



Project Summary

An Evaluation of Full-Scale Fabric Filters on Utility Boilers: PP and L Brunner Island Station Unit 1

John W. Richardson, John D. McKenna, and John C. Mycock

The objective of this program was to evaluate and characterize the performance of full-scale fabric filter units installed on 100 MW or larger coal-fired power plants. This document reports the results of total mass and fractional size particulate emission tests at one location. Operating and maintenance data from this location are also included. A separate report documents a similar emission test on a second site.

Two series of tests were conducted at Pennsylvania Power and Light's Brunner Island Station Unit 1 on August 12-16, 1981, and September 2-4, 1982. Five inlet/outlet total mass tests were conducted in August 1981, and three inlet/outlet total mass tests were conducted in September 1982.

Emissions for Unit 1 are controlled by a 24-compartment Carborundum baghouse that has a designed gas flow of 1,200,000 acfm* at 330°F. Each compartment contains 264 bags, each measuring 11.5 in. in diameter and 35 ft 4 in. in length.

Average outlet concentrations for both test series were higher than expected. Outlet emissions for the August 1981 tests averaged 0.037 lb/10⁶ Btu, and the average baghouse efficiency was 99.7%. Average outlet emissions for the September 1982 tests were 0.096 lb/10⁶ Btu, and the average

baghouse efficiency was 98.4%. The allowable particulate emission rate for this source stipulated by the Pennsylvania Department of Environmental Resources is 0.10 lb/10⁶ Btu.

Two inlet/outlet and two blank cascade impactor tests were performed during the August 1981 program. The impactor test series of September 1982 included 10 runs: 4 inlet, 4 outlet, and 2 blanks. Average mass mean diameters were 13.4 μm at the inlet and 7.0 μm at the outlet during the August 1981 tests, and 19.9 μm at the inlet and 9.0 μm at the outlet during the September 1982 tests.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

ETS, Inc., was funded by EPA to conduct a program to characterize the performance of three full-scale fabric filter units operating on large (>100 MW) coal-fired power plants. The objective of the program was to document the capabilities and behavior of fabric filters applied to large utilities burning a range of coals.

The purpose of the test series described in this report was to determine

*Readers more familiar with the metric system may use the conversion factors at the end of this Summary.

Table 1. Data Summary

(Test Series 1, PP&L Brunner Island, Unit 1)

OUTLET EMISSION DATA

August 12-16, 1981

Run & Date	Particulate Emissions			MW Production	Flow acfm dscfm	Temp. °F	Orsat			Stack Gas Moisture %
	lb 10 ⁶ Btu	lb/hr	gr/acf				CO ₂ %	O ₂ %	CO %	
1 8/12/81	0.027	85.0	0.0085	337	1170000 730000	294	12.2	6.0	0.1	5.7
2 8/13/81	0.018	53.0	0.0056	345	1110000 680000	289	12.9	5.3	0.2	7.8
3 8/14/81	0.078	273	0.025	341	1250000 780000	280	12.9	5.3	0.1	7.6
4 8/15/81	0.037	128	0.012	340	1260000 780000	282	13.1	5.3	0.1	7.6
5 8/16/81	0.026	91	0.008	340	1330000 790000	289	13.1	5.2	0.0	6.8

INLET LOADING DATA

Run & Date	Baghouse Col. Eff. %	Particulate Loading		Baghouse Diff. Pres. in. H ₂ O	Flow acfm dscfm	Temp. °F	Orsat			Stack Gas Moisture %
		lb/hr	gr/acf				CO ₂ %	O ₂ %	CO %	
1 8/12/81	99.8	52000	6.16	8.0	980000 600000	286	13.1	5.4	0.0	11.0
2 8/13/81	99.8	29000	2.96	8.1	1140000 710000	290	12.7	5.4	0.0	8.1
3 8/14/81	99.2	37000	3.88	7.9	1110000 690000	290	12.1	5.7	0.0	9.1
4 8/15/81	99.7	42000	4.32	8.3	1140000 710000	293	13.0	5.3	0.0	8.1
5 8/16/81	99.8	45000	4.66	8.5	1120000 690000	300	13.1	5.2	0.0	7.1

particulate emissions in pounds per million Btu and to determine particle size using cascade impactors at Pennsylvania Power and Light's Brunner Island Station Unit 1.

Two separate test programs were conducted at the Brunner Island Station during this research program from November 1980 to October 1983. The first test series was performed in August 1981, and the second in August-September 1982.

The particulate emissions at the inlet to and outlet from the baghouse were tested according to Federal Register Reference Methods 1-5. Assembly and use of the impactor train followed state-of-the-art protocol and general Method 5 sampling train procedures.

Five inlet/outlet particulate total mass tests were performed during the 1981 test series, and three inlet/outlet particulate

total mass tests during the 1982 test series. Summaries of these test data are in Tables 1 and 2.

In addition to the two detailed test programs conducted at the PP&L Brunner Island Station, detailed operational and maintenance data were recorded for 2 years, from unit start-up, October 19, 1980, through September 31, 1982. These data have been analyzed exhaustively, and the results and recommendations of this work appear in this report.

Process and Control Device Description

PP&L's Brunner Island Station Unit 1 consists of a tangentially fired Combustion Engineering boiler, rated at 350 MW and 2,200,000 lb steam/hr. Boiler operating conditions are 2,500 psig and 1005°F at the superheater. Reheater de-

sign is 600 psig with an outlet steam temperature of 1005°F.

Pulverized coal is supplied to the boiler by five Combustion Engineering Raymond bowl mills. The boiler is fired with No. 2 fuel oil during start-up. Fuel oil can also be used to supplement coal-firing at any boiler load.

The flue gas from boiler 1 is directed into a common stack that is shared with Unit 2. Two induced-draft fans are installed on each unit. The I.D. fans for Unit 1 were modified by PP&L to accommodate the baghouse.

Particulate emissions from Unit 1 were initially controlled by two parallel electrostatic precipitators (ESPs). Extensive duct work runs and modifications were required to locate a full-scale baghouse at the site. This baghouse was designed, furnished, delivered, and erected by the Carborundum Company.

The newer ESP was blanked off and retired in place, and all the gas flow was directed through the original ESP. Only the perforated plates were removed from the original ESP.

The baghouse consists of 24 compartments with 264 bags per compartment, totaling 6,336 bags. Bag dimensions are 11.5 in. in diameter by 35 ft 4 in. in length. Most of the original bags were 9.3 oz fiberglass with Teflon "B" finish. Reverse air cleaning is used to periodically remove particulate which has collected on the interior of the filter bags. The baghouse can be cleaned either on a continuous timed cycle or on a differential pressure basis. The baghouse has a bypass damper designed for a flue gas volume of 330,000 acfm at 300°F. The standby heating system is an electrical resistance type with controls to maintain the baghouse at 300°F after shut-down.

Testing Methodology, Sampling Equipment and Procedures

Particulate emission tests were conducted according to U.S. EPA Reference Methods 5 and 17 procedures in conjunction with Methods 1, 2, 3, and 4. An Alundum thimble (Method 17) was used

for testing on the inlet because the concentration of particulate matter in the gas stream to the baghouse was very high. The EPA contract specified Method 5 sampling on the outlet. A Norton AN-899 retention Alundum thimble was used in this test series to prevent vacuum problems and reduce the extra time required to change filters and check for leaks. Subsequent laboratory analysis supported this decision because no more than 6.5% of the total outlet particulate catch was deposited on the Method 5 filter during any of the tests of the August 1981 test program.

Each test included a 49-point traverse with a 5-minute sampling duration for each point, resulting in a total test time of 4 hours and 5 minutes.

The particulate sampling equipment used is referred to as the "EPA Particulate Sampling Train," designed and developed by the U.S. EPA.

The apparatus used consisted of a stainless steel sampling nozzle, an Alundum thimble, a Method 5 filter holder containing an 87-mm Schleicher and Sherell #1-HV high-purity glass filter, a series of four Greenburg-Smith impingers, a check valve, a leakless vacuum pump, a dry gas meter, and a calibrated orifice. The impingers and con-

necting tubes were Pyrex glass, connected with glass ball-and-socket joints. The probe was Type 316 stainless steel.

Using a Type S pitot tube, a velocity traverse was performed along each traverse axis during each particulate run. The velocity pressure at each sampling point was measured, using an inclined manometer. A thermocouple attached to the pitot tube measured gas stream temperature. Thermal potential was measured with an Omega portable potentiometer.

Before beginning a run, the sampling train including probe and nozzle was leak-tested by plugging the nozzle with a rubber stopper and applying a vacuum of 15 in. Hg to the system. This procedure was repeated at the conclusion of each run. The maximum allowable leakage rate of 0.02 cfm was not exceeded during any of the leak tests.

At the completion of each test, the sampling nozzle, the inside of the probe, the inside of the thimble holder, and the front-half of the glass fiber filter holder were washed with deionized water and acetone. The washings were collected in separate storage containers. The Alundum thimble and the glass fiber filter were removed from their respective

Table 2. Data Summary

(Test Series 2, PP&L Brunner Island, Unit 1)

OUTLET EMISSION DATA											September 2-3, 1982	
Run & Date	Particulate Emissions			MW Production	Flow acfm dscfm	Temp. °F	Orsat			Stack Gas Moisture %		
	lb/10 ⁶ Btu	lb/hr	gr/acf				CO ₂ %	O ₂ %	CO %			
1 9/2/82	0.071	251	0.021	335	1370000 820000	318	13.0	6.0	0.0	5.1		
2 9/3/82	0.104	395	0.032	335	1440000 890000	306	12.6	6.2	0.0	4.2		
3 9/3/82	0.114	397	0.035	335	1340000 820000	311	12.5	6.4	0.0	4.8		

INLET LOADING DATA											
Run & Date	Particulate Loading			Baghouse Diff. Pres. in. H ₂ O	Flow acfm dscfm	Temp. °F	Orsat			Stack Gas Moisture %	Baghouse Col. Eff. %
	lb/10 ⁶ Btu	lb/hr	gr/acf				CO ₂ %	O ₂ %	CO %		
1 9/2/82	6.18	17000	1.77	8.2	1140000 670000	315	13.0	6.0	0.0	11.0	98.6
2 9/3/82	7.84	25000	2.35	8.0	1230000 720000	308	12.8	6.0	0.0	11.1	98.4
3 9/3/82	7.82	24000	2.43	8.2	1160000 690000	314	12.5	6.3	0.0	9.2	98.3

filter holders and stored in separate storage containers.

Summary of Results for First Brunner Island Test Series

Results for particulate total mass emission tests performed August 12-16, 1981, at PP&L Brunner Island Unit 1, steam-electric station are summarized in Table 1. As shown in Table 1, the average particulate emission rate for these five tests was 0.037 lb/10⁶ Btu, compared to a Department of Environmental Resources' allowable emission rate of 0.10 lb/10⁶ Btu.

Six cascade impactor tests were performed: two inlet, two outlet, and two blanks. Average mass mean diameter was 13.4 μm at the inlet and 7.0 μm at the outlet.

Description of Second Brunner Island Test Series

A second series of particulate tests and impactor tests were conducted at the Brunner Island Unit 1 station, September 2-4, 1982. The same objectives were incorporated into the program as for the test program of August 1981.

Test protocol, test port locations, and sampling equipment were also the same as those used in the first test program.

Summary of Results—Second Test Series

Results of the three inlet/outlet particulate total mass emission tests performed September 2-4, 1982, are summarized in Table 2. The average particulate emission rate for the outlet tests was 0.096 lb/10⁶ Btu, more than twice the emission rate of the August 1981 tests, yet still below the Pennsylvania Department of Environmental Resources' allowable emission rate of 0.10 lb/10⁶ Btu.

The impactor test series included 10 runs: 4 inlet, 4 outlet, and 2 blanks. Computer manipulation of these data showed two peaks each for both the inlet and outlet runs. Average mass mean diameter was 19.9 μm at the inlet and 9.0 μm at the outlet.

Metric Conversions

This Summary includes certain non-metric units for the reader's convenience. Those more familiar with the metric system may use the following conversion factors.

Nonmetric	Times	Yields Metric
Btu	1.055	kJ
°F	5/9 (°F-32)	°C
ft	30.48	cm
ft ³	28.32	l
gr	0.065	g
in.	2.54	cm
in. ²	6.45	cm ²
lb	0.454	kg

J. Richardson, J. McKenna, and J. Mycock are with ETS, Inc., Roanoke, VA 24018. Dale L. Harmon is the EPA Project Officer (see below).

The complete report, entitled "An Evaluation of Full-scale Fabric Filters on Utility Boilers: PP&L Brunner Island Station Unit 1," (Order No. PB 85-235 521/AS; Cost: \$20.50, subject to change) will be available only from:

*National Technical Information Service
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