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RIVESVILLE MULTICELL FLUIDIZED-BED BOILER

Quarterly Technical Progress Report for Period
October—December 1979

Work Performed Under Contract No. AC21-81MC16230

Pope, Evans and Robbins, Incorporated
New York, New York

TECHNICAL INFORMATION CENTER
UNITED STATES DEPARTMENT OF ENERGY

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Prepared by

Pope, Evans and Robbins, Incorporated

Quarterly Technical Progress Report

For the period October - December, 1979

Prepared for

**UNITED STATES DEPARTMENT OF ENERGY
Morgantown Energy Technology Center
Morgantown, West Virginia**

Under Contract No. DE-AC21-81MC16230

ABSTRACT

The objective of this program is to design, construct and test a multicell fluidized-bed boiler as a pollution-free method of burning high-sulfur or highly corrosive coals without excessive maintenance problems. The fluidized-bed boiler will provide approximately 300,000 pounds of steam per hour. Steam pressure and temperature conditions were selected to meet requirements of the site at which the boiler was installed.

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INTRODUCTION

General

The Government, in order to implement research and development work on the multicell fluidized bed boiler operating under utility electric power generation conditions, awarded DOE/ERDA/OCR Contract No. EX-76-C-01-1237 to Pope, Evans and Robbins Incorporated (PER) on October 5, 1972. The work under this contract is a follow-up to work previously performed by PER under OCR Contract No. 14-01-0001-478 as amended, and OCR Contract No. 14-02-0001-1229 which indicated that continued development would have a high probability of success.

Tasks and Phases

The objective of the program covered by DOE Contract No. EX-76-C-01-1237 is to test a multicell fluidized bed boiler as a pollution-free method of burning high-sulfur coals or highly corrosive coals without excessive maintenance.

The objective is to be accomplished by designing, constructing and operating a multicell fluidized bed boiler under utility electric power generation conditions in four technically distinct, but chronologically overlapping phases:

Phase I	MFB Boiler and Plant Design: performance of experiments in the Alexandria, VA. Laboratory to optimize MFB boiler performance.
Phase II	Fabrication, Installation and Shakedown Status Operation.
Phase III	Demonstration Operation under SO ₂ Acceptor Mode.
Phase IV	Preparation of Design and Operation Manuals and design of a factory-assembled industrial MFB unit.

This quarterly report covers work performed under Phase I, III and IV of the contract in the period October, November, December 1979.

1.0 SUMMARY OF PERFORMED TASKS

1.1 Alexandria, VA Laboratory Operation

Work in the Alexandria laboratory included the following:

<u>Activity No.</u>	<u>Description</u>
1620	Stack Gas Baghouse Test Program
407	Flyash Reinjection
118	Flyash Disposal System Modifications

The following tests were completed during the reporting period.

<u>Test No.</u>	<u>Date</u>	<u>Description</u>	<u>Duration (Hrs)</u>
704-21	10/04/79	Baghouse Testing and flyash feeder evaluation	5
704-22	10/09/79	Baghouse testing and flyash feeder evaluation	5
704-23	10/17/79	Baghouse testing and double flyash feeder evaluation	10
704-24	10/24-26/79	Baghouse testing and flyash feeder evaluation	56
704-25	10/31-11/02/79	Baghouse testing and flyash feeder evaluation	50
PDU-7	11/06/79	Flyash Reinjection	6
704-26	11/08/79	Flyash Reinjection	9
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1.2 Rivesville MFB Plant Operations

During this reporting period, advantage was taken of the scheduled outage brought on by Monongahela Power's boiler and turbine outage by installing a Fuller-Kinyon fuel feed system for the MFB C-cell. In addition, other major items undertaken during this period included the replacement of C and B-cell perforated air distributors with the "nut and bolt" design, replacement of boiler bed thermocouples, installation of main feedwater line block valve and flow orifice, and a hydrostatic test on the boiler. In addition, approximately 150 maintenance and repair jobs were completed this period.

1.3 New York Office Engineering

The New York Office design and engineering staff continued to perform various tasks in support of the overall program and the Rivesville MFB Plant Operations. These tasks included studies and evaluation of systems and equipment and modifications to the MFB plant to improve performance and increase reliability. Tasks performed include:

- Review of revised design drawings for the Fuller-Kinyon fuel feed system
- Structural design check completed for the laboratory second floor slab
- Investigated need for expansion joints on the vertical run of Fuller-Kinyon system

1.4 Subcontract Activities

1.4.1 MFB Plant Advisory Operations Assistance (Stone & Webster Engineering Corporation)

S&W continued to furnish operations assistance at the Rivesville MFB Plant and provide engineering and design support for plant modifications. Engineering tasks included resolving problems associated with ash cooler T-42 excessive carryover and design for installation of the D-cell 2½" B & W letdown valve. A design for converting the ash discharge to the silo from a pressure to a vacuum system was also investigated. In addition, S&W investigated handling/disposal of coal fines from the Rotex screen.

1.4.2 MFB Steam Generator Development (Foster Wheeler Energy Corporation)

Foster Wheeler Energy Corporation engaged in the following activities in support of Rivesville MFB operation:

- Fabrication of replacement drilled bolt air distributors for cell C was completed and the units shipped to

Rivesville for installation in the MFB.

1.5 Review of Significant Events

During the period October through December 1979, the following significant events occurred:

- Installation of Fuller-Kinyon Fuel Injection System to Service C Cell
- Replacement of C and B Cell's Perforated Air Distributors with the "Nut and Bolt" Design

1.6 Future Planning

The following activities are scheduled for the January, February, March 1980 period:

- Continue performance and emission testing
- Continue baghouse and flyash reinjection testing and prepare a data base testing program at Alexandria PDU
- Continue performance testing on new source Rivesville limestone in the Alexandria PDU
- Continue New York Office Engineering support to improve MFB operation and reliability

2.0 ALEXANDRIA, VA LABORATORY RESULTS

2.1 Stack Gas Baghouse Test Program (Activity No. 1620)

In order to study the application of fabric filters for final particulate removal in the FBC process, a test baghouse was installed and is being tested at the PDU laboratory. Performance testing using a reverse air and/or shake cleaning mode was completed during the reporting period. Design parameters for the test unit in this configuration are as follows:

Baghouse:

Manufacturer	Envirotech Division, Buell Corporation
Gas Flow Rate	3000 ACFM
Temperature	500° F
Compartments	1
Dimensions	9'L x 5'W x 35'H

Bags:

Manufacturer	Norblow Division, Envirotech
Total Bags	32
Diameter	8"
Length	23'
Active Area/Bag	48.2 sq. ft.
Fabric	Glass, 54/30 count, 3x1 twill
Finish	Teflon "B", 7-10% by weight
Permeability	50-75 CFV @ 1/2" H ₂ O
Weight	9.5 oz/sq. yd.
Air-to-Cloth Ratio	2.0 ACFM/ft ²

2.1.1 Operation and Test Procedures

Since the test baghouse is a single compartment unit, the stack gas is diverted to the atmosphere during cleaning in the reverse air and/or shaker mode. To obtain hot gas to reverse the air flow during cleaning, three-way poppet valves are arranged as shown in Figure 1 to pressurize the clean side of the bags with gas from the dust collection side. The cleaning cycle consists of four timed steps in the following order:

1. bypass to atmosphere,
2. reverse air bag flexing
3. bag shaking
4. dust settling dwell time

The duration of each of these steps in the cleaning cycle are variable from 0 to 120 seconds and the period between cycles is variable from 0 to 120 minutes. In a reserve air only cleaning

mode (no shake), the bag shake period becomes a settling dwell time and in the shake only cleaning mode, the reverse air period becomes a dwell period.

Performance tests were conducted during the reporting period at various air-to-cloth ratios. The purpose of each test was collection of sufficient data for evaluation of mass collection efficiencies, penetrations, relative bag cleaning capacity of the cleaning modes, outlet dust concentrations, outlet dust loadings in terms of pounds of particulate per million Btu fired, and percent stack opacity.

Instrumentation monitored during the baghouse operation included:

- pressure gages on the high and low side of the baghouse fan,
- differential pressure gages for measuring pressure drop across the bags,
- thermocouples in the inlet and outlet flue gas lines,
- a Lear Siegler model RM-41 transmissometer for measuring optical density of gas outlet stream.

Sampling and measurement of the baghouse inlet and outlet dust loading was conducted during selected operating time periods using Rader high volume isokinetic flue gas samplers.

2.1.2 Performance Testing

Following a review of baghouse performance data based on tests run last period, a new direction in baghouse testing was adopted this period. Due to problems in several areas described below, testing in the reverse air and reverse air with shake modes of operation was abandoned in favor of shake only. Accordingly, all reverse air flexing bags were removed from the baghouse and replaced with bags suited for operation in the shake only mode.

As previously reported, the single compartment design of the test unit compromises testing in the reverse air mode. The baghouse was designed to use hot gas from the dirty air side to flex the bags during reverse air flow. This procedure led to several problems including excessive bag pressure drop due to solids accumulation on both sides of the cloth. For example, ΔP values rose to 8 in. w.c. within 30 minutes of cleaning in some tests. Further, accumulation of dust on the clean side of the baghouse was found on two occasions to be smoldering in a few days after the unit was shut down.

This is believed to be the result of hydration of the calcium oxide in the flyash with moisture in the air. This heated the flyash to the point where combustion of the carbon soot could begin.

In addition, collection efficiencies were lower than expected. The outlet particulate emissions were measured to be below the new source performance standard of 0.03 lb. particulate per 10⁶ Btu fired in only four of 35 sample periods. Finally, since reverse air flexing with dirty air is not conventional practice, data collected on such a system would not be representative of baghouses in final particulate filter systems in future FBC units.

In order to operate the test unit representatively in the reverse air mode, a source of clean hot gas would be necessary. Since this would require extensive duct work modifications and the addition of air heating equipment, no plans are being made to continue reverse air testing.

2.1.3 Performance Results

Two baghouse evaluation tests were conducted (Table 2.1 and 2.2), Test No. 704-23, a 10-hour run, and Test No. 704-24, a 56-hour run. After installation and prior to Test No. 704-23, the new shake only bags were precoated with limestone dust. During Test No. 704-23, the first test with the new bags at an air-to-cloth ratio of 2.0 ACFM/ft², the baghouse outlet was sampled six times. The data shows that the new source standard of 0.03 lbs. particulate per 10⁶ Btu fired was never met. Observation showed that when the baghouse returned to operation following a clean cycle, visible emissions were seen at the baghouse outlet. However, no visible emissions were seen during operation, even though the outlet lb/hr values were higher than expected for operation with new precoated bags. Examination of the bags after Test No. 704-23 revealed no obvious leaks. Thus it was felt that dust which accumulated on the clean side of the baghouse and in the duct work during previous reverse air operation, had not been completely purged. Prior to Test No. 704-24, the baghouse was repeatedly cleaned until no visible emissions appeared in going from the clean to the operate mode. Also, since reverse air testing is no longer planned, a blind flange was installed to isolate the dirty gas from the clean air side of the reverse air poppet valve.

The baghouse outlet was sampled 11 times during Test No. 704-24. These results are shown in Table 2. Mass collection efficiencies were better than 99 percent in all cases as was expected. More importantly, the data shows the baghouse exceeded the new source standard in each case. The results indicate that the outlet loading in terms of lbs particulate/10⁶ Btu fired, remained fairly constant despite an inlet loading variation of almost two.

2.1.4 Evaluation of Cleaning Modes

Baghouse operation during Test No. 704-24 showed vast improvement over any tests run where reverse air was used. Tables 2.2-2.3 show some of these improvements. Test Nos. 704-17 and 704-20 were run using all three cleaning modes, reverse air, reverse air with shake, and shake only. Test No. 704-24 was run, following bag replacement and removal of all dust from the clean air

side. In 2.3, note that in Test No. 704-24, the bag ΔP prior to cleaning was nearly half that for Test Nos. 704-17 or 704-20, despite the fact that the time between cleanings was doubled or quadrupled. In fact, several instances during Test No. 704-24 saw the bag ΔP rise to only 5.2 in. w.c. after two hours of operation, still not as great as the 5.6 in. w.c. seen in Test No. 704-20 after only 30 minutes. The clean bag ΔP measured as described previously, Quarterly Report No. 16, as again less than any value for shake only seen in tests employing reverse air cleanings.

Test 704-25 was a 56 hour repeat of Test 704-24. Both tests were run at an air-to-cloth (A/C) ratio of 2.0 ACFM/ft². The baghouse performance results for Test 704-25 shown in 2.4 are nearly identical to those of Test 704-24. In both cases, mass collection efficiencies were 99.7 percent or better while the outlet loadings in terms of lbs particulate/10⁶ Btu fell well below the new source performance standard of 0.03 lbs/10⁶ Btu in all sampling periods. Furthermore, baghouse operation showed the bag ΔP rises to no more than 4.8" w.c. after 75 minutes of operation, starting from a typical clean bag ΔP value after cleaning of 2.4" w.c.

Having obtained satisfactory results at an A/C of 2.0, modifications were completed to test the shake only mode at an A/C of 3.0. Operating at this condition, Tests 704-30 and 704-31 were 56 hour runs duplicating the test conditions of Tests 704-28 and 704-20. The baghouse outlet was sampled thirteen times during Test 704-30. A summary of baghouse performance for Test 704-30 is given in 2.5. Note the large variation of inlet dust loadings of the early morning samples versus those taken in late afternoon. Reinjection systems were turned on every day at 0800 hours and off at 1900 hours. By 1600 hours, the cyclone was filled, eliminating the primary dust removal system and causing baghouse inlet values to rise from a normal 70 to 90 lb/hr range to near 200 lbs/hr. However, note that baghouse collection efficiency remained 99.8% or better while outlet dust loading was below the 0.03 lbs particulate/10⁶ Btu performance standard in all cases. Baghouse ΔP values, overall, were higher with A/C of 3.0 versus the values seen at an A/C of 2.0. Typically at an A/C of 2.0, a clean bag ΔP of approximately 2.4" w.c. was seen with a value of approximately 4.8" w.c. realized after 75 minutes. With an A/C of 3.0, the clean bag ΔP was near 5.0" w.c. This was accomplished by holding all previous test variables constant and removing 529 ft² of filter fabric, i.e. 11 bags. The voids left in the tube sheet by bag removal were sealed to prevent leakage of dust laden gases to the clean air side of the bags. Further, the baghouse ID fan speed was increased to compensate for the anticipated increased baghouse pressure drop due to bag removal. Tests 704-28 and 704-29 were short termed (8 hour) shakedown tests to check system and baghouse emissions performance. The results of sample periods for these tests are given in Table 6. During the first sampling period of Test 704-28, 0945 hours, the dust loading to the baghouse fell within normal operating values of 60-100 lbs/hr. However, during the second sampling

period, bed material was inadvertantly fed to the boiler from storage causing baghouse inlet dust loadings to rise to more than 300 lbs/hr. Despite bag ΔP rising to more than 8" w.c. within 7-10 minutes of cleaning, the baghouse outlet values remained essentially constant in terms of lbs particulate/ 10^6 Btu and still met the performance standard of .03 lbs/ 10^6 Btu.

Prior to sampling periods of Test 704-29, the baghouse was repeatedly cleaned to remove any dust accumulation in the ductwork resulting from the heavy inlet loading during Test 704-28. The outlet stream was sampled once during Test 704-29 and the performance result was well within the standard of .03 lbs/ 10^6 Btu, see Table 6.

Typical bag ΔP values while operating with an A/C of 3.0 were higher than that experienced at an A/C of 2.0, as expected. For example, a typical bag ΔP value after cleaning was 5.4 to 5.8" w.c. with an increase to 8" w.c. in approximately 45 minutes.

Test 704-31 was a repeat of 704-30. Outlet samples were again taken and mass collection efficiencies were again 99.8% or better.

Tests 704-30 and 704-31 mark the end of baghouse testing in the shake only mode. Action began this period and will continue into the next period to convert the baghouse to the pulse jet cleaning mode. Upon completion of these modifications, testing of the baghouse will resume.

2.2 Flyash Reinjection (Activity 407)

Operation of the PDU with flyash reinjection continued during the reporting period. In this operating mode, flyash collected in the multicone cyclone is pneumatically transported back into the bed to improve PDU performance. Analysis of test results for the pervious period led to the development and testing of a two point flyash feed system and splitter.

2.2.1 Flyash Recycle Performance Results

During the reporting period, the chemical analysis of samples from Test No. 704-20 were completed and are given in Table 7. The operating conditions of Test 704-20 are shown in Table 8. Based on the analyses, the average combustion efficiency for the test was 85 percent at an average flyash recycle rate of 415 lbs/hr. The average sulfur capture for the test was 79% at an average molar calcium-to-sulfur ratio of 3.0. Due to the relatively low combustion efficiencies observed during Test 704-20 with flyash reinjection, a new feeder was designed, see Figure 2. This feeder splits the flyash into two streams as it gravity-feeds into the flyash nozzles. The flyash is then injected into two points in the bed.

This new feeder was developed to reduce the solids-to-air ratio at the feeder outlet, and to reduce the amount of flyash injected at one point in the bed. Earlier oil firing and flyash reinjection tests had shown the importance of the fuel-to-air ratio in the feeder. This is especially important with a solid fuel because of the oxygen requirements at the surface of the fuel. Furthermore, if too much flyash is injected at one point in the bed, a cooler region could develop which would prevent the flyash from reaching an ignition temperature before it leaves the bed. If this happens, combustion of the flyash would be greatly reduced.

Test 704-23 was the first test run on the new reinjection system. This system fed flyash well at lower bed depths up to 12 inches. Rate measurements for this test are shown in Table 9. However, as the bed depth increased, the back pressure on the eductor increased and the flyash rate dropped off. This could be observed directly in the 4-inch diameter pyrex spool piece which had been installed on the system. As the back pressure increased, transport air began to blow back up into the spool piece which slowed the flow of material into the feeder. After Test 704-23, the diffuser section of the nozzle was removed and the eductor was bored out to .281 inches ID. This was done to increase the air flow in the feed-pipe and to decrease the back pressure on the nozzle. Originally, the nozzle ID was .265 inches.

Test 704-24 was a 56 hour test to measure combustion efficiency using the modified feeder. During the test, four sets of samples were taken; two sets with reinjection, and two sets without reinjection. Table 10 shows the operating conditions during the four sample periods. Based on the results of the chemical analyses shown in Table 11, the average combustion efficiency with reinjection was 83 percent. There was no noticeable improvement in the efficiency.

Problems with the reinjection system in Test 704-24 resulted in erratic feeding of flyash. First high back pressures resulted in considerable back flow of air up the pyrex spool piece. This made visual flyash recycle rate measurements in the glass spool piece impossible. Partially closing the four-inch slide gate, located above the glass spool piece, decreased the amount of blow back, but reduced the flyash flow. Periodically, the fly ash would bridge above the slide gate and stop the flyash flow completely.

After Test 704-24, the flyash feed pipe from the nozzle to the boiler was changed from one-inch schedule 40 pipe to 1½ inch schedule 40 pipe. The diffuser section was modified at the nozzle outlet. These improvements reduced the nozzle back pressure by reducing the frictional losses. Cold tests showed a flyash flow rate of 1800 lbs/hr when feeding against no bed.

Test 704-25 was a 56 hour test using the flyash double feeder. Results of the chemical analysis of four sets of samples taken

during this test are given in Table 12. Based on the chemical analyses, the average combustion efficiency for the test was 88 percent at the operating conditions shown in Table 13. The test was run at an average calcium to sulfur molar feed ratio of 4.4 resulting in a capture of 85 percent with flyash reinjection.

Because of the combustion efficiency results of tests 704-24 and 704-25, a shakedown Test, PDU-7, was run in order to determine if any of the reinjected flyash was burning in the PDU. The oxygen concentration in the freeboard and freeboard temperatures were used as indicators with and without reinjection. These measurements are shown as a function of time in Figure 3. Flyash reinjection was initiated at time reference points 1 and 4. As can be seen, the percent excess oxygen began to drop and the freeboard temperatures increased at these times.

The flyash reinjection system was shutoff at time reference points 2 and 5. Once the reinjection was turned off, the oxygen and freeboard temperatures returned to normal operating levels. Over this time period, the bed temperatures remained relatively constant.

At the time indicated by point 3 on Figure 3, the coal feed rate was increased. This was to compare the effect of flyash combustion on the operating conditions to the effect of additional coal feed. At this time, the bed temperature increased, but the freeboard temperatures remained relatively constant, changing only 30 degrees. However, both times the flyash reinjection was turned on, the freeboard temperatures increased by 150 degrees. These observations indicate that some of the flyash was burning in the freeboard.

Test 704-26 was conducted to measure the combustion efficiency under test conditions similar to Test PDU-7. One set of samples were collected during the test and the results of the analyses are shown in Table 14. The combustion efficiency for the test was 95 percent with operating conditions as shown in Table 15. In this test, the bed temperatures increased when the flyash reinjection was begun. This is contrary to the results of Test PDU-7 in which the bed temperatures remained relatively constant during the reinjection periods. This would seem to indicate more in-bed burning of the flyash during this later test.

Test 704-27 was a 20 hour run. During the test, the bed was slumped several times to enable changes to be made in the reinjection system. When each change was made, the PDU was brought back on line and data was collected on the changes, see Table 16. Using this data, improvements will be made on an empirical model to predict eductor performance with solids flow.

2.2.2 Flyash Reinjection, Activity No. 1623

The chemical analyses for Test 704-28, a fifteen hour test run in November, were completed, see Table 17. Based on the chemical

analyses, the combustion efficiency was 89 percent at the operating conditions shown in Table 18. The test was run at an average molar calcium to sulfur ratio of 4.0 which resulted in a sulfur capture of 88 percent.

Flyash feed rates were measured during Test 704-28 using the mass velocity technique, see Table 19. During the test, a .292 inch nozzle diameter was used and the eductor inlet pressure was varied from 8 to 13.9 psi. Several measurements were made of the flyash rates at each pressure.

Test 704-30 was a thirty-three hour test. During the test, samples were taken and flyash feed rates were measured. The chemical analyses for this test are shown in Table 20. Based on the chemical analyses, the combustion efficiency was 86 percent at the operating conditions shown in Table 21. Because of problems with the sulfur dioxide analyzer, the sulfur capture could not be measured. The flyash feed rates were measured using the mass velocity measurement, see Table 22. During this test, the nozzle diameter was .297 inches and the eductor pressure was maintained at 12 pounds per square inch.

Table 2.1
Baghouse Performance Results
Test 704-23

Date/Time	Bag Δ P in W.C.	Inlet Particulate Grains/SCF LB/HR	Outlet Particulate Grains/SCF LB/HR	Col.	LB/10 ⁶	Opacity
<u>10/17/79</u> 1500	2.4		.044 .844		.068	1%
<u>10/17/79</u> 1510	3.6	No Inlet	.023 .440		.035	1%
<u>10/17/79</u> 1520	4.6	Testing Done	.051 .967		.078	1%
<u>10/17/79</u> 1530	5.8		.057 1.089		.087	2.9%
<u>10/17/79</u> 1540	6.8		.048 .914		.073	2.6%
<u>10/17/79</u> 1550	8.0		.079 1.494		.120	3.2%

Table 2.2
Baghouse Performance Results
Test 704-24

Date/Time	Bag Δ P in W.C.	Inlet Particulate		Outlet Particulate		Col.	LB/10 ⁶	Opacity
		Grains/SCF	LB/HR	Grains/SCF	LB/HR			
10/24/79 1530	2.4	6.01	111.6	.0057	.123	99.9	.012	1%
10/24/79 1537	2.7			.0082	.176	99.8	.018	1%
10/24/79 1545	3.0			.0002	.176	99.8	.018	1%
10/24/79 1554	3.3	X	X	.0065	.141	99.9	.014	1%
10/24/79 1602	3.6			.0065	.141	99.9	.014	1%
10/25/79 1321	2.4			.0106	.211	99.7	.017	1%
10/25/79 1330	2.7	3.22	64.8	.0124	.246	99.7	.020	1%
10/25/79 1339	3.0	V	V	.0070	.132	99.8	.011	1%
10/25/79+ 1530	3.8 to 4.6			.0026	.050	99.9	.004	1%
10/25/79++ 1100	1.9 to 3.5	3.45	69.9	.0098	.195	99.7	.016	1%
10/25/79++ 1500	1.9 to 3.0	3.56	73.5	.0023	.044	99.9	.0037	1%

+ Sampled for 30 minutes
++ Sampled for 45 minutes

Table 2.3 Comparison of Baghouse Operation in the Shake Only Clean Mode Before and After the Elimination of Reverse Air Operation

Test No. *	Shake Time	Time Between Cleanings	Typ. Bag ΔP Prior to Clean. " H ₂ O	# Cycles Considered	Clean Bag ΔP , in. w.c.	
					Average	Standard Deviation
704.17	30 sec	15 min	6.80	20	4.95	0.29
704.17	60 sec	15 min	6.48	6	4.70	0.17
704.20	60 sec	30 min	5.60	10	3.46	0.13
704.24	60 sec	60 min	3.84	42	2.03	0.22

*Tests 704-17 and 704-20 run along with reverse air testing.
 Test 704-24 run with new bags in shake only, never reverse air.
 Conditions for all tests were nearly identical with A/C of 2.0 acfm/ft.

Table 2.4
Baghouse Performance Results
Test 704-25 (10/31--11/2/79)

Date/Time	Bag Δ P In. H ₂ O	Inlet Particulate		Outlet Particulate		Col.	$\frac{\text{LBS}}{10^6 \text{ Btu}}$	Opacity
		Grains/SCF	LB/HR	Grains/SCF	LB/HR			
<u>11/1/79</u> 1000	2.4 to 4.7	5.50	95.1	.0023	.044	99.9	.005	1%
<u>11/1/79</u> 1500	2.4 to 4.8	4.16	77.7	.0080	.154	99.8	.016	1%
<u>11/2/79</u> 0800	2.4 to 4.8	4.02	72.6	.0035	.066	99.9	.006	1%
<u>11/2/79</u> 1125	3.2 to 3.8	2.30	43.7	.0054	.099	99.8	.009	1%

11/2/79 11:25 AM
11/2/79 11:25 AM

Table 2.5
Baghouse Performance Results
Test 704-30, 12/5-7/1979

Date/Time	Bag ΔP During Sampling, "H ₂ O	Inlet Particulate Grains/SCF	LB/HR	Outlet Particulate Grains/SCF	LB/HR	Mass Collection	LB/10 ⁶ Btu Particulate
<u>12/5/79</u> 0410	5.4 to 6.7			.010	.094		.010
<u>12/5/79</u> 0630	5.7 to 6.9			.002	.029		.003
<u>12/5/79</u> 0745	6.1 to 7.2	3.33	60.2	.002	.044	99.9	.004
<u>12/5/79</u> 1300	6.4 to 8.0			.015	.281	99.9	.028
<u>12/5/79</u> 1500	4.48 to 8.0	10.16	209.3	.010	.194		.019
<u>12/6/79</u> 0250	5.7 to 8.0			.007	.126		.012
<u>12/6/79</u> 0441	5.4 to 7.8			.004	.073		.007
<u>12/6/79</u> 0715	5.8 to 8.0	3.77	67.9	.006	.112	99.8	.011
<u>12/6/79</u> 1300	5.2 to 7.8			.009	.171		.017
<u>12/6/79</u> 1500	5.3 to 8.0	10.7	196	.014	.261	99.9	.026

Table 2.4 (continued)
 Baghouse Performance Results
 Test 704-30, 12/5-7/1979

Date/Time	Bag Δ P During Sampling, "H ₂ O	Inlet Particulate		Outlet Particulate		Mass Collection	LB/10 ⁶ Btu Particulate
		Grains/SCF	LB/HR	Grains/SCF	LB/HR		
2.14 <u>12/7/79</u> 0230	5.7 to 6.6			.004	.067		.006
<u>12/7/79</u> 1522	5.4 to 7.8			.005	.082		.007
<u>12/7/79</u> 0710	5.4 to 8.0	4.34	78.8	.005	.100	99.9	.009

Table 2.6
Baghouse Performance Results
Tests 704-28 (11/28/79), 704-29 (11/30/79)

Date/Time	Bag Δ P In. H ₂ O	Inlet Particulate Grains/SCF LB/HR		Outlet Particulate Grains/SCF LB/HR		Col.	$\frac{\text{LBS}}{10^6 \text{ Btu}^*}$	Opacity
Test No. 704.28:								
<u>11/28/79</u> 0945	5.4-6.3	4.10	75	.011	.223	99.7	.021	NA
<u>11/28/79</u> 1300	5.0- 8.0	17.6	325	.018	.342	99.9	.030	NA
Test No. 704-29:								
<u>11/30/79</u> 1200	5.8-7.2	No inlet tests		.009	.164	--	.017	NA

*Based on coal sample taken for Test 704-26. The same coal was used for Tests 704-26 through 704-29. Values will be updated following completion of chemical analyses for given test.

Table 2.7
Chemical Analyses
Test 704-20 9/26/79

	Time	C	H	S	Ca	Ash
Coal		.7450	.0443	.0293	.161	.1443
Limestone		.1237	.118	.20	.4010	.5848
Flyash	1000	.2692	.0128	.0467	.1235	.6660
Lead	1345	.5423	.0115	.0158	.0651	.412
Flyash	1000	.4791	.0099	.028	.0961	.501
Emitted	1345	.3747	.0051	.014	.2279	.6194
Dust	1000	.4041	.0089	.0117	.0352	.5245
	1345	.2444	.0080	.009	.0566	.7239
Bed	1000	.0107	.0016	.0501	.4793	.9697
	1345	.0134	.0023	.0706	.4786	.9592

Table 2.8
Operating Conditions Summary for Test 704-20

Time	1500	0800	1000	1345
Bed Temperature, °F	1555	1619	1576	1800
O ₂ in Flue Gas, %	3.0	2.6	2.9	1.0
Fuel Feed Rate, lb/hr	996	974	909	956
Limestone Feed Rate, lb/hr	260	260	260	260
Bed Drain Rate, lb/hr	0	5	62	0
Stack Dust Rate, lb/hr	85.1	*	87.0	89.5
Main Air Flow Rate, lb/hr	7420	7595	7568	7352
Total Air Flow Rate, lb/hr	8203	8498	8432	8215
Superficial Velocity, ft/sec	12.2	13.1	12.7	14.1
Static Bed Depth, Inches	25.0	22.0	23.0	13.0
EOBH (effective operating bed height), Inches	44.5	43.0	45.5	31.0
SO ₂ , ppm	605	522	574	1078
Steam Flow, lb/hr	5538	5538	5584	5584
NO _x , ppm	188	379	357	503
Hydrocarbons, ppm	125	360	270	839

*Data not taken

Table 2.9

Test 704-23

Total Flyash Recycle Rates
Using Mass Velocity Measurements

Bed Depth (Inches)	Time (Seconds)	Volume (ft ³) Emptied	Mass Flow (#/HR) *
6	4.62	.0582	1834
6	4.78	.0582	1773
8	4.82	.0582	1758
8	5.02	.0582	1688
9	5.11	.0582	1658
10	5.17	.0582	1639
10	5.12	.0582	1655
11	5.10	.0582	1662
12	5.53	.0582	1532

*The average bulk density of the flyash was measured to be 40.5 lb/ft³

Table 2.10
Operating Conditions Summary for Test 704-24

Time	1500	0800	1000	1600	0900	1400
Bed Temperature, °F	1439	1560	1603	1614	1588	1557
O ₂ in Flue Gas, %	**	3.5	3.5	3.5	3.2	3.5
Fuel Feed Rate, lb/hr	760	886	888	820	946	894
Limestone Feed Rate, lb/hr	358	378	380	346	404	416
Bed Drain Rate, lb/hr	**	35	73	175	0	55
Stack Dust Rate, lb/hr	111.6	129	64.8	58	69.9	73.5
Main Air Flow Rate, lb/hr	7618	7669	7618	7645	7655	7611
Total Air Flow Rate, lb/hr	8787	8830	8765	8815	8809	8784
Superficial Velocity, ft/sec	12.5	13.0	13.2	13.5	13.2	12.9
Static Bed Depth, Inches	20	30	30	26	29	31
EOBH (effective operating bed height), Inches	43.0	53.5	52.5	48.5	48.0	49.5
SO ₂ , ppm	**	**	**	**	200	150
Steam Flow, lb/hr	4252	5152	5195	5152	5297	5254
NO _x , ppm	358	410	419	426	528	535
Hydrocarbons, ppm	50	300	100	40	172	169

**No data reported

Table 2.11
Chemical Analyses
Test 704-24 10/24-10/26

	Time	C	H	S	Ca	Ash
Coal Composites	10/24	.7276	.0444	.0239	.0051	.1472
	10/25	.7129	.0441	.0238	.0085	.1876
	10/26	.7346	.0455	.0130	.0056	.1135
Limestone Composites	10/24	.1102	.118	0	.3924	.5744
	10/25	.1102	.118	0	.4009	.5775
	10/26	.1057	.118	0	.4056	.5748
Bed	0800	.0108	.0013	.0445	.4221	.9722
	1000	.0113	.0003	.0459	.5104	.9670
	0900	.0121	.0011	.0551	.5161	.9824
	1400	.0063	.0007	.0633	.5171	.9898
Flyash Emitted	0800	.3769	.9942	.0351	.2971	.6863
	1000	.2350	.0035	.0391	.3363	.7451
	0900	.2590	.0048	.0337	.2827	.6870
	1400	.3158	.0033	.0335	.2449	.6600
Dust	0800	.1806	.0027	.0238	.1309	.7940
	1000	.1237	.0037	.0258	.1355	.7246
	0900	.1871	.0064	.0245	.1023	.7936
	1400	.1922	.0071	.0294	.1181	.7849

Table 2.12
Chemical Analyses for Test 704-25, 10/31/79 - 11/2/79

		C	H	S	Ca	Ash
<u>Coal Composites</u>						
	11/1/79	.7081	.0448	.0277	.0016	.1504
	11/2/79	.6802	.0439	.0275	.0024	.1841
<u>Limestone Composites</u>						
	11/1/79	.1022	.0056	0.0	.4005	.5759
	11/2/79	.0934	.0011	0.0	.4124	.5693
<u>Bed</u>						
0800	11/1/79	.0194	.0027	.0626	.5153	.9660
1200	11/1/79	.0086	.0012	.0610	.5016	.9738
0845	11/2/79	.0047	.0005	.0469	.4023	.9788
1215	11/2/79	.0032	.0006	.0381	.3869	.9831
<u>Dust</u>						
0800	11/1/79	.1681	.0050	.0188	.0986	.8051
1200	11/1/79	.1945	.9934	.9244	.1055	.7829
0845	11/2/79	.1933	.0062	.0913	.0905	.7792
1215	11/2/79	.1368	.0047	.1234	.0897	.8336

Table 2.13
Operating Conditions Summary for Test 704-25, 10/31/79 - 11/2/79

Time	0800	1200	1500	0845	1215
Fuel	Coal	Coal	Coal	Coal	coal
Bed Temperature, °F	1603	1591	1610	1548	1612
O ₂ in Flue Gas, %	3.0	2.9	2.3	3.7	3.5
Fuel Feed Rate, lb/hr	768	836	857	855	850
Flyash Collection Rate, lb/hr	63	76	84	80	63
Limestone Feed Rate, lb/hr	312	300	242	302	344
Bed Drain Rate, lb/hr	91	54	121	164	5
Stack Dust Rate, lb/hr	68.0	95.1	77.7	72.6	43.6
Main Air Flow Rate, lb/hr	7585	7489	7461	7480	7439
Total Air Flow Rate, lb/hr	8745	8664	8629	8644	8613
Superficial Velocity, ft/sec	13.3	13.1	13.1	12.7	13.1
Static Bed Depth, Inches	27	27	28	27	26.6
EOBH (effective operating bed height) Inches	49	49	49	45.5	45.0
SO ₂ ppm	332	267	384	395	350
Steam Flow, lb/hr	4813	4738	4884	4394	4650
NO _x , ppm	461	453	434	427	440
Hydrocarbons, ppm	152	219	194	145	181

2.22

Table 2.14
Chemical Analyses for Test 704-26, 11/8/79

	C	H	S	Ca	Ash
Coal Composite	.7063	.0465	.0256	.0045	.1591
Limestone Composite	.1275	.0012	.0	.4023	.5781
Bed 1400 hrs.	.0168	.0024	.0134	.4922	.9795
Flyash 1400 hrs.	.1113	.0021	.0061	.3352	.8791
Dust 1400 hrs.	.1068	.0023	.003	.1632	.8713

Table 2.15
Operating Conditions Summary for Test 704-26, 11/8/79

Time	1200	1300	1400
Fuel	Coal	Coal	Coal
Bed Temperature, °F	1692	1823	1871
O ₂ in Flue Gas, %	1.5	1.5	1.5
Fuel Feed Rate, lb/hr	678	772	667
Flyash Collection Rate, lb/hr	52	52	65
Limestone Feed Rate, lb/hr	310	304	194
Bed Drain Rate, lb/hr	190	190	0
Stack Dust Rate, lb/hr	*	*	67.2
Main Air Flow Rate, lb/hr	5610	5857	5841
Total Air Flow Rate, lb/hr	6778	7020	7004
Superficial Velocity, ft/sec	11.1	12.3	12.5
Static Bed Depth, inches	12.0	10.5	10.0
EOBH (effective operating bed height) inches	27.5	23.0	21.0

* Data not taken

Table 2.16
Flyash Reinjection Rates
Test 704-27, 11/13/79

Nozzle Diameter (inches)	Blower Pressure (psig)	Bulk Density* (LB/FT ³)	Mass Flow (LB/HR)	Air Flow (LB/HR)
2.25	.265, 1 inch long	12	820	161
		9.9	820	147
		8.0	819	135
	.265, .25 inch long	14	653	161
		12.5	721	155
		10	873	139
		8	993	130
	.2812	12	1211	187.5

* The average of values measured during the test

Table 2.17
Chemical Analysis for Test 704-28, 11/28/79

	Elemental Analysis				
	C	H	S	Ca	Ash
Coal	.703	.043	.033	.005	.140
Limestone	.119	.000	0	.415	.569
Bed	.007	.001	.072	.457	.986
Flyash	.320	.005	.034	.188	.647
Dust	.168	.004	.067	.298	.804

Table 2.18
Operating Conditions Summary for Test 704-28
11/28/79

Time	1015	1200	1400
Bed Temperature, °F	1495	1470	1511
O ₂ in Flue Gas, %	3.2	4.1	1.9
Fuel Feed Rate, lb/hr	860	820	876
Flyash Collection Rate, lb/hr	26	49	74
Limestone Feed Rate, lb/hr	346	324	351
Stack Dust Rate, lb/hr	*	*	332
Main Air Flow Rate, lb/hr	7667	7661	7683
Total Air Flow Rate, lb/hr	8852	8832	8850
Superficial Velocity, ft/sec	12.7	12.5	12.8
Static Bed Depth, inches	26.5	28.0	27.0
EOBH (effective Operating bed height), inches	47.5	57.5	57.5

* Data not taken

Table 2.19
Flyash Reinjection Feed Rates Test 704-28
11/28/79

Blower Pressure	8.0	9.9	11.0	12.0	13.9
Mass Flow	650	648	732	701	706
	635	656	564	593	724
	615	637	632	627	767

All data was taken with the slide gate open.

Nozzle Diameter .292 inches

Bulk Density of the flyash was measured 44.2 lbs/ft³

Table 2.20
Chemical Analysis for Test 704-30, 12/5-7/79

		Elemental Analysis				Ash
		C	H	S	Ca	
Coal						
12/5		.685	.043	.024	.001	.158
12/6		.701	.044	.029	.003	.169
12/7		.733	.046	.021	.003	.132
Limestone						
12/5		.121	.001	0.0	.399	.573
12/6		.104	.001	0.0	.417	.569
12/7		.120	.001	0.0	.413	.569
Flyash						
1600	12/5	.455	.008	.052	.097	.508
1100	12/6	.361	.006	.021	.181	.657
1600	12/6	.247	.006	.045	.259	.727
0830	12/7	.278	.004	.036	.149	.703
Bed						
1600	13/5	.020	.002	.055	.502	.986
1100	12/6	.010	.001	.055	.483	.990
1600	12/6	.010	.000	.054	.500	.986
0830	12/7	.015	.001	.153	.500	.972
Dust						
1600	12/5	.317	.006	.030	.079	.642
1100	12/6	.166	.003	.022	.100	.801
1600	12/6	.299	.005	.143	.313	.672
0830	12/7	.179	1004	.034	.163	.796

Table 2.21
Operating Conditions Summary for Test 704-30
12/5-7/79

Time	1600	1100	1600	0830
Date	12/5/79	12/6/79	12/6/79	12/7/79
Bed Temperature, °F	1550	1513	1539	1529
O ₂ in Flue Gas, %	3.8	3.6	3.5	4.1
Fuel Feed Rate, lb/hr	822	788	794	835
Flyash Collection, Rate lb/hr	29	44	125	5
Limestone Feed Rate, lb/hr	342	336	310	308
Bed Drain Rate, lb/hr	170	137	170	68
Stack Dust Rate, lb/hr	209	65	196	78.8
Main Air Flow Rate, lb/hr	7499	7543	7450	7717
Total Air Flow Rate, lb/hr	8683	8727	8630	8891
Superficial Velocity, ft/sec	13.0	12.8	12.8	13.1
Static Bed Depth, inches	25	24	25	24.5
EOBH (effective operating bed height), inches	45	45	46	44

Table 2.22
Flyash ReInjection Feed Rates, Test 704-30,
12/5-7/79

Blower Pressure	12.0		
Nozzle Diameter	.297 inches		
Mass Flow	Trial I	Trial II	Trial III
	762	835	825
	816	682	798
	850	745	610
	895	915	935
	786	710	860

All data was taken with the slide gate open.
Bulk density was measured at 41.3 lbs/ft³

3.0 RIVESVILLE MFB PLANT OPERATIONS

3.1 General

The Rivesville MFB was in a scheduled ten-week outage during the period of October through December 1979. Numerous maintenance and repair activities were undertaken, as well as specific equipment testing.

Boiler lightoff activities commenced in December to expeditiously as possible prepare the unit for long runs in commercial modes. Many lightoff problems surfaced, but each in turn was solved improving both mechanical readiness of equipment and learning curve experience of plant operators.

3.2 Outage Maintenance and Repair

During the outage, dictated by Monongahela Power's boiler and turbine overhaul, several maintenance and repair jobs were completed. Major items completed during the outage include:

- Installation of Fuller-Kinyon Fuel Injection System to service C-cell.
- Replacement of C and B-cells' perforated air distributors with the "nut and Bolt" design.
- Restoration of boiler bed thermocouples
- Installation of main feedwater line block valve and flow orifice
- Installation of Kamyr alternate C-cell bed drain valve
- Complete overhaul of the ESP

3.3 Lightoff Activities

In December, a hydrostatic test was performed on the boiler and leaks were repaired. A satisfactory hydrostatic test was performed on the circulation pump seal water heat exchanger.

Initial start-up occurred on 13 December, but was halted to replace the north burner can and throat assembly. The problem was traced to a damaged vaporizer tube and refractory.

Lightoff attempts and problems were as follows:

- December 5 - Initial start-up halted to replace north burner can and throat assembly. The cause of malfunction was traced to a damaged vaporizer tube and refractory.

- December 18 - Circulation pump amps fluctuated abnormally and pumps were secured.
- December 19 - East Circulation pump seized and problem was traced to a sleeve bushing installed by manufacturer in an inverted position causing the oil impeller to be cracked (Figure 3.4).
- December 29 - South burner was secured to repair a broken vaporizing tube.
- December 30 - Unit was secured as agglomerations were noticed.
- December 31 - A low flame condition in the north burner was corrected, but fluidization was not achieved due to improper limestone size distribution (no fines).

3.4 Bed Drains

In a continuing program to develop improved hardware for the fluidized bed technology, we are exploring several bed drain control systems. These include:

1. Mitdump valve installed in B-cell in order to allow the bed drain rotary feeder to be purged prior to shut-down (Exhibit I)
2. Kamyr six inch high temperature ball valve with pneumatic operator installed in C-cell (Exhibit II)
3. Sixty degree angle self cleaning slide gate installed in D-cell (Exhibit V)

These alternatives are installed at the spare letdown ports in each cell. Performance of each alternative will be compared to the original equipment rotary feeders and will provide a back-up system in case of rotary feeder pluggage.

3.5 Bed Thermocouples

Original bed thermocouple arrangement incorporated ceramic sheaths protruding through the air distributor and upwards into the bed. This arrangement proved fragile, difficult to maintain and interfered with bed access. A "hanging" arrangement was developed (See Exhibit III) and installed during the outage. Results with this design will be reported in a future report.

3.6 Fuller-Kinyon Testing

During the month of October, a test plan for the testing of the Fuller-Kinyon system was prepared. The objectives were determining:

1. Splitter performance

2. Overall system performance
3. System reliability
4. Effects upon fluidized bed operation

The Fuller-Kinyon feed system tests were conducted in December. The south side was tested first, then the north. Exhibit X illustrates the test set-up.

Problems encountered during testing include the following:

- A-north belt feeder not interlocked with the C-cell feed permissive.
- Rotary feeder for north system jammed due to a nail trapped between the flights and casing. Also, the feeder's zero speed switch was jumpered.
- North screw pump made severe screeching noises caused by loose drive belts and an improperly aligned motor.

Test results, as shown in Exhibits XI and XII, show deviations of $\pm 5\%$ for the south side and $\pm 10\%$ on the north. These are within acceptable limits.

Exhibit XIII shows the locations of all test points.

Size analyses were performed on samples gathered after each test. Results of these analyses are shown in Exhibit XIV. The size analyses from the south side are suspect due to the amount of time that this coal had been sitting in the A-north bin; large amounts of fines were expected. This is shown in the analyses of the south coal. However, from the analyses of the north coal, it appears that the Fuller-Kinyon system causes extensive degradation of the coal. A mean size of the two north tests shows a decrease in size of approximately one half. This degradation occurs mostly in the $-\frac{1}{2}$ - $+\frac{1}{2}$ size range.

It appears that a considerable amount of -20 mesh fines are generated by this system. This could cause problems with carryover and combustion in the future.

The correlation of pressure drop to distribution appeared to work efficiently. Results indicate a tube pluggage or drastic change in distribution will be evident by observing splitter pressure drop.

Based on this test data and results, the following comments and recommendations are made:

1. Severe degradation of the coal is evident. Whether this will affect performance of C-cell remains to be seen.

2. The splitters are within distributions established by the vibrating feeders.
3. The system will not be run until all interlocks have been completed and jumpers removed.
4. The purge air for the pressure taps should be left on at all times to insure that the taps are clear.

3.7 Sundstrand Blower Testing

The Sundstrand eductor blowers were tested. The east (spare) blower could not be tested because it was not electrically connected. The west and center blowers were operated at four conditions:

- All valves open
- 4 valves open
- 3 valves open
- 2 valves open

At each condition, a velocity traverse was made, inlet and outlet pressures taken and motor amps read in order to determine blower performance. Exhibit VI shows the location of the test points. Exhibit VII shows test data for each blower.

Based on test results shown in Exhibit VIII, it appears that both blowers meet the manufacturer's curves (Exhibit IX). However, a pressure switch/alarm should be installed to warn operators of high discharge pressures.

3.8 Electrostatic Precipitator Planned Testing

In October, the eight bolts connecting the rapper arm of the wire rapper of the electrostatic precipitator were improperly installed. This produced a gap between striking plate and arm, thereby not allowing full force to be transmitted to clean the wires. All bolts have been tightened and tack welded in place. Upcoming runs will determine the result of the changes.

MITDUMP VALVE

Trial installation in B cell - December, 1979

EXHIBIT II
KAMYR BALL VALVE

Trial installation in C cell spare letdown port

December 1979

EXHIBIT III
THERMOCOUPLE LOCATIONS FOR B AND C CELLS

EXHIBIT IV

CIRCULATION PUMP MOTOR BEARING ASSEMBLIES

1. Fan	10. Pressure Disc
2. Locknuts	11. Oil Bottle
3. Cartridge Housing Cap & Cover	12. Oil Cup Assembly
4. Gaskets	13. Cartridge Housing
5. Ball Bearings	14. Ball Bearing
6. Cartridge Housing	15. Gaskets
7. Gaskets	16. Oil Chamber
8. Oil Chamber	17. Impeller and Locknut
9. Impeller	18. Pressure Disc

EXHIBIT V

SIDE VIEW, SELF CLEANING SLIDE GATE

Note: Slide gate operator located behind valve. To be installed in D cell's spare letdown port.

January 1980

POPE, EVANS AND ROBBINS

ARRANGEMENT OF SUNDSTRAND BLOWERS & TEST POINTS

EXHIBIT VI

EXHIBIT VII
SUNSTRAND BLOWER TEST
12/01/79

Center Blower

Condition	1	2	3	4
Pitot ΔP (avg) "w.c.	8.22	5.49	3.57	1.90
Bar. Press (avg) "Hg	29.03	29.03	29.03	29.03
Inlet Press (avg) "Hg	-1.90	-1.87	-0.80	-0.60
Disch Press (avg) "Hg	17.17	18.33	18.90	18.70
Ambient Temp (avg) $^{\circ}F$	55.0	56.0	55.0	55.0
Disch Temp (avg) $^{\circ}F$	155.0	157.0	167.5	170.0
Amps (avg)	75.6	60.7	53.5	44.8

West Blower

Condition	1	2	3	4
Pitot ΔP (avg) "w.c.	8.77	6.25	3.84	2.02
Bar. Press (avg) "Hg	29.02	29.02	29.02	29.02
Inlet Press (avg) "Hg	-2.2	-1.4	-0.9	-0.49
Disch Press (avg) "Hg	17.32	18.30	18.85	18.95
Ambient Temp (avg) $^{\circ}F$	55.5	56.6	60.0	66.5
Disch Temp (avg) $^{\circ}F$	155.5	163.5	169.0	168.5
Amps (avg)	80.5	67.80	58.9	48.9

Condition 1 - 6 Valves Open
Condition 2 - 4 Valves Open
Condition 3 - 3 Valves Open
Condition 4 - 2 Valves Open

EXHIBIT VIII
SUNDSTRAND BLOWER TEST

Center Blower

Condition	1	2	3	4
Temp °F	155.0	157.7	167.5	170.0
Pressure psi	8.44	9.01	9.29	9.19
Velocity fpm	10,007	8,043	6,540	4,791
Flow acfm	840.6	675.6	549.4	402.4
Flow scfm	1138.9	934.3	756.8	549.9
Blower ΔP spi	9.37	9.92	9.68	9.48
Filter ΔP psi	0.93	0.92	0.39	0.29

West Blower

Condition	1	2	3	4
Temp °F	155.5	163.5	169.0	168.5
Pressure psi	8.51	8.99	9.26	9.31
Velocity fpm	10,325	8,681	6,795	4,922
Flow acfm	867.3	729.7	570.8	413.4
Flow scfm	1177.7	998.2	783.5	569.1
Blower ΔP psi	9.59	9.68	9.70	9.55
Filter ΔP psi	1.08	0.60	0.44	0.24

B-3230 60 HZ PERFORMANCE CURVES

PRESSURE ONLY

EXHIBIT IX

SPLITTER TEST ARRANGEMENT

EXHIBIT X

EXHIBIT XI
TEST RESULTS
C-SOUTH FEED SYSTEM
12/13/79

Point No.	40%		80%		60%	
	Weight	Dev. From Average	Weight	Dev. From Average	Weight	Dev. From Average
1	97.5	3.1%	211	3.6%	160.5	1.5%
2	103	8.9%	210	3.1%	160.0	1.2%
3	94.0	-0.6%	210	3.1%	160.0	1.2%
4	97.5	3.1%	208	2.1%	158.5	0.3%
5	86.0	-9.1%	189.5	-7.0%	157.0	-0.7%
6	89.5	-5.4%	194	-4.8%	152.5	-3.5%
Total Wt.	567.5		1222.5		948.5	
Belt Feeder Wt.	558		1077		848	
Avg. Split	94.6		203.8		158.1	
Largest Dev.	9.0		5.3%		2.5%	
Standard Deviation	6.13%		9.45%		3.02%	

EXHIBIT XII
TEST RESULTS
C-NORTH FEED SYSTEM

Point No.	40%			80%		
	Weight	P	Dev.	Weight	P	Dev.
1	97.5	6.0	-7.8%	239	7.5	-2.9%
2	110.5	6.0	4.4%	244	5.7	-0.8%
3	101.5	4.5	-4.1%	231.5	9.5	-5.9%
4	98.0	7.5	-7.4%	228	5.5	-7.3%
5	107.0	4.0	1.1%	255.5	4.0	3.9%
6	120.5	7.0	13.9%	278	6.0	13.1%
Total Wt.		635.0		1476.0		
Belt Feeder Wt.		556		958		
Average Split		105.8		246.0		
Largest Deviation		10.9%		10.2%		
Standard Deviation		8.81%		18.45%

C CELL NORTH

C CELL SOUTH

SPLITTER DISCHARGE NUMBERING

EXHIBIT XIII

EXHIBIT XIV
SIZE ANALYSIS OF COAL DISCHARGING FULLER SYSTEM

	Coal Entering System	COAL DISCHARGING FULLER SYSTEM					Mean Discharging Of Fuller System	
SCREEN SIZE	N Coal	S 40	S 60	S 80	N 40	N 80	MN w/o S	MN W/S
+ $\frac{1}{2}$	0.5%	0%	0.5%	0.6%	0.3%	.2%	0.25%	0.32%
- $\frac{1}{2}$ + $\frac{1}{4}$	43.7%	14.30%	17.9%	16.2%	26.9%	20.7%	23.80%	19.30%
- $\frac{1}{4}$ +5	31.6%	22.1%	25.7%	18.5%	27.7%	26.3%	27.00%	24.06%
-5 +10	12.6%	21.40%	21.1%	14.8%	18.5%	19.0%	18.75%	18.96%
-10 +12	1.2%	2.7%	2.0%	1.7%	2.1%	2.0%	2.05%	2.10%
-12 +20	0.4%	8.2%	5.3%	5.4%	6.0%	6.6%	6.30%	6.30%
-20	6.8%	30.9%	27.6%	42.8%	18.6%	25.2%	21.9%	29.02%
MN Size U	2886.4	1060.4	1178.5	852.0	1551.7	1252.5	1402.1%	1179.

EXHIBIT XV

POPE, EVANS AND ROBBINS INCORPORATED
 RIVESVILLE, WEST VIRGINIA
 MFB MONTHLY OPERATING SUMMARY

Period October - December

OPERATING HOURS

	<u>Period</u>	<u>To Date</u>
Oil Fired - CBC	<u>42.1</u> hrs.	<u>1737.4</u> hrs.
Coal Fired - CBC	<u>0</u> hrs.	<u>3109.9</u> hrs.
- C Cell	<u>0</u> hrs.	<u>1176.7</u> hrs.
- B Cell	<u>0</u> hrs.	<u>567.5</u> hrs.
- A Cell	<u>0</u> hrs.	<u>5.8</u> hrs.
Commercial Operation	<u>0</u> hrs.	<u>371.5</u> hrs.

Total Coal Consumption	<u>8075</u> lbs.	<u>4</u> T.
Total Sorbent Consumption	<u>2020</u> lbs.	<u>1</u> T.
Approximate Feedwater Consumption	<u>0</u> lbs.	<u>0</u> gals
Approximate Steam Vented	<u>0</u> lbs.	<u>0</u> gals
Approximate Blow Down	<u>0</u> lbs.	<u>0</u> gals
Commercial Steam Generation	<u>0</u> lbs.	<u>0</u> gals
Total Fuel Oil Consumption		<u>6996</u> gals.
Demineralized Water Credit		<u>0</u> gals.

Number of Starts

CBC	<u>0</u>
C Cell	<u>0</u>
B Cell	<u>0</u>
A Cell	<u>0</u>

Multicell Operation

D	<u>0</u> hrs.
DC	<u>0</u> hrs.
DCB	<u>0</u> hrs.
DCBA	<u>0</u> hrs.

4.0 NEW YORK OFFICE DESIGN AND ENGINEERING

The New York Office design and engineering staff has been engaged in various tasks in support of the overall program and the Rivesville MFB Plant operations. These tasks include studies and evaluations of systems and equipment and modifications to the MFB plant to improve performance and increase reliability based on experience gained from operation.

During this reporting period, the New York Office Engineering engaged in the following tasks:

Alternate Coal Feed System for C-Cell

Continued review of revised design drawings for the Fuller-Kinyon coal feed system for C-cell. Control circuit design sketches for the Fuller equipment were also reviewed.

Investigated the need for expansion joints on the vertical run of the fuel feed system to accommodate downward thermal expansion of the boiler.

Facilities Update

Updating of design analyses and drawing revisions continued, to reflect "as built" conditions. A field trip will be scheduled to check the installation of the lift framing for the boiler circulating pumps, the Fuller-Kinyon system for C-cell, and the additional platforms installed for access/egress.

5.0 SUBCONTRACTOR ACTIVITIES

5.1 Foster Wheeler Energy Corporation

During the reporting period, fabrication of replacement drilled bolt air distributors for C and B-cells of Rivesville MFB was completed and the units were shipped.

During November, the B and C-cell replacement air distributors arrived on site and were installed under FWEC Service Department supervision.

Evaluation of the Rivesville MFB performance data at full and part load conditions continued.

5.2 Stone & Webster Engineering Corporation (MFB Plant Advisory Operations Assistance)

Stone & Webster continued to support PER field personnel during the reporting period in the areas of safety and instrumentation. Headquarters activity concentrated on development of a topical report investigating ash cooler cyclone excessive carryover.

A design for converting the ash discharge to the silo transport system from a pressure to a vacuum system was investigated and meetings with vendor representatives were conducted at the site.

The Ducon proposal for modifications to the flyash reinjection system was also reviewed during the reporting period and endorsed for purchase.

Mr. J. M. MacNeill will be assigned as SWEC Senior Field Representative effective November 15, 1979.