	132	50	64	6.4	0.16	151	54371	
1/23/94	15:00		46	85	1328	132	50	61	6.1	0.15	143	54514	
1/23/94	15:30	184	46	96	1327	132	50	64	6.8	0.18	160	54674	
1/23/94	16:00		47	84	1339	132	50	64	6.1	0.15	142	54816	
1/23/94	16:30	185	47	92	1338	132	50	61	6.6	0.17	155	54971	
1/23/94	17:00		46	83	1343	132	50	64	6.0	0.15	140	55111	
1/23/94	17:30	186	47	94	1333	132	50	64	6.7	0.18	157	55268	
1/23/94	18:00		47	83	1334	131	53	64	6.0	0.14	140	55408	
1/23/94	18:30	187	46	90	1323	132	55	64	6.4	0.15	152	55559	
1/23/94	19:00		47	86	1329	132	53	64	6.2	0.15	145	55704	
1/23/94	19:30	188	46	92	1340	132	53	64	6.6	0.16	154	55858	
1/23/94	20:00		47	81	1342	132	50	64	5.8	0.15	137	55995	
1/23/94	20:30	189	45	96	1337	132	53	64	6.8	0.17	161	56156	
1/23/94	21:00		45	87	1338	131	50	61	6.3	0.16	146	56301	
1/23/94	21:30	190	46	93	1340	133	50	61	6.6	0.17	156	56457	
1/23/94	22:00		46	94	1321	132	50	69	6.7	0.18	158	56615	
1/23/94	22:30	191	45	90	1308	132	50	64	6.3	0.16	150	56766	
1/23/94	23:00		46	84	1306	131	53	64	5.9	0.14	140	56906	
1/23/94	23:30	192	46	94	1305	131	50	64	6.6	0.17	157	57063	

E-13

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													REMARKS
DATE	TIME	HRS	MW	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/KØ	ASH FILTERED LB	TOTAL ASH LB	
							DP(t ₉₀) IN WG	TRIGGER IN WG					
1/24/94	0:00		45	81	1304	131	50	64	5.7	0.14	136	57199	
1/24/94	0:30	193	45	91	1316	132	53	64	6.4	0.16	153	57352	
1/24/94	1:00		45	88	1309	132	53	61	6.2	0.15	147	57499	
1/24/94	1:30	194	46	90	1317	132	53	64	6.4	0.15	152	57651	
1/24/94	2:00		45	84	1312	130	53	69	6.0	0.14	141	57793	
1/24/94	2:30	195	47	86	1304	132	53	61	6.0	0.14	144	57937	
1/24/94	3:00		46	81	1308	132	53	66	5.7	0.13	137	58073	
1/24/94	3:30	196	47	91	1318	133	53	61	6.4	0.16	153	58226	
1/24/94	4:00		45	84	1321	132	53	64	5.9	0.14	140	58367	
1/24/94	4:30	197	45	94	1314	132	53	64	6.6	0.16	158	58524	
1/24/94	5:00		45	86	1328	132	53	64	6.1	0.14	145	58669	
1/24/94	5:30	198	47	90	1333	133	53	66	6.4	0.15	151	58820	
1/24/94	6:00		47	83	1350	132	50	64	6.0	0.15	140	58960	
1/24/94	6:30	199	47	89	1354	132	50	61	6.4	0.16	148	59108	
1/24/94	7:00		47	82	1345	132	53	64	5.9	0.14	138	59247	
1/24/94	7:30	200	46	85	1338	132	53	64	6.1	0.14	142	59389	
1/24/94	8:00		45	83	1331	131	53	64	6.0	0.14	140	59528	
1/24/94	8:30	201	45	87	1323	133	53	66	6.1	0.14	145	59673	
1/24/94	9:00		47	80	1326	133	53	72	5.7	0.13	134	59807	
1/24/94	9:30	202	47	93	1340	133	53	64	6.6	0.16	155	59962	
1/24/94	10:00		47	83	1355	133	53	64	6.0	0.14	140	60102	
1/24/94	10:30	203	45	85	1356	131	55	64	6.2	0.14	142	60244	
1/24/94	11:00		42	72	1316	124	50	64	5.3	0.13	120	60364	
1/24/94	11:30	204	38	59	1264	118	47	58	4.4	0.11	99	60463	
1/24/94	12:00		30	45	1206	106	44	55	3.6	0.09	76	60538	
1/24/94	12:30	205	27	58	1160	103	44	55	4.7	0.11	97	60635	
1/24/94	13:00		24	44	1119	101	44	61	3.5	0.08	73	60709	
1/24/94	13:30	206	20	70	1091	101	42	53	5.4	0.15	117	60826	
1/24/94	14:00		18	42	1047	94	42	50	3.4	0.08	70	60896	
1/24/94	14:30	207	14	68	1006	93	42	50	5.4	0.14	113	61010	
1/24/94	15:00		12	80	971	92	42	47	6.2	0.17	133	61143	
1/24/94	15:30	208	9	90	946	93	39	55	6.9	0.22	151	61294	
1/24/94	16:00		9	88	936	92	39	47	6.7	0.20	147	61441	
1/24/94	16:30	209	9	96	933	92	39	47	7.3	0.24	160	61601	
1/24/94	17:00		8	85	930	92	39	47	6.5	0.19	142	61743	
1/24/94	17:30	210	8	91	942	91	39	44	7.0	0.22	153	61895	
1/24/94	18:00		9	91	939	93	42	47	6.9	0.20	153	62048	
1/24/94	18:30	211	16	95	960	95	42	50	7.2	0.21	159	62207	
1/24/94	19:00		22	93	996	97	42	50	7.1	0.21	156	62363	
1/24/94	19:30	212	27	92	1028	98	42	53	7.1	0.21	154	62517	
1/24/94	20:00		30	93	1059	100	44	53	7.2	0.20	155	62672	
1/24/94	20:30	213	36	89	1110	102	44	58	7.0	0.20	149	62822	
1/24/94	21:00		41	87	1178	105	47	58	7.0	0.19	146	62968	
1/24/94	21:30	214	44	90	1236	107	47	61	7.3	0.20	151	63118	
1/24/94	22:00		48	91	1279	109	47	72	7.5	0.21	152	63271	
1/24/94	22:30	215	48	89	1313	109	47	64	7.4	0.21	149	63419	
1/24/94	23:00		50	88	1338	110	50	64	7.4	0.20	148	63567	
1/24/94	23:30	216	48	92	1341	110	50	64	7.8	0.21	154	63721	

E-14

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW ₀	FLOW ₀ KPPH	T DEG F	P PSIG	BASELINE DP (to) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB					
1/25/94	0:00		51	91	1343	114	50	55	7.5	0.20	153	63874				
1/25/94	0:30	217	50	91	1340	114	50	69	7.4	0.20	153	64026				
1/25/94	1:00		50	88	1333	115	55	66	7.1	0.18	148	64175				
1/25/94	1:30	218	49	87	1328	115	50	64	7.0	0.18	146	64321				
1/25/94	2:00		52	89	1335	115	50	72	7.2	0.19	150	64471				
1/25/94	2:30	219	51	90	1336	116	50	66	7.3	0.19	152	64622				
1/25/94	3:00		50	90	1336	115	50	66	7.3	0.20	152	64774				
1/25/94	3:30	220	51	91	1335	116	50	66	7.3	0.19	152	64926				
1/25/94	4:00		49	88	1342	116	50	66	7.1	0.19	147	65073				
1/25/94	4:30	221	50	85	1358	116	50	72	6.9	0.18	142	65215				
1/25/94	5:00		52	87	1368	116	50	66	7.1	0.19	145	65360				
1/25/94	5:30	222	49	84	1363	115	50	69	6.9	0.18	142	65502				
1/25/94	6:00		50	85	1354	115	50	66	6.9	0.18	142	65644				
1/25/94	6:30	223	49	84	1351	115	50	69	6.9	0.18	141	65785				
1/25/94	7:00		49	82	1341	115	50	75	6.7	0.17	137	65922				
1/25/94	7:30	224	49	82	1333	115	55	66	6.7	0.15	138	66060				
1/25/94	8:00		50	82	1331	115	50	66	6.6	0.17	137	66197				
1/25/94	8:30	225	48	80	1333	114	50	69	6.5	0.16	134	66332				
1/25/94	9:00		49	86	1324	114	53	75	6.9	0.17	143	66475				
1/25/94	9:30	226	48	81	1321	114	53	66	6.5	0.15	136	66611				
1/25/94	10:00		47	83	1305	112	47	64	6.8	0.19	140	66751				
1/25/94	10:30	227	47	84	1282	113	50	64	6.7	0.17	141	66892				
1/25/94	11:00		49	83	1297	114	50	66	6.6	0.17	139	67031				
1/25/94	11:30	228	49	84	1304	114	50	66	6.7	0.17	140	67171				
1/25/94	12:00		47	80	1310	112	50	66	6.5	0.16	134	67305				
1/25/94	12:30	229	47	84	1311	112	50	61	6.9	0.18	141	67446				
1/25/94	13:00		45	85	1309	111	50	69	7.0	0.18	143	67589				
1/25/94	13:30	230	47	83	1316	113	53	69	6.8	0.16	140	67729				
1/25/94	14:00		47	80	1340	113	53	69	6.6	0.16	134	67863				
1/25/94	14:30	231	48	79	1348	114	53	69	6.5	0.15	133	67996				
1/25/94	15:00		49	84	1380	115	53	69	7.0	0.17	141	68137				
1/25/94	15:30	232	48	81	1421	115	53	75	6.9	0.17	136	68273				
1/25/94	16:00		47	88	1449	114	50	66	5.9	0.15	114	68387	* Freeboard fire in PFBC.			
1/25/94	16:30	233	43	75	1396	111	47	66	6.5	0.18	126	68513				
1/25/94	17:00		45	82	1352	112	47	66	6.9	0.19	138	68651				
1/25/94	17:30	234	45	85	1329	111	47	64	7.0	0.20	142	68794				
1/25/94	18:00		46	89	1327	112	47	64	7.3	0.21	148	68942				
1/25/94	18:30	235	47	87	1319	112	47	58	7.1	0.20	146	69088				
1/25/94	19:00		45	86	1319	112	50	64	7.0	0.18	144	69232				
1/25/94	19:30	236	47	84	1335	113	50	66	6.9	0.18	140	69372				
1/25/94	20:00		49	87	1360	114	50	66	7.2	0.19	145	69518				
1/25/94	20:30	237	47	85	1361	113	53	66	7.1	0.18	143	69661				
1/25/94	21:00		46	78	1353	112	50	66	6.5	0.16	131	69791				
1/25/94	21:30	238	44	86	1330	112	50	64	7.1	0.18	144	69935				
1/25/94	22:00		46	85	1321	113	50	66	6.9	0.18	142	70077				
1/25/94	22:30	239	46	84	1319	112	50	64	6.9	0.18	141	70218				
1/25/94	23:00		46	89	1320	113	50	66	7.2	0.19	149	70367				
1/25/94	23:30	240	48	84	1333	113	47	66	6.9	0.19	141	70508				

E-15

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data

DATE	TIME	HRS	MW ₀	FLOW ₀ KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (t ₀) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀	ASH FILTERED LB		
1/26/94	0:00		48	81	1331	114	50	64	6.6	0.17	135	70043	
1/26/94	0:30	241	48	88	1327	113	50	64	7.0	0.18	145	70788	
1/26/94	1:00		49	88	1330	114	50	66	7.2	0.19	147	70935	
1/26/94	1:30	242	48	87	1326	114	50	66	7.0	0.18	145	71080	
1/26/94	2:00		50	86	1331	115	50	66	6.9	0.18	144	71224	
1/26/94	2:30	243	47	84	1328	113	50	64	6.8	0.18	141	71365	
1/26/94	3:00		48	87	1329	114	50	64	7.0	0.18	146	71511	
1/26/94	3:30	244	48	87	1327	114	50	64	7.0	0.18	146	71650	
1/26/94	4:00		48	86	1324	114	50	66	6.9	0.18	144	71801	
1/26/94	4:30	245	47	88	1319	114	53	66	7.1	0.17	147	71948	
1/26/94	5:00		48	89	1311	114	50	61	7.1	0.19	148	72096	
1/26/94	5:30	246	47	87	1314	114	50	66	7.0	0.18	146	72242	
1/26/94	6:00		47	85	1316	114	53	72	6.9	0.16	143	72385	
1/26/94	6:30	247	48	87	1312	114	50	66	7.0	0.18	146	72532	
1/26/94	7:00		47	83	1305	113	50	75	6.7	0.17	139	72671	
1/26/94	7:30	248	47	85	1302	113	53	66	6.8	0.16	142	72813	
1/26/94	8:00		49	88	1302	114	53	66	7.0	0.17	147	72960	
1/26/94	8:30	249	45	76	1294	111	50	66	6.2	0.15	128	73088	
1/26/94	9:00		41	78	1256	109	47	64	6.3	0.16	131	73219	
1/26/94	9:30	250	37	83	1216	108	44	64	6.6	0.19	139	73358	
1/26/94	10:00		29	83	1173	106	47	55	6.6	0.17	139	73497	
1/26/94	10:30	251	29	78	1131	103	44	55	6.2	0.16	131	73628	
1/26/94	11:00		24	36	1094	94	42	53	3.0	0.07	60	73688	
1/26/94	11:30	252	21	45	1069	91	42	50	3.8	0.09	75	73764	
1/26/94	12:00		20	68	1044	90	42	50	5.7	0.15	114	73878	
1/26/94	12:30	253	18	63	1022	89	42	50	5.3	0.13	105	73983	
1/26/94	13:00		15	36	989	86	39	47	3.0	0.07	60	74043	
1/26/94	13:30	254	13	73	956	86	39	55	6.0	0.17	122	74165	
1/26/94	14:00		12	83	936	85	39	47	6.8	0.20	139	74303	
1/26/94	14:30	255	10	82	922	84	39	47	6.7	0.20	137	74440	
1/26/94	15:00		9	86	912	84	39	44	6.9	0.21	144	74584	
1/26/94	15:30	256	10	86	900	84	39	44	7.0	0.21	144	74728	
1/26/94	16:00		9	90	901	84	39	44	7.2	0.23	151	74879	
1/26/94	16:30	257	8	88	894	83	39	44	7.1	0.22	147	75026	
1/26/94	17:00		7	90	892	83	38	44	7.3	0.25	152	75178	
1/26/94	17:30	258	7	85	875	82	39	44	6.8	0.20	142	75320	
1/26/94	18:00		9	89	874	84	39	44	7.0	0.22	149	75469	
1/26/94	18:30	259	9	91	881	84	39	47	7.2	0.23	152	75622	
1/26/94	19:00		11	89	892	84	39	47	7.1	0.22	148	75770	
1/26/94	19:30	260	9	89	896	84	39	47	7.2	0.22	149	75919	
1/26/94	20:00		11	91	902	85	42	53	7.3	0.21	152	76071	
1/26/94	20:30	261	18	88	933	87	42	53	7.0	0.20	148	76219	
1/26/94	21:00		20	92	957	89	42	50	7.3	0.22	153	76373	
1/26/94	21:30	262	21	96	973	98	44	55	7.1	0.20	161	76534	
1/26/94	22:00		24	95	996	102	44	55	6.9	0.19	159	76693	
1/26/94	22:30	263	26	98	1014	103	44	55	7.2	0.20	164	76857	
1/26/94	23:00		28	95	1032	103	44	55	7.0	0.20	159	77016	
1/26/94	23:30	264	31	96	1050	105	47	55	7.1	0.19	161	77178	

E-16

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 16 THRU JANUARY 29, 1994)

* Corrected data													
DATE	TIME	HRS	MW _o	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀	ASH FILTERED LB		
1/27/94	0:00		33	99	1068	105	47	66	7.3	0.20	165	77343	
1/27/94	0:30	265	35	98	1088	106	47	66	7.4	0.20	165	77508	
1/27/94	1:00		38	97	1110	107	47	61	7.3	0.20	163	77671	
1/27/94	1:30	266	41	97	1130	109	47	58	7.3	0.20	162	77833	
1/27/94	2:00		44	98	1159	110	50	64	7.4	0.19	164	77997	
1/27/94	2:30	267	46	97	1183	110	50	64	7.4	0.19	163	78160	
1/27/94	3:00		45	97	1204	111	50	64	7.5	0.20	162	78322	
1/27/94	3:30	268	48	98	1230	112	53	66	7.6	0.19	164	78486	
1/27/94	4:00		51	96	1261	115	53	69	7.5	0.19	162	78648	
1/27/94	4:30	269	52	99	1279	116	55	80	7.7	0.18	166	78814	
1/27/94	5:00		51	92	1282	116	53	69	7.2	0.18	155	78969	
1/27/94	5:30	270	51	96	1279	115	53	69	7.5	0.19	162	79130	
1/27/94	6:00		50	97	1279	115	53	75	7.6	0.19	163	79293	
1/27/94	6:30	271	50	95	1277	115	53	80	7.5	0.19	160	79453	
1/27/94	7:00		50	93	1280	115	53	72	7.3	0.18	157	79610	
1/27/94	7:30	272	50	91	1280	115	53	66	7.1	0.17	152	79762	
1/27/94	8:00		51	96	1288	117	55	75	7.5	0.18	161	79924	
1/27/94	8:30	273	54	96	1317	118	55	75	7.5	0.18	161	80084	
1/27/94	9:00		54	101	1328	130	58	75	7.3	0.16	169	80253	
1/27/94	9:30	274	58	97	1351	130	64	89	7.1	0.14	162	80415	* Tempering air turned on.
1/27/94	10:00		57	105	1316	132	58	77	7.4	0.17	176	80591	
1/27/94	10:30	275	58	106	1313	136	58	77	7.3	0.17	178	80769	
1/27/94	11:00		59	104	1317	138	58	80	7.1	0.16	174	80944	
1/27/94	11:30	276	60	106	1318	140	58	80	7.1	0.16	178	81122	
1/27/94	12:00		59	104	1321	140	58	75	7.0	0.16	174	81296	
1/27/94	12:30	277	60	110	1323	140	61	77	7.4	0.16	185	81481	
1/27/94	13:00		60	108	1325	140	61	83	7.3	0.16	181	81661	
1/27/94	13:30	278	60	110	1325	140	61	89	7.4	0.16	184	81846	
1/27/94	14:00		59	107	1321	140	61	83	7.2	0.16	180	82025	
1/27/94	14:30	279	60	111	1320	140	61	83	7.5	0.16	186	82211	
1/27/94	15:00		59	106	1324	140	61	83	7.1	0.15	178	82389	
1/27/94	15:30	280	59	110	1324	140	61	83	7.4	0.16	184	82573	
1/27/94	16:00		59	109	1325	140	61	83	7.3	0.16	183	82755	
1/27/94	16:30	281	59	112	1329	140	61	83	7.6	0.17	188	82943	
1/27/94	17:00		59	107	1334	140	58	83	7.2	0.17	179	83122	
1/27/94	17:30	282	59	108	1339	140	58	80	7.3	0.17	180	83303	
1/27/94	18:00		59	107	1339	141	61	83	7.2	0.16	179	83482	
1/27/94	18:30	283	59	109	1342	141	61	83	7.4	0.16	183	83665	
1/27/94	19:00		58	101	1344	140	61	80	6.9	0.14	169	83834	
1/27/94	19:30	284	59	108	1351	141	61	80	7.3	0.16	181	84015	
1/27/94	20:00		59	107	1349	142	61	86	7.3	0.16	180	84195	
1/27/94	20:30	285	59	103	1349	141	61	80	7.0	0.15	173	84368	
1/27/94	21:00		59	105	1349	141	69	80	7.1	0.13	177	84545	
1/27/94	21:30	286	59	107	1347	141	58	80	7.2	0.17	179	84724	
1/27/94	22:00		59	105	1341	141	61	80	7.1	0.15	177	84900	
1/27/94	22:30	287	58	102	1344	141	61	80	6.9	0.15	172	85072	
1/27/94	23:00		59	107	1341	141	58	80	7.3	0.17	180	85252	
1/27/94	23:30	288	57	108	1336	140	61	80	7.3	0.16	180	85432	

E-17

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data

DATE	TIME	MRS	MW _o	FLOW _o KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/KØ	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG					
1/28/94	0:00		58	110	1332	141	61	80	7.4	0.16	184	85616	
1/28/94	0:30	289	58	107	1333	140	61	80	7.2	0.16	179	85795	
1/28/94	1:00		58	105	1338	140	61	80	7.1	0.15	176	85971	
1/28/94	1:30	290	58	101	1341	140	60	80	6.8	0.12	169	86149	
1/28/94	2:00		58	100	1340	141	61	80	7.3	0.16	181	86322	
1/28/94	2:30	291	58	100	1342	141	60	80	7.3	0.14	182	86503	
1/28/94	3:00		58	100	1345	141	61	80	7.3	0.16	181	86685	
1/28/94	3:30	292	57	100	1346	140	61	80	7.2	0.15	177	86862	
1/28/94	4:00		58	104	1345	141	61	72	7.0	0.15	175	87036	
1/28/94	4:30	293	58	105	1354	141	58	77	7.1	0.16	176	87213	
1/28/94	5:00		59	100	1356	144	61	77	7.2	0.16	181	87393	
1/28/94	5:30	294	59	100	1346	144	61	77	7.2	0.16	180	87574	
1/28/94	6:00		59	100	1346	145	61	77	7.1	0.16	181	87755	
1/28/94	6:30	295	60	100	1348	144	61	80	7.0	0.15	177	87932	
1/28/94	7:00		59	111	1349	145	61	77	7.3	0.16	185	88117	
1/28/94	7:30	296	59	100	1351	145	61	77	7.0	0.15	178	88295	
1/28/94	8:00		59	112	1339	144	60	77	7.4	0.15	188	88483	
1/28/94	8:30	297	60	111	1325	147	61	77	7.1	0.15	186	88668	
1/28/94	9:00		59	115	1320	147	61	75	7.4	0.16	192	88860	
1/28/94	9:30	298	59	109	1318	146	61	75	7.0	0.15	182	89043	
1/28/94	10:00		59	100	1318	145	61	75	7.0	0.15	181	89223	
1/28/94	10:30	299	59	104	1317	145	61	75	6.8	0.14	175	89398	
1/28/94	11:00		59	109	1311	146	61	75	7.0	0.15	183	89581	
1/28/94	11:30	300	59	109	1311	145	61	77	7.1	0.15	183	89764	
1/28/94	12:00		59	102	1313	145	61	77	6.6	0.14	170	89935	
1/28/94	12:30	301	58	112	1313	145	61	77	7.2	0.16	187	90122	
1/28/94	13:00		60	112	1312	146	61	77	7.3	0.16	188	90310	
1/28/94	13:30	302	59	109	1309	145	61	77	7.1	0.15	183	90493	
1/28/94	14:00		58	111	1307	145	60	86	7.2	0.13	186	90680	
1/28/94	14:30	303	58	109	1306	144	61	77	7.0	0.15	182	90862	
1/28/94	15:00		58	109	1305	144	61	77	7.1	0.15	183	91045	
1/28/94	15:30	304	58	106	1302	144	61	75	6.9	0.15	179	91224	
1/28/94	16:00		57	100	1301	145	61	77	7.0	0.15	182	91406	
1/28/94	16:30	305	58	100	1302	144	61	77	7.0	0.15	181	91587	
1/28/94	17:00		58	110	1305	145	61	75	7.1	0.15	184	91771	
1/28/94	17:30	306	57	107	1305	144	61	75	6.9	0.15	180	91950	
1/28/94	18:00		56	100	1304	144	61	75	7.0	0.15	181	92131	
1/28/94	18:30	307	58	107	1310	144	61	72	7.0	0.15	180	92311	
1/28/94	19:00		56	105	1311	145	64	75	6.8	0.13	176	92486	
1/28/94	19:30	308	57	111	1319	144	58	72	7.2	0.17	186	92672	
1/28/94	20:00		58	100	1318	145	58	72	7.0	0.16	182	92853	
1/28/94	20:30	309	56	109	1322	145	58	75	7.1	0.16	182	93036	
1/28/94	21:00		56	106	1329	144	58	72	7.0	0.16	178	93214	
1/28/94	21:30	310	54	113	1326	143	58	69	7.5	0.18	196	93404	
1/28/94	22:00		53	104	1324	142	58	72	6.9	0.15	174	93578	
1/28/94	22:30	311	52	107	1319	139	64	80	7.2	0.15	179	93757	
1/28/94	23:00		51	102	1318	138	58	72	6.9	0.15	171	93928	
1/28/94	23:30	312	52	103	1315	137	58	66	7.0	0.16	173	94100	

E-18

TABLE 2 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 13 (JANUARY 15 THRU JANUARY 29, 1994)

* Corrected data													RELATIVE	
DATE	TIME	HRS	MNO	FLOW ^a KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/KØ	ASH FILTERED LB	TOTAL ASH LB	REMARKS	
							DP (ts) IN WG	TRIGGER IN WG						
1/29/94	0:00		49	102	1311	136	58	66	7.0	0.15	170	94271		
1/29/94	0:30	313	50	104	1290	136	55	69	7.1	0.17	175	94445		
1/29/94	1:00		48	102	1284	136	55	69	6.9	0.16	171	94616		
1/29/94	1:30	314	47	97	1261	133	58	66	6.6	0.14	162	94779		
1/29/94	2:00		47	100	1267	133	55	69	7.2	0.17	178	94957		
1/29/94	2:30	315	47	107	1274	133	55	66	7.3	0.17	179	95136		
1/29/94	3:00		48	100	1280	133	55	69	6.8	0.16	167	95303		
1/29/94	3:30	316	48	103	1278	134	55	69	7.1	0.17	173	95476		
1/29/94	4:00		48	101	1270	134	55	69	6.9	0.16	169	95646		
1/29/94	4:30	317	48	103	1275	133	58	69	7.0	0.15	172	95818		
1/29/94	5:00		50	101	1292	134	55	69	7.0	0.16	170	95988		
1/29/94	5:30	318	49	100	1294	134	55	66	7.3	0.17	177	96165		
1/29/94	6:00		49	100	1283	134	55	66	6.9	0.16	168	96332		
1/29/94	6:30	319	48	98	1279	132	55	66	6.8	0.16	164	96496		
1/29/94	7:00		48	101	1270	133	61	69	6.9	0.14	169	96666		
1/29/94	7:30	320	47	100	1252	132	58	69	7.2	0.16	177	96843		
1/29/94	8:00		48	101	1245	133	58	77	6.8	0.15	169	97012		
1/29/94	8:30	321	48	105	1239	132	61	69	7.1	0.15	176	97189		
1/29/94	9:00		48	103	1236	132	58	69	7.0	0.15	173	97362		
1/29/94	9:30	322	47	103	1233	132	58	72	6.9	0.15	173	97535		
1/29/94	10:00		48	102	1232	133	58	72	6.9	0.15	172	97707		
1/29/94	10:30	323	47	98	1230	132	55	69	6.6	0.15	165	97872		
1/29/94	11:00		48	103	1226	133	58	72	6.9	0.15	173	98045		
1/29/94	11:30	324	49	105	1260	133	58	72	7.2	0.16	176	98221		
1/29/94	12:00		47	99	1281	133	58	75	6.8	0.15	165	98388		
1/29/94	12:30	325	47	101	1284	132	58	72	7.0	0.15	170	98556		
1/29/94	13:00		48	101	1285	132	58	72	7.0	0.15	169	98725		
1/29/94	13:30	326	48	98	1279	132	58	69	6.8	0.15	164	98889		
1/29/94	14:00		47	98	1275	133	58	72	6.8	0.15	165	99053		
1/29/94	14:30	327	43	101	1269	132	58	80	7.0	0.15	170	99223		
1/29/94	15:00		43	98	1268	132	58	72	6.8	0.15	165	99388		
1/29/94	15:30	328	43	101	1265	133	58	72	6.9	0.15	169	99557		
1/29/94	16:00		46	99	1265	132	58	72	6.8	0.15	166	99723		
1/29/94	16:30	329	49	100	1263	133	61	80	6.8	0.14	168	99891		
1/29/94	17:00		48	101	1262	133	61	75	6.9	0.14	169	100059		
1/29/94	17:30	330	48	97	1261	133	61	75	6.6	0.13	162	100221		
1/29/94	18:00		48	94	1263	133	61	72	6.4	0.13	157	100379		
1/29/94	18:30	331	47	98	1260	133	58	80	6.7	0.14	164	100543		
1/29/94	19:00		48	96	1259	133	61	75	6.5	0.13	161	100704		
1/29/94	19:30	332	49	99	1263	134	61	72	6.7	0.14	166	100870		
1/29/94	20:00		49	98	1269	138	61	75	6.5	0.13	164	101034		
1/29/94	20:30	333	49	90	1281	139	42	75	6.0	0.19	152	101186	* 20:31 Combustor trip due to overheated evaporator tube.	

E-19

TABLE 3 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 14 (FEBRUARY 17 THRU FEBRUARY 18, 1994)

* Corrected data

DATE	TIME	HRS	MW ₀	FLOW			BASELINE		FACE	RELATIVE		TOTAL ASH LB	REMARKS
				T DEG F	P PSIG	DP (ts) IN WG	TRIGGER IN WG	VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB			
2/17/94	14:30		-3	59	715	36	19	22	7.9	0.54			
2/17/94	15:00	0	-2	63	732	36			8.5	-			* 14:58 coal fire.
2/17/94	15:30		2	68	863	47	30	42	8.5	0.35	113		
2/17/94	16:00	1	5	83	945	70	30	42	7.5	0.34	140	253	
2/17/94	16:30		7	86	958	83	33	42	7.2	0.29	144	397	
2/17/94	17:00	2	10	88	968	84	33	50	7.4	0.30	147	544	
2/17/94	17:30		10	93	983	84	33	44	7.9	0.35	156	761	
2/17/94	18:00	3	13	89	978	85	36	47	7.5	0.27	149	850	
2/17/94	18:30		14	89	985	85	36	47	7.5	0.27	148	998	
2/17/94	19:00	4	15	89	993	85	36	47	7.6	0.28	150	1148	
2/17/94	19:30		16	90	999	86	36	55	7.6	0.28	151	1299	
2/17/94	20:00	5	16	93	1007	88	36	53	7.7	0.30	156	1454	
2/17/94	20:30		15	92	1018	90	39	53	7.6	0.26	155	1609	
2/17/94	21:00	6	20	91	1034	91	39	53	7.5	0.26	152	1762	
2/17/94	21:30		20	92	1049	91	42	53	7.6	0.24	154	1915	
2/17/94	22:00	7	22	89	1061	92	39	61	7.4	0.25	149	2065	
2/17/94	22:30		23	98	1073	104	42	58	7.4	0.24	164	2228	
2/17/94	23:00	8	25	101	1085	105	42	58	7.6	0.25	170	2398	
2/17/94	23:30		25	96	1097	105	44	58	7.3	0.21	161	2559	

TABLE 3 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 14 (FEBRUARY 17 THRU FEBRUARY 18, 1994)

* Corrected data													REMARKS
DATE	TIME	HRS	MW _e	FLOW _a KPPH	T DEG F	P PSIG	BASELINE		FACE	RELATIVE		TOTAL	
							DP (ts) IN WG	TRIGGER IN WG	VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB	ASH LB	
2/18/94	0:00	9	30	100	1104	100	42	58	7.0	0.25	167	2726	
2/18/94	0:30		31	100	1113	100	42	58	7.0	0.25	168	2894	
2/18/94	1:00	10	30	76	1118	103	42	58	6.9	0.17	127	3021	
2/18/94	1:30		31	99	1118	100	42	56	7.5	0.25	165	3100	
2/18/94	2:00	11	32	98	1124	100	42	60	7.5	0.25	165	3351	
2/18/94	2:30		34	94	1135	107	42	55	7.2	0.23	158	3500	
2/18/94	3:00	12	30	97	1152	100	44	60	7.4	0.22	163	3671	
2/18/94	3:30		39	104	1172	109	47	72	8.0	0.24	175	3846	
2/18/94	4:00	13	42	89	1199	110	47	75	6.9	0.19	149	3995	
2/18/94	4:30		43	97	1220	111	50	72	7.5	0.20	162	4157	
2/18/94	5:00	14	48	99	1252	118	50	83	7.5	0.20	167	4324	
2/18/94	5:30		50	100	1273	128	53	69	7.7	0.20	181	4505	
2/18/94	6:00	15	54	111	1294	133	64	75	7.7	0.16	186	4691	
2/18/94	6:30		50	115	1269	133	53	75	7.8	0.21	192	4882	
2/18/94	7:00	16	54	112	1280	134	58	75	7.7	0.18	188	5071	
2/18/94	7:30		54	113	1286	135	55	75	7.6	0.19	189	5260	
2/18/94	8:00	17	55	110	1302	135	58	72	7.6	0.18	185	5444	
2/18/94	8:30		55	106	1301	134	55	75	7.4	0.18	178	5623	
2/18/94	9:00	18	53	107	1294	134	55	72	7.4	0.18	180	5803	
2/18/94	9:30		50	107	1278	133	58	75	7.3	0.17	180	5983	
2/18/94	10:00	19	50	106	1273	132	64	77	7.3	0.15	178	6161	
2/18/94	10:30		50	107	1273	133	64	80	7.3	0.15	179	6340	
2/18/94	11:00	20	49	109	1270	133	55	86	7.5	0.18	183	6523	
2/18/94	11:30		50	109	1271	134	58	75	7.4	0.17	182	6706	* 11:37 Combustor trip
2/18/94	12:00	21	36	87	1193	127	50	61	6.0	0.14	147	6852	

E-21

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data										RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW%	FLOW* KPPH	T DEG F	P PSIG	BASELINE DP (ts) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/K ²	ASH FILTERED LB		
2/19/94	6:00		-2	47	727	48	19	22	6.8	0.33			
2/19/94	6:30	0	1	59	800	48	28	33	6.9	0.28			* 06:15 coal fire.
2/19/94	7:00		4	71	981	66	36	44	6.9	0.27	119		
2/19/94	7:30	1	5	79	931	80	33	44	6.8	0.25	133	252	
2/19/94	8:00		8	77	972	85	33	44	6.5	0.24	130	382	
2/19/94	8:30	2	12	76	1016	86	36	47	6.5	0.22	128	510	
2/19/94	9:00		11	89	1084	101	39	53	7.0	0.23	149	660	
2/19/94	9:30	3	30	84	1140	105	42	55	6.6	0.20	142	801	
2/19/94	10:00		34	94	1172	113	42	53	7.0	0.22	158	959	
2/19/94	10:30	4	38	99	1185	124	44	61	6.9	0.20	166	1120	
2/19/94	11:00		39	101	1203	125	47	58	7.0	0.20	169	1294	
2/19/94	11:30	5	41	102	1217	126	47	58	7.1	0.20	171	1465	
2/19/94	12:00		43	99	1227	126	47	66	6.9	0.19	165	1630	
2/19/94	12:30	6	45	98	1236	127	58	66	6.9	0.15	164	1795	
2/19/94	13:00		45	85	1256	127	50	72	6.0	0.15	143	1937	
2/19/94	13:30	7	46	86	1265	127	50	66	6.2	0.15	145	2082	
2/19/94	14:00		44	84	1247	126	55	69	5.9	0.13	141	2223	
2/19/94	14:30	8	44	98	1247	126	50	69	6.9	0.18	164	2387	
2/19/94	15:00		43	91	1252	127	55	69	6.4	0.14	152	2539	
2/19/94	15:30	9	45	96	1254	126	50	69	6.8	0.18	161	2700	
2/19/94	16:00		43	83	1258	126	50	69	5.9	0.14	140	2839	
2/19/94	16:30	10	42	99	1243	126	50	66	7.0	0.19	167	3000	
2/19/94	17:00		41	81	1246	126	50	69	5.7	0.14	136	3142	
2/19/94	17:30	11	42	96	1246	126	50	66	6.8	0.18	162	3303	
2/19/94	18:00		41	84	1234	125	47	72	6.0	0.15	141	3444	
2/19/94	18:30	12	41	93	1233	125	55	64	6.5	0.15	155	3600	
2/19/94	19:00		42	89	1237	126	50	66	6.3	0.16	150	3749	
2/19/94	19:30	13	42	92	1233	126	50	66	6.5	0.16	155	3904	
2/19/94	20:00		43	88	1234	126	50	66	6.2	0.15	147	4052	
2/19/94	20:30	14	41	96	1230	126	47	69	6.7	0.19	161	4213	
2/19/94	21:00		42	78	1234	126	50	61	5.3	0.12	127	4340	
2/19/94	21:30	15	42	92	1243	126	50	64	6.5	0.16	154	4493	
2/19/94	22:00		43	84	1242	126	50	64	5.9	0.14	141	4634	
2/19/94	22:30	16	42	95	1247	126	50	64	6.7	0.17	159	4793	
2/19/94	23:00		41	83	1238	126	47	64	5.9	0.15	140	4933	
2/19/94	23:30	17	42	96	1234	126	47	58	6.7	0.19	161	5094	

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data													RELATIVE	
DATE	TIME	HRS	MW	FLOW			BASELINE		FACE	PERME-	ASH	TOTAL	REMARKS	
				KPPH	T DEG F	P PSIG	DP (ts) IN WG	TRIGGER IN WG	VELOCITY FT/MIN	ABILITY K/K0	FILTERED LB	ASH LB		
2/20/94	0:00		40	95	1228	125	47	61	6.7	0.18	159	5252		
2/20/94	0:30	18	40	98	1228	126	50	58	6.8	0.18	164	5417		
2/20/94	1:00		41	88	1228	126	47	61	6.2	0.16	148	5504		
2/20/94	1:30	19	42	91	1233	127	47	64	6.4	0.17	153	5717		
2/20/94	2:00		42	88	1233	126	50	64	6.2	0.15	147	5804		
2/20/94	2:30	20	41	81	1234	126	47	61	5.7	0.15	136	6001		
2/20/94	3:00		42	92	1236	126	47	61	6.4	0.17	154	6154		
2/20/94	3:30	21	41	89	1236	126	47	61	6.2	0.17	149	6303		
2/20/94	4:00		41	93	1231	126	47	58	6.5	0.18	155	6458		
2/20/94	4:30	22	42	86	1237	126	47	61	6.1	0.16	145	6603		
2/20/94	5:00		40	83	1233	126	47	58	5.8	0.15	139	6742		
2/20/94	5:30	23	40	98	1235	127	47	61	6.8	0.19	164	6905		
2/20/94	6:00		41	88	1237	126	47	61	6.2	0.16	147	7052		
2/20/94	6:30	24	41	94	1238	127	47	61	6.6	0.18	157	7209		
2/20/94	7:00		40	89	1235	127	47	58	6.3	0.17	150	7359		
2/20/94	7:30	25	41	94	1233	127	44	69	6.6	0.19	158	7517		
2/20/94	8:00		41	89	1234	126	47	61	6.2	0.16	149	7666		
2/20/94	8:30	26	40	84	1234	126	47	61	5.9	0.15	141	7807		
2/20/94	9:00		39	85	1231	126	47	58	5.9	0.15	142	7949		
2/20/94	9:30	27	40	89	1230	126	47	61	6.2	0.16	149	8097		
2/20/94	10:00		40	93	1238	126	44	64	6.5	0.19	155	8253		
2/20/94	10:30	28	40	94	1234	126	47	58	6.6	0.18	158	8411		
2/20/94	11:00		39	84	1228	126	47	58	5.9	0.15	142	8552		
2/20/94	11:30	29	40	94	1233	127	50	58	6.6	0.17	158	8710		
2/20/94	12:00		40	85	1237	126	47	66	6.0	0.15	142	8853		
2/20/94	12:30	30	38	93	1238	126	47	58	6.5	0.18	156	9009		
2/20/94	13:00		38	93	1232	126	50	58	6.5	0.17	156	9165		
2/20/94	13:30	31	40	98	1242	127	47	58	6.9	0.19	164	9329		
2/20/94	14:00		40	94	1246	127	47	61	6.6	0.18	158	9487		
2/20/94	14:30	32	39	96	1243	127	47	69	6.8	0.19	162	9649		
2/20/94	15:00		40	92	1239	127	47	61	6.5	0.17	154	9803		
2/20/94	15:30	33	38	97	1239	126	47	58	6.8	0.19	162	9965		
2/20/94	16:00		40	88	1241	126	47	61	6.2	0.16	148	10113		
2/20/94	16:30	34	39	94	1244	127	47	61	6.6	0.18	158	10271		
2/20/94	17:00		39	89	1242	126	47	58	6.3	0.17	149	10420		
2/20/94	17:30	35	40	97	1244	127	47	61	6.8	0.19	163	10583		
2/20/94	18:00		40	96	1247	126	47	58	6.8	0.19	160	10743		
2/20/94	18:30	36	38	93	1240	126	47	58	6.5	0.18	155	10898		
2/20/94	19:00		39	88	1236	126	47	58	6.2	0.16	148	11046		
2/20/94	19:30	37	39	94	1244	127	50	61	6.6	0.17	157	11203		
2/20/94	20:00		38	89	1240	126	47	64	6.3	0.17	149	11353		
2/20/94	20:30	38	39	101	1243	126	47	58	7.1	0.20	169	11521		
2/20/94	21:00		40	89	1247	127	47	58	6.3	0.17	149	11671		
2/20/94	21:30	39	39	85	1243	125	44	58	6.0	0.17	142	11813		
2/20/94	22:00		39	92	1240	126	47	58	6.5	0.18	154	11967		
2/20/94	22:30	40	39	92	1248	126	47	58	6.6	0.18	155	12122		
2/20/94	23:00		40	83	1247	127	47	58	5.8	0.15	139	12281		
2/20/94	23:30	41	40	87	1246	125	47	58	6.2	0.17	147	12407		

E-23

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data													RELATIVE	
DATE	TIME	HRS	MW ₀	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS	
							DP (ts) IN WG	TRIGGER IN WG						
2/21/94	0:00		39	87	1245	126	47	61	6.1	0.16	146	12558		
2/21/94	0:30	42	39	98	1244	126	47	58	7.0	0.20	165	12718		
2/21/94	1:00		40	94	1245	127	47	58	6.6	0.18	158	12876		
2/21/94	1:30	43	39	87	1245	126	47	58	6.2	0.16	147	13022		
2/21/94	2:00		40	93	1243	127	47	61	6.5	0.18	156	13178		
2/21/94	2:30	44	39	97	1243	126	47	58	6.9	0.19	163	13341		
2/21/94	3:00		39	89	1243	126	50	58	6.3	0.16	150	13491		
2/21/94	3:30	45	40	88	1242	126	47	58	6.2	0.16	147	13638		
2/21/94	4:00		40	89	1242	126	44	58	6.3	0.18	149	13787		
2/21/94	4:30	46	40	91	1248	126	50	58	6.5	0.16	153	13939		
2/21/94	5:00		39	90	1240	126	44	58	6.4	0.18	151	14091		
2/21/94	5:30	47	40	91	1245	126	47	58	6.4	0.17	152	14243		
2/21/94	6:00		39	91	1241	127	44	61	6.4	0.19	152	14395		
2/21/94	6:30	48	38	91	1239	126	47	61	6.4	0.17	152	14547		
2/21/94	7:00		39	85	1243	127	47	58	6.0	0.16	143	14690		
2/21/94	7:30	49	40	92	1243	127	44	55	6.5	0.19	155	14845		
2/21/94	8:00		40	89	1241	127	44	55	6.2	0.18	149	14994		
2/21/94	8:30	50	38	90	1236	126	44	58	6.4	0.18	152	15146		
2/21/94	9:00		39	92	1238	127	44	55	6.5	0.19	155	15301		
2/21/94	9:30	51	39	88	1239	126	44	58	6.2	0.18	148	15449		
2/21/94	10:00		37	92	1168	126	47	55	6.2	0.16	154	15603		
2/21/94	10:30	52	37	102	1168	127	47	58	6.9	0.19	172	15775		
2/21/94	11:00		38	93	1169	127	47	58	6.2	0.16	155	15930		
2/21/94	11:30	53	40	95	1178	127	47	60	6.4	0.17	159	16089		
2/21/94	12:00		42	98	1195	129	50	61	6.6	0.17	165	16254		
2/21/94	12:30	54	45	96	1212	129	50	58	6.6	0.17	162	16416		
2/21/94	13:00		46	91	1208	129	50	61	6.1	0.15	152	16568		
2/21/94	13:30	55	46	94	1216	130	50	58	6.3	0.16	157	16725		
2/21/94	14:00		47	104	1229	131	47	61	7.0	0.20	175	16900		
2/21/94	14:30	56	48	97	1241	131	47	58	6.6	0.18	162	17062		
2/21/94	15:00		49	98	1236	131	47	58	6.6	0.18	164	17226		
2/21/94	15:30	57	47	94	1233	131	47	69	6.4	0.17	158	17384		
2/21/94	16:00		47	94	1228	131	47	61	6.3	0.17	157	17541		
2/21/94	16:30	58	48	97	1220	131	47	61	6.5	0.18	162	17703		
2/21/94	17:00		48	91	1229	131	47	61	6.2	0.16	152	17856		
2/21/94	17:30	59	45	87	1226	129	47	61	6.0	0.15	145	18001		
2/21/94	18:00		46	96	1218	130	47	72	6.5	0.18	161	18162		
2/21/94	18:30	60	47	92	1220	131	53	61	6.2	0.14	154	18316		
2/21/94	19:00		46	97	1215	130	53	61	6.6	0.16	163	18479		
2/21/94	19:30	61	48	97	1230	132	50	61	6.5	0.17	163	18642		
2/21/94	20:00		47	96	1218	131	53	64	6.5	0.15	161	18803		
2/21/94	20:30	62	47	96	1222	130	50	66	6.5	0.16	161	18964		
2/21/94	21:00		47	91	1217	131	53	61	6.1	0.14	153	19117		
2/21/94	21:30	63	47	90	1209	130	50	61	6.1	0.15	152	19268		
2/21/94	22:00		47	98	1210	131	50	61	6.6	0.17	164	19432		
2/21/94	22:30	64	47	98	1220	130	55	61	6.5	0.14	161	19593		
2/21/94	23:00		48	98	1227	131	55	64	6.7	0.15	165	19758		
2/21/94	23:30	65	48	91	1232	132	55	61	6.1	0.13	152	19910		

E-24

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data												RELATIVE		TOTAL	REMARKS
DATE	TIME	HRS	FLOW MW	T KPPH	P DEG F	PSIG	BASELINE DP (ts) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/K0	ASH FILTERED LB	ASH LB			
2/22/94	0:00		49	98	1228	132	50	66	6.6	0.17	164	20074			
2/22/94	0:30	66	49	97	1233	132	53	64	6.5	0.16	162	20236			
2/22/94	1:00		48	98	1235	132	50	64	6.6	0.17	164	20400			
2/22/94	1:30	67	50	93	1238	132	53	64	6.3	0.15	156	20556			
2/22/94	2:00		49	97	1244	133	53	64	6.5	0.16	162	20718			
2/22/94	2:30	68	49	102	1245	133	53	64	6.9	0.17	171	20889			
2/22/94	3:00		50	89	1241	134	53	61	6.0	0.14	150	21038			
2/22/94	3:30	69	49	97	1245	134	50	69	6.5	0.17	162	21200			
2/22/94	4:00		51	100	1245	134	50	61	6.7	0.17	168	21369			
2/22/94	4:30	70	50	82	1241	133	50	61	5.5	0.13	138	21507			
2/22/94	5:00		50	94	1243	134	53	64	6.3	0.15	158	21605			
2/22/94	5:30	71	50	95	1241	134	55	72	6.3	0.14	159	21824			
2/22/94	6:00		50	89	1242	134	55	69	6.0	0.13	149	21973			
2/22/94	6:30	72	51	102	1246	136	58	66	6.7	0.14	170	22143			
2/22/94	7:00		50	96	1244	137	61	66	6.3	0.12	160	22304			
2/22/94	7:30	73	50	95	1237	137	53	64	6.2	0.15	159	22463			
2/22/94	8:00		49	86	1230	138	61	75	5.6	0.11	145	22608			
2/22/94	8:30	74	48	102	1219	137	58	69	6.6	0.14	171	22778			
2/22/94	9:00		51	95	1229	139	61	72	6.1	0.12	159	22938			
2/22/94	9:30	75	52	98	1249	139	58	69	6.4	0.13	164	23102			
2/22/94	10:00		52	92	1263	140	58	61	5.9	0.12	154	23256			
2/22/94	10:30	76	55	98	1281	140	69	77	6.3	0.11	161	23417			
2/22/94	11:00		56	86	1298	142	72	77	5.6	0.09	144	23561			
2/22/94	11:30	77	57	98	1314	144	77	86	6.4	0.10	164	23725			
2/22/94	12:00		58	102	1324	149	69	80	6.5	0.11	170	23896			
2/22/94	12:30	78	58	110	1331	149	61	83	7.0	0.15	184	24080			
2/22/94	13:00		59	97	1329	150	55	77	6.1	0.14	162	24242			
2/22/94	13:30	79	59	102	1329	149	55	75	6.5	0.15	171	24414			
2/22/94	14:00		59	101	1328	150	58	75	6.4	0.14	169	24583			
2/22/94	14:30	80	58	90	1327	149	58	69	5.7	0.12	151	24734			
2/22/94	15:00		59	100	1326	150	58	69	6.8	0.15	181	24915			
2/22/94	15:30	81	58	106	1330	149	58	80	6.8	0.15	178	25093			
2/22/94	16:00		58	100	1331	150	55	77	6.9	0.17	181	25274			
2/22/94	16:30	82	58	94	1335	148	55	77	6.0	0.14	157	25431			
2/22/94	17:00		58	102	1338	148	58	80	6.6	0.14	170	25601			
2/22/94	17:30	83	58	99	1340	149	55	83	6.4	0.15	166	25768			
2/22/94	18:00		58	102	1339	150	55	72	6.5	0.15	171	25939			
2/22/94	18:30	84	58	103	1340	149	55	72	6.6	0.16	172	26111			
2/22/94	19:00		59	103	1343	150	55	72	6.6	0.16	173	26285			
2/22/94	19:30	85	58	94	1347	150	55	83	6.0	0.14	158	26443			
2/22/94	20:00		58	104	1346	150	53	75	6.6	0.17	174	26617			
2/22/94	20:30	86	58	97	1351	150	53	69	6.3	0.15	163	26780			
2/22/94	21:00		59	102	1348	150	55	72	6.5	0.15	171	26951			
2/22/94	21:30	87	0	0	0	0			0.0	-	0	26951	* Data problem		
2/22/94	22:00		0	0	0	0			0.0	-	0	26951			
2/22/94	22:30	88	0	0	0	0			0.0	-	0	26951			
2/22/94	23:00		0	0	0	0			0.0	-	0	26951			
2/22/94	23:30	89	0	0	0	0			0.0	-	0	26951			

E-25

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data													RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW%	FLOW* KPPH	T DEG F	P PSIG	BASELINE DP (ts) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/K0	ASH FILTERED LB	TOTAL ASH LB				
2/23/94	0:00		0	0	0	0			0.0	-	0	26951				
2/23/94	0:30	90	58	115	1351	151	55	77	7.3	0.18	192	27143	* Data problem repaired			
2/23/94	1:00		58	111	1357	150	55	66	7.1	0.18	180	27329				
2/23/94	1:30	91	59	103	1350	151	53	80	6.6	0.17	172	27501				
2/23/94	2:00		59	110	1353	151	55	77	7.0	0.17	184	27685				
2/23/94	2:30	92	58	108	1353	151	53	77	6.9	0.18	180	27865				
2/23/94	3:00		57	107	1352	151	55	75	6.9	0.17	180	28045				
2/23/94	3:30	93	57	101	1345	150	55	66	6.4	0.15	169	28214				
2/23/94	4:00		57	107	1341	150	55	72	6.8	0.16	179	28393				
2/23/94	4:30	94	56	93	1343	149	53	69	5.9	0.14	155	28548				
2/23/94	5:00		56	108	1342	149	58	72	6.9	0.16	181	28730				
2/23/94	5:30	95	57	98	1342	150	55	75	6.2	0.14	164	28893				
2/23/94	6:00		57	106	1345	150	55	75	6.8	0.16	178	29072				
2/23/94	6:30	96	57	91	1345	149	58	72	5.8	0.12	152	29224				
2/23/94	7:00		57	106	1345	150	58	75	6.8	0.15	178	29402				
2/23/94	7:30	97	57	105	1347	150	60	89	6.7	0.13	175	29578				
2/23/94	8:00		57	109	1364	150	53	75	7.1	0.19	183	29761				
2/23/94	8:30	98	57	106	1371	150	53	77	6.9	0.18	178	29938				
2/23/94	9:00		57	106	1375	150	50	69	6.9	0.19	177	30116				
2/23/94	9:30	99	55	99	1371	150	55	80	6.4	0.15	168	30282				
2/23/94	10:00		56	108	1368	150	53	75	6.9	0.18	177	30459				
2/23/94	10:30	100	57	93	1364	149	50	69	6.1	0.16	156	30615				
2/23/94	11:00		56	107	1358	150	53	72	6.9	0.18	179	30794				
2/23/94	11:30	101	56	96	1353	148	53	77	6.2	0.15	160	30954				
2/23/94	12:00		56	98	1358	148	53	75	6.4	0.16	165	31119				
2/23/94	12:30	102	56	100	1354	149	50	75	6.4	0.17	168	31287				
2/23/94	13:00		56	101	1355	150	50	75	6.5	0.18	170	31457				
2/23/94	13:30	103	57	105	1356	150	50	75	6.7	0.18	175	31632				
2/23/94	14:00		55	101	1350	147	50	75	6.6	0.18	169	31801				
2/23/94	14:30	104	52	107	1322	148	53	80	6.9	0.18	180	31980				
2/23/94	15:00		49	98	1308	144	53	61	5.9	0.14	151	32132				
2/23/94	15:30	105	49	100	1308	145	47	64	6.5	0.18	168	32300				
2/23/94	16:00		51	99	1306	145	47	64	6.4	0.18	168	32486				
2/23/94	16:30	106	49	89	1304	141	47	66	5.9	0.16	149	32615				
2/23/94	17:00		46	89	1291	139	47	66	5.9	0.16	150	32765				
2/23/94	17:30	107	44	92	1270	138	47	58	6.1	0.17	155	32920				
2/23/94	18:00		48	107	1269	141	50	64	6.9	0.19	179	33099				
2/23/94	18:30	108	47	95	1280	141	50	69	6.2	0.16	159	33258				
2/23/94	19:00		49	105	1293	142	53	69	6.8	0.17	175	33433				
2/23/94	19:30	109	51	100	1312	143	53	75	6.6	0.16	167	33600				
2/23/94	20:00		47	81	1303	139	53	69	5.5	0.12	137	33737				
2/23/94	20:30	110	42	82	1267	131	47	66	5.6	0.15	137	33874				
2/23/94	21:00		35	75	1248	118	47	66	5.6	0.14	125	33999				
2/23/94	21:30	111	31	77	1189	117	44	55	5.7	0.15	130	34129				
2/23/94	22:00		31	92	1182	118	44	55	6.7	0.19	155	34283				
2/23/94	22:30	112	30	81	1174	117	42	53	5.9	0.17	136	34419				
2/23/94	23:00		31	92	1177	118	42	58	6.6	0.21	154	34573				
2/23/94	23:30	113	29	74	1173	117	42	55	5.4	0.15	124	34697				

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data													RELATIVE	
DATE	TIME	HRS	MW ₀	FLOW* KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS	
							DP (ts) IN WG	TRIGGER IN WG						
2/24/94	0:00		30	79	1172	118	42	55	5.7	0.16	133	34830		
2/24/94	0:30	114	30	76	1175	117	42	53	5.5	0.16	128	34958		
2/24/94	1:00		31	86	1177	118	44	55	6.2	0.17	144	35102		
2/24/94	1:30	115	31	87	1180	118	44	55	6.3	0.18	146	35248		
2/24/94	2:00		31	88	1183	118	44	55	6.3	0.18	148	35396		
2/24/94	2:30	116	32	90	1186	120	44	58	6.4	0.18	150	35546		
2/24/94	3:00		32	86	1187	121	44	58	6.1	0.17	144	35691		
2/24/94	3:30	117	32	89	1191	122	44	58	6.3	0.18	149	35840		
2/24/94	4:00		31	88	1186	121	44	61	6.2	0.17	148	35988		
2/24/94	4:30	118	32	90	1184	122	44	55	6.3	0.18	151	36138		
2/24/94	5:00		33	94	1186	122	44	55	6.6	0.19	157	36295		
2/24/94	5:30	119	33	79	1188	123	44	55	5.5	0.15	132	36427		
2/24/94	6:00		32	86	1188	122	44	55	6.1	0.17	145	36572		
2/24/94	6:30	120	32	83	1188	123	44	58	5.8	0.16	139	36711		
2/24/94	7:00		33	82	1193	123	47	58	5.7	0.14	138	36849		
2/24/94	7:30	121	35	87	1201	124	50	58	6.1	0.15	146	36994		
2/24/94	8:00		35	93	1209	126	47	58	6.5	0.17	157	37151		
2/24/94	8:30	122	44	94	1206	129	50	61	6.7	0.17	158	37309		
2/24/94	9:00		50	97	1344	132	55	66	7.0	0.16	163	37472		
2/24/94	9:30	123	50	84	1373	133	55	64	6.1	0.14	141	37613		
2/24/94	10:00		50	90	1385	133	53	64	6.6	0.16	151	37763		
2/24/94	10:30	124	52	87	1362	134	53	69	6.2	0.15	146	37910		
2/24/94	11:00		50	90	1366	133	50	66	6.5	0.17	151	38060		
2/24/94	11:30	125	52	91	1370	134	50	64	6.5	0.17	152	38212		
2/24/94	12:00		55	97	1387	136	53	64	6.9	0.18	162	38375		
2/24/94	12:30	126	57	96	1376	141	53	69	6.6	0.17	161	38535		
2/24/94	13:00		57	97	1397	141	53	72	6.7	0.17	163	38699		
2/24/94	13:30	127	57	95	1390	141	58	77	6.6	0.14	158	38857		
2/24/94	14:00		57	91	1373	144	53	66	6.1	0.15	152	39009		
2/24/94	14:30	128	55	100	1355	143	53	75	6.7	0.17	167	39176		
2/24/94	15:00		56	88	1358	143	55	77	5.9	0.13	148	39324		
2/24/94	15:30	129	56	99	1357	144	53	80	6.6	0.17	166	39490		
2/24/94	16:00		56	101	1354	143	53	72	6.8	0.17	169	39659		
2/24/94	16:30	130	56	98	1357	144	55	72	6.6	0.15	165	39824		
2/24/94	17:00		56	101	1362	144	55	80	6.8	0.16	170	39994		
2/24/94	17:30	131	56	90	1362	144	61	86	6.0	0.12	150	40144		
2/24/94	18:00		56	105	1366	144	55	80	7.0	0.17	176	40320		
2/24/94	18:30	132	57	99	1363	144	55	69	6.6	0.16	166	40485		
2/24/94	19:00		56	101	1361	144	55	75	6.8	0.16	169	40655		
2/24/94	19:30	133	56	96	1365	145	55	77	6.4	0.15	161	40816		
2/24/94	20:00		56	98	1367	144	61	77	6.6	0.14	164	40980		
2/24/94	20:30	134	54	101	1360	145	53	72	6.8	0.17	170	41150		
2/24/94	21:00		56	104	1362	146	53	80	6.9	0.18	175	41325		
2/24/94	21:30	135	56	102	1364	146	53	80	6.7	0.17	170	41495		
2/24/94	22:00		55	104	1361	146	53	72	6.9	0.18	175	41670		
2/24/94	22:30	136	55	100	1362	146	55	80	6.6	0.16	168	41838		
2/24/94	23:00		55	102	1360	145	55	80	6.8	0.16	171	42009		
2/24/94	23:30	137	55	104	1361	145	61	83	6.9	0.15	175	42184		

E-27

TABLE 4 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 15 (FEBRUARY 19 THRU FEBRUARY 25, 1994)

* Corrected data													RELATIVE		TOTAL ASH LB	REMARKS
DATE	TIME	HRS	MW%	FLOW* KPPH	T DEG F	P PSIG	BASELINE DP (ta) IN WG	TRIGGER IN WG	FACE VELOCITY FT/MIN	PERME- ABILITY K/KØ	ASH FILTERED LB					
2/25/94	0:00		55	103	1358	146	53	58	6.8	0.17	172	42356				
2/25/94	0:30	138	56	103	1368	146	53	77	6.8	0.17	172	42528				
2/25/94	1:00		55	101	1368	145	53	75	6.7	0.17	169	42697				
2/25/94	1:30	139	56	98	1368	146	53	75	6.5	0.18	164	42861				
2/25/94	2:00		56	97	1364	146	55	77	6.5	0.15	163	43024				
2/25/94	2:30	140	56	103	1368	147	53	80	6.8	0.17	173	43197				
2/25/94	3:00		56	100	1368	146	53	69	6.7	0.17	168	43365				
2/25/94	3:30	141	56	98	1368	146	53	66	6.5	0.16	164	43529				
2/25/94	4:00		56	96	1362	146	53	77	6.3	0.16	161	43698				
2/25/94	4:30	142	56	101	1362	146	53	83	6.7	0.17	170	43860				
2/25/94	5:00		55	107	1360	146	66	83	7.1	0.14	179	44039				
2/25/94	5:30	143	56	104	1362	147	53	80	6.9	0.18	175	44214				
2/25/94	6:00		55	102	1358	146	53	83	6.7	0.17	171	44385				
2/25/94	6:30	144	55	108	1361	146	58	83	7.1	0.16	180	44568				
2/25/94	7:00		55	103	1362	146	53	69	6.8	0.17	172	44738				
2/25/94	7:30	145	55	113	1360	146	50	75	7.5	0.22	190	44928				
2/25/94	8:00		55	108	1358	146	61	75	7.1	0.15	181	45109				
2/25/94	8:30	146	55	111	1360	146	53	72	7.3	0.20	186	45295				
2/25/94	9:00		55	107	1360	146	53	72	7.1	0.19	180	45475				
2/25/94	9:30	147	55	104	1361	146	50	75	6.9	0.19	174	45649				
2/25/94	10:00		55	111	1358	146	53	75	7.3	0.20	186	45835				
2/25/94	10:30	148	55	109	1360	146	58	75	7.2	0.17	183	46017				
2/25/94	11:00		54	102	1361	146	53	77	6.7	0.17	171	46188				
2/25/94	11:30	149	54	104	1363	146	50	89	6.9	0.19	175	46363				
2/25/94	12:00		55	106	1365	146	47	75	7.0	0.21	178	46541				
2/25/94	12:30	150	54	112	1360	146	47	77	7.4	0.23	187	46728				
2/25/94	13:00		55	113	1361	146	50	77	7.5	0.22	190	46918	* 13:09 Combustor trip due to a sorbent air compressor surge and trip.			
2/25/94	13:30		-2	29	1036	42	19	42	4.5	0.24	49	46966				

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 8 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG					
3/03/94	10:00	0	-2	40	735	39			5.2	-			* 10:13 coal fire.
3/03/94	10:30		2	45	814	46			5.4	-	75		
3/03/94	11:00	1	4	57	876	62			5.8	-	96	170	
3/03/94	11:30		6	60	909	69			5.8	-	100	271	
3/03/94	12:00	2	6	63	927	73			5.8	-	105	376	
3/03/94	12:30		7	65	938	79			5.7	-	110	486	
3/03/94	13:00	3	7	63	943	78	25	89	5.6	0.26	106	592	
3/03/94	13:30		8	74	953	80			6.4	-	124	716	
3/03/94	14:00	4	9	74	969	80	30	42	6.5	0.26	124	840	
3/03/94	14:30		12	72	978	81	28	39	6.3	0.29	120	960	
3/03/94	15:00	5	11	71	983	80	25	39	6.3	0.33	119	1079	
3/03/94	15:30		13	74	995	83	30	42	6.4	0.26	124	1203	
3/03/94	16:00	6	14	77	1021	86	30	47	6.6	0.28	128	1331	
3/03/94	16:30		17	76	1042	87	30	50	6.5	0.27	127	1458	
3/03/94	17:00	7	20	78	1078	88	30	50	6.8	0.30	131	1589	
3/03/94	17:30		23	76	1097	89	30	47	6.6	0.29	127	1716	
3/03/94	18:00	8	26	86	1118	100	33	58	6.9	0.28	144	1860	
3/03/94	18:30		27	85	1134	101	33	53	6.8	0.28	143	2003	
3/03/94	19:00	9	29	85	1154	102	33	53	6.8	0.28	142	2145	
3/03/94	19:30		32	86	1179	103	36	55	7.0	0.27	144	2289	
3/03/94	20:00	10	35	84	1199	103	36	58	6.9	0.26	142	2430	
3/03/94	20:30		38	89	1220	109	39	61	7.1	0.25	149	2580	
3/03/94	21:00	11	40	90	1232	111	39	64	7.1	0.25	151	2731	
3/03/94	21:30		42	88	1245	113	39	64	6.9	0.24	148	2879	
3/03/94	22:00	12	46	100	1265	125	42	69	7.2	0.25	168	3046	
3/03/94	22:30		48	101	1279	126	42	69	7.3	0.25	169	3216	
3/03/94	23:00	13	51	98	1306	127	42	72	7.2	0.25	165	3380	
3/03/94	23:30		53	92	1326	131	44	75	6.6	0.20	155	3535	

E-29

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 8 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW ₀	FLOP KPPH	T DEG F	P PSIQ	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG					
3/04/94	0:00	14	56	97	1352	136	44	75	6.8	0.21	163	3699	
3/04/94	0:30		56	96	1379	136	47	72	6.7	0.19	158	3857	
3/04/94	1:00	15	55	94	1378	137	47	83	6.7	0.19	157	4014	
3/04/94	1:30		55	96	1380	136	47	75	6.9	0.20	161	4176	
3/04/94	2:00	16	56	98	1377	137	50	75	6.9	0.19	164	4340	
3/04/94	2:30		55	95	1380	136	47	75	6.8	0.20	160	4500	
3/04/94	3:00	17	54	96	1386	135	50	83	6.9	0.19	160	4660	
3/04/94	3:30		55	91	1373	136	50	72	6.4	0.17	152	4812	
3/04/94	4:00	18	52	87	1368	135	50	75	6.2	0.16	146	4958	
3/04/94	4:30		40	97	1278	130	47	72	6.8	0.19	163	5121	
3/04/94	5:00	19	40	94	1263	131	50	69	6.5	0.16	158	5278	
3/04/94	5:30		48	95	1295	134	50	75	6.5	0.17	159	5437	
3/04/94	6:00	20	53	91	1363	136	50	75	6.4	0.17	153	5590	
3/04/94	6:30		52	95	1347	135	50	75	6.7	0.18	159	5749	
3/04/94	7:00	21	51	93	1340	135	50	72	6.5	0.17	156	5906	
3/04/94	7:30		51	90	1336	135	50	72	6.3	0.16	151	6057	
3/04/94	8:00	22	53	96	1351	136	53	72	6.7	0.17	161	6218	
3/04/94	8:30		53	94	1364	136	53	72	6.6	0.17	158	6376	
3/04/94	9:00	23	52	95	1349	136	53	72	6.7	0.17	160	6535	
3/04/94	9:30		52	93	1350	136	53	72	6.5	0.16	156	6692	
3/04/94	10:00	24	52	96	1352	136	53	80	6.7	0.17	161	6853	
3/04/94	10:30		52	94	1349	136	53	75	6.6	0.16	158	7011	
3/04/94	11:00	25	52	93	1348	136	53	72	6.5	0.16	155	7166	
3/04/94	11:30		52	91	1345	136	53	72	6.4	0.15	153	7319	
3/04/94	12:00	26	51	94	1335	136	53	72	6.5	0.16	157	7477	
3/04/94	12:30		51	94	1333	136	53	75	6.6	0.16	158	7635	
3/04/94	13:00	27	50	93	1336	136	53	72	6.5	0.16	156	7791	
3/04/94	13:30		50	93	1330	136	53	72	6.4	0.16	155	7946	
3/04/94	14:00	28	50	90	1333	136	53	72	6.3	0.15	152	8097	
3/04/94	14:30		52	91	1333	136	53	72	6.3	0.15	153	8250	
3/04/94	15:00	29	53	91	1354	137	53	72	6.3	0.15	152	8402	
3/04/94	15:30		54	94	1374	140	53	72	6.5	0.16	157	8559	
3/04/94	16:00	30	56	97	1370	143	55	75	6.5	0.15	162	8721	
3/04/94	16:30		56	97	1323	147	55	83	6.2	0.14	162	8883	
3/04/94	17:00	31	58	105	1320	148	50	77	6.8	0.15	176	9060	
3/04/94	17:30		58	105	1335	149	50	72	6.7	0.15	176	9236	
3/04/94	18:00	32	60	103	1346	149	50	80	6.6	0.15	173	9409	
3/04/94	18:30		60	102	1365	150	58	83	6.5	0.15	170	9579	
3/04/94	19:00	33	60	100	1376	150	58	91	6.5	0.15	168	9747	
3/04/94	19:30		59	103	1373	150	58	86	6.7	0.15	173	9920	
3/04/94	20:00	34	59	103	1376	149	58	80	6.7	0.15	173	10093	
3/04/94	20:30		60	102	1377	151	58	83	6.6	0.15	170	10264	
3/04/94	21:00	35	59	103	1376	149	58	83	6.7	0.15	173	10437	
3/04/94	21:30		59	101	1375	149	58	94	6.6	0.15	169	10606	
3/04/94	22:00	36	59	104	1373	149	58	80	6.8	0.15	174	10779	
3/04/94	22:30		59	100	1374	150	61	83	6.5	0.14	167	10946	
3/04/94	23:00	37	59	100	1374	150	61	83	6.5	0.14	168	11114	
3/04/94	23:30		59	102	1374	150	58	86	6.6	0.15	171	11286	

E-30

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 3 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW _o	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (t ₉₀) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀			
3/05/94	0:00	38	59	101	1374	149	58	86	6.6	0.15	170	11456	
3/05/94	0:30		59	105	1375	150	61	86	6.8	0.15	177	11633	
3/05/94	1:00	39	58	99	1377	149	61	86	6.5	0.14	168	11799	
3/05/94	1:30		59	100	1375	151	58	89	6.5	0.14	168	11967	
3/05/94	2:00	40	58	101	1378	149	66	80	6.6	0.12	169	12136	
3/05/94	2:30		59	105	1378	151	61	86	6.8	0.15	176	12311	
3/05/94	3:00	41	58	100	1380	150	61	83	6.5	0.14	168	12479	
3/05/94	3:30		58	101	1378	150	61	83	6.6	0.14	170	12649	
3/05/94	4:00	42	59	98	1391	150	61	80	6.4	0.13	164	12812	
3/05/94	4:30		60	102	1392	151	58	83	6.7	0.15	171	12984	
3/05/94	5:00	43	58	99	1384	150	61	83	6.5	0.14	168	13150	
3/05/94	5:30		60	99	1392	151	58	83	6.5	0.14	166	13316	
3/05/94	6:00	44	58	96	1381	150	58	83	6.3	0.14	160	13477	
3/05/94	6:30		58	101	1384	151	61	83	6.5	0.14	169	13646	
3/05/94	7:00	45	58	103	1384	150	61	83	6.8	0.14	173	13819	
3/05/94	7:30		58	103	1384	151	58	83	6.7	0.15	172	13991	
3/05/94	8:00	46	59	99	1381	150	58	83	6.5	0.14	166	14156	
3/05/94	8:30		58	104	1381	151	58	89	6.7	0.15	174	14330	
3/05/94	9:00	47	58	100	1382	150	58	86	6.5	0.15	168	14498	
3/05/94	9:30		58	98	1382	151	58	83	6.4	0.14	165	14663	
3/05/94	10:00	48	58	98	1382	150	58	83	6.4	0.14	164	14826	
3/05/94	10:30		58	102	1382	151	58	83	6.6	0.15	171	14998	
3/05/94	11:00	49	57	96	1380	149	58	91	6.3	0.14	162	15159	
3/05/94	11:30		58	101	1381	151	58	83	6.6	0.15	169	15329	
3/05/94	12:00	50	58	96	1382	150	58	83	6.3	0.14	161	15490	
3/05/94	12:30		59	100	1392	151	55	83	6.5	0.15	168	15657	
3/05/94	13:00	51	59	104	1394	150	58	83	6.8	0.16	174	15831	
3/05/94	13:30		58	96	1391	151	89	94	6.3	0.08	162	15993	
3/05/94	14:00	52	59	104	1373	151	64	77	6.7	0.14	174	16167	
3/05/94	14:30		59	100	1369	151	55	89	6.5	0.15	168	16336	
3/05/94	15:00	53	59	96	1368	150	55	80	6.3	0.14	162	16497	
3/05/94	15:30		59	102	1369	151	55	80	6.6	0.16	172	16669	
3/05/94	16:00	54	59	102	1373	150	55	86	6.6	0.16	172	16841	
3/05/94	16:30		59	102	1371	151	58	80	6.6	0.15	170	17011	
3/05/94	17:00	55	59	101	1370	150	55	83	6.6	0.16	170	17181	
3/05/94	17:30		58	100	1369	150	55	80	6.4	0.15	167	17349	
3/05/94	18:00	56	57	103	1368	149	55	86	6.7	0.16	172	17521	
3/05/94	18:30		58	105	1370	150	55	86	6.8	0.16	176	17697	
3/05/94	19:00	57	58	95	1367	149	53	97	6.2	0.15	159	17856	
3/05/94	19:30		58	104	1369	151	55	77	6.7	0.16	175	18031	
3/05/94	20:00	58	58	103	1371	150	55	86	6.7	0.16	173	18204	
3/05/94	20:30		58	101	1370	151	53	80	6.5	0.16	169	18373	
3/05/94	21:00	59	58	101	1372	149	55	80	6.6	0.16	169	18542	
3/05/94	21:30		59	105	1370	151	55	80	6.8	0.16	176	18718	
3/05/94	22:00	60	58	104	1371	150	55	80	6.8	0.16	175	18893	
3/05/94	22:30		58	101	1378	151	55	77	6.5	0.15	169	19062	
3/05/94	23:00	61	58	99	1381	150	55	77	6.5	0.15	166	19228	
3/05/94	23:30		59	101	1378	152	55	77	6.5	0.16	170	19398	

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 18 (MARCH 8 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE		TOTAL ASH LB	REMARKS
							DP (t ₀) IN WQ	TRIGGER IN WQ		PERME- ABILITY K/K ₀	ASH FILTERED LB		
3/08/94	0:00	62	58	99	1378	150	55	88	6.5	0.15	167	19505	
3/08/94	0:30		59	105	1379	152	53	86	6.8	0.17	176	19741	
3/08/94	1:00	63	59	100	1379	151	53	86	6.5	0.16	168	19988	
3/08/94	1:30		58	102	1377	152	55	86	6.5	0.16	171	20079	
3/08/94	2:00	64	58	105	1380	151	53	77	6.8	0.18	177	20256	
3/08/94	2:30		58	98	1375	152	53	77	6.8	0.18	165	20421	
3/08/94	3:00	65	57	99	1374	150	53	77	6.5	0.18	167	20587	
3/08/94	3:30		58	105	1376	151	53	77	6.8	0.18	177	20764	
3/08/94	4:00	66	58	99	1374	150	53	77	6.4	0.16	166	20930	
3/08/94	4:30		59	103	1372	152	53	80	6.6	0.17	172	21102	
3/08/94	5:00	67	57	103	1379	150	53	77	6.7	0.17	172	21274	
3/08/94	5:30		58	104	1381	152	53	77	6.7	0.17	174	21448	
3/08/94	6:00	68	57	97	1379	151	53	77	6.8	0.16	163	21612	
3/08/94	6:30		58	104	1378	152	53	77	6.7	0.17	175	21787	
3/08/94	7:00	69	58	100	1379	151	53	77	6.5	0.16	167	21954	
3/08/94	7:30		58	102	1376	152	53	77	6.6	0.17	172	22125	
3/08/94	8:00	70	58	101	1379	151	53	84	6.6	0.17	170	22295	
3/08/94	8:30		58	105	1378	152	50	75	6.8	0.19	178	22472	
3/08/94	9:00	71	58	106	1378	151	50	75	6.8	0.19	178	22650	
3/08/94	9:30		58	105	1378	152	53	66	6.8	0.17	178	22826	
3/08/94	10:00	72	58	105	1374	151	53	69	6.8	0.17	176	23002	
3/08/94	10:30		57	103	1373	151	53	72	6.7	0.17	172	23174	
3/08/94	11:00	73	57	104	1369	151	53	68	6.7	0.17	175	23349	
3/08/94	11:30		57	104	1370	152	53	66	6.7	0.17	174	23523	
3/08/94	12:00	74	56	102	1365	151	53	69	6.6	0.17	172	23694	
3/08/94	12:30		56	101	1365	149	53	72	6.5	0.16	169	23863	
3/08/94	13:00	75	55	100	1362	148	53	72	6.6	0.17	168	24032	
3/08/94	13:30		56	101	1365	148	53	77	6.6	0.17	169	24200	
3/08/94	14:00	76	56	97	1365	147	50	75	6.4	0.17	163	24363	
3/08/94	14:30		56	94	1365	147	53	75	6.2	0.15	157	24520	
3/08/94	15:00	77	56	102	1362	145	53	75	6.8	0.17	172	24692	
3/08/94	15:30		56	102	1363	146	53	80	6.7	0.17	171	24863	
3/08/94	16:00	78	56	97	1364	145	53	80	6.5	0.16	163	25026	
3/08/94	16:30		58	102	1365	148	53	77	6.7	0.17	171	25197	
3/08/94	17:00	79	57	98	1370	146	53	72	6.5	0.16	165	25361	
3/08/94	17:30		57	100	1369	147	53	80	6.6	0.17	167	25528	
3/08/94	18:00	80	57	96	1371	146	53	80	6.4	0.16	161	25689	
3/08/94	18:30		57	99	1369	149	53	77	6.5	0.16	166	25855	
3/08/94	19:00	81	58	102	1367	148	53	80	6.7	0.17	171	26026	
3/08/94	19:30		58	96	1367	149	53	80	6.3	0.15	161	26187	
3/08/94	20:00	82	57	97	1366	148	53	80	6.3	0.16	162	26349	
3/08/94	20:30		58	99	1369	149	53	80	6.5	0.16	166	26515	
3/08/94	21:00	83	57	104	1370	148	53	77	6.8	0.18	174	26689	
3/08/94	21:30		59	102	1369	149	53	80	6.6	0.17	171	26860	
3/08/94	22:00	84	57	97	1369	149	55	83	6.3	0.15	162	27023	
3/08/94	22:30		57	99	1370	149	55	80	6.5	0.15	167	27189	
3/08/94	23:00	85	57	103	1370	148	55	80	6.7	0.16	172	27362	
3/08/94	23:30		57	100	1370	149	55	80	6.5	0.15	168	27530	

E-32

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 3 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (t ₉₀) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀			
3/07/94	0:00	86	57	98	1373	148	53	89	6.5	0.16	165	27694	
3/07/94	0:30		57	102	1376	149	53	75	6.7	0.17	171	27866	
3/07/94	1:00	87	57	104	1371	149	53	77	6.8	0.18	175	28041	
3/07/94	1:30		58	98	1371	150	55	90	6.2	0.14	160	28201	
3/07/94	2:00	88	58	97	1373	148	55	80	6.3	0.15	162	28363	
3/07/94	2:30		58	101	1376	150	53	80	6.6	0.17	169	28532	
3/07/94	3:00	89	58	100	1380	149	53	89	6.6	0.17	168	28700	
3/07/94	3:30		58	103	1379	150	53	83	6.7	0.17	173	28873	
3/07/94	4:00	90	57	99	1381	149	53	80	6.5	0.16	166	29038	
3/07/94	4:30		58	96	1379	150	53	83	6.3	0.16	161	29206	
3/07/94	5:00	91	57	101	1377	150	53	80	6.6	0.17	170	29369	
3/07/94	5:30		57	104	1371	150	50	80	6.8	0.19	175	29545	
3/07/94	6:00	92	56	99	1372	149	50	80	6.4	0.17	165	29710	
3/07/94	6:30		57	99	1375	150	53	80	6.4	0.16	166	29875	
3/07/94	7:00	93	57	98	1374	149	53	80	6.4	0.16	164	30039	
3/07/94	7:30		58	99	1372	150	50	80	6.4	0.17	166	30205	
3/07/94	8:00	94	58	99	1374	150	50	80	6.4	0.17	166	30371	
3/07/94	8:30		57	103	1383	150	53	80	6.7	0.17	173	30543	
3/07/94	9:00	95	58	99	1374	150	53	77	6.5	0.16	167	30710	
3/07/94	9:30		57	100	1375	149	53	86	6.6	0.17	168	30878	
3/07/94	10:00	96	58	98	1377	150	55	77	6.4	0.15	164	31042	
3/07/94	10:30		58	103	1376	152	53	80	6.6	0.17	172	31214	
3/07/94	11:00	97	58	101	1379	151	50	77	6.5	0.18	169	31383	
3/07/94	11:30		58	99	1376	150	50	75	6.5	0.17	166	31549	
3/07/94	12:00	98	58	103	1386	150	50	77	6.7	0.19	173	31722	
3/07/94	12:30		58	100	1390	150	50	77	6.6	0.18	168	31890	
3/07/94	13:00	99	57	100	1391	149	50	77	6.6	0.18	168	32058	
3/07/94	13:30		58	102	1389	150	50	77	6.7	0.18	171	32229	
3/07/94	14:00	100	57	101	1390	150	61	77	6.7	0.14	170	32399	
3/07/94	14:30		58	98	1388	150	53	80	6.4	0.16	164	32563	
3/07/94	15:00	101	58	100	1373	149	50	80	6.5	0.18	168	32731	
3/07/94	15:30		55	102	1371	148	50	80	6.7	0.18	170	32901	
3/07/94	16:00	102	57	103	1369	149	53	75	6.7	0.17	173	33074	
3/07/94	16:30		55	101	1368	148	50	80	6.6	0.18	169	33243	
3/07/94	17:00	103	57	101	1367	148	50	80	6.6	0.18	170	33413	
3/07/94	17:30		55	105	1369	149	50	80	6.9	0.19	177	33590	
3/07/94	18:00	104	55	102	1371	148	53	86	6.7	0.17	171	33761	
3/07/94	18:30		57	101	1371	148	50	80	6.6	0.18	169	33930	
3/07/94	19:00	105	58	99	1372	149	50	80	6.5	0.17	166	34095	
3/07/94	19:30		58	99	1369	147	50	77	6.5	0.18	166	34261	
3/07/94	20:00	106	58	101	1365	148	50	80	6.6	0.18	170	34431	
3/07/94	20:30		55	97	1365	149	50	83	6.4	0.17	163	34594	
3/07/94	21:00	107	54	97	1365	148	50	80	6.4	0.17	163	34758	
3/07/94	21:30		58	99	1367	148	50	77	6.5	0.17	166	34924	
3/07/94	22:00	108	54	101	1365	148	50	77	6.6	0.18	169	35093	
3/07/94	22:30		55	104	1367	148	50	77	6.8	0.19	175	35267	
3/07/94	23:00	109	55	102	1367	148	50	80	6.7	0.18	171	35438	
3/07/94	23:30		55	98	1365	149	50	80	6.4	0.17	164	35602	

E-33

TABLE 5 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 3 THRU MARCH 9, 1994)

DATE	TIME	HRS	MIN	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL	REMARKS
							DP (ta) IN WG	TRIGGER IN WG		PERME- ABILITY K/K0		ASH LB	
3/03/94	0:00	110	54	97	1368	148	47	77	6.5	0.19	163	35765	
3/03/94	0:30		56	97	1369	149	50	86	6.3	0.17	162	35927	
3/03/94	1:00	111	56	104	1371	149	50	86	6.8	0.19	174	36102	
3/03/94	1:30		55	99	1372	148	50	86	6.5	0.18	166	36268	
3/03/94	2:00	112	56	99	1378	147	50	77	6.6	0.18	168	36434	
3/03/94	2:30		56	104	1380	149	50	86	6.8	0.19	174	36608	
3/03/94	3:00	113	57	104	1381	149	50	86	6.8	0.19	174	36782	
3/03/94	3:30		55	99	1371	148	50	86	6.5	0.17	166	36948	
3/03/94	4:00	114	55	100	1369	149	50	86	6.5	0.18	168	37116	
3/03/94	4:30		56	102	1371	149	50	77	6.6	0.18	171	37287	
3/03/94	5:00	115	56	99	1369	149	50	86	6.5	0.17	166	37452	
3/03/94	5:30		56	104	1367	150	50	86	6.7	0.19	174	37626	
3/03/94	6:00	116	55	104	1368	149	50	86	6.8	0.19	175	37801	
3/03/94	6:30		55	98	1372	149	50	86	6.4	0.17	164	37965	
3/03/94	7:00	117	55	100	1376	149	53	83	6.5	0.16	167	38133	
3/03/94	7:30		54	101	1376	148	53	83	6.6	0.17	169	38301	
3/03/94	8:00	118	54	99	1377	148	50	83	6.5	0.18	167	38468	
3/03/94	8:30		55	100	1379	147	50	86	6.7	0.18	168	38636	
3/03/94	9:00	119	55	98	1385	147	50	86	6.5	0.18	165	38801	
3/03/94	9:30		55	102	1397	148	50	77	6.8	0.19	171	38972	
3/03/94	10:00	120	57	104	1396	149	47	75	6.9	0.21	175	39147	
3/03/94	10:30		55	103	1392	147	50	75	6.9	0.19	173	39320	
3/03/94	11:00	121	56	102	1397	148	50	75	6.8	0.19	171	39491	
3/03/94	11:30		55	103	1393	149	50	75	6.8	0.19	172	39663	
3/03/94	12:00	122	55	101	1392	148	50	75	6.7	0.19	170	39833	
3/03/94	12:30		56	99	1388	148	50	77	6.5	0.18	166	40006	
3/03/94	13:00	123	57	99	1378	149	50	77	6.5	0.17	166	40165	
3/03/94	13:30		57	103	1375	149	50	77	6.7	0.18	172	40337	
3/03/94	14:00	124	57	103	1377	149	50	83	6.7	0.18	172	40510	
3/03/94	14:30		58	105	1378	150	50	77	6.9	0.19	176	40686	
3/03/94	15:00	125	56	100	1375	148	50	77	6.6	0.18	167	40853	
3/03/94	15:30		57	101	1372	149	50	77	6.6	0.18	170	41023	
3/03/94	16:00	126	57	99	1373	150	50	86	6.5	0.17	167	41196	
3/03/94	16:30		56	103	1372	149	53	86	6.7	0.17	172	41362	
3/03/94	17:00	127	57	100	1372	149	50	77	6.5	0.18	168	41529	
3/03/94	17:30		57	99	1373	150	50	75	6.5	0.17	167	41696	
3/03/94	18:00	128	57	101	1375	149	50	75	6.6	0.18	170	41866	
3/03/94	18:30		56	107	1368	149	50	69	7.0	0.20	180	42048	
3/03/94	19:00	129	57	101	1374	150	53	72	6.6	0.17	169	42215	
3/03/94	19:30		58	100	1375	149	53	75	6.5	0.17	168	42383	
3/03/94	20:00	130	56	101	1373	149	53	77	6.6	0.17	170	42553	
3/03/94	20:30		57	102	1378	150	53	77	6.6	0.17	171	42724	
3/03/94	21:00	131	57	100	1374	150	53	86	6.5	0.17	168	42892	
3/03/94	21:30		57	100	1374	150	53	77	6.5	0.16	168	43060	
3/03/94	22:00	132	58	102	1370	152	53	77	6.5	0.16	171	43231	
3/03/94	22:30		57	104	1370	151	53	77	6.7	0.17	175	43406	
3/03/94	23:00	133	57	105	1368	151	50	75	6.8	0.19	177	43583	
3/03/94	23:30		57	105	1368	152	50	75	6.7	0.18	176	43758	

E-34

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 16 (MARCH 8 THRU MARCH 9, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (t ₀) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀			
3/09/94	0:00	134	55	100	1354	149	50	77	6.9	0.19	179	43937	
3/09/94	0:30		55	98	1352	148	50	77	6.4	0.17	165	44101	
3/09/94	1:00	135	56	100	1348	149	50	77	6.5	0.17	168	44269	
3/09/94	1:30		54	100	1347	148	50	80	6.9	0.19	177	44446	
3/09/94	2:00	136	55	100	1348	148	50	77	6.5	0.17	167	44614	
3/09/94	2:30		54	94	1350	149	50	77	6.1	0.16	157	44771	
3/09/94	3:00	137	54	100	1352	148	47	75	6.5	0.19	168	44939	
3/09/94	3:30		55	98	1348	148	50	75	6.2	0.16	160	45099	
3/09/94	4:00	138	54	102	1349	149	50	77	6.6	0.18	171	45270	
3/09/94	4:30		53	102	1348	148	50	77	6.6	0.18	172	45442	
3/09/94	5:00	139	53	100	1350	147	47	77	6.6	0.19	168	45610	
3/09/94	5:30		54	100	1350	149	50	75	6.5	0.17	168	45778	
3/09/94	6:00	140	54	105	1350	147	50	77	6.9	0.19	176	45955	
3/09/94	6:30		52	98	1338	146	47	77	6.4	0.18	164	46119	
3/09/94	7:00	141	51	103	1340	148	47	75	6.6	0.19	172	46291	
3/09/94	7:30		52	102	1336	146	50	76	6.7	0.18	172	46463	
3/09/94	8:00	142	52	102	1337	147	50	77	6.6	0.18	171	46634	
3/09/94	8:30		53	101	1341	148	50	77	6.5	0.18	169	46803	
3/09/94	9:00	143	53	97	1346	146	50	80	6.3	0.17	163	46966	
3/09/94	9:30		53	100	1348	147	50	75	6.5	0.17	168	47133	
3/09/94	10:00	144	54	100	1355	150	50	83	6.4	0.17	167	47300	
3/09/94	10:30		53	98	1358	148	47	75	6.4	0.18	165	47465	
3/09/94	11:00	145	53	102	1354	148	50	72	6.6	0.18	170	47635	
3/09/94	11:30		51	100	1349	147	25	50	6.5	0.49	168	47803	* 11:30 Combustor trip due to sorbent air compressor surge and trip.
3/09/94	12:00		-3	34	961	38	19	25	5.3	0.29	57	47880	

135

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (t ₀) IN WG	TRIGGER IN WG					
3/16/94	14:30		-2	37	731	39	19	22	4.8	0.23			
3/16/94	15:00	0	1	41	769	42	22	25	5.2	0.23			* 14:48 coal fire.
3/16/94	15:30		3	52	859	61	30	39	5.4	0.18	88		
3/16/94	16:00	1	5	62	922	74	28	26	5.6	0.23	103	191	
3/16/94	16:30		6	82	944	75	30	42	5.6	0.20	104	295	
3/16/94	17:00	2	7	60	945	76	30	39	5.4	0.19	101	396	
3/16/94	17:30		9	62	950	77	33	44	5.6	0.18	104	500	
3/16/94	18:00	3	13	61	983	79	33	47	5.4	0.18	102	602	
3/16/94	18:30		19	62	1029	85	33	50	5.4	0.18	104	706	
3/16/94	19:00	4	26	78	1172	103	33	58	6.3	0.25	131	838	
3/16/94	19:30		33	77	1158	109	36	53	5.9	0.20	129	966	
3/16/94	20:00	5	35	76	1164	109	44	55	5.8	0.15	127	1093	
3/16/94	20:30		37	80	1180	110	39	58	6.2	0.20	135	1228	
3/16/94	21:00	6	38	79	1188	110	39	64	6.1	0.19	132	1359	
3/16/94	21:30		40	80	1197	110	39	61	6.2	0.20	135	1494	
3/16/94	22:00	7	43	81	1213	112	39	55	6.2	0.20	135	1630	
3/16/94	22:30		45	81	1232	112	42	64	6.3	0.19	135	1765	
3/16/94	23:00	8	48	81	1254	115	42	64	6.2	0.19	136	1900	
3/16/94	23:30		50	80	1200	118	44	64	6.1	0.17	134	2035	

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW ₆	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ta) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀			
3/17/94	0:00	9	54	93	1290	132	44	64	6.4	0.19	155	2190	
3/17/94	0:30		54	91	1300	131	44	72	6.5	0.19	153	2343	
3/17/94	1:00	10	53	88	1299	132	44	66	6.2	0.18	148	2491	
3/17/94	1:30		53	87	1307	130	44	69	6.2	0.18	145	2637	
3/17/94	2:00	11	52	87	1283	133	44	64	6.0	0.17	147	2783	
3/17/94	2:30		53	89	1298	134	44	58	6.2	0.18	150	2933	
3/17/94	3:00	12	54	91	1305	135	47	66	6.3	0.17	153	3086	
3/17/94	3:30		54	93	1324	134	47	66	6.5	0.18	155	3241	
3/17/94	4:00	13	54	92	1324	135	47	66	6.4	0.18	154	3395	
3/17/94	4:30		54	90	1311	136	47	69	6.6	0.19	161	3556	
3/17/94	5:00	14	55	93	1325	137	47	69	6.4	0.18	156	3713	
3/17/94	5:30		55	94	1324	136	47	69	6.5	0.18	157	3870	
3/17/94	6:00	15	56	94	1329	138	47	69	6.4	0.18	157	4027	
3/17/94	6:30		55	94	1331	137	47	69	6.5	0.18	157	4184	
3/17/94	7:00	16	54	93	1329	137	55	72	6.4	0.15	158	4340	
3/17/94	7:30		55	93	1338	138	50	75	6.4	0.17	156	4496	
3/17/94	8:00	17	56	91	1349	138	50	72	6.3	0.16	152	4648	
3/17/94	8:30		55	93	1344	137	55	75	6.4	0.15	155	4803	
3/17/94	9:00	18	56	94	1342	141	50	69	6.3	0.16	157	4960	
3/17/94	9:30		57	90	1355	146	53	66	6.5	0.16	164	5124	
3/17/94	10:00	19	60	101	1381	150	53	75	6.6	0.17	170	5294	
3/17/94	10:30		61	100	1392	151	55	72	6.5	0.16	168	5462	
3/17/94	11:00	20	59	101	1319	150	53	69	6.4	0.16	169	5632	
3/17/94	11:30		60	102	1305	150	55	72	6.4	0.15	172	5803	
3/17/94	12:00	21	61	100	1319	152	53	75	6.6	0.17	178	5981	
3/17/94	12:30		60	102	1322	150	55	75	6.4	0.15	171	6152	
3/17/94	13:00	22	59	101	1314	150	55	72	6.3	0.15	169	6320	
3/17/94	13:30		60	103	1312	151	55	72	6.4	0.15	172	6492	
3/17/94	14:00	23	59	103	1314	150	55	72	6.5	0.15	173	6665	
3/17/94	14:30		60	98	1328	151	55	66	6.2	0.14	165	6830	
3/17/94	15:00	24	58	100	1310	151	55	72	6.3	0.14	168	6998	
3/17/94	15:30		56	100	1302	149	55	72	6.3	0.14	168	7166	
3/17/94	16:00	25	56	99	1303	149	55	75	6.2	0.14	165	7331	
3/17/94	16:30		56	102	1298	150	55	75	6.4	0.15	171	7503	
3/17/94	17:00	26	55	105	1300	149	61	72	6.6	0.14	177	7679	
3/17/94	17:30		56	104	1303	149	69	77	6.5	0.12	175	7854	
3/17/94	18:00	27	56	102	1310	151	64	86	6.4	0.12	171	8025	
3/17/94	18:30		56	105	1312	150	53	80	6.6	0.16	176	8200	
3/17/94	19:00	28	56	97	1303	150	53	72	6.1	0.15	163	8364	
3/17/94	19:30		56	104	1307	151	55	75	6.5	0.15	174	8538	
3/17/94	20:00	29	57	99	1317	150	55	72	6.2	0.14	165	8703	
3/17/94	20:30		54	105	1320	150	55	72	6.6	0.16	176	8879	
3/17/94	21:00	30	54	105	1317	151	55	72	6.6	0.15	176	9056	
3/17/94	21:30		53	103	1307	150	55	77	6.5	0.15	173	9229	
3/17/94	22:00	31	53	104	1297	149	55	66	6.5	0.15	174	9402	
3/17/94	22:30		54	105	1307	150	55	72	6.6	0.15	177	9579	
3/17/94	23:00	32	54	97	1310	150	55	72	6.1	0.14	162	9741	
3/17/94	23:30		54	106	1310	149	55	75	6.7	0.16	177	9919	

E-37

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/K ₀	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (t ₀) IN WG	TRIGGER IN WG					
3/18/94	0:00	33	53	101	1312	151	55	75	6.3	0.15	170	10089	
3/18/94	0:30		53	103	1312	150	55	69	6.5	0.15	173	10261	
3/18/94	1:00	34	54	104	1319	150	55	72	6.5	0.15	174	10438	
3/18/94	1:30		53	102	1321	149	53	72	6.5	0.16	171	10607	
3/18/94	2:00	35	53	97	1332	150	61	69	6.2	0.13	163	10770	
3/18/94	2:30		53	104	1325	151	55	69	6.6	0.16	175	10945	
3/18/94	3:00	36	53	103	1327	152	55	72	6.4	0.15	172	11117	
3/18/94	3:30		54	102	1333	151	55	69	6.5	0.15	171	11288	
3/18/94	4:00	37	53	101	1338	152	55	72	6.4	0.15	169	11457	
3/18/94	4:30		54	106	1351	153	58	69	6.7	0.15	177	11634	
3/18/94	5:00	38	54	98	1352	152	61	69	6.2	0.13	164	11799	
3/18/94	5:30		54	103	1353	151	58	66	6.6	0.15	173	11972	
3/18/94	6:00	39	54	104	1347	152	58	80	6.6	0.15	174	12146	
3/18/94	6:30		54	105	1342	150	58	77	6.7	0.15	175	12322	
3/18/94	7:00	40	53	102	1345	151	58	75	6.5	0.14	171	12493	
3/18/94	7:30		55	103	1354	153	58	75	6.5	0.15	173	12668	
3/18/94	8:00	41	55	107	1351	152	58	75	6.8	0.15	179	12845	
3/18/94	8:30		54	99	1353	152	58	86	6.3	0.14	166	13010	
3/18/94	9:00	42	55	103	1360	153	58	75	6.5	0.14	172	13182	
3/18/94	9:30		55	101	1369	151	61	77	6.5	0.14	169	13351	
3/18/94	10:00	43	55	96	1381	151	58	77	6.2	0.14	161	13513	
3/18/94	10:30		56	99	1402	152	58	80	6.5	0.14	166	13679	
3/18/94	11:00	44	56	103	1399	152	58	77	6.8	0.15	173	13852	
3/18/94	11:30		55	104	1383	151	69	80	6.7	0.12	175	14027	
3/18/94	12:00	45	55	101	1391	153	61	80	6.5	0.14	169	14196	
3/18/94	12:30		54	101	1392	151	61	80	6.5	0.14	169	14365	
3/18/94	13:00	46	55	97	1392	151	61	80	6.3	0.13	162	14527	
3/18/94	13:30		55	103	1379	152	61	80	6.6	0.14	172	14699	
3/18/94	14:00	47	54	100	1385	151	58	80	7.0	0.16	181	14881	
3/18/94	14:30		55	107	1391	151	58	80	7.0	0.16	180	15061	
3/18/94	15:00	48	55	107	1397	152	58	77	7.0	0.16	180	15241	
3/18/94	15:30		55	104	1373	150	58	77	6.7	0.15	174	15415	
3/18/94	16:00	49	55	103	1379	149	55	77	6.7	0.16	172	15588	
3/18/94	16:30		55	109	1379	152	58	77	7.0	0.16	183	15770	
3/18/94	17:00	50	47	106	1389	151	58	72	6.9	0.16	177	15948	
3/18/94	17:30		46	107	1391	150	55	80	7.0	0.17	180	16127	
3/18/94	18:00	51	46	111	1391	151	58	77	7.2	0.17	185	16313	
3/18/94	18:30		46	99	1391	149	55	77	6.5	0.16	168	16479	
3/18/94	19:00	52	45	107	1399	149	55	77	7.1	0.17	179	16658	
3/18/94	19:30		44	105	1392	148	64	77	7.0	0.14	176	16834	
3/18/94	20:00	53	46	106	1399	149	55	75	7.0	0.17	178	17012	
3/18/94	20:30		45	105	1394	149	55	77	7.0	0.17	178	17188	
3/18/94	21:00	54	46	110	1389	149	55	75	7.3	0.18	185	17373	
3/18/94	21:30		44	104	1388	148	64	75	6.9	0.14	174	17548	
3/18/94	22:00	55	45	102	1381	148	53	83	6.7	0.17	171	17719	
3/18/94	22:30		45	107	1384	149	55	75	7.0	0.17	179	17897	
3/18/94	23:00	56	46	108	1387	149	53	75	7.1	0.19	181	18078	
3/18/94	23:30		44	107	1395	149	55	77	7.1	0.17	179	18257	

E-38

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW ₀	FLOW T		P	BASELINE		FACE	RELATIVE	ASH	TOTAL	REMARKS
				KPPH	DEG F		PSIG	DP (t ₀)					
							IN WG	IN WG	FT/MIN	ABILITY	LB	LB	
										K/K ₀			
3/19/94	0:00	57	45	107	1399	149	55	61	7.1	0.17	179	18436	
3/19/94	0:30		42	101	1403	144	53	83	6.9	0.18	170	18605	
3/19/94	1:00	58	40	106	1335	143	55	69	7.0	0.17	178	18783	
3/19/94	1:30		39	105	1320	144	50	64	6.9	0.19	176	18959	
3/19/94	2:00	59	39	102	1326	144	50	77	6.7	0.18	170	19129	
3/19/94	2:30		39	96	1315	142	50	69	6.3	0.16	160	19290	
3/19/94	3:00	60	41	101	1317	144	53	69	6.6	0.16	169	19459	
3/19/94	3:30		40	98	1312	143	53	69	6.4	0.16	165	19623	
3/19/94	4:00	61	43	101	1328	146	55	72	6.5	0.15	169	19792	
3/19/94	4:30		43	92	1370	149	55	83	6.1	0.14	155	19947	
3/19/94	5:00	62	43	102	1384	148	61	72	6.8	0.14	171	20119	
3/19/94	5:30		44	95	1309	148	55	75	6.3	0.15	160	20278	
3/19/94	6:00	63	45	96	1403	148	53	75	6.4	0.16	161	20440	
3/19/94	6:30		45	102	1398	149	55	75	6.8	0.16	172	20611	
3/19/94	7:00	64	44	100	1397	149	55	72	6.6	0.16	167	20778	
3/19/94	7:30		44	95	1400	149	61	77	6.3	0.13	160	20938	
3/19/94	8:00	65	45	99	1398	149	55	75	6.6	0.16	166	21104	
3/19/94	8:30		43	102	1389	148	55	77	6.8	0.16	171	21275	
3/19/94	9:00	66	44	99	1384	149	55	77	6.5	0.16	167	21442	
3/19/94	9:30		45	98	1387	147	55	72	6.5	0.15	164	21606	
3/19/94	10:00	67	44	98	1394	148	53	77	6.5	0.16	164	21769	
3/19/94	10:30		44	103	1396	149	55	77	6.8	0.16	173	21942	
3/19/94	11:00	68	45	98	1400	149	55	77	6.6	0.16	165	22107	
3/19/94	11:30		45	98	1393	148	55	77	6.5	0.15	164	22271	
3/19/94	12:00	69	44	100	1397	149	55	75	6.6	0.16	168	22439	
3/19/94	12:30		44	95	1394	148	53	77	6.3	0.16	160	22599	
3/19/94	13:00	70	43	102	1393	148	53	75	6.8	0.18	171	22770	
3/19/94	13:30		40	97	1338	141	53	72	6.5	0.16	163	22933	
3/19/94	14:00	71	38	102	1293	142	50	69	6.7	0.18	172	23104	
3/19/94	14:30		39	102	1274	142	53	72	6.6	0.16	171	23275	
3/19/94	15:00	72	39	101	1266	142	53	72	6.5	0.16	169	23444	
3/19/94	15:30		38	103	1266	142	53	69	6.6	0.16	173	23617	
3/19/94	16:00	73	38	95	1268	142	53	72	6.1	0.14	159	23776	
3/19/94	16:30		38	102	1269	143	55	72	6.5	0.15	170	23946	
3/19/94	17:00	74	38	101	1274	142	55	72	6.5	0.15	170	24116	
3/19/94	17:30		40	100	1279	142	55	75	6.5	0.15	168	24284	
3/19/94	18:00	75	39	100	1290	144	55	75	6.4	0.15	167	24451	
3/19/94	18:30		39	97	1290	143	61	75	6.3	0.13	162	24613	
3/19/94	19:00	76	40	98	1276	142	55	75	6.3	0.14	164	24777	
3/19/94	19:30		38	97	1261	143	55	72	6.2	0.14	162	24939	
3/19/94	20:00	77	39	98	1273	143	55	75	6.3	0.14	164	25103	
3/19/94	20:30		39	99	1283	144	55	75	6.4	0.15	167	25269	
3/19/94	21:00	78	39	100	1306	144	58	75	6.5	0.14	167	25437	
3/19/94	21:30		40	96	1307	143	55	75	6.3	0.14	161	25597	
3/19/94	22:00	79	40	95	1317	144	58	69	6.2	0.13	159	25757	
3/19/94	22:30		39	99	1311	145	58	75	6.4	0.14	166	25923	
3/19/94	23:00	80	39	94	1300	141	55	75	6.2	0.14	157	26080	
3/19/94	23:30		41	100	1317	145	55	72	6.5	0.15	168	26247	

E-39

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW ₀	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K ₀		ASH LB	
3/20/94	0:00	81	40	103	1329	145	55	72	6.7	0.16	172	26419	
3/20/94	0:30		41	95	1335	146	55	75	6.2	0.14	159	26578	
3/20/94	1:00	82	39	100	1323	145	55	80	6.5	0.15	167	26745	
3/20/94	1:30		39	99	1316	145	55	75	6.4	0.15	167	26912	
3/20/94	2:00	83	40	97	1317	145	55	75	6.3	0.14	163	27075	
3/20/94	2:30		38	93	1313	143	61	75	6.1	0.12	155	27230	
3/20/94	3:00	84	40	97	1305	145	55	75	6.3	0.14	162	27392	
3/20/94	3:30		38	97	1309	144	66	80	6.3	0.11	162	27555	
3/20/94	4:00	85	39	97	1311	145	58	80	6.3	0.13	162	27717	
3/20/94	4:30		41	98	1310	145	55	75	6.3	0.14	164	27881	
3/20/94	5:00	86	41	97	1308	145	58	75	6.3	0.13	162	28043	
3/20/94	5:30		40	96	1307	145	58	80	6.2	0.13	161	28204	
3/20/94	6:00	87	40	98	1309	144	58	75	6.4	0.14	165	28369	
3/20/94	6:30		40	101	1308	145	58	75	6.6	0.14	170	28539	
3/20/94	7:00	88	39	94	1308	145	58	75	6.1	0.13	158	28698	
3/20/94	7:30		42	95	1318	145	58	75	6.2	0.13	159	28856	
3/20/94	8:00	89	42	98	1327	146	58	75	5.8	0.12	151	29007	
3/20/94	8:30		40	100	1327	146	55	75	6.5	0.15	168	29175	
3/20/94	9:00	90	41	97	1326	146	58	75	6.3	0.13	162	29337	
3/20/94	9:30		40	97	1331	146	58	75	6.3	0.14	163	29500	
3/20/94	10:00	91	40	97	1330	145	58	75	6.3	0.14	163	29663	
3/20/94	10:30		40	98	1332	146	58	75	6.4	0.14	165	29828	
3/20/94	11:00	92	41	97	1327	146	64	75	6.3	0.12	162	29990	
3/20/94	11:30		40	102	1325	145	58	75	6.6	0.15	171	30160	
3/20/94	12:00	93	40	98	1325	146	58	75	6.3	0.14	164	30325	
3/20/94	12:30		42	97	1332	146	58	83	6.3	0.14	163	30487	
3/20/94	13:00	94	39	95	1337	146	58	77	6.2	0.13	159	30648	
3/20/94	13:30		40	96	1334	145	61	75	6.3	0.13	160	30806	
3/20/94	14:00	95	40	99	1327	144	55	75	6.5	0.15	165	30971	
3/20/94	14:30		41	97	1319	145	55	72	6.3	0.14	162	31134	
3/20/94	15:00	96	40	98	1325	146	58	75	6.3	0.14	164	31298	
3/20/94	15:30		40	99	1324	145	64	75	6.5	0.13	167	31464	
3/20/94	16:00	97	42	104	1320	145	58	72	6.7	0.15	174	31638	
3/20/94	16:30		40	97	1316	146	58	75	6.3	0.14	163	31801	
3/20/94	17:00	98	41	97	1311	145	58	75	6.3	0.14	163	31964	
3/20/94	17:30		39	97	1309	145	58	75	6.3	0.14	163	32127	
3/20/94	18:00	99	40	99	1301	145	64	75	6.4	0.12	166	32293	
3/20/94	18:30		39	95	1306	144	58	75	6.2	0.13	160	32452	
3/20/94	19:00	100	39	95	1308	144	58	75	6.2	0.13	159	32611	
3/20/94	19:30		39	98	1312	145	58	72	6.4	0.14	164	32776	
3/20/94	20:00	101	40	96	1322	145	58	75	6.2	0.13	161	32938	
3/20/94	20:30		40	93	1332	147	58	75	6.1	0.13	157	33093	
3/20/94	21:00	102	40	97	1354	147	58	75	6.3	0.14	162	33255	
3/20/94	21:30		39	98	1353	145	58	75	6.5	0.14	164	33419	
3/20/94	22:00	103	39	93	1338	146	58	83	6.1	0.13	157	33576	
3/20/94	22:30		39	94	1341	146	58	75	6.1	0.13	157	33733	
3/20/94	23:00	104	41	98	1338	146	61	75	6.4	0.13	164	33897	
3/20/94	23:30		40	93	1333	146	58	75	6.1	0.13	156	34053	

E-40

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/KØ	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG					
3/21/94	0:00	105	40	95	1327	146	61	75	6.2	0.13	160	34212	
3/21/94	0:30		39	100	1326	145	58	83	6.5	0.14	167	34380	
3/21/94	1:00	106	39	97	1318	143	58	69	6.4	0.14	163	34542	
3/21/94	1:30		40	95	1325	146	58	75	6.2	0.13	160	34702	
3/21/94	2:00	107	41	95	1328	145	61	80	6.2	0.13	159	34861	
3/21/94	2:30		40	96	1341	145	58	77	6.3	0.14	161	35022	
3/21/94	3:00	108	39	94	1345	146	61	75	6.2	0.12	157	35180	
3/21/94	3:30		41	100	1343	146	58	77	6.5	0.14	167	35347	
3/21/94	4:00	109	42	94	1338	146	61	77	6.1	0.12	157	35504	
3/21/94	4:30		41	99	1334	146	64	83	6.5	0.13	167	35670	
3/21/94	5:00	110	42	101	1338	146	58	77	6.6	0.15	170	35840	
3/21/94	5:30		41	102	1342	146	58	75	6.6	0.15	170	36010	
3/21/94	6:00	111	40	99	1358	146	58	75	6.5	0.14	165	36176	
3/21/94	6:30		42	96	1365	147	58	75	6.3	0.14	160	36336	
3/21/94	7:00	112	43	95	1364	147	58	83	6.3	0.14	160	36496	
3/21/94	7:30		42	97	1352	147	61	77	6.4	0.13	163	36659	
3/21/94	8:00	113	40	97	1340	146	61	77	6.3	0.13	162	36821	
3/21/94	8:30		41	100	1341	146	58	77	6.6	0.15	168	36989	
3/21/94	9:00	114	42	94	1337	144	55	75	6.2	0.14	157	37146	
3/21/94	9:30		39	98	1328	144	55	72	6.5	0.15	165	37311	
3/21/94	10:00	115	38	103	1321	144	55	66	6.7	0.16	173	37484	
3/21/94	10:30		41	98	1329	145	55	72	6.5	0.15	165	37649	
3/21/94	11:00	116	41	94	1394	146	58	75	6.3	0.14	157	37806	
3/21/94	11:30		41	94	1419	146	61	75	6.5	0.14	158	37964	
3/21/94	12:00	117	42	95	1430	148	61	77	6.4	0.14	159	38122	
3/21/94	12:30		43	93	1431	146	61	77	6.4	0.13	156	38278	
3/21/94	13:00	118	41	94	1415	144	61	77	6.5	0.14	157	38435	
3/21/94	13:30		42	94	1407	144	61	77	6.4	0.13	157	38592	
3/21/94	14:00	119	41	91	1407	144	61	77	6.2	0.13	152	38744	
3/21/94	14:30		41	93	1411	145	61	77	6.4	0.13	157	38901	
3/21/94	15:00	120	41	88	1411	145	66	77	6.0	0.11	148	39048	
3/21/94	15:30		40	91	1403	144	61	80	6.2	0.13	153	39201	
3/21/94	16:00	121	42	92	1402	143	64	80	6.3	0.12	154	39355	
3/21/94	16:30		42	94	1403	144	64	80	6.4	0.13	157	39512	
3/21/94	17:00	122	43	90	1403	142	61	80	6.2	0.13	150	39662	
3/21/94	17:30		40	90	1403	142	61	80	6.3	0.13	151	39813	
3/21/94	18:00	123	40	94	1410	143	64	80	6.5	0.13	158	39970	
3/21/94	18:30		41	92	1403	142	64	80	6.4	0.13	155	40125	
3/21/94	19:00	124	42	92	1395	141	66	80	6.4	0.12	154	40279	
3/21/94	19:30		41	91	1395	142	64	80	6.3	0.12	152	40431	
3/21/94	20:00	125	40	91	1398	142	64	83	6.3	0.12	153	40584	
3/21/94	20:30		42	90	1394	141	72	80	6.3	0.11	151	40735	
3/21/94	21:00	126	40	90	1393	142	64	89	6.2	0.12	151	40886	
3/21/94	21:30		40	91	1403	142	66	83	6.3	0.12	153	41039	
3/21/94	22:00	127	42	92	1410	142	61	83	6.4	0.13	154	41193	
3/21/94	22:30		42	91	1413	143	64	83	6.3	0.12	152	41345	
3/21/94	23:00	128	41	89	1414	142	64	83	6.2	0.12	150	41495	
3/21/94	23:30		42	89	1417	142	72	83	6.2	0.11	150	41645	

E-41

TABLE 6 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MIN	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE PERME- ABILITY K/K0	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG					
3/22/94	0:00	129	40	92	1415	143	64	83	6.4	0.13	155	41800	
3/22/94	0:30		41	90	1416	143	64	83	6.3	0.12	151	41961	
3/22/94	1:00	130	41	94	1417	142	66	83	6.5	0.12	157	42100	
3/22/94	1:30		42	89	1428	144	72	83	6.2	0.11	149	42257	
3/22/94	2:00	131	41	91	1423	143	61	83	6.3	0.13	152	42409	
3/22/94	2:30		42	92	1417	143	66	83	6.4	0.12	155	42564	
3/22/94	3:00	132	42	95	1427	144	61	83	6.6	0.14	159	42723	
3/22/94	3:30		42	90	1432	143	61	83	6.3	0.13	151	42874	
3/22/94	4:00	133	40	93	1418	142	58	89	6.5	0.14	156	43030	
3/22/94	4:30		40	91	1419	143	58	80	6.3	0.14	153	43183	
3/22/94	5:00	134	40	91	1424	140	61	83	6.5	0.13	152	43335	
3/22/94	5:30		43	92	1433	141	58	80	6.5	0.15	155	43490	
3/22/94	6:00	135	40	91	1420	142	58	86	6.4	0.14	153	43643	
3/22/94	6:30		41	92	1418	141	55	77	6.5	0.15	154	43797	
3/22/94	7:00	136	41	87	1414	140	55	80	6.2	0.14	146	43943	
3/22/94	7:30		39	94	1412	141	58	80	6.6	0.15	158	44101	
3/22/94	8:00	137	40	85	1409	136	53	89	6.2	0.15	143	44244	
3/22/94	8:30		34	85	1324	132	53	72	6.0	0.14	142	44386	
3/22/94	9:00	138	37	90	1286	137	58	77	6.0	0.13	151	44537	
3/22/94	9:30		38	86	1364	135	55	75	6.1	0.14	144	44681	
3/22/94	10:00	139	32	89	1281	130	53	89	6.3	0.15	150	44831	
3/22/94	10:30		30	86	1215	131	58	72	5.9	0.12	147	44978	
3/22/94	11:00	140	42	87	1367	140	58	83	6.0	0.13	146	45124	
3/22/94	11:30		42	91	1410	140	58	77	6.4	0.14	153	45277	
3/22/94	12:00	141	42	94	1428	142	61	75	6.6	0.14	157	45434	
3/22/94	12:30		39	94	1411	140	58	75	6.6	0.15	157	45591	
3/22/94	13:00	142	36	87	1365	134	55	77	6.3	0.14	147	45738	
3/22/94	13:30		34	91	1324	133	58	77	6.4	0.14	153	45890	
3/22/94	14:00	143	35	93	1307	134	55	77	6.5	0.15	156	46047	
3/22/94	14:30		36	88	1315	135	58	77	6.1	0.13	148	46195	
3/22/94	15:00	144	35	90	1316	130	58	86	6.6	0.14	164	46358	
3/22/94	15:30		36	89	1328	137	58	77	6.1	0.13	150	46500	
3/22/94	16:00	145	35	94	1311	137	58	77	6.4	0.14	158	46665	
3/22/94	16:30		36	94	1310	138	61	80	6.3	0.13	157	46823	
3/22/94	17:00	146	34	90	1309	137	61	80	6.1	0.12	150	46973	
3/22/94	17:30		36	94	1315	137	61	89	6.4	0.13	158	47131	
3/22/94	18:00	147	36	92	1320	139	69	80	6.2	0.11	154	47286	
3/22/94	18:30		34	86	1313	137	66	80	5.9	0.10	144	47430	
3/22/94	19:00	148	35	91	1312	137	66	80	6.2	0.11	152	47582	
3/22/94	19:30		34	92	1311	137	66	80	6.2	0.11	154	47736	
3/22/94	20:00	149	34	93	1312	137	61	80	6.3	0.13	156	47892	
3/22/94	20:30		35	86	1310	137	69	80	5.8	0.10	144	48035	
3/22/94	21:00	150	36	93	1310	137	66	80	6.3	0.12	157	48192	
3/22/94	21:30		33	90	1305	135	66	80	6.2	0.11	151	48343	
3/22/94	22:00	151	35	90	1304	137	66	80	6.1	0.11	151	48494	
3/22/94	22:30		36	93	1306	138	66	80	6.3	0.11	156	48651	
3/22/94	23:00	152	34	90	1317	137	66	77	6.1	0.11	150	48801	
3/22/94	23:30		35	90	1313	137	66	77	6.1	0.11	150	48951	

E-42

TABLE 8 - ADVANCED PARTICLE FILTER SUMMARY OF CONDITIONS, TEST RUN 17 (MAR 16 THRU MAR 23, 1994)

DATE	TIME	HRS	MW%	FLOW KPPH	T DEG F	P PSIG	BASELINE		FACE VELOCITY FT/MIN	RELATIVE	ASH FILTERED LB	TOTAL ASH LB	REMARKS
							DP (ts) IN WG	TRIGGER IN WG		PERME- ABILITY K/K0			
3/23/94	0:00	153	35	93	1317	138	66	80	6.3	0.12	156	49107	
3/23/94	0:30		33	90	1320	137	69	80	6.2	0.11	150	49258	
3/23/94	1:00	154	35	89	1333	137	66	80	6.1	0.11	149	49406	
3/23/94	1:30		34	93	1337	138	66	80	6.4	0.12	157	49563	
3/23/94	2:00	155	33	92	1338	137	69	80	6.3	0.11	154	49717	
3/23/94	2:30		35	91	1338	137	69	80	6.3	0.11	152	49869	
3/23/94	3:00	156	33	89	1325	138	66	80	6.1	0.11	150	50019	
3/23/94	3:30		35	93	1322	137	66	80	6.3	0.12	155	50174	
3/23/94	4:00	157	34	89	1329	137	69	80	6.1	0.11	149	50323	
3/23/94	4:30		36	93	1324	138	69	89	6.3	0.11	150	50479	
3/23/94	5:00	158	34	93	1327	137	69	80	6.4	0.11	155	50634	
3/23/94	5:30		35	97	1332	137	66	80	6.7	0.12	162	50790	
3/23/94	6:00	159	35	94	1333	138	66	80	6.4	0.12	158	50954	
3/23/94	6:30		35	92	1335	137	66	80	6.3	0.12	154	51108	
3/23/94	7:00	160	33	94	1333	136	72	86	6.5	0.11	157	51265	
3/23/94	7:30		34	93	1333	138	69	80	6.4	0.11	157	51422	
3/23/94	8:00	161	34	91	1340	138	69	83	6.3	0.11	152	51574	
3/23/94	8:30		34	90	1340	138	72	83	6.2	0.10	150	51725	
3/23/94	9:00	162	33	93	1362	138	69	83	6.5	0.11	157	51881	
3/23/94	9:30		33	90	1372	138	75	80	6.3	0.10	151	52032	
3/23/94	10:00	163	35	94	1378	138	66	83	6.6	0.12	157	52190	
3/23/94	10:30		35	91	1372	139	72	80	6.3	0.11	152	52342	
3/23/94	11:00	164	0	1	1340	5	3	66	0.7	0.28	2	52344	* 10:50 Combustor trip due to a gas turbine lube oil system failure alarm.
3/23/94	11:30		0	0	1290	0			0.0	-	0	52344	

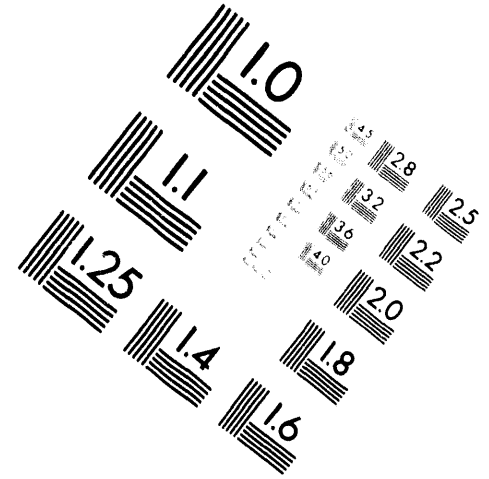
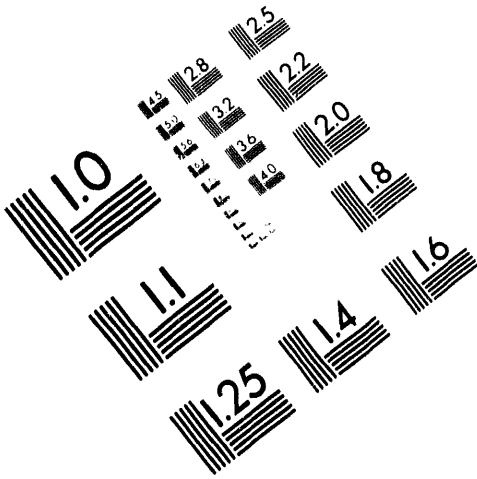
E-43



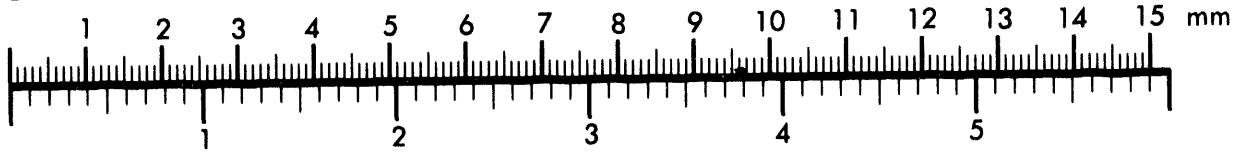
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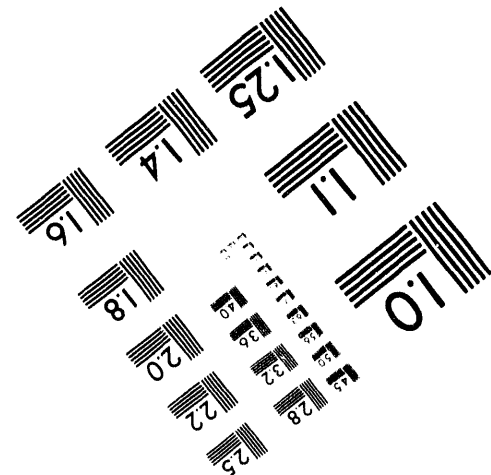
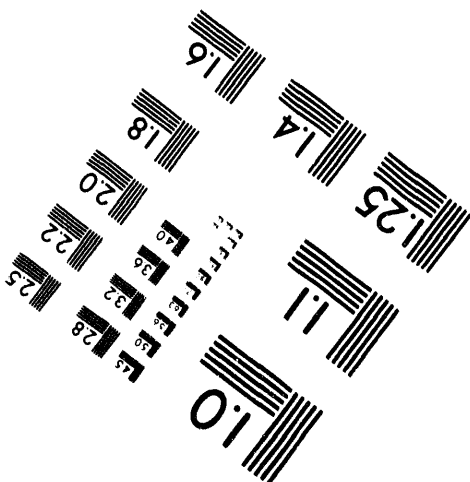
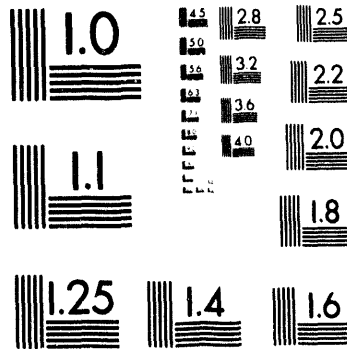
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12/28/94

END