INNOVATIVE CLEAN COAL TECHNOLOGY

500 MW DEMONSTRATION OF ADVANCED WALL-FIRED COMBUSTION TECHNIQUES FOR THE REDUCTION OF NITROGEN OXIDE (NO_x) EMISSIONS FROM COAL-FIRED BOILERS

Plant Hammond

Environmental Monitoring Program
Report of Phase 2 (Overfire Air Tests)

Prepared by:

Southern Company Services, Inc.
Birmingham, Alabama

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EXECUTIVE SUMMARY

This report summarizes the results obtained during Environmental Monitoring Program (EMP) activities conducted during the second testing phase of an Innovative Clean Coal Technology (ICCT) demonstration of advanced wall-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. This second phase demonstrates the Advanced Overfire Air (AOFA) retrofit with existing Foster-Wheeler (FWEC) burners. The project is being conducted at Georgia Power Company's Plant Hammond Unit 4 located near Rome, Georgia.

The primary goal of this project is to characterize the effectiveness of low NO_x combustion equipment through the collection and analysis of long-term emissions data supported by short-term characterization data. During each test phase, diagnostic, performance, long-term, and verification tests are performed. The advanced combustion techniques used in this demonstration project are being tested using the following phased approach:

Phase 1: Baseline testing on the "as found" Unit 4 boiler;

Phase 2: AOFA installation and testing;

Phase 3a: Low NO_x burner (LNB) installation and testing;

Phase 3b: LNB plus AOFA testing.

EMP activities consist of sampling and analysis activities performed during each phase's testing periods, together with compliance monitoring performed on gaseous and aqueous streams. Energy Technology Consultants, Inc. (ETEC) is responsible for the preparation of interim test reports on each project phase, as well as a comprehensive test report to be prepared at the end of the project. Radian Corporation is responsible to Southern Company Services, Inc. (SCS) for the preparation of the EMP reports.

During Phase 2, a total of 82 diagnostic, 9 performance and 15 verification tests were performed. Ninety-two days of long-term testing were conducted. All of the sampling and analytical methods used were specified and approved in the Environmental Monitoring Plan that was prepared for this project.

EMP monitoring conducted during Phase 2 testing periods showed the following:

- AOFA operation resulted in lower NO_x emissions from Unit 4, compared to the baseline testing conducted under Phase 1. Based on the analysis of the long-term test data, a reduction in NO_x emissions of about 24% was obtained while operating at high loads. The reduction decreased to about 12% when operating at a load of 300 MWe.

- AOFA operation resulted in increased levels of LOI and carbon, indicative of a small decrease in overall coal utilization, compared to baseline operation. The observed impact was smallest for the bottom ash, while the loss on ignition (LOI) and carbon content of the fly ash increased by nearly a factor of two compared to baseline. The LOI appeared to consist primarily of unburned carbon.

- Carbon monoxide emissions also increased relative to baseline until the excess oxygen levels were raised. During long-term testing, lower carbon monoxide emission rates were lower than those observed than during baseline testing.

- Generally low levels of total hydrocarbon (THC) emissions were found during Phase 2 long-term testing (0.0005 to 0.002 lb/MMBtu).

- Sulfur dioxide emissions during both Phases 1 and 2 were comparable. No trends were observed between SO_2 emission rates and operating conditions. Although SO_2 emissions will vary with coal sulfur content, the large amount of data scatter and the small variation in coal sulfur content made it impossible to verify the existence of a relationship.

- Relative to Phase 1 baseline testing, AOFA operation did not appear to have any impact on either the ratio of SO_3 to SO_2 concentrations or on the resistivity of the fly ash entering the ESP. Based on these results, ESP efficiency during AOFA operation should be similar to baseline operation.

- Aqueous stream monitoring showed no exceedances of permit limits for any of the monitored parameters during the Phase 2 testing period.

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1.0 INTRODUCTION

As an Innovative Clean Coal Technology demonstration, this project, entitled "500 MWe Demonstration of Advanced, Wall-Fired Combustion Techniques for the Reduction of Nitrogen Oxide (NO_x) Emissions from Coal-Fired Boilers," is required to develop and implement an approved Environmental Monitoring Plan (EMP). The EMP for this project was prepared by Radian Corporation for Southern Company Services, Inc. (SCS) and submitted to DOE on September 14, 1990 [1]. The EMP includes supplemental and compliance monitoring of a number of gaseous, aqueous, and solid streams.

This report presents the results of EMP activities conducted during Phase 2 (Advanced Overfire Air Retrofit) of the project.

1.1 Project Description

Southern Company Services signed a Cooperative Agreement for this ICCT Round II project on December 20, 1989. The project is investigating a number of retrofit NO_x reduction techniques on Unit 4 at Georgia Power Company's Plant Hammond, near Rome, Georgia. Emissions and performance are being characterized for this wall-fired boiler while operating in the following configurations:

- Baseline ("as-found") configuration - Phase 1;
- Advanced Overfire Air (AOFA) retrofit - Phase 2;
- Low NO_x burner (LNB) retrofit - Phase 3a; and
- Combined AOFA and LNB configuration - Phase 3b.

[1] Some changes in the EMP are currently under consideration by DOE.

The major objectives of the project are to:

- Demonstrate (in a logical stepwise fashion) the performance of three combustion NO_x control technologies (i.e., AOFA, LNB, and AOFA plus LNB);
- Determine the short-term NO_x emission trends for each of the operating configurations;
- Determine the dynamic long-term NO_x emission characteristics for each of the operating configurations using advanced statistical techniques;
- Evaluate progressive cost-effectiveness (i.e., dollars per ton of NO_x removed) of the low NO_x technologies tested; and
- Determine the effects on other combustion parameters (e.g., CO production, carbon carry-over, particulate characteristics) of applying the low NO_x combustion technologies.

Each of the four project phases involve three distinct testing periods: short-term characterization, long-term characterization, and short-term verification. The short-term characterization testing establishes trends of NO_x emissions, as related to various operating parameters and establishes the influence of the operating mode on other combustion parameters. The long-term characterization testing, which takes place over 50-80 days (or more) of continuous testing, establishes the dynamic response of NO_x emissions while the unit is operated under normal system dispatch conditions. The short-term verification testing is conducted to determine if any fundamental changes in NO_x emission characteristics occurred during the long-term test period.

EMP activities consist of sampling and analysis activities performed during each phase's testing periods, together with compliance monitoring performed on gaseous and aqueous streams. Energy Technology Consultants, Inc. (ETEC) prepares Phase Reports containing all of the results obtained in fulfillment of the project's objectives as outlined above. The reader is referred to the report entitled "Innovative Clean Coal Technology (ICCT) 500 MW Demonstration of Advanced Wall-Fired Combustion

Techniques for the Reduction of Nitrogen Oxide (NO_x) Emissions from Coal-Fired Boilers; Phase 2 - Overfire Air Tests," by Lowell S. Smith and Matthew P. Cooper of ETEC, which was cleared for publication by DOE Patent Counsel on July 13, 1992. Radian has prepared this EMP Phase 2 Report that presents the data obtained in fulfillment of the monitoring requirements outlined in the EMP.

1.2 Project Organization

The project organization is shown in Figure 1-1. The Project Manager is provided by SCS, and has overall responsibility for project execution. ETEC has responsibility for both the on-site testing and the analysis of data for all project phases. Spectrum Systems, Inc. provides a full-time, on-site instrument technician who is responsible for operation and maintenance of the data acquisition system (DAS), which is housed within the instrument control room. Southern Research Institute (SoRI) is responsible for testing related to the flue gas particulate measurements during the performance testing portion of the short-term characterization tests. Flame Refractories, Inc. (Flame) is responsible for activities related to fuel/air input parameters and furnace output temperature measurements during the performance testing portion of the short-term characterization tests. W. S. Pitts, Inc. (WSPC) is responsible for analysis of the emission and performance data for the long-term characterization tests. Radian Corporation is responsible to SCS for EMP activities, including preparation of the Environmental Monitoring Plan, and associated quarterly, annual, and phase reports.

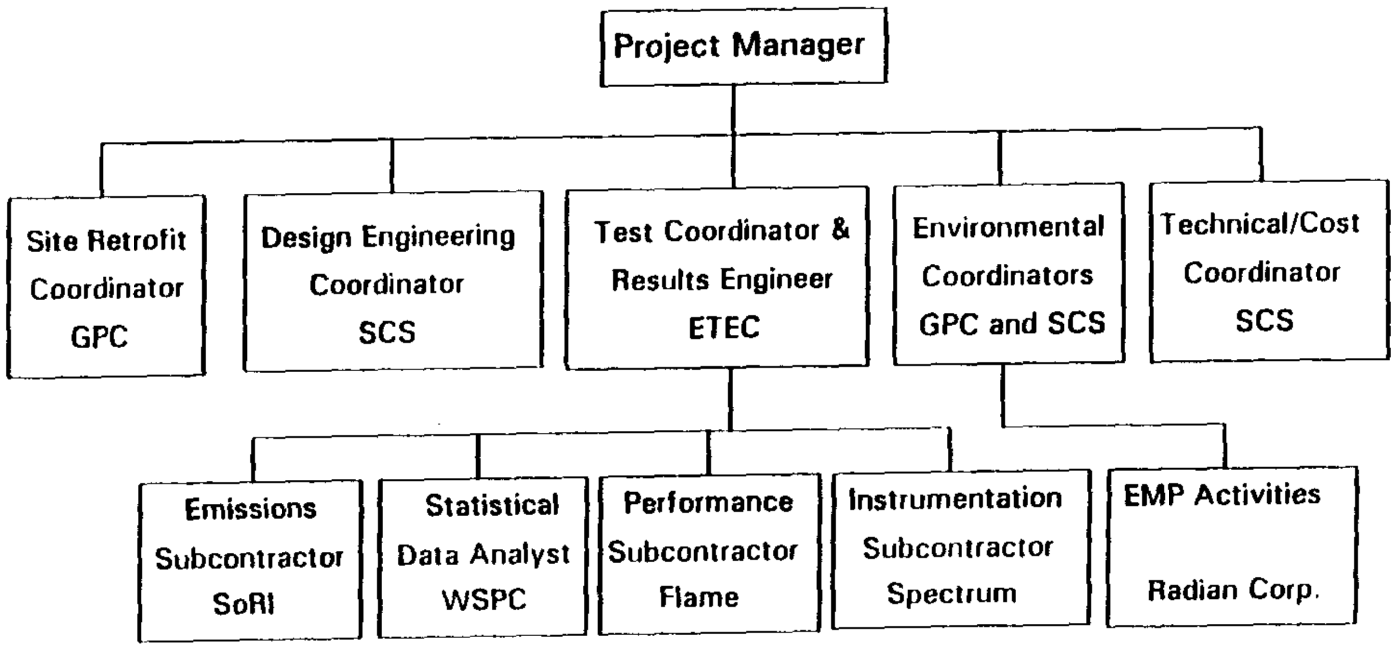

Figure 1-1. Plant Hammond Demonstration Project Organization

1.3 Hammond Unit 4 Description

Four generating units, with a total capacity of 800 MW, operate at Plant Hammond. Units 1 through 3 are 100 MW wall-fired boilers. Unit 4, a Foster Wheeler opposed wall-fired boiler rated at 500 MW, is the site of the ICCT combustion modification project. Six mills provide pulverized eastern bituminous coal to 24 Intervane burners arranged in a matrix of 12 (three rows of four burners) on the front and rear walls. Each mill provides coal to four burners.

Unit 4 is a balanced draft unit with two forced draft and three induced draft fans. Particulate emissions are controlled by a cold side ESP. The flue gases exit the economizer through two Ljungstrom air preheaters, pass through the cold side ESP, then through the induced draft fans and finally out to the stack. All four units at Plant Hammond exhaust to a single 750 foot high stack. The exhaust gas streams from Units 1-3 are combined and discharged through a single liner, while Unit 4 exhausts through a separate liner.

Wastewater from low-volume waste streams, coal pile runoff, and the ash sluice system flows into three on-site ash ponds, from which blowdown is discharged, along with once-through cooling water, to the Coosa River. Solid waste, in the form of bottom ash and fly ash, is sluiced to the ash pond system.

Figure 1-2 is a simplified schematic flow diagram of Unit 4 showing the major coal, air, and flue gas streams, as well as the locations of the EMP sampling points.

For Phase 2, an advanced overfire air system was retrofitted to the unit, consisting of ducts, dampers, various instrumentation and controls, and OFA ports above the top burner rows on both the front and rear furnace walls. The overfire air is extracted from the two main secondary air ducts between the air flow venturis and the

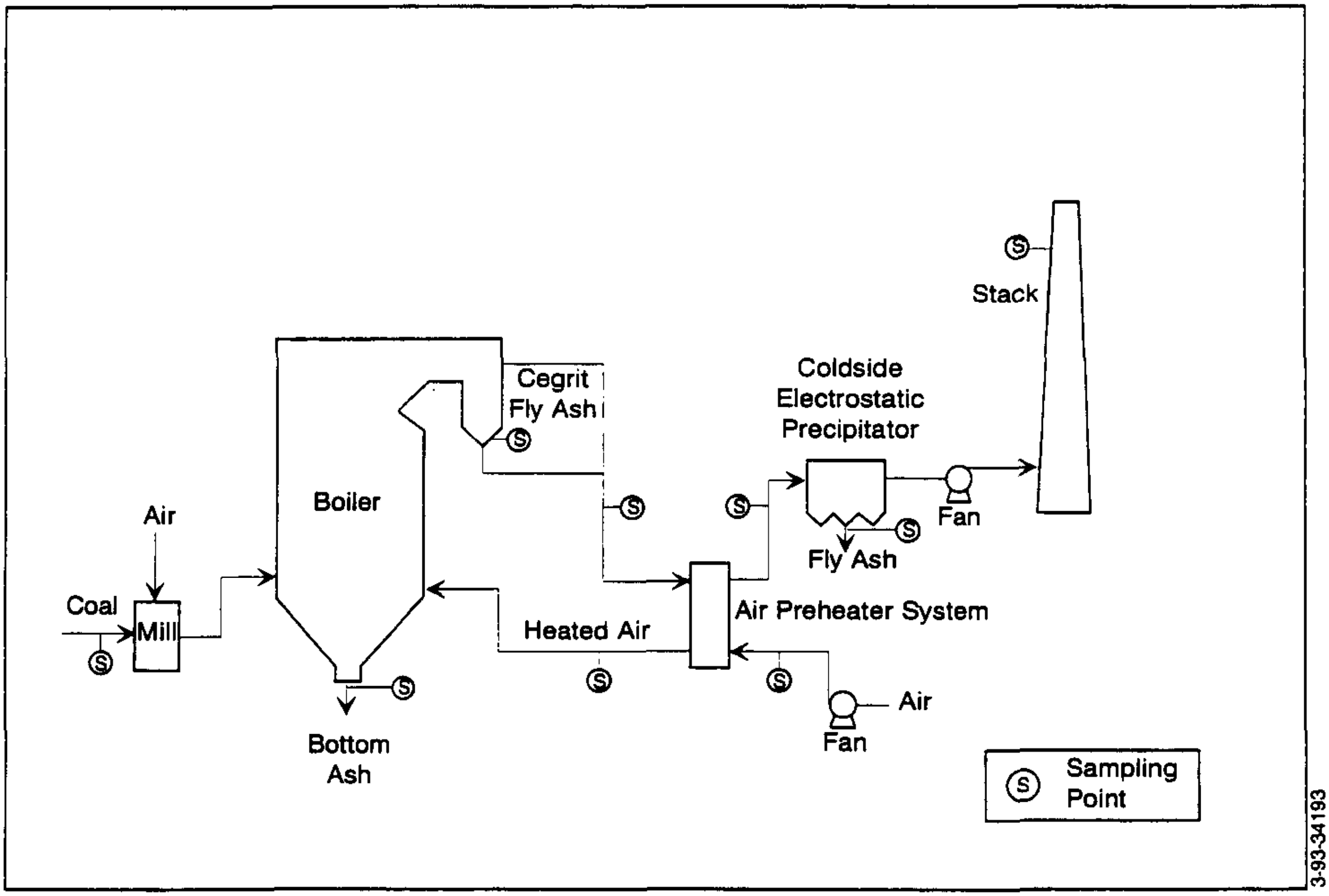

Figure 1-2. Unit 4 Schematic Flow Diagram

entrances to the combustion air windbox. Figure 1-3 shows the major components of the AOFA retrofit.

1.4 Report Organization

The remainder of this report is organized as follows:

- Section 2 discusses the EMP monitoring planned for each of the test periods during Phase 2;
- Section 3 briefly summarizes the sampling and analytical methods;
- Section 4 presents and discusses the gas stream monitoring results;
- Section 5 presents and discusses the aqueous stream monitoring results;
- Section 6 presents and discusses the solid stream monitoring results;
- Section 7 discusses EMP-related quality assurance/quality control activities performed during Phase 2;
- Section 8 provides a summary of reports that were prepared of compliance monitoring activities; and
- Section 9 presents conclusions based on the EMP monitoring results.

Appendix A contains data tables for each of the streams monitored as part of the EMP.

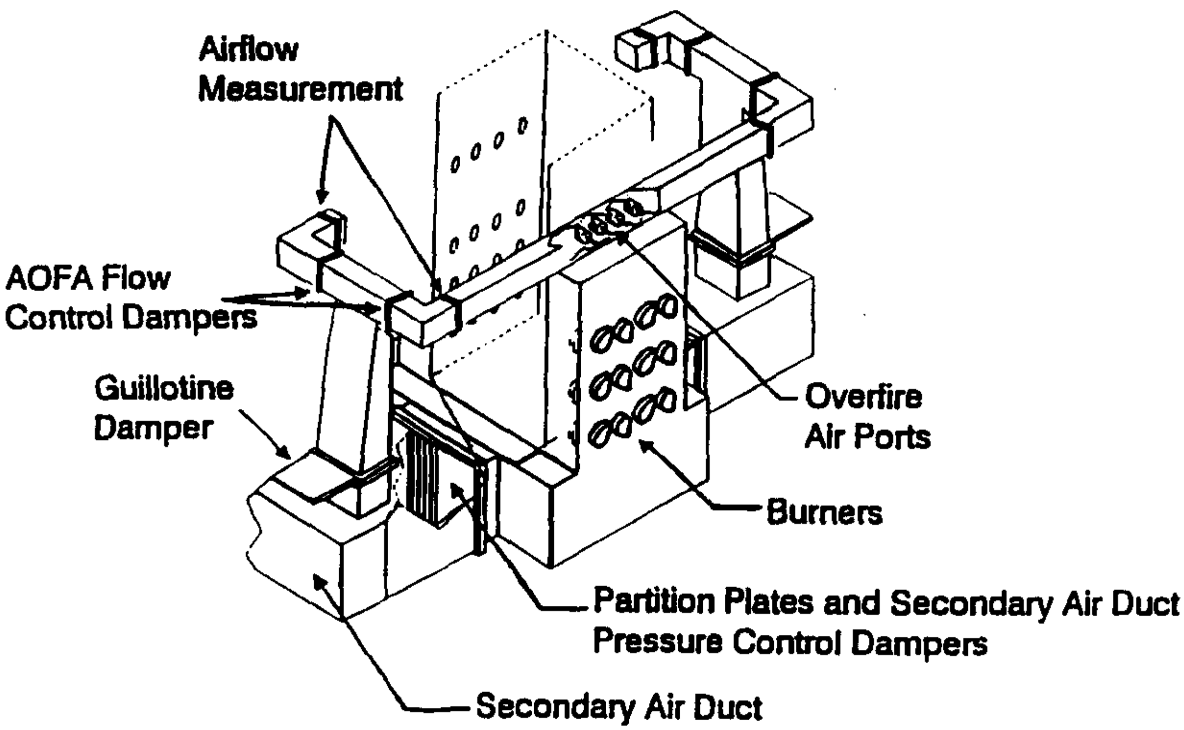

Figure 1-3. AOFA Retrofit Configuration (Source: ETEC Phase 2 Report)

2.0 PHASE 2 EMP MONITORING

Phase 2 consisted of three test elements: short-term characterization, long-term characterization, and short-term verification tests.

Short-term characterization tests are performed to establish the trends of Nox emissions under the most commonly used boiler operating conditions. The short-term testing is in turn divided into two elements: diagnostic tests and performance tests. Diagnostic tests are used to establish gaseous emission trends, and last from one to three hours at each set of operating conditions. Performance testing is used to establish boiler efficiency and steaming capability as well as gaseous and particulate emissions and mill performance. Each performance test lasts from 10 to 12 hours. All of the short-term characterization tests are conducted with the unit in a fixed configuration while it is off system load dispatch, to ensure steady boiler operation. The primary operating parameters that were varied during these tests included boiler load, excess oxygen, mill pattern, mill bias, and AOFA damper position. The emphasis of the EMP is on the gaseous and particulate emissions data obtained during these tests, as well as the coal feed characteristics. During Phase 2, a total of 82 diagnostic tests and 9 performance tests were conducted.

Long-term testing is conducted under normal system load dispatch control. At all load levels above 280 Mwe, the AOFA dampers were set in the 50% open position. Between 180 Mwe and 280 Mwe the dampers were maintained at 20% open; they were shut off below 180 Mwe. Long-term testing provides emission and operational results that are subsequently subjected to sophisticated statistical analysis to obtain a true representation of the emissions from the unit. Data are recorded continuously over the entire long-term testing period, which lasted 92 days during Phase 2.

Following the long-term testing period, verification testing is conducted to determine whether changes in unit condition and coal feed have occurred that might have an impact on the interpretation of the long-term test data. Verification tests are conducted in a manner similar to the diagnostic tests; four or five basic test configurations are tested during this short effort. A total of 15 verification tests were conducted during Phase 2.

Table 2-1 is a summary of the tests performed during Phase 2. For each series of tests, the table shows the dates, number of tests, and the total days of testing. This information was used to determine the total number of planned samples for each parameter during each series of tests.

Tables 2-2, 2-3, and 2-4 present the EMP integrated monitoring schedules for gaseous, aqueous, and solid streams, respectively, for Phase 2.

Table 2-1

Phase 2 (AOFA) Test Summary

Test Series	Dates	Number of Tests	Number of Days
Diagnostic	5/23/90 - 6/29/90 and 8/14/90 - 8/16/90	82	19
Performance	7/10/90 - 7/18/90	9	9
Long-Term Characterization	10/16/90 - 2/22/91 and 3/1/91 - 3/8/91	NA	92
Verification	2/22/91 - 2/28/91	15	6

NA = Not applicable.

Table 2-2

Gaseous Streams: Integrated EMP Monitoring Schedule
Plant Hammond

Parameter	Economizer Outlet Gas			Preheater Outlet Gas			Stack Gas								
							KVB CEM [3]			Opacity Monitor			Other		
	D/V [1]	P	L	D/V	P	L	D/V	P	L	D/V	P	L	D/V	P	L
Opacity												C [c][2,4]			
SO_2							a	a	C						
CO	a	b		a	b		a	a	C						
NO_x	a	b		a	b		a	a	C						
O_2	a	b		a	b		a	a	C						
THC							a	a	C						
SO_2/SO_3					4/T										
Particulate Matter:															
Loading					3/T										A[c]
Size Distribution					3/T										
Carbon Content, %					d										
Loss-on-Ignition					d										
Resistivity					3/T										

Notes:

1. Monitoring phase elements:
   - D = Diagnostic tests
   - P = Performance tests
   - L = Long-term tests
   - V = Verification tests

2. Monitoring frequency:
   - a = At least 2 averages per test
   - b = At least 10 averages per test
   - d = Composite of solids from mass loading measurement
   - n/T = Sampled a minimum of n times per test
   - C = Continuous
   - A = Annual
   - [c] = Compliance parameter

3. The KVB CEM is configured so that flue gas samples can be drawn from the economizer outlet, air heater outlet, and stack. Except for the stack probe, all lines pass through individual flow control valves and bubblers.

4. Opacity is measured in the stack using a dedicated monitor.

Table 2-3

Aqueous Streams: Integrated Monitoring Schedule

Parameter	Ash Pond Emergency Overflow[1]	Ash Transport Water Blowdown	Ash Pond Final Discharge
Total Suspended Solids	2/M [c][2]	2/M [c]	
pH	2/M [c]		2/M [c]
Oil and Grease	2/M [c]	2/M [c]	

Notes:

1. Ash pond emergency overflow is sampled only during discharge.
2. Monitoring frequency:

   2/M = Twice per month.

   [c] = Compliance monitoring.

Table 2-4

Solid Streams: Integrated Monitoring Schedule Plant Hammond

Parameter	Coal[1]			Bottom Ash[2]			ESP Fly Ash[3]			CEGRIT Fly Ash[4]		
	D/V[5]	P	L	D/V	P	L	D/V	P	L	D/V	P	L
Proximate and Ultimate Analysis, Ash, Moisture, C, H, N, S, Cl, O (by diff.), and HHV	1/Da[6]	3/Da	1/W									
Volatile/Semivolatile Organics							a					
Loss-on-Ignition					1/Da			1/T		1/T	2/T	1/W
Laboratory Resistivity								1/T				

Notes:

1. Coal sample is a composite from all operating mills.
2. *Bottom ash sample is composited from east and west bottom ash hoppers.*
3. ESP ash is collected from precipitator ash hoppers.
4. CEGRIT samples consist of east- and west-side samples, each analyzed separately.
5. Monitoring phase elements:
   - D = Diagnostic tests
   - P = *Performance tests*
   - L = Long-term tests
   - V = Verification tests
6. Monitoring frequency:
   - a = Sampled once during Baseline (Phase 1) and once during one of the NO_x reduction test Phases.
   - n/T = *Sampled a minimum of n times per test*
   - n/Da = Minimum of n samples per day
   - n/W = *Minimum of n samples per week*
   - [c] = *Compliance parameter*

3.0 SAMPLING AND ANALYTICAL METHODS

The sampling and analytical methods specified by the Environmental Monitoring Plan and used during Phase 2 are summarized in Tables 3-1 through 3-3. The reader should refer to the ETEC Phase Reports for additional details on the sampling and analytical methods used in this project.

There were no deviations from the sampling and analytical methods specified in the EMP.

3.1 Gaseous Stream Parameters

The KVB Extractive Continuous Emissions Monitor was used to provide quantitative analyses for NO_x, SO_2, CO, O_2, and total hydrocarbons. SoRI was responsible for solid and sulfur (SO_2, SO_3) emissions testing, which included measurement of particulate matter loading, size distribution, ash resistivity, carbon content, and LOI.

3.2 Aqueous Stream Parameters

The streams and parameters to be monitored and the monitoring schedules are specified in the Georgia Department of Natural Resources NPDES Permit No. GA0001457. Georgia Power personnel obtain samples and perform all aqueous parameter analyses. Results were obtained from Operation Monitoring Reports submitted by Georgia Power.

3.3 Solid Stream Parameters

Plant personnel obtained coal, bottom ash, and ESP fly ash samples. The CEGRIT on-line samplers automatically collected grab samples of fly ash in the furnace

Table 3-1

Sampling and Analytical Methods Summary: Gaseous Streams

Parameter	Sampling Method	Analytical Method/Instrument
Opacity	--	Lear Siegler Opacity Monitor
SO_2	GAS	Western Research Ultraviolet
CO	GAS	Siemens NDIR
NO_x	GAS	TECO Chemiluminescence
O_2	GAS	Thermox O_2 Electroanalytic (stack gas) and Yokagawa in-situ O_2 probes (economizer outlet and air preheater outlet)
SO_3	Cheney-Homolya Controlled Condensation	Titration
Total Hydrocarbons	GAS	Rosemount FID
Particulate Matter:		
Loading	EPA Method 17	Gravimetric
Size Distribution	Isokinetic	Gravimetric
Carbon Content, %	EPA Method 17	
Resistivity	In-Situ Probe	Electrode Cell

GAS = Continuous extractive and in situ gas analysis system.

Table 3-2

Sampling and Analytical Methods: Aqueous Streams

Parameter	Sampling Method	Analytical Method/Instrument
Total Suspended Solids	Grab	Filtration/Drying/Gravimetric; EPA 160.2
pH	Grab	Electrometric; Std Methods 432
Oil and Grease	Grab	Freon Extraction/Gravimetric; EPA Method 413.1, SM 503A

Table 3-3

Sampling and Analytical Methods: Solids Streams

Parameter	Sampling Method	Analytical Method
Ultimate Analyses	Grab/Composite	Combustion/Gravimetric/Titration; ASTM D3176
Moisture Content	Grab/Composite	Gravimetric; ASTM D3173
Chlorine	Grab/Composite	Fusion/IC or Titration; ASTM D2361
Higher Heating Value	Grab/Composite	Combustion; ASTM D2015
Sulfur	Grab/Composite	High Temperature Combustion; ASTM D3177
Ash	Grab/Composite	Combustion/Gravimetric; ASTM D3174
Volatile/Semivolatile Organics	Grab/Composite	Purge-and-Trap or Extraction/GC/MS/ Analyses; EPA 8240, 8270

backpass. Coal samples were shipped to Alabama Power's General Test Laboratory in Birmingham, where they were subjected to proximate and ultimate analyses. Loss-on-Ignition (LOI) measurements were performed on bottom ash, ESP fly ash, and CEGRIT fly ash.

4.0 GASEOUS STREAM MONITORING RESULTS

This section presents the results of the gaseous stream EMP monitoring performed during the period covered by Phase 2. These results are also compared to those obtained during Phase 1 (baseline) monitoring. Three gas streams were monitored as specified in the EMP: economizer outlet gas, air preheater outlet gas, and stack gas.

Table 4-1 presents the actual and planned Phase 2 gaseous stream monitoring. As shown in this table, most of the planned EMP monitoring was performed during Phase 2. In some cases, especially for the economizer outlet gas and stack gas, more than the planned amount of monitoring was actually conducted. It appears that monitoring of the preheater outlet gas was not conducted as planned during the diagnostic and verification test periods. However, the emphasis of the EMP is on the stack gas data, except for the SO_3/SO_2 and particulate matter monitoring data obtained from the preheater outlet gas. Sufficient data were obtained from the preheater outlet gas stream for these parameters, and from the stack gas for the other parameters, from which to develop analyses and draw conclusions.

Appendix A contains all of the short-term results in tabular form. The daily averages obtained during long-term testing are also listed.

The following sections present the results of the Phase 2 testing for gaseous streams, primarily in graphical form. These results are also compared to those from the Phase 1 baseline testing. The short-term monitoring results for the stack gas stream were selected for presentation since all of the long-term monitoring was also done on the stack gas. These results are presented in Section 4.1 The SO_3/SO_2 and particulate matter results for the preheater outlet gas are presented in Section 4.2. The long-term stack gas testing results are presented in Section 4.3. Section 4.4 presents the results of compliance monitoring conducted during Phase 2.

Table 4-1

Gaseous Streams: Actual and Planned Monitoring [1]

Parameter	Economizer Outlet Gas			Preheater Outlet Gas			Stack Gas			
	D [2]	P	V	D	P	V	D	P	L	V
SO_2							164/164	77/18	C/C	40/30
CO	562/164	409/90	258/30	0/164	133/90	0/30	164/164	77/18	C/C	40/30
NO_x	562/164	409/90	258/30	0/164	133/90	0/30	164/164	77/18	C/C	40/30
O_2	562/164	409/90	258/30	0/164	133/90	0/30	164/164	77/18	C/C	40/30
THC							164/164	77/18	C/C	40/30
SO_3/SO_2					32/36					
Particulate Matter:										
Loading					13/27					
Size Distribution					18/27					
Carbon Content, %					5/9					
Loss on Ignition (LOI)					5/9					
Resistivity (Spark, I/V Methods)					30/27					

[1] 562/164 = 562 measurements taken/164 measurements planned.

[2] Monitoring phase elements:

C = Continuous
D = Diagnostic tests
L = Long-term tests
P = Performance tests
V = Verification tests

Additional gaseous stream monitoring (not shown above):

- Stack gas opacity is measured on a continuous basis in response to a compliance requirement.
- Stack gas particulate loading is measured annually in response to a compliance requirement.

4.1 Short-Term Results for the Stack Gas

This section presents the short-term stack gas monitoring results for NO_x, SO_2, total hydrocarbons, and CO.

4.1.1 Nitrogen Oxides Emissions

In Figures 4-1 through 4-4, NO_x emission data obtained during all three of the Phase 2 short-term testing periods are presented as a function of stack gas oxygen concentration for each of the four nominal operating load levels at which testing was performed (i.e., 480, 450, 400, and 300 MW). Data are presented from the tests conducted with the AOFA damper in the 50% open position. As explained in the ETEC Phase 2 report, the diagnostic tests showed that this position was the "optimum" over the load range, taking into account both NO_x reduction and effects on boiler operation (e.g., excess oxygen level impacts on CO concentration and carbon loss). Consistent results were obtained during diagnostic, performance, and verification tests at each load level. As expected, the NO_x emission rate increased at higher flue gas oxygen levels. Figures 4-1, 4-3, and 4-4 also present graphical comparisons of the Phase 2 results with those obtained during all of the Phase 1 baseline testing at 480, 400, and 300 MW, respectively. Compared with the baseline tests, reductions in NO_x emissions were obtained at each load level using AOFA. Although emission trends were investigated during short-term testing, only the long-term test results were intended to be used in determining achievable NO_x reductions. The long-term data are presented in Section 4.3.

4.1.2 Sulfur Dioxide Emissions

As expected, no relationships were indicated between stack gas SO_2 emissions and operating load or flue gas oxygen concentration during Phase 2. Although

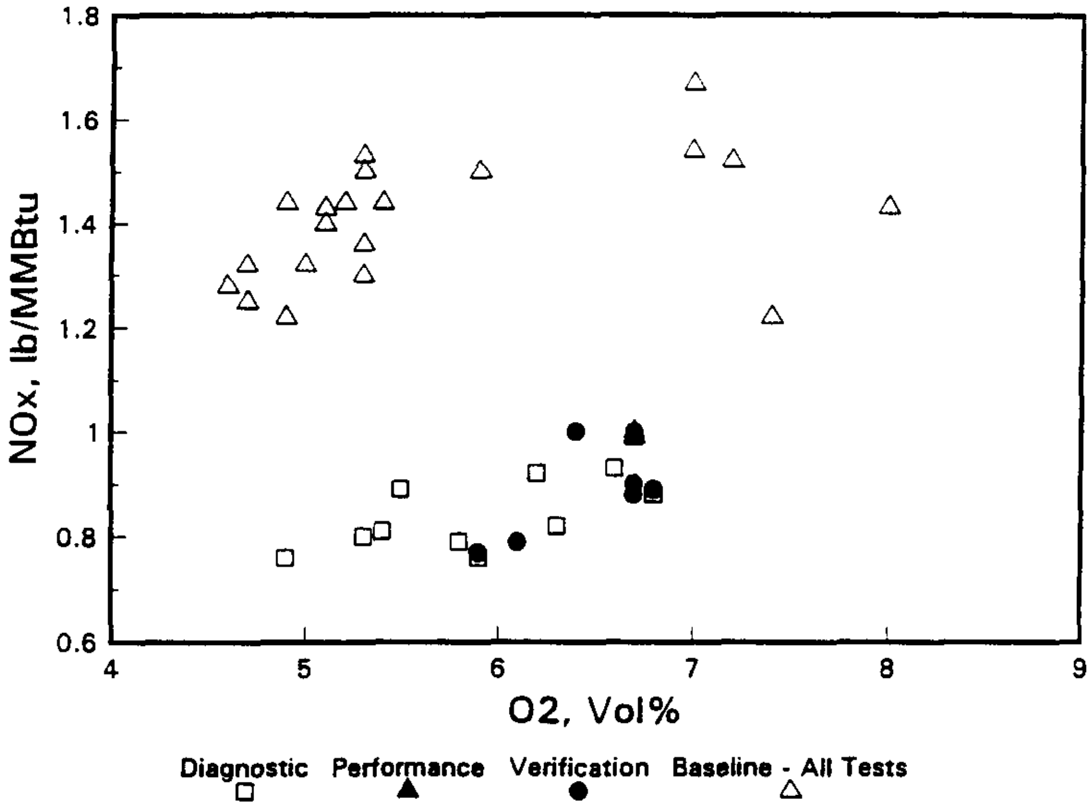

Figure 4-1. Short-Term NO_x Emission Versus Stack Gas Oxygen Concentration at 480 MW: Phase 2 (AOFA)

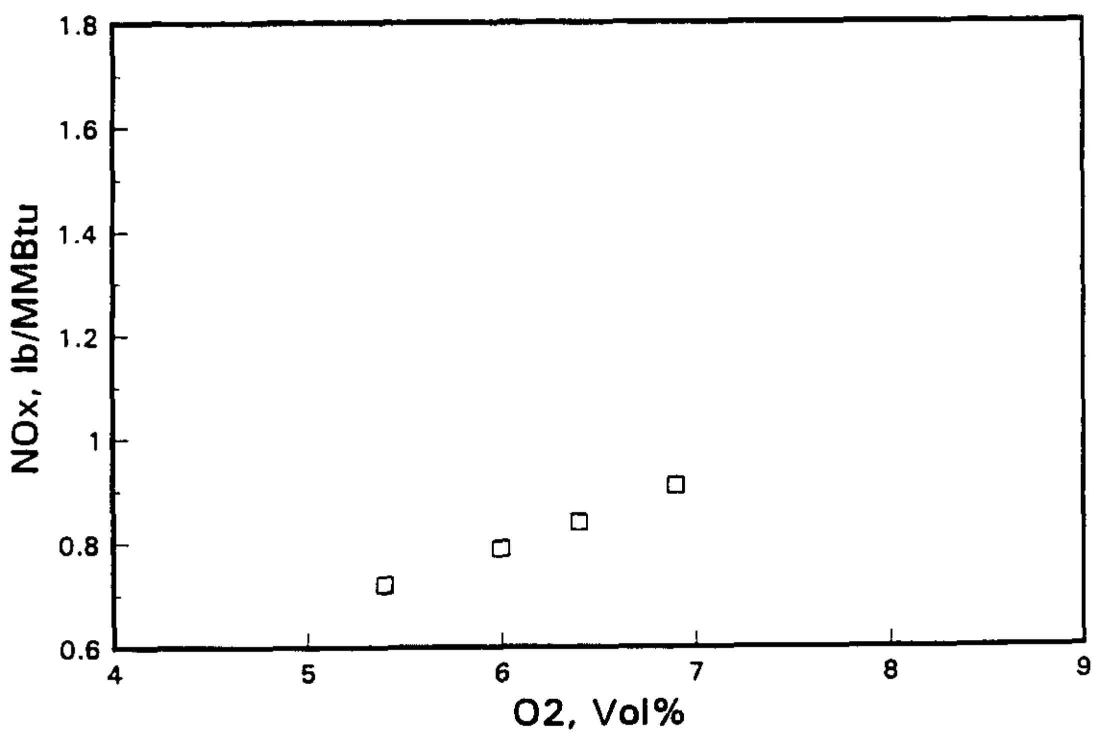

Figure 4-2. Short-Term NO_x Emission Versus Stack Gas Oxygen Concentration at 450 MW: Phases 1 (Baseline) and 2 (AOFA)

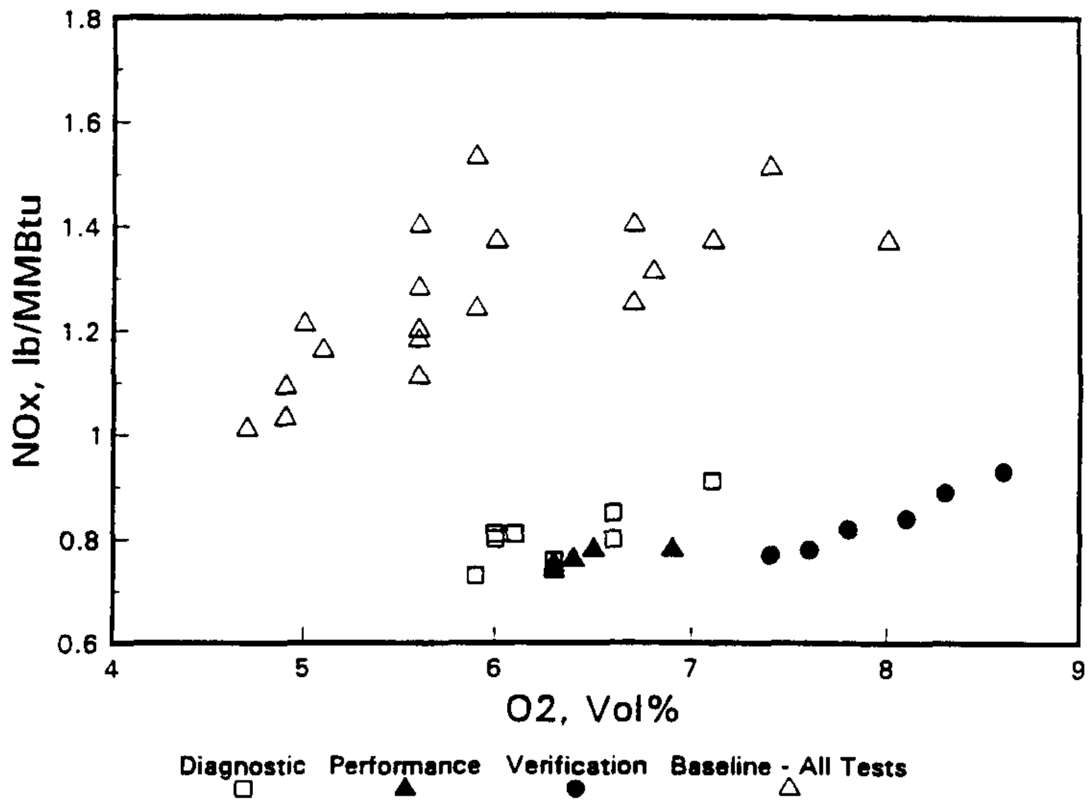

Figure 4-3. Short-Term NO_x Emissions Versus Stack Gas Oxygen Concentration at 400 MW: Phases 1 (Baseline) and 2 (AOFA)

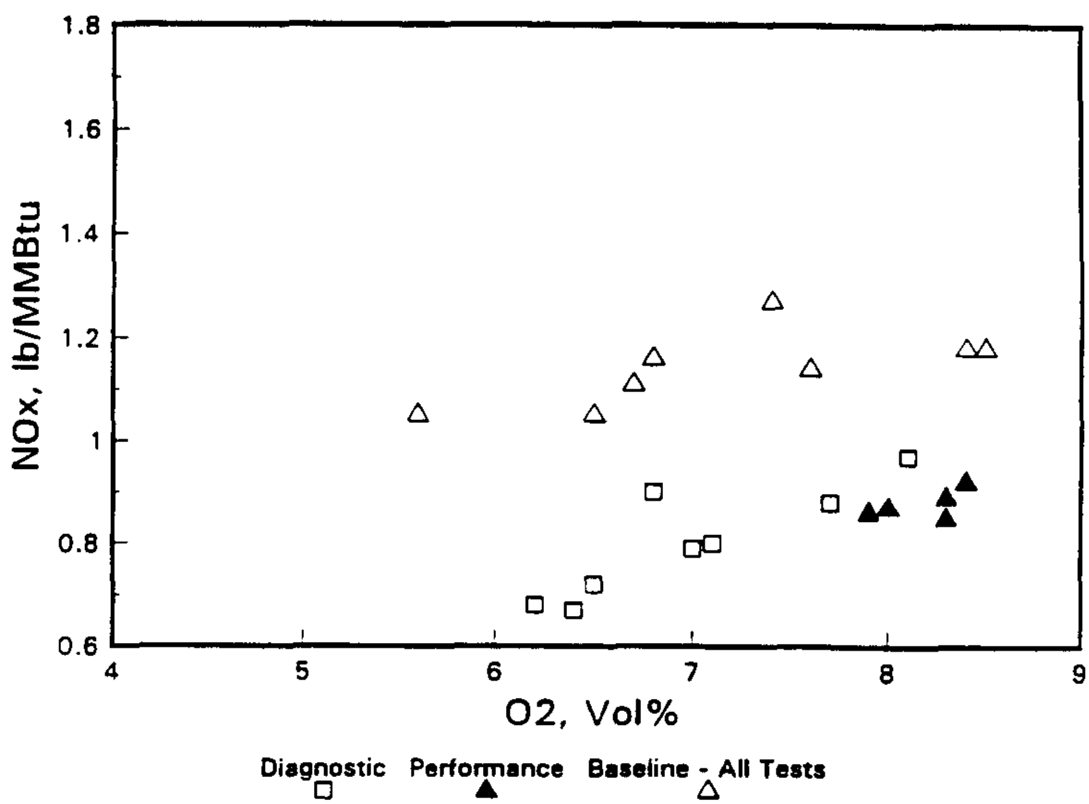

Figure 4-4. Short-Term NO_x Emissions Versus Stack Gas Oxygen Concentration at 300 MW: Phases 1 (Baseline) and 2 (AOFA)

the SO_2 emissions are related to coal sulfur content, the variation in coal sulfur content was too small, and the SO_2 data scatter was too great to define this relationship.

The SO_2 emissions observed during short-term monitoring for Phases 1 and 2 generally fell in the same ranges, consistent with the small variation in coal sulfur between the two phases.

4.1.3 Total Hydrocarbons Emissions

Figure 4-5 is a graphical presentation of the Phase 2 short-term stack gas THC concentration plotted as a function of load. No correlation was found between THC concentration and load or oxygen concentration. The THC level during the Phase 2 short-term testing varied from 1 to 4 ppmv (corrected to 3% O_2). Figure 4-5 also includes the THC levels measured during Phase 1. In general, the Phase 1 THC data showed considerably more scatter, and the average THC concentration at each load level was slightly higher, than for the Phase 2 results.

4.1.4 Carbon Monoxide Emissions

The short-term stack gas CO concentration data for Phases 1 and 2 are presented in Figure 4-6. As with THC, no relationships were found between CO concentration and load or oxygen concentration based on the short-term data. The Phase 2 data showed more scatter than those for Phase 1, and the average CO concentration was higher in Phase 2.

4.2 Short-Term Results for Preheater Outlet Gas

Monitoring for SO_3/SO_2 and several particulate matter parameters was conducted on the preheater outlet gas stream was conducted during the Phase 2 performance testing period. Results are summarized in this section.

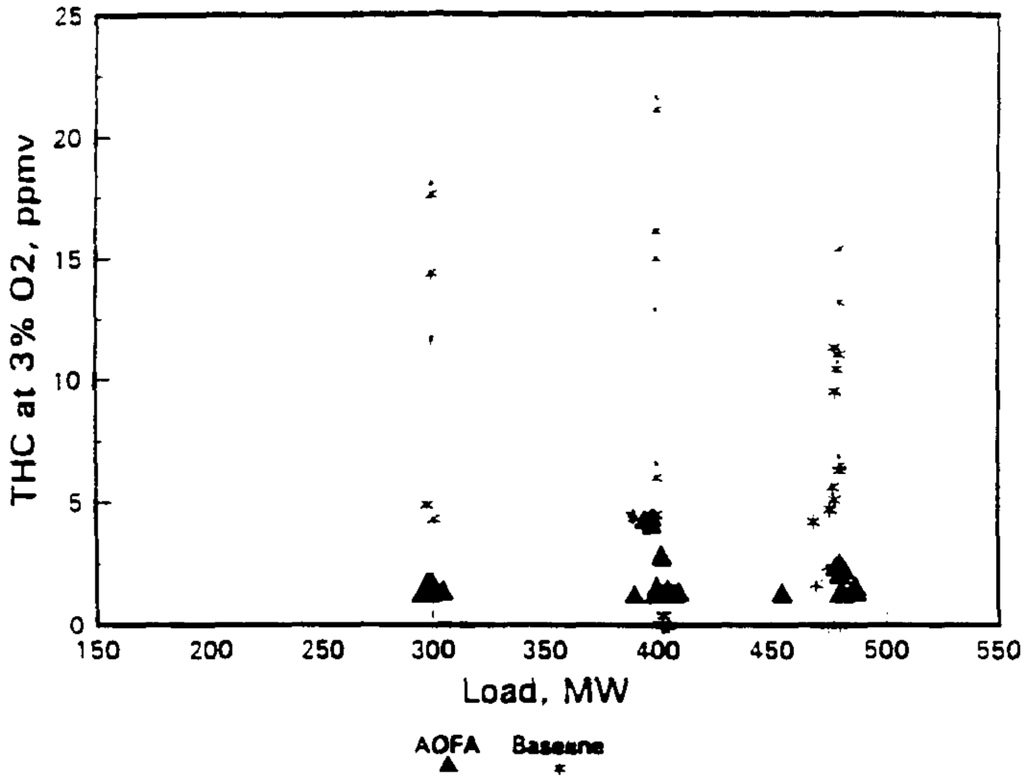

Figure 4-5. Short-Term Stack Gas Total Hydrocarbon Concentration Versus Load: Phases 1 (Baseline) and 2 (AOFA)

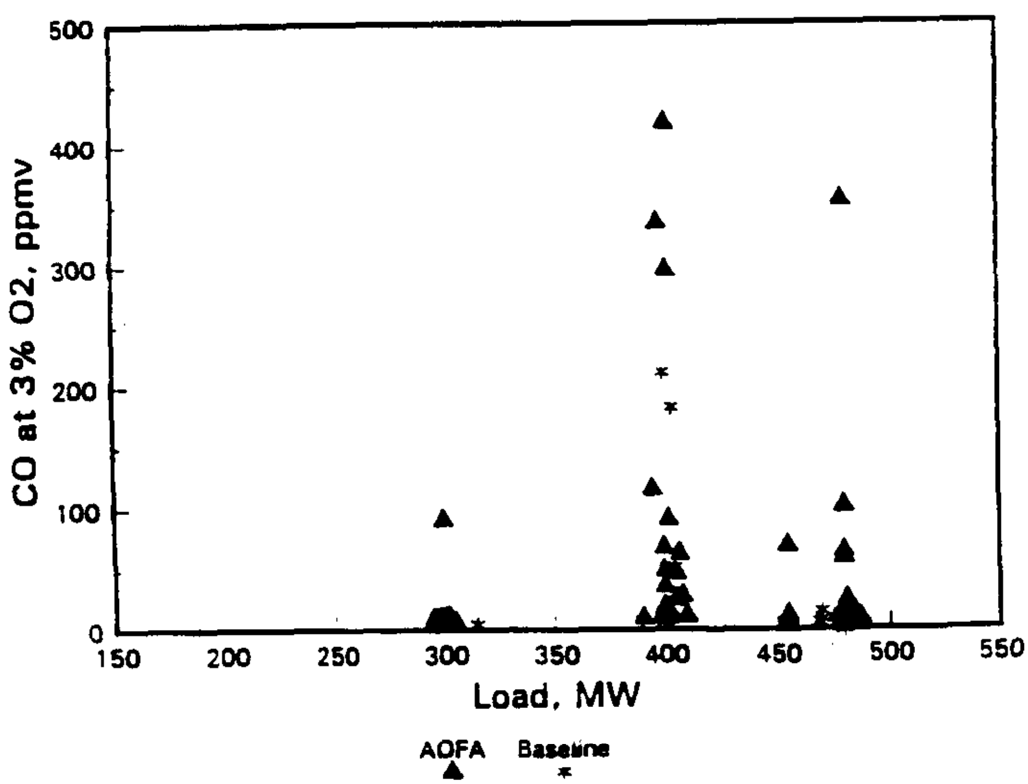

Figure 4-6. Short-Term Stack Gas CO Concentration Versus Load: Phases 1 (Baseline) and 2 (AOFA)

4.2.1 SO_3/SO_2 Ratio

During combustion, the majority of the coal sulfur is converted to sulfur dioxide, while a small fraction is further oxidized to sulfur trioxide. The concentration of sulfur trioxide is important from an environmental standpoint, since it will form sulfuric acid in the presence of water vapor. It is also important from a process standpoint, since it has a beneficial impact on the operation of the electrostatic precipitators.

The average ratios of SO_3 to SO_2 concentrations measured at each load level are shown in Figure 4-7 for both Phase 1 and Phase 2 tests. The 95% confidence interval about the mean is included for the Phase 2 tests conducted at an AOFA damper position of 50 percent. As indicated previously, this position was found to be the "optimum" during the diagnostic tests. For comparison purposes, the mean values of the SO_3/SO_2 ratio obtained at an AOFA damper position of 75% are also shown.

During baseline tests at a load of 300 MW, the excess oxygen was 4.0 to 4.4% compared to levels from 2.4 to 3.5% during other baseline tests. This is probably the reason for the higher SO_3/SO_2 ratio observed for the baseline tests at this load. The data for the 400 MW, 50% AOFA test showed a lower SO_3 value than for the other Phase 2 tests. This may have been the result of the low gas temperatures experienced during this test, which could have resulted in sub-dewpoint operation. At full load, the ratios observed during the baseline, 75% AOFA, and 50% AOFA tests were very comparable. Based on the available data, it does not appear that AOFA operation affected the amount of SO_3 which is formed. The excess oxygen level has the biggest impact on SO_3 formation.

4.2.2 Particulate Loading

Particulate loading was measured in the flue gas exiting the air preheater. Average loadings measured at 300, 400, and 480 MW are shown in Figure 4-8 for both

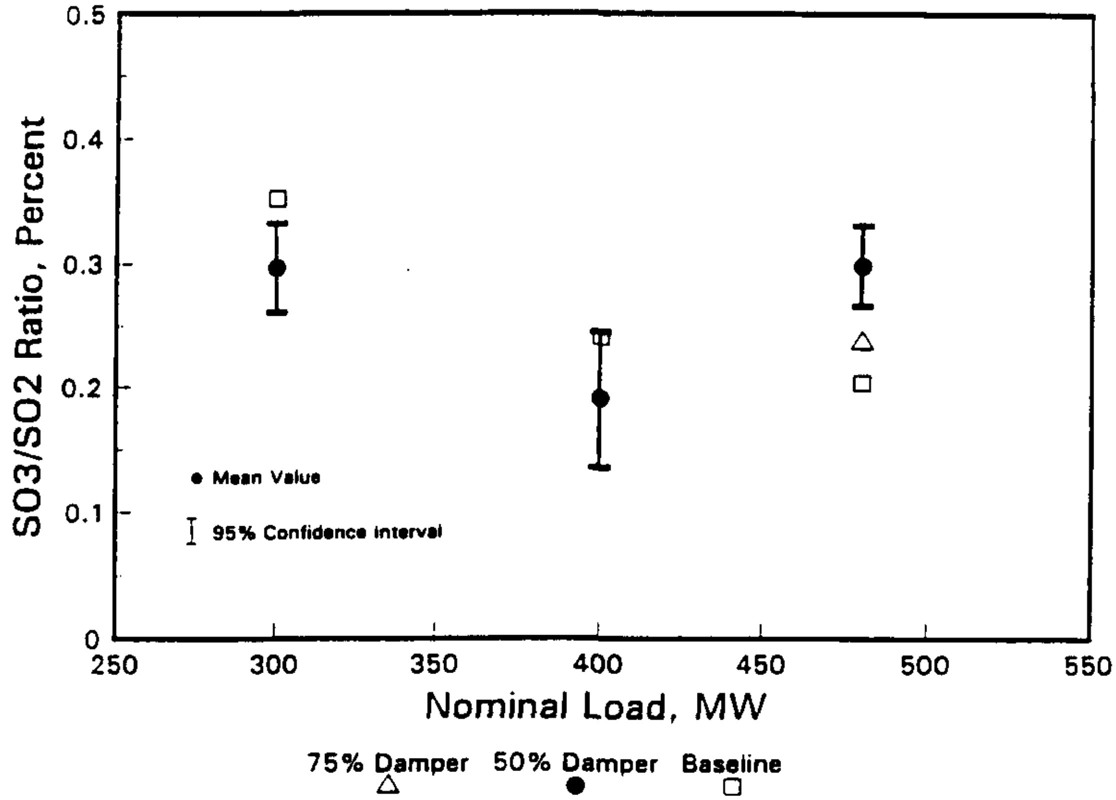

Figure 4-7. Preheater Outlet Gas SO_3/SO_2 Ratio Versus Load (95% Confidence Interval): Phases 1 (Baseline) and 2 (AOFA)

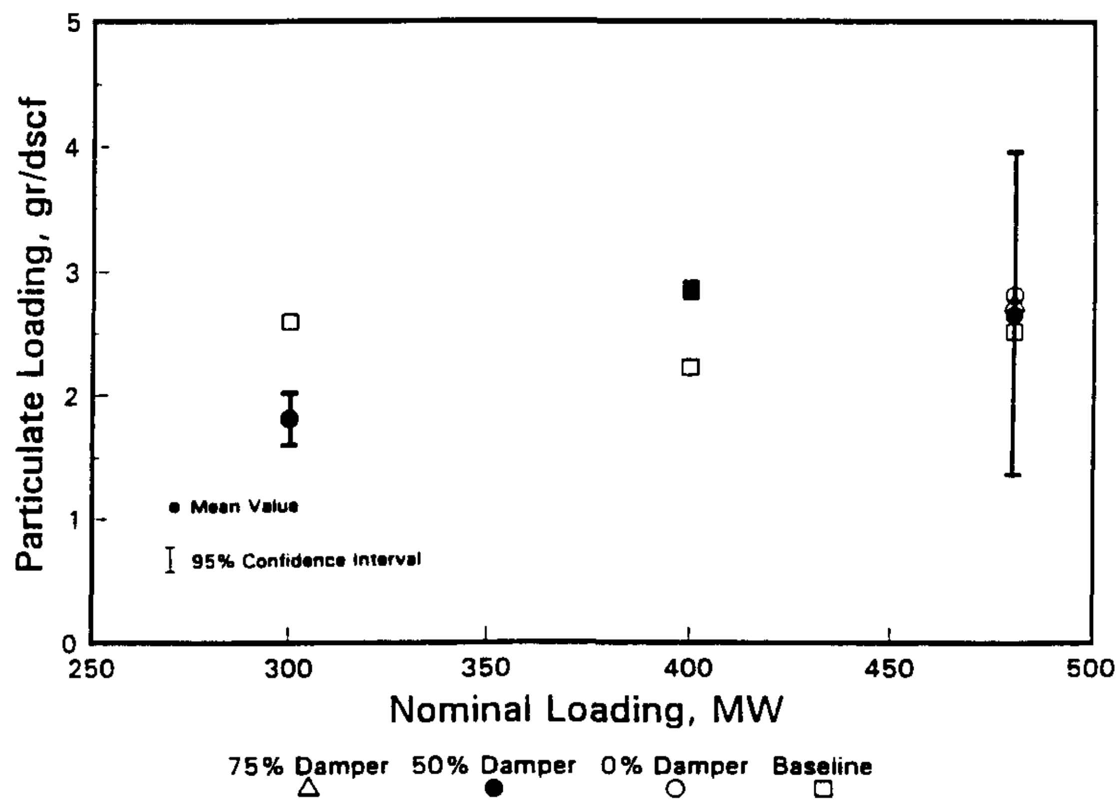

Figure 4-8. Preheater Outlet Gas Particulate Loading Versus Load (95% Confidence Interval): Phases 1 (Baseline) and 2 (AOFA)

Phase 1 and Phase 2 tests. The 95% confidence interval about the mean is shown for the Phase 2 tests conducted at an AOFA damper position of 50 percent. For comparison purposes, the mean values obtained during the baseline test and at AOFA damper positions of 0 and 75% are also presented. From these results, it does not appear that AOFA operation had a significant impact on the particulate loading in the flue gas at the inlet to the ESP.

4.2.3 Particle Size Distribution

Figure 4-9 shows the size distribution of the particulate matter in the preheater outlet gas measured during Phase 2. The results are very similar to those obtained during Phase 1.

4.2.4 Carbon and LOI Content

The amount of unburned carbon and the loss on ignition (LOI) measured in samples of fly ash particulates are indicators of Unit 4 combustion efficiency during the test period. These two parameters were measured using particulate samples collected to determine particulate loading. The results, shown in Figures 4-10 and 4-11 show that AOFA operation had a significant impact on the amount of carbon remaining in the fly ash; the amount of carbon in the fly ash during AOFA operation was nearly two times that observed during baseline testing. Comparable carbon and LOI contents were measured at AOFA damper positions of 50 and 75 percent. The values obtained at the damper position of 0% (i.e., closed damper), are comparable to those obtained during baseline testing. Figure 4-12 shows the correlation between the LOI and the carbon content of the fly ash, indicating that the measured LOI was primarily carbon.

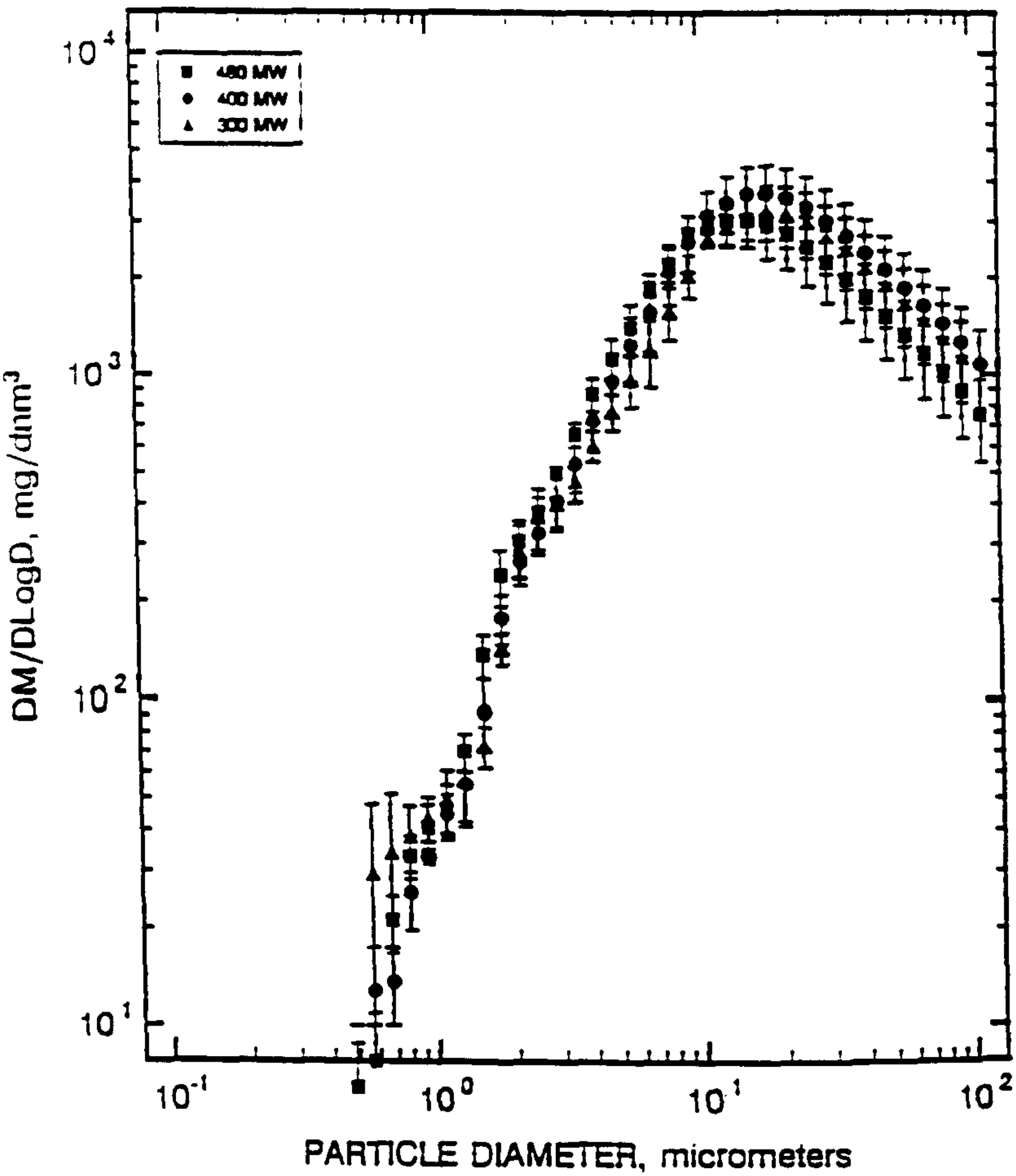

Figure 4-9. Preheater Outlet Gas Differential Particle Mass Distribution: Phase 2 (AOFA) (Source: ETEC Report)

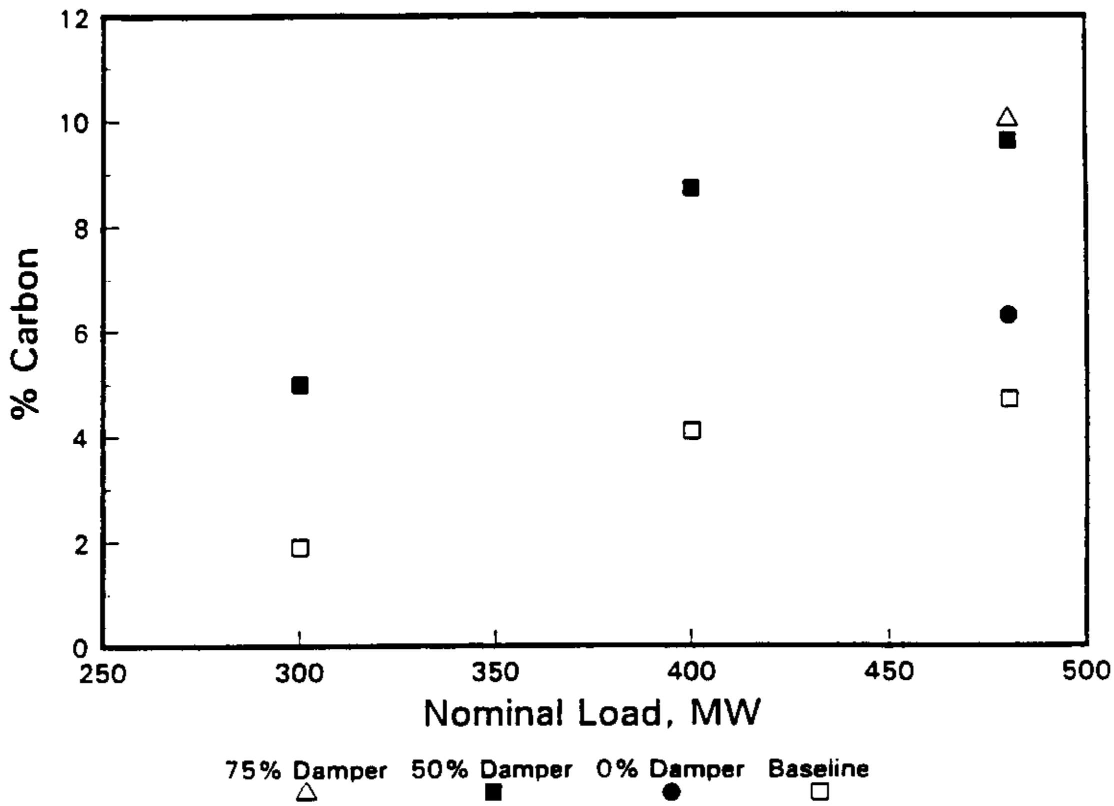

Figure 4-10. Carbon Content of Preheater Outlet Gas Particulates Versus Load: Phases 1 (Baseline) and 2 (AOFA)

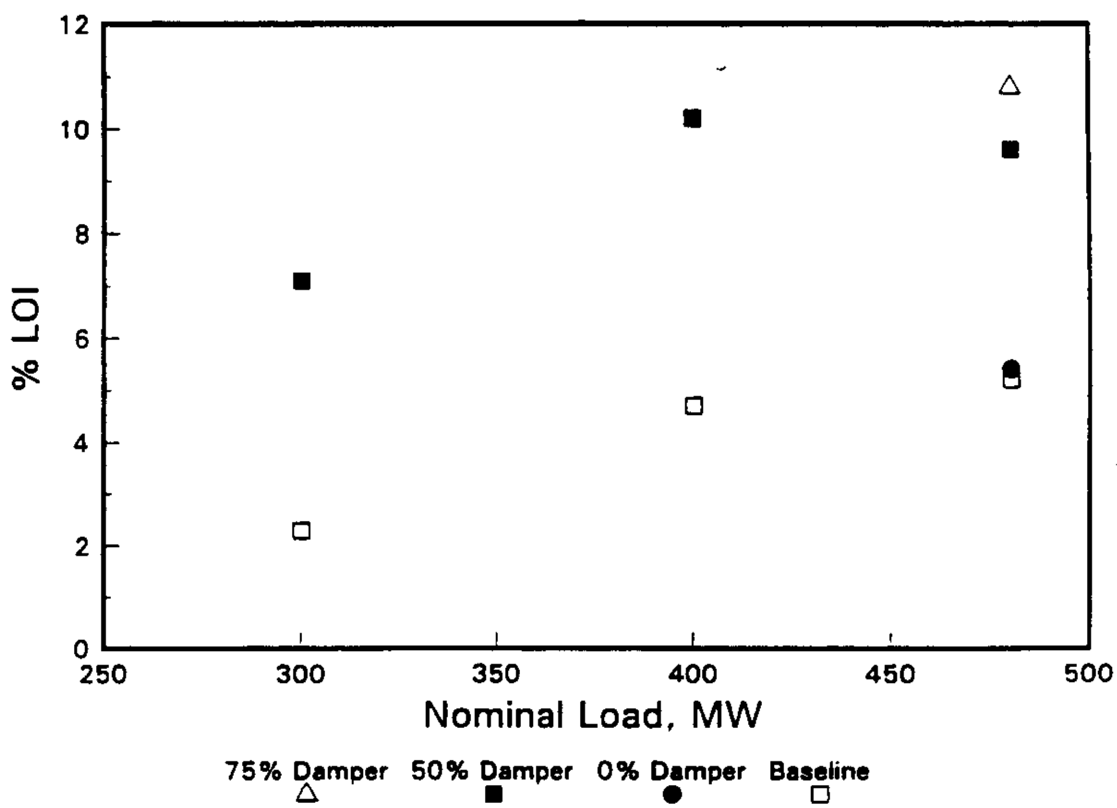

Figure 4-11. LOI Measurements of Preheater Outlet Gas Particulates Versus Load: Phases 1 (Baseline) and 2 (AOFA)

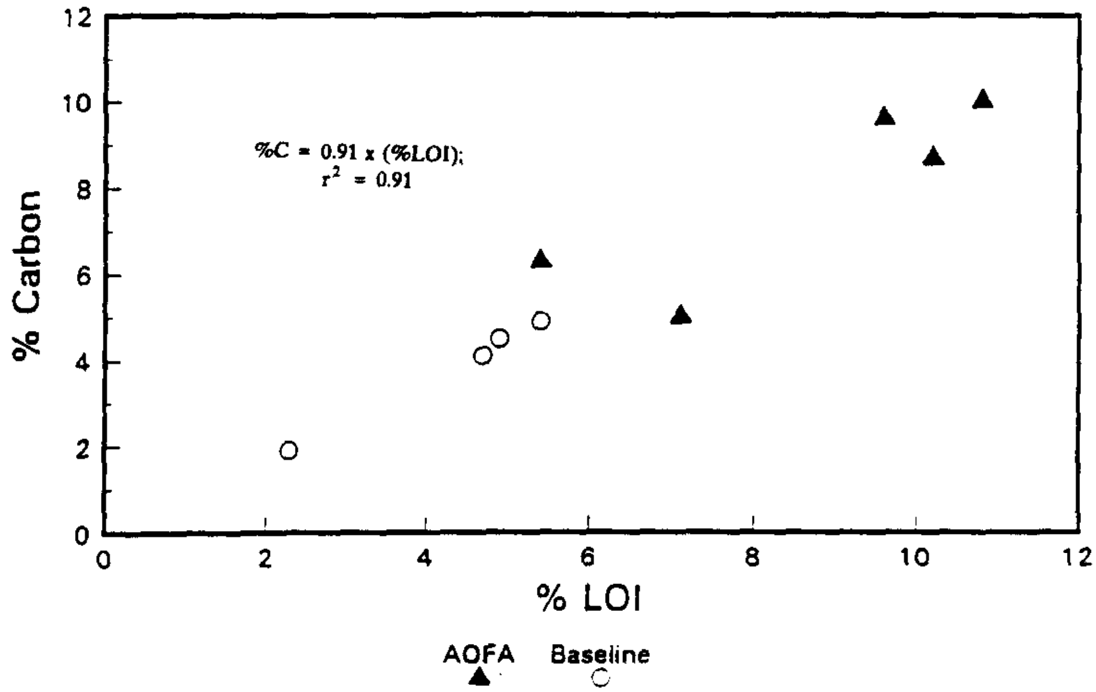

Figure 4-12. Relationship Between Carbon Content and LOI of Preheater Outlet Gas Particulate: Phases 2 (Baseline) and 2 (AOFA)

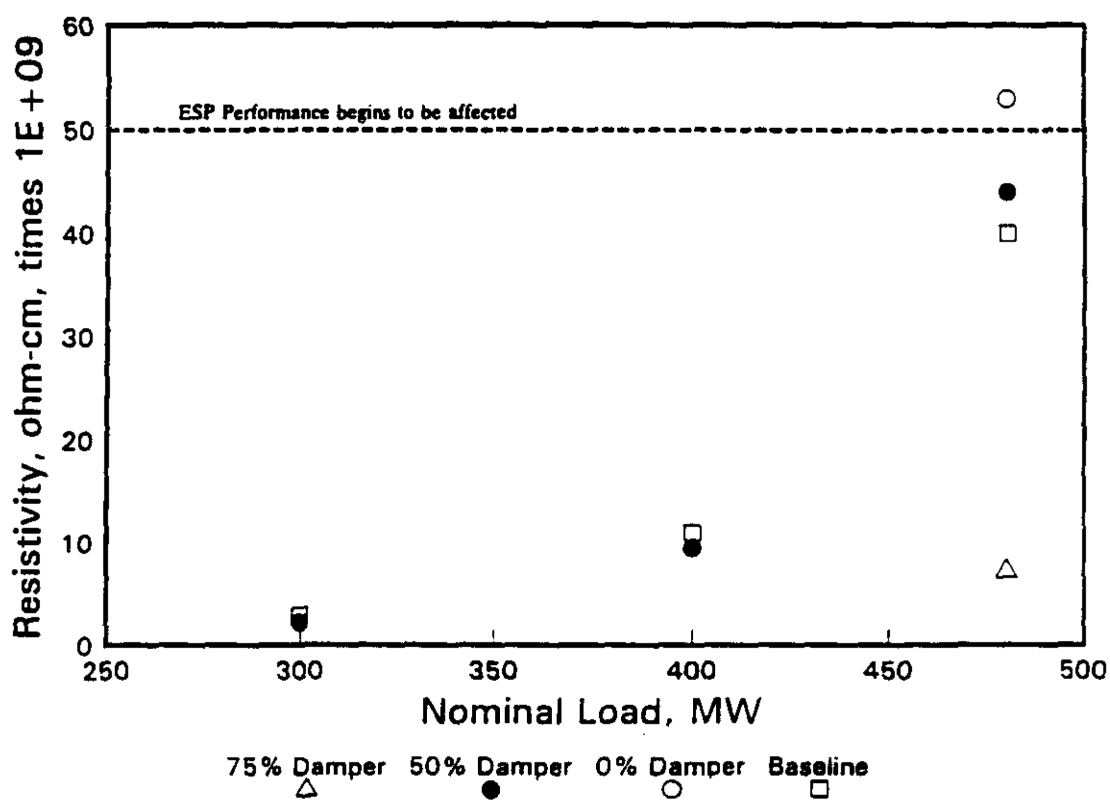

Figure 4-13. Average In-Situ Resistivity Measurements for Particle Resistivity in Preheater Outlet Gas - Spark Method

4.2.5 In-Situ Particle Resistivity

The resistivity of the particulate matter entering an ESP is an important variable that may impact particulate removal efficiency. The authors of the ETEC Phase 2 report suggest that ESP performance may be adversely impacted if the resistivity exceeds 2 - 5 x 10^{10} ohm-cm. The in-situ resistivities of the particulates were measured using the spark method, and the average resistivities are plotted versus nominal load in Figure 4-13 for both Phase 1 and 2 operation; similar results were obtained using the voltage-current (V-I) method to measure resistivities. It does not appear that AOFA operation had any deleterious impact on the particulate resistivity, and the use of AOFA should not lead to degradation in ESP performance. In fact, the highest average resistivity was found for the particles collected at a load level of 480 MW and with the AOFA damper closed.

4.3 Long-Term Monitoring Results

Long-term testing consisted of continuous measurements of operating parameters while the unit was under system load dispatch control. Unit load and concentrations of O_2, NO_x, SO_2, CO, and THC were measured and results recorded using the computerized data acquisition system. Five-minute average data were used to compute hourly averages that were in turn used to compute daily averages. Some five-minute data were lost due to CEM outages. In these cases, data were treated using an adaptation of EPA's NSPS guidelines for determining how much data is sufficient to compute an hourly average for emission monitoring purposes. In the case of daily average emissions, only those days meeting the NSPS guideline of at least 18 hours of valid hourly data per day were used.

Five-minute average data were used to evaluate the relationship between NO_x and load and between the NO_x and O_2 levels in the stack gas at various load levels. Hourly average emission analyses, calculated from the five-minute average data, were used to assess hour-to-hour variations in NO_x emissions O_2 levels, and load. Daily average emission data were used to establish trends in emissions as functions of O_2 levels, and load, and to calculate 30-day rolling NO_x emission levels for the entire long-term period. The ETEC Phase 2 report focuses on the NO_x emission results. This EMP report summarizes the emission trends for NO_x, but also presents the emission trends for SO_2, CO, and THC, based on the daily average data.

4.3.1 Nitrogen Oxides Emissions

Daily average NO_x emissions are plotted versus load in Figure 4-14. Data from both Phases 1 and 2 are presented. The data show that NO_x emissions were reduced during AOFA operation compared to baseline. A statistical analysis of the five-minute average data shows this relationship more clearly. Figure 4-15 presents the mean NO_x emission rate as a function of load; the reduction in NO_x emissions due to AOFA operation is shown as a function of load level in Figure 4-16. An average reduction in NO_x emissions of 24% was obtained during AOFA operation at high load conditions (460-490 MW); somewhat lesser reductions were obtained at lower loads.

4.3.2 Sulfur Dioxide Emissions

Daily average SO_2 emissions data for Phases 1 and 2 are presented in Figure 4-17. Although there is considerable scatter, the data from both phases appear to fall in the same range, consistent with the similarity in coal sulfur content between the two phases. The overall average emission rate for Phase 2 based on the daily average emission data was 2.08 lb/MMBtu. For Phase 1, an average of 2.36 lb/MMBtu was calculated. The slightly higher emission rate for Phase 1 is consistent with the slightly higher average coal sulfur content observed during Phase 1 long-term testing.

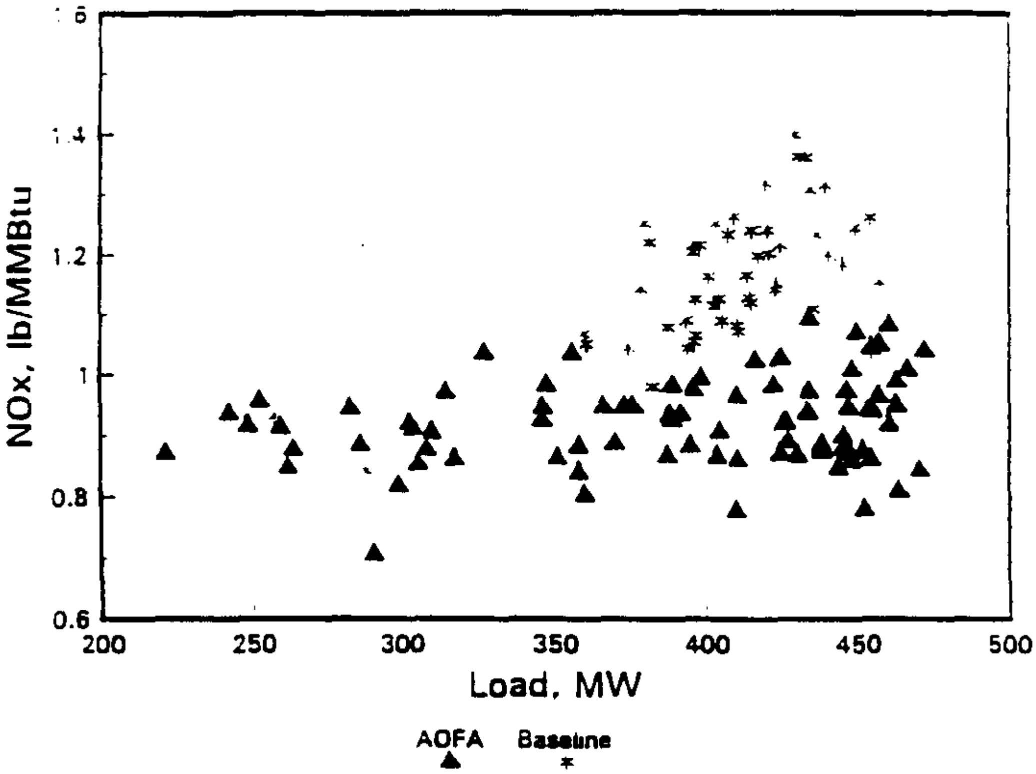

Figure 4-14. Long-Term Daily Average NO_x Emissions Versus Load: Phases 1 (Baseline) and 2 (AOFA)

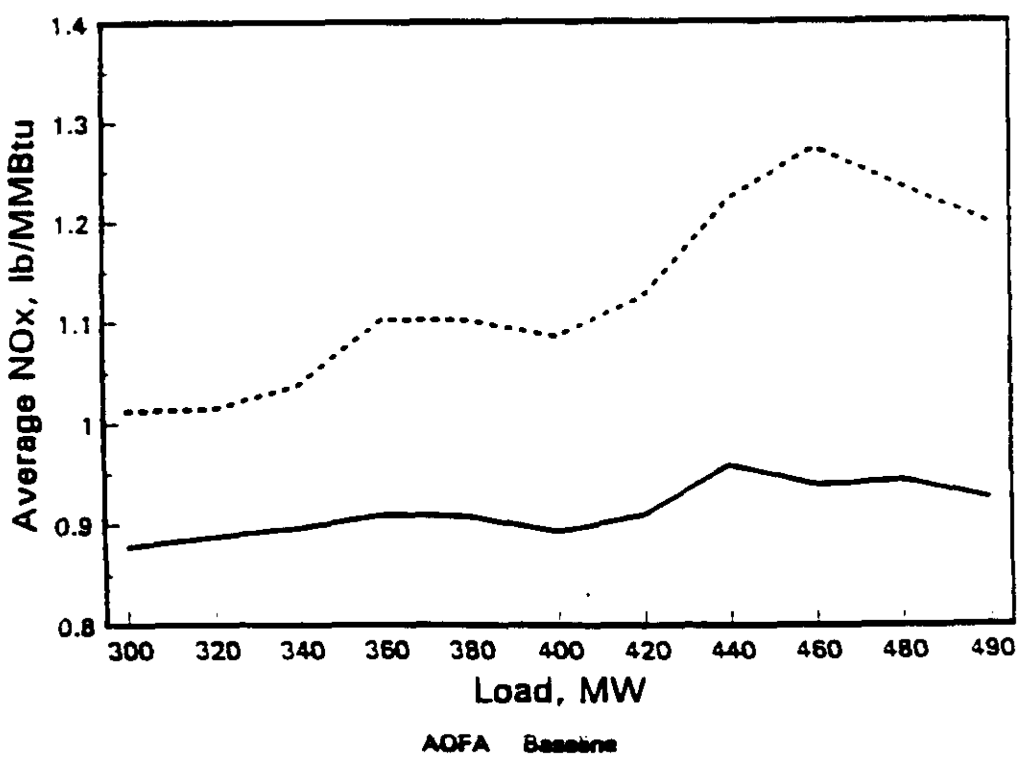

Figure 4-15. Average Long-Term NO_x Emissions Versus Load: Phases 1 (Baseline) and 2 (AOFA)

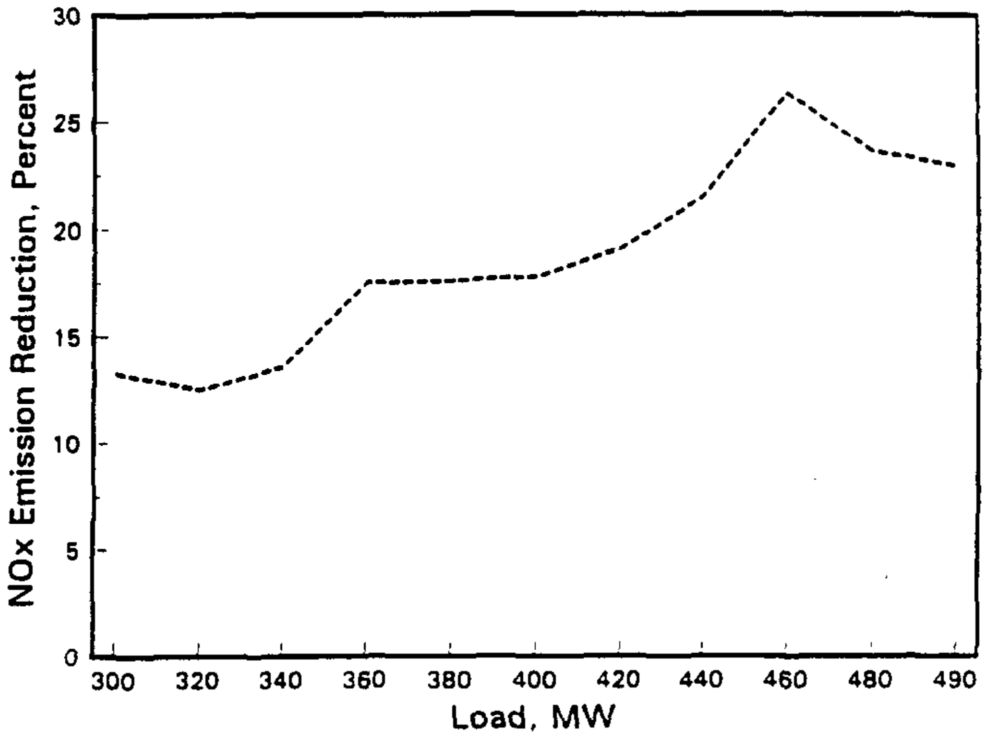

Figure 4-16. Average Reduction in NO_x Emissions Versus Load Between Phases 1 (Baseline) and 2 (AOFA)

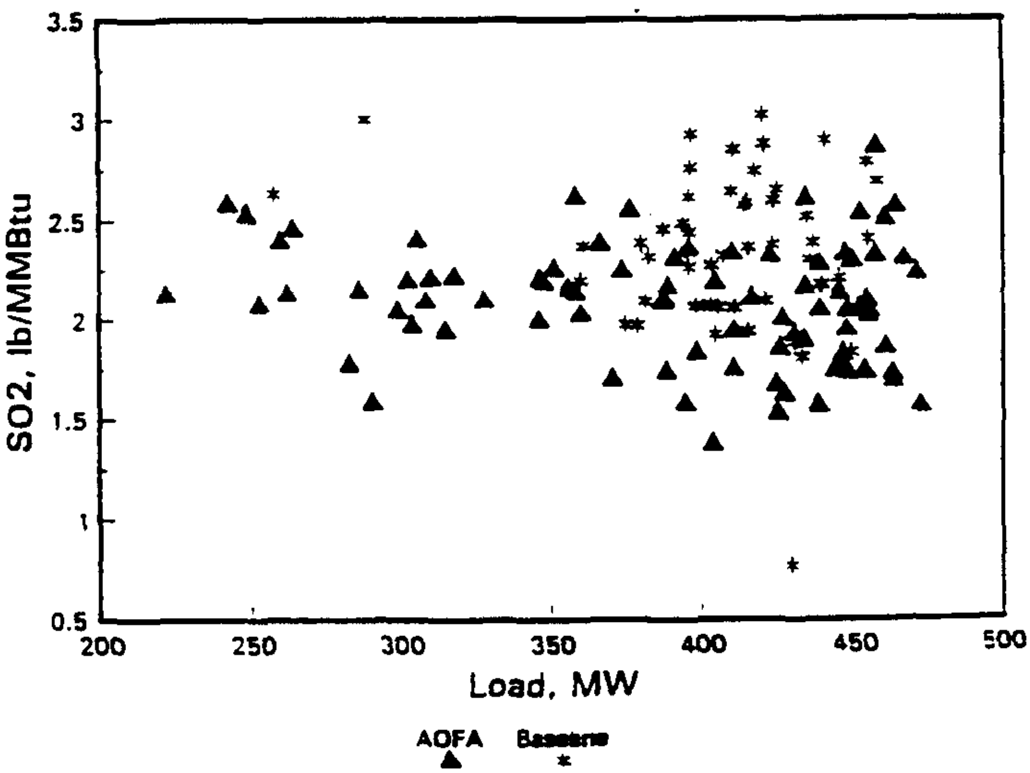

Figure 4-17. Long-Term Daily Average SO_2 Emissions Versus Load: Phases 1 (Baseline) and 2 (AOFA)

4.3.3 Carbon Monoxide Emissions

Daily average CO emissions data from Phase 1 and Phase 2 long-term testing periods are presented in Figure 4-18. Considerably more scatter was seen in the Phase 1 data than for Phase 2. The overall CO emission rate observed during Phase 2 was 0.01 lb/MMBtu; a rate of 0.04 lb/MMBtu was found for Phase 1. Part of the reason for this may well have been the higher oxygen concentration used at the higher load levels during AOFA operation, as shown in Figure 4-19. At the lower loads, the CO emission rates for Phases 1 and 2 were comparable.

4.3.4 Total Hydrocarbons

The long-term daily average THC emission rate data are presented in Figure 4-20. For the most part, the values obtained during Phase 2 varied from 0.0005 to 0.002 lb/MMBtu; an overall mean rate of 0.001 lb/MMBtu was calculated. A large number of the data points for Phase 1 were reported as zero; it appears that there may have been instrument problems during these periods. During periods when nonzero values were obtained, the values were very similar to those obtained during Phase 2 at the same load levels. No relationship was found between the daily average THC emission rate and the flue gas oxygen concentration.

4.4 Compliance Monitoring Results

As a part of the EMP, data were obtained on the opacity of the stack gas stream using a continuous opacity monitor. Georgia Power provides periodic reports to the Department of Natural Resources detailing the daily excess opacity emissions from each of the two plant stacks (i.e., Units 1-3 and Unit 4). Copies of these reports have been provided as appendices to the quarterly EMP progress reports.

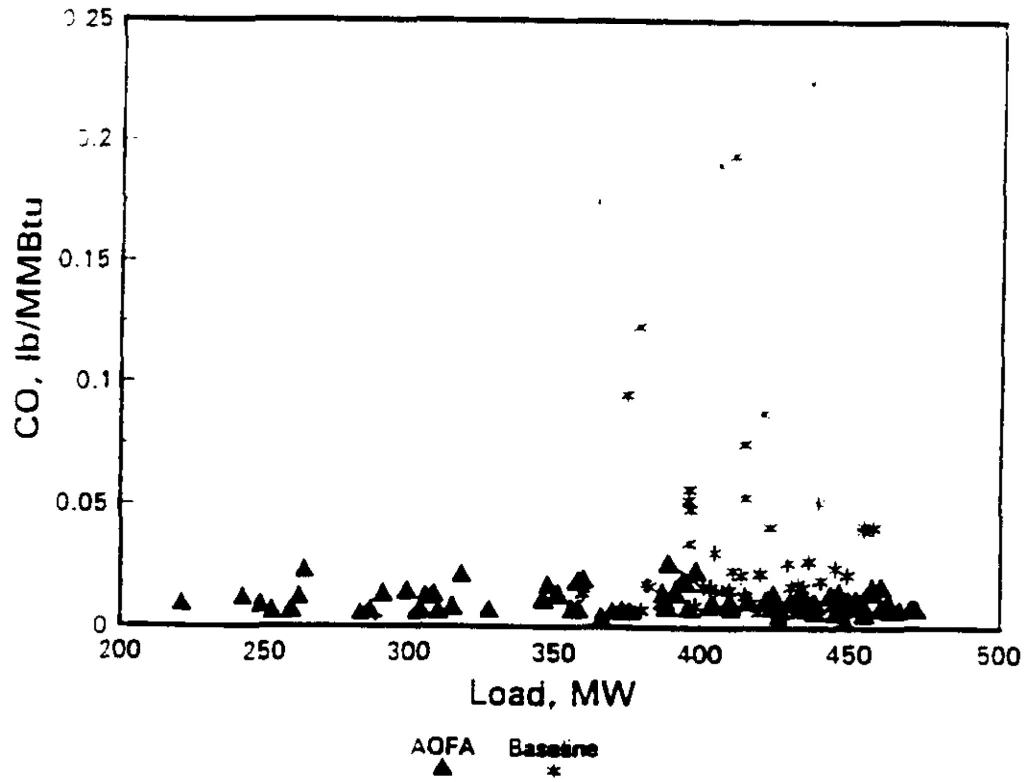

Figure 4-18. Long-Term Daily Average CO Emissions Versus Load: Phases 1 (Baseline) and 2 (AOFA)

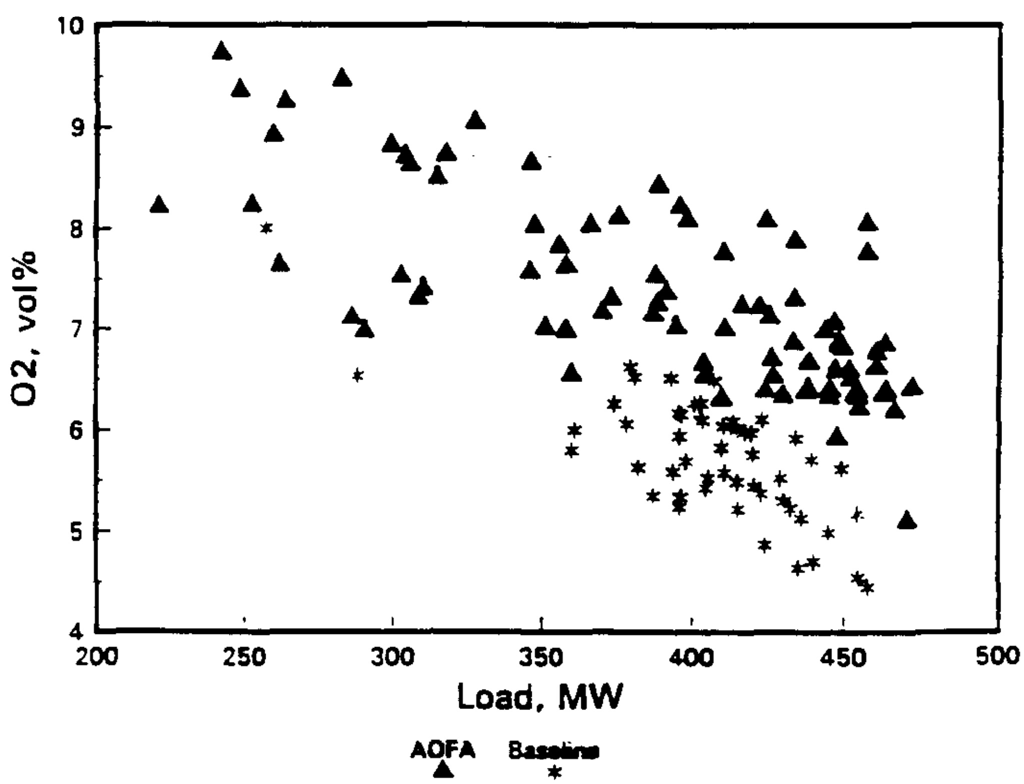

Figure 4-19. Long-Term Daily Average Oxygen Concentration Versus Load: Phases 1 (Baseline) and 2 (AOFA)

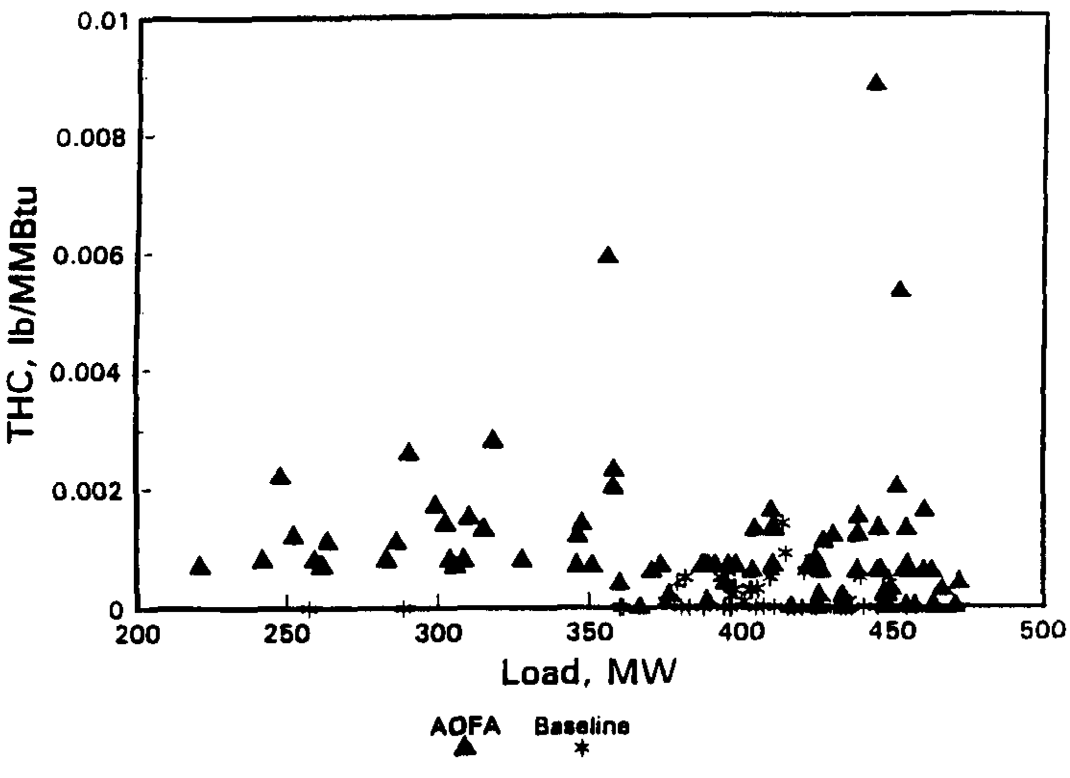

Figure 4-20. Long-Term Daily Average THC Emissions Versus Load: Phases 1 (Baseline) and 2 (AOFA)

A summary of the daily excess opacity emissions data from the Phase 2 long-term testing period (fourth quarter of 1990 and first quarter of 1991) is provided in Table 4-2. The table shows the dates when the stack gas opacity exceeded the permitted limit, the number of six-minute averages during each day with excess emissions, the average opacity over all of these periods, and a short explanation of the reasons for the exceedances. The applicable emission limit is 40% opacity during any six-minute monitoring period. It is important to remember that the table contains information only for those periods when opacity exceedances occurred. During the majority of the time when the boiler was in operation the stack gas opacity below the opacity limit.

An examination of the table shows that the majority of the excess emissions occurred during boiler start up or shut down periods, or when there were difficulties with the ESP (e.g., low power levels, arcing, trip-outs, problems or adjustments to the rapping mechanism or SO_3 injection system). Excess emissions also occurred during periods of upset or unusual operation of the coal feeders or fans, or when the boiler tubes were being cleaned by soot blowing or deslagging. None of these conditions appears to have been attributable to the AOFA system, since similar causes of excess emissions were also observed during baseline testing.

Table 4-2

Stack Gas Opacity: Summary of Excess Emissions During Phase 2 Long-Term Testing[a,b]

Date	Number of Six-Minute Averages With Excess Emissions[c]	Average Opacity	Reasons for Excess Emissions
10/17/90	4	49	deslagging boiler, raising load, low power to ESP sections arcing
10/18/90	1	42	"D" coal feeder tripped
10/19/90	1	51	"D" coal feeder tripped
10/20/90	17	48	unit off line, washing precipitators
10/21/90	27	89	unit start up
10/22/90	104	91	unit start up
10/23/90	10	46	SO_3 system out, low ESP power levels
10/24/90	95	51	running compliance tests w/out SO_3 system -- violations excused by state
10/25/90	1	43	adjusting SO_3 and O_2
10/26/90	2	46	put vibrator in service, blowing soot
10/27/90	1	43	raising load
10/30/90	8	58	boiler upset on AGC, boiler leak -- coming off line
10/31/90	84	90	problems with opacity monitor -- erroneous readings
11/01/90	97	87	unit start up
11/02/90	23	88	unit start up, low ESP power arcing
11/03/90	2	41	ESP section tripped
11/04/90	1	49	boiler upset
11/05/90	4	44	trouble with "C" mill (1), boiler upset, I.D. fan problems
11/07/90	3	42	putting "A" I.D. fan in service
11/09/90	3	41	putting SO_3 system in service, low ESP power levels (2)
11/10/90	12	89	unit off line, ESP out of service
11/11/90	71	85	unit off line, fans running, rapper in service: start up (47)

Table 4-2 (Continued)

Date	Number of Six-Minute Averages With Excess Emissions[c]	Average Opacity	Reasons for Excess Emissions
11/12/90	70	92	unit start up
11/15/90	1	43	soot blowing
11/27/90	48	48	bringing unit back on line
11/30/90	1	45	rapper intensity adjustment
12/01/90	2	43	ESP section tripped, soot blowing
12/03/90	1	46	trouble with "B" mill
12/05/90	2	50	reset rapper control, "D" mill trouble
12/06/90	2	45	rapper control out
12/08/90	1	46	deslagging boiler
12/09/90	1	54	trouble with air on "E" mill
12/10/90	2	45	soot blowing, trouble with air on "E" mill
12/13/90	1	43	trouble with "D" mill
12/14/90	52	68	coming off line, rapper still in service, fans running
12/15/90	47	89	unit start up
12/18/90	23	86	"A" fan in service, ESP section tripped out, start up after unit trip
12/19/90	28	89	unit start up, "A" fan in service, rapper control back in service
12/24/90	1	40	working on full ESP hoppers
12/28/90	67	79	ESP rapper control MODs, unit off line
12/31/90	51	89	unit start up, fire out; unit on standby
01/03/91	45	84	unit start up, fire out; unit on standby
01/08/91	65	91	start up -- oil firing
01/09/91	117	92	unit start up, fire out; continue with start up
01/10/91	14	92	unit coming off line
01/11/91	56	89	unit off line
01/15/91	208	93	unit start up, fire out; continue with start up

Table 4-2 (Continued)

Date	Number of Six-Minute Averages With Excess Emissions[c]	Average Opacity	Reasons for Excess Emissions
01/16/91	7	76	unit start up, trouble with F.D. fans
01/17/91	2	50	put "A" I.D. fan in service
01/25/91	52	64	bringing unit off line; unit off -- ESPs off
01/27/91	156	93	unit start up, fans in service
01/28/91	2	43	put "A" I.D. fan in service
02/05/91	3	43	"A" F.D. and "B" I.D. fans back in service; "E" mill in service
02/18/91	5	51	ESP section tripped while bringing unit off line; washing air heaters
02/19/91	70	91	unit start up, fans in service, oil fire
02/20/91	57	90	unit start up: put third fan in service
03/08/91	2	63	trouble with coal pulverizers; oil feed to stabilize

[a]This summary was taken from Quarterly Compliance Reports submitted by Georgia Power.

[b]Data are shown for Unit 4 only.

[c]The emission limit is 40% opacity for any six-minute averaging period.

5.0 AQUEOUS STREAM MONITORING RESULTS

This section presents the results of aqueous stream monitoring performed during the period covered by Phase 2. Three aqueous streams have been designated for monitoring: ash pond emergency overflow, ash transport water blowdown, and final discharge. The parameters selected for monitoring are those required for compliance with Plant Hammond's existing NPDES permit.

Table 5-1 presents the actual and planned aqueous stream monitoring. As shown in this table, all of the planned monitoring was performed during Phase 2. Since there were no discharges from the ash pond emergency outflow during this period, it was not necessary to monitor this stream. The aqueous stream monitoring results were taken from quarterly compliance reports submitted by Georgia Power Company to the Environmental Protection Division of the Georgia Department of Natural Resources. These compliance reports have also been included as appendices to the EMP Quarterly Reports prepared and submitted to DOE as part of this project. The data summarized in this section were taken from the compliance reports for the following periods: second through fourth quarters of 1990 and first quarter of 1991.

Table 5-2 summarizes the environmental monitoring results obtained during Phase 2; averages, standard deviations, number of data points, and ranges are shown for each parameter. The results from Phase 2 are similar to those obtained previously in Phase 1. No exceedances of the regulatory limits imposed by the plant's NPDES permit were found.

Table 5-1

Aqueous Streams: Actual and Planned Monitoring[1]

Parameter	Ash Pond Emergency Overflow	Ash Transport Water Blowdown	Final Discharge
Total Suspended Solids	0/24[2]	24/24	0/0
pH	0/24[2]	0/0	24/24
Oil & Grease	0/24[2]	24/24	0/0

[1] 24/24 = 24 measurements made/24 measurements planned.

[2] There were no discharges during the reporting period.

Table 5-2

Aqueous Streams: Phase 2 Results

Parameter	Average	Standard Deviation	No. of Data Points	Range	Permit Limits
Ash Pond Emergency Overflow					
TSS (mg/L)	(a)				30 Avg./100 Max.
pH	(a)				6.0 - 9.0
Oil & Grease (mg/L)	(a)				15 Avg./100 Max.
Ash Transport Water Blowdown					
TSS (mg/L)	5.9	4.1	24	2 - 22	30 Avg./100 Max.
Oil & Grease (mg/L)	<5	0	24	<5	15 Avg./100 Max.
Final Discharge					
pH	7.34	0.13	24	6.90 - 7.80	6.0 - 9.0

(a) There were no discharges during the Phase 2 reporting period.

6.0 SOLID STREAM MONITORING RESULTS

The results of solid stream monitoring performed during Phase 2 are presented in this section.

Monitoring of four solid streams is specified in the project's Environmental Monitoring Plan: coal feed, bottom ash, ESP fly ash, and CEGRIT fly ash. The coal is monitored to detect changes in composition that might impact the results obtained for the NO_x reduction technologies. The bottom and fly ash are monitored for loss on ignition to determine the potential impacts of the NO_x reduction technologies on coal utilization. The fly ash streams are monitored for resistivity to determine whether the NO_x reduction technologies might affect ESP control efficiency.

Table 6-1 shows the actual and planned monitoring frequencies for each of the solid stream parameters.

6.1 Coal Analyses

A statistical summary of the coal analyses performed during Phase 2 is presented in Table 6-2. Figure 6-1 presents, in graphical form, the average ultimate analyses for each of the test periods. As can be seen, the coal analyses were quite consistent between each of the Phase 2 test periods. These results are also comparable to the coal analyses performed during Phase 1; Table 6-3 compares the 95% confidence intervals computed using all of the data for each of the two phases. Carbon content and heating value were slightly higher during Phase 2, while sulfur, ash and oxygen were all slightly lower. The confidence intervals for the other parameters overlap.

Table 6-1

Solid Streams: Actual and Planned Monitoring [1]

Parameter	Coal				Bottom Ash			ESP Fly Ash			CEGRIT Fly Ash			
	D	P	L	V	D	P	V	D	P	V	D	P	L	V
Proximate/Ultimate Analysis	0/16	27/27	16/19	7/6										
Volatile/Semivolatile Organics								[2]						
Loss on Ignition (LOI)						9/9		2/0	9/9		2/82	21/18	17/19	11/15
Laboratory Resistivity									9/9					

[1] 27/27 = Twenty-seven measurements planned/27 measurements taken.

[2] Not scheduled to be monitored during Phase 2.

Table 6-2

Summary of Phase 2 Coal Analyses

Parameter	Performance Tests			Long-Term Tests			Verification Tests		
	Ave.	Std. Dev.	Range	Avg.	Std. Dev.	Range	Avg.	Std. Dev.	Range
Carbon, wt%	73.17	0.77	72.16-75.38	74.05	2.54	70.58-82.63	74.17	1.47	71.36-76.69
Hydrogen, wt%	4.72	0.08	4.53-4.85	4.59	0.68	1.96-4.91	4.79	0.09	4.62-4.89
Nitrogen, wt%	1.42	0.07	1.21-1.52	1.45	0.11	1.07-1.57	1.47	0.05	1.40-1.57
Sulfur, wt%	1.64	0.09	1.44-1.82	1.49	0.28	0.63-1.80	1.54	0.06	1.45-1.64
Chlorine, wt%	0.056	0.020	0.020-0.088	0.032	0.011	0.01-0.06	0.034	0.009	0.02-0.05
Oxygen, wt%	4.55	0.33	4.02-5.39	5.05	1.47	2.29-10.0	4.48	0.77	2.81-5.36
Ash, wt%	8.90	0.76	7.53-10.20	9.68	0.78	8.38-10.93	9.60	0.19	9.26-9.85
Moisture, wt%	5.60	0.88	4.11-7.45	3.70	1.32	1.75-6.38	3.97	1.44	3.12-7.38
HHV, Btu/lb	13,000	134	12,832-13,435	13,060	260	12,325-13,454	13,135	188	12,707-13,283

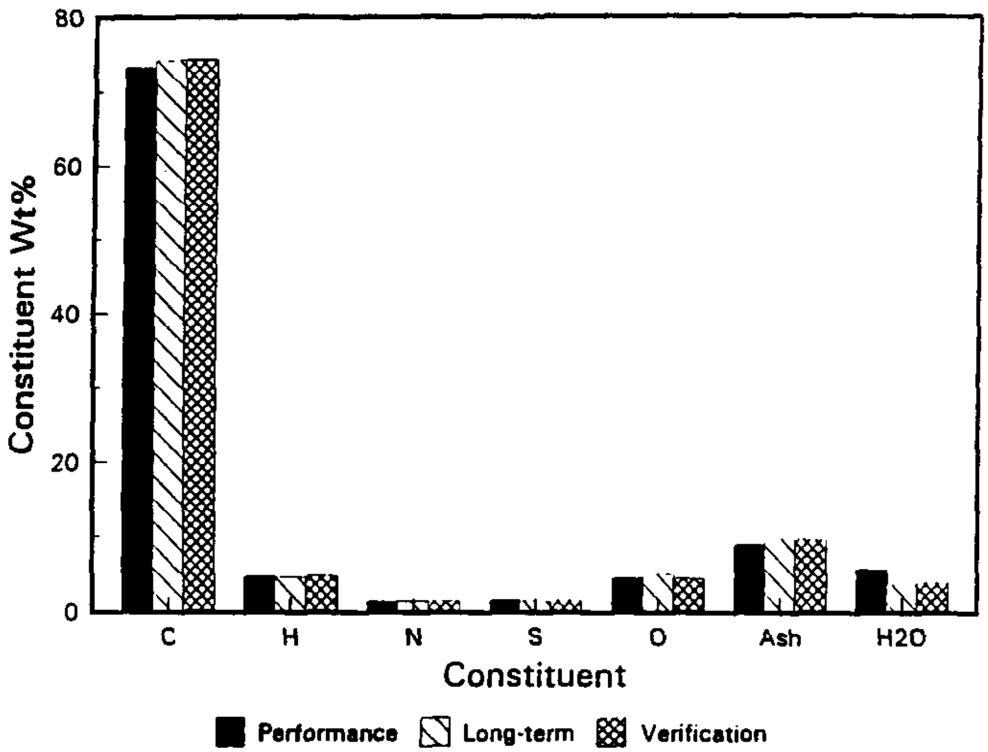

Figure 6-1. Average Ultimate Analysis Results for Coal Feed During Phase 2 (AOFA) Testing Periods

Table 6-3

Comparison of Phase 1 and Phase 2 Coal Analyses (95% Confidence Intervals)

Parameter	Phase 1	Phase 2
Carbon, wt%	72.03 ± 0.39	73.59 ± 0.048
Hydrogen, wt%	4.69 ± 0.03	4.69 ± 0.11
Nitrogen, wt%	1.44 ± 0.02	1.44 ± 0.02
Sulfur, wt%	1.73 ± 0.03	1.58 ± 0.05
Chlorine, wt%	0.039 ± 0.005	0.045 ± 0.006
Oxygen, wt%	5.70 ± 0.16	4.70 ± 0.27
Ash, wt%	9.93 ± 0.012	9.25 ± 0.23
Moisture, wt%	4.52 ± 0.31	4.76 ± 0.41
HHV, Btu/lb	12,845 ± 64	13,038 ± 56

6.2 Bottom Ash

Bottom ash was analyzed for loss on ignition (LOI) as a measure of the completeness of combustion. The average results for Phases 1 and 2 are both plotted versus nominal load in Figure 6-2. As shown, the LOI was higher during AOFA operation than during baseline testing. This is consistent with the results for the fly ash particulates presented previously in Section 4.1.2, indicating that the coal combustion was not as complete with AOFA in operation.

6.3 ESP Fly Ash

ESP fly ash was analyzed for LOI, and samples were also subjected to resistivity measurements.

Figure 6-3 presents the average LOI values versus nominal load for both Phase 1 and Phase 2. These results show that the amount of unconverted material present in the ESP fly ash was higher during AOFA operation than it was during baseline monitoring. This overall conclusion is consistent with the LOI measurements made on other solid streams leaving the boiler, although the specific values obtained, especially at the 400 MW load level, are higher than those measured in samples from the other streams.

The resistivity of the ESP fly ash samples obtained during Phase 2 testing were measured at a series of temperatures in the laboratory. The results for the ESP fly ash obtained during the 480 MWe, 50% AOFA tests are shown in Figure 6-4. Tests were also conducted at a single temperature in the presence of 2.1 ppm SO_3; this concentration is representative of the SO_3 level measured in the flue gas. The data indicate that in the presence of the measured SO_3 concentrations, ESP performance should not be limited by fly ash resistivity. This is in agreement with the results obtained during Phase 1.

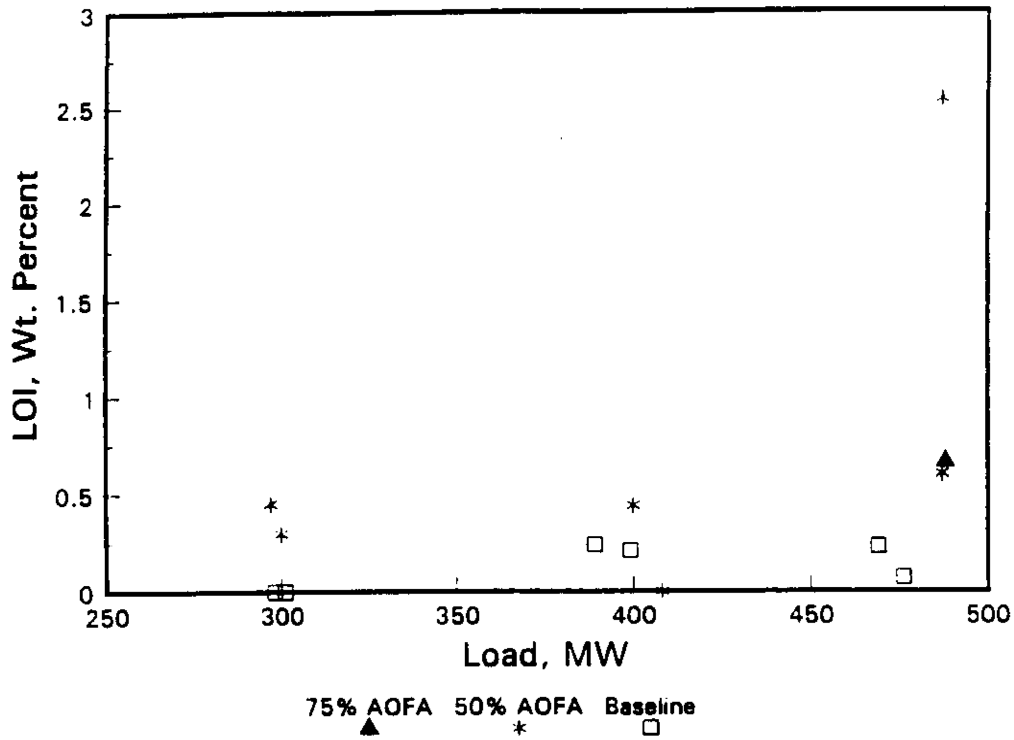

Figure 6-2. Average Bottom Ash LOI Measurement Versus Load: Phases 1 (Baseline) and 2 (AOFA)

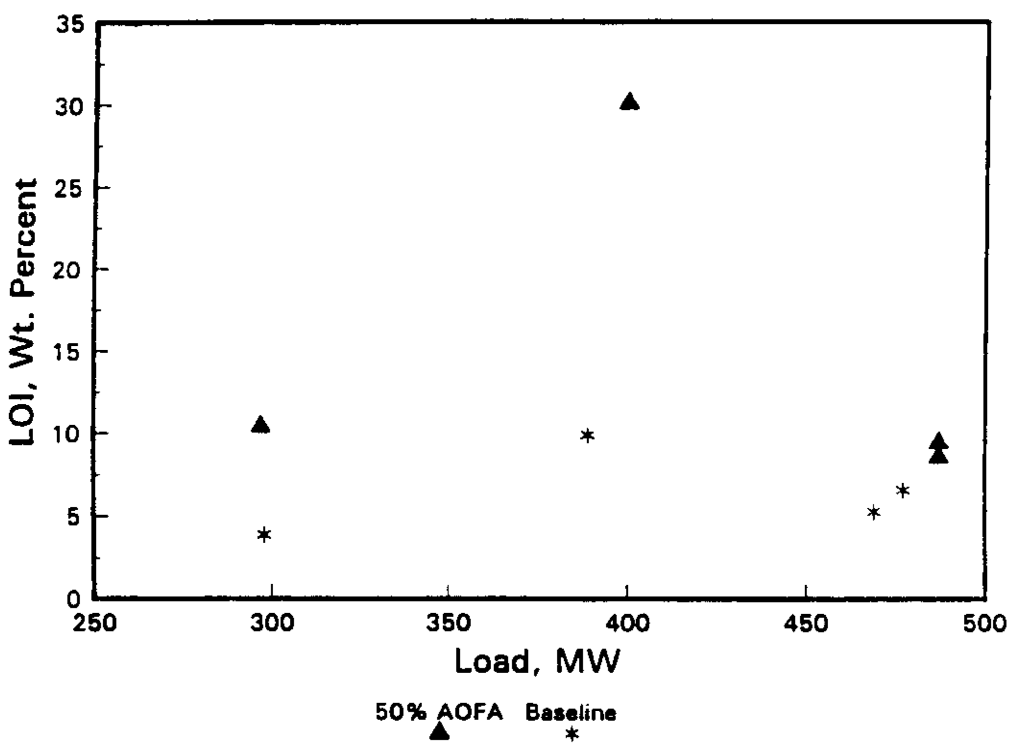

Figure 6-3. Average ESP Fly Ash LOI Measurement Versus Load: Phases 1 (Baseline) and 2 (AOFA)

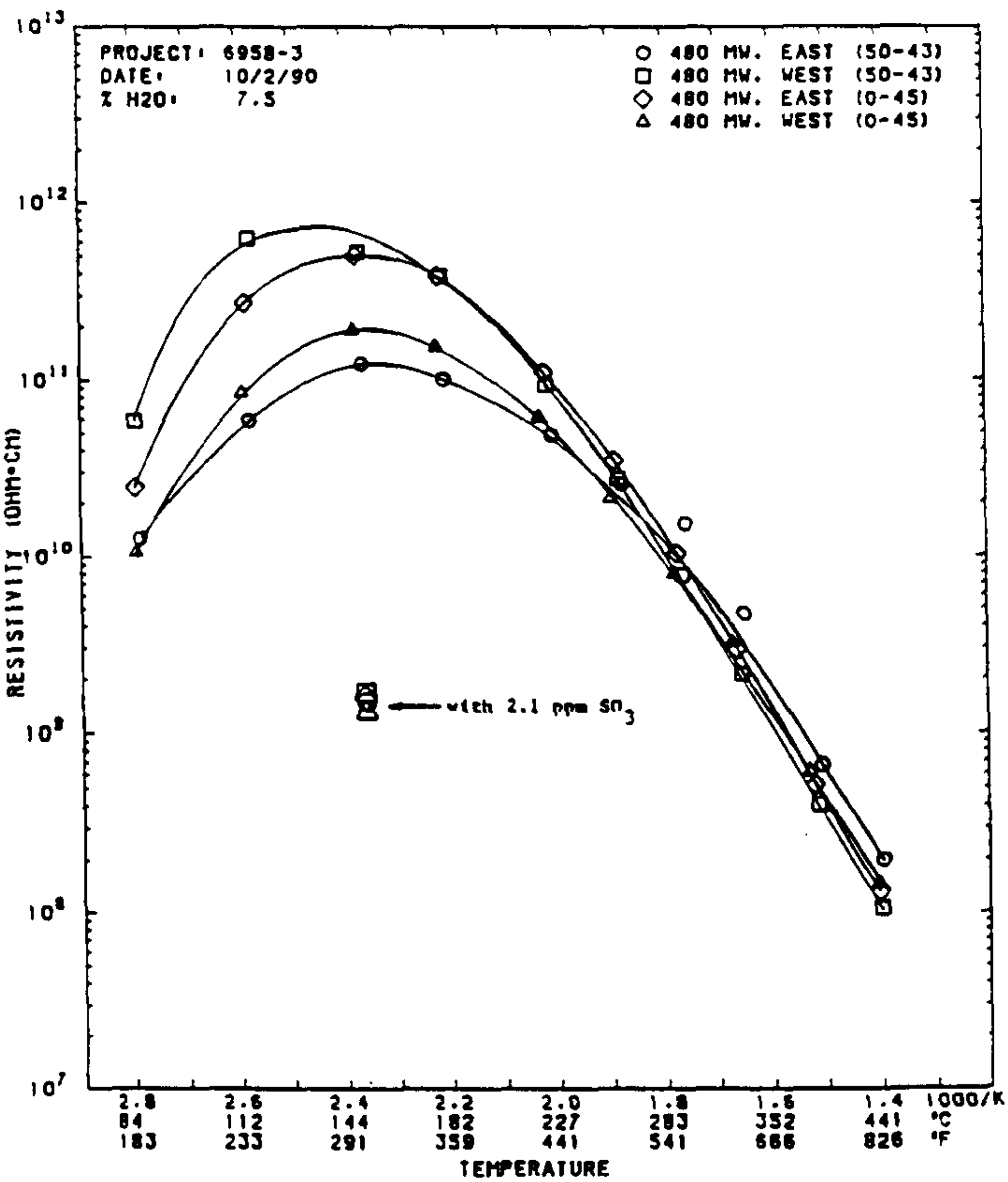

Figure 6-4. ESP Hopper Ash Resistivity: Phase 2 (AOFA)
(Source: ETEC Report)

6.4 CEGRIT Fly Ash

Grab samples of the fly ash in the furnace backpass were collected using the on-line CEGRIT Samplers. These samples were analyzed for LOI; the mean values at each load level are presented graphically in Figure 6-5. For comparison purposes, the mean values from Phase 1 are plotted on the same graph. The data show that the LOI measured in the CEGRIT fly ash was higher during AOFA operation than during the baseline testing. This is consistent with the LOI measurements made on other solid streams leaving the boiler. The highest LOI level was reached at a load of 400 MW; this was also the case with ESP fly ash.

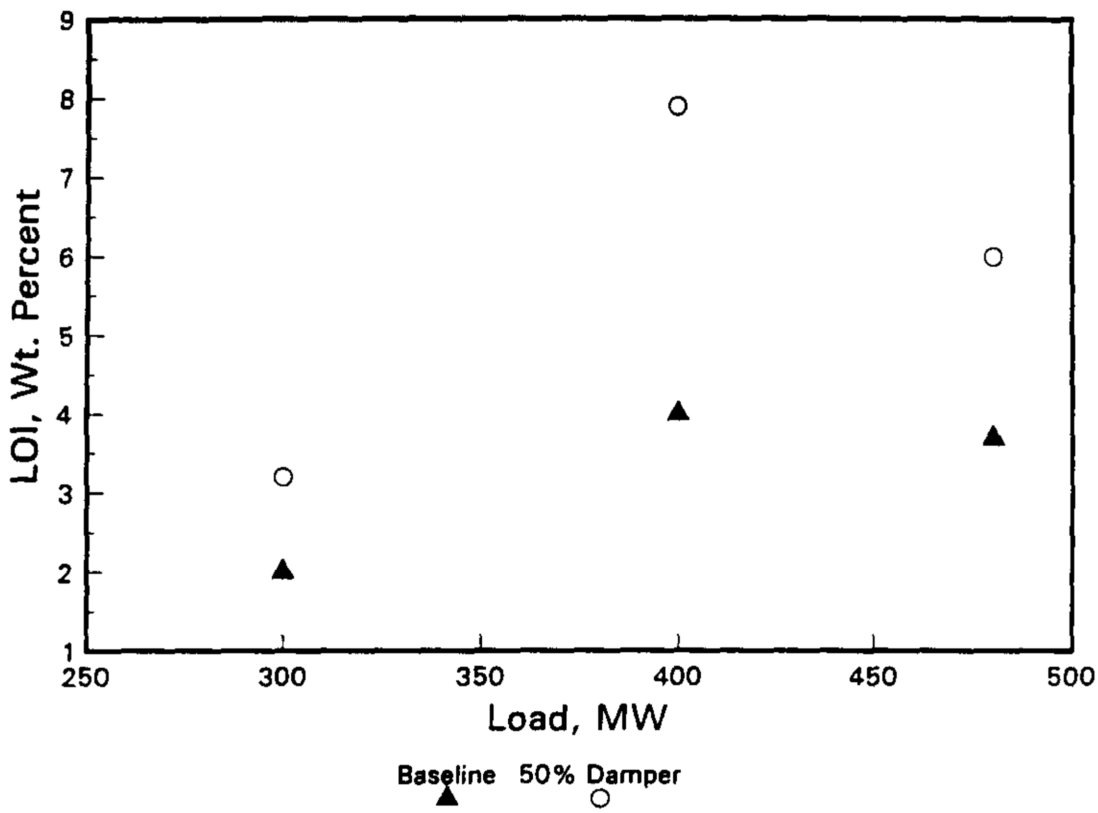

Figure 6-5. Average CEGRIT Ash LOI Measurements Versus Load: Phases 1 (Baseline) and 2 (AOFA)

7.0 QUALITY ASSURANCE AND QUALITY CONTROL

The environmental monitoring plan for the Plant Hammond Clean Coal project includes, as an appendix, a quality assurance/quality control plan. That plan describes procedures for producing acceptable data, including:

- Adherence to accepted methods;
- Adequate documentation and sample custody; and
- Quality assessment.

This section presents the results of each of these QA/QC procedures performed during Phase 2 testing.

7.1 Adherence to Accepted Methods

The sampling and analytical methods specified by the Environmental Monitoring Plan and used during Phase 2 are summarized in Section 3.0 of this report.

As discussed in Section 3.0, there were no deviations from the procedures specified in the Environmental Monitoring Plan during Phase 2.

7.2 Adequate Documentation and Sample Custody

At Plant Hammond, documentation and sample custody procedures that are part of the existing compliance monitoring programs have been approved by the state regulatory agency and are followed during EMP activities. Documentation is reviewed during audits of both compliance and supplemental monitoring.

Procedures for documentation and sample custody for supplemental monitoring were reviewed as part of a Technical Systems Audit conducted by Radian

Corporation from July 11 to 13, 1990, during the Phase 2 performance testing period. The audit included activities of Spectrum Systems, Inc. (the CEM); ETEC (coal and ash sampling); and SoRI (outlet gas sampling and analysis). A report containing the detailed results of this audit was prepared and included in the Quarterly EMP Report for the period July - September 1991. This audit found no major problems, but informal recommendations were made for improvements in the sample tracking system for coal and ash samples that are sent off-site for analysis. A follow-up to this audit, conducted in March 1991, found that these recommendations had been successfully implemented.

7.3 Quality Assessment

Quality assessment is provided by the collection and analysis of replicate samples and "blind" audit samples. That is, the results of these analyses provide the basis for estimating precision and accuracy for the parameters measured.

During Phase 2, replicate samples of the coal feed were collected and analyzed as summarized in Table 7-1. The results show that with one exception (i.e., the samples obtained on March 5, 1991) satisfactory accuracy (as measured using the coefficient of variation, defined as the sample standard deviation divided by the sample mean) was obtained for nearly all of the ultimate/proximate analysis parameters measured under the EMP. As expected, the results were not as good for chlorine, which is present at very low concentrations.

An audit set of two samples of coal and two samples of ash were submitted to the Georgia Power laboratory for analysis as a "single blind" along with the other samples collected on July 13, 1990. Because the coal audit samples were misplaced in transit (this was before the sample custody procedures were implemented), another set of coal samples was submitted in March 1991. The results for the ash samples, which were analyzed for LOI, and the coal samples, which were subjected to proximate and ultimate analyses, are presented in Tables 7-2 and 7-3, respectively. The results for both the ash

Table 7-1

Summary of Replicate Samples for Supplemental Monitoring (Coal Feed Only)

Date/Test	H_2O, %	C, %	H, %	N, %	Cl, %	S, %	Ash, %	BTU/lb
07/10/90	5.07	72.74	4.74	1.38	0.068	1.77	9.75	12,895
Performance	4.95	72.16	4.54	1.49	0.040	1.71	9.76	12,914
% COV	1.20	0.40	2.16	3.83	25.93	1.72	0.05	0.07
07/14/90	6.63	73.30	4.80	1.39	0.047	1.59	8.24	13,039
Performance	6.16	72.85	4.53	1.44	0.030	1.60	8.30	13,088
% COV	3.67	0.31	2.89	1.77	22.08	0.31	0.36	0.19
07/18/90	4.11	73.37	4.72	1.49	0.029	1.55	10.01	13,096
Performance	4.17	73.46	4.58	1.52	0.020	1.56	9.86	13,112
% COV	0.72	0.06	1.51	1.00	18.37	0.32	0.75	0.06
07/24/90	2.42	74.97	4.91	1.46	0.03	1.44	9.83	13,361
Performance	2.06	75.80	4.86	1.57	0.01	1.44	9.30	13,454
% COV	8.04	0.55	0.51	3.63	50.00	0.00	2.77	0.35
03/05/90	1.75	82.63	1.96	1.07	0.04	0.63	9.68	13,043
Performance	2.74	70.58	4.69	1.52	0.03	1.80	8.68	12,325
% COV	22.05	7.87	41.05	17.37	14.29	48.15	5.45	2.83
02/26/91	3.12	74.64	4.89	1.47	0.04	1.58	9.26	13,258
Performance	3.18	76.69	4.62	1.49	0.03	1.54	9.67	13,283
% COV	0.95	1.35	2.84	0.68	14.29	1.28	2.17	0.09

COV is the coefficient of variation, defined as (Standard Deviation/Mean) x 100 percent.

Table 7-2

Performance Audit Results for LOI in Fly Ash

Sample Number	Audit Value, %	Reported Value, %	Recovery %
CCT-9007-03	0.88	0.88	100
CCT-9007-04	1.23	1.07	87

$$\text{Recovery} = \frac{\text{Reported Value}}{\text{Audit Value}} \times 100\%$$

Table 7-3

Performance Audit Results for Coal Analysis

Parameter	Sample No. H4PH2-155			Sample No. H4PH2-155		
	Audit Value, %	Reported Value, %	Recovery, %	Audit Value, %	Reported Value, %	Recovery, %
Carbon	83.44	82.63	99.0	72.68	70.58	97.1
Hydrogen	2.11	1.96	92.9	5.23	4.96	94.8
Nitrogen	0.92	1.07	116.3	1.52	1.52	100.0
Chlorine	0.03	0.04	133.3	0.04	0.03	75.0
Sulfur	0.63	0.63	100.0	1.95	1.80	92.3
Ash	10.76	9.68	90.0	9.10	8.68	95.4
Oxygen	2.11	2.29	108.5	9.48	10.0	105.5
HHV, Btu/lb	13,079	13,043	99.7	12,941	12,325	95.2

$$\text{Recovery} = \frac{\text{Reported Value}}{\text{Audit Value}} \times 100\%$$

and coal samples indicated acceptable accuracy, as measured by analyte recovery. Recoveries within the range 80-120% were obtained for all analytes except chlorine, for which less accurate results can be expected because of its low concentrations in the coal.

8.0 COMPLIANCE REPORTING

During Phase 2, which began on May 23, 1990 and ended on February 28, 1991, compliance reports were submitted by Georgia Power Company to the Environmental Protection Division of the Georgia Department of Natural Resources, in accordance with the requirements of Unit 4's air operating permit (No. 4911-057-5011-0), as amended; and of Plant Hammond's NPDES permit (GA0001457). The air operating permit was amended effective February 2, 1990, to account for the AOFA system and the low NO_x burners.

The air operating permit requires the monitoring of coal feed composition (i.e., sulfur, ash, moisture, and heating value), particulate matter emissions (as total particulate loading), and opacity. The NPDES permit requires that the pH and concentrations of suspended solids and oil and grease be reported for various aqueous discharge streams.

Copies of the compliance reports have been included as appendices to the quarterly and annual EMP reports for this project.

9.0 CONCLUSIONS

The following conclusions were drawn as a result of the data presented in this EMP Phase 2 Report:

- AOFA operation resulted in decreased NO_x emissions from Unit 4, compared to the baseline testing conducted under Phase 1. Based on the analysis of the long-term test data, an average reduction of about 24% was obtained while operating at high loads (460-490 MW), while the reduction decreased to about 12% when operating at a load of 300 MWe.

- AOFA operation resulted in increased levels of LOI and carbon, indicative of a small decrease in overall coal utilization compared to baseline operation. The observed impact was smallest for the bottom ash, while the loss on ignition (LOI) and carbon content of the fly ash increased by nearly a factor of two compared to baseline. The LOI appeared to consist primarily of unburned carbon.

- Carbon monoxide emissions also increased relative to baseline until the excess oxygen levels were raised. During long-term testing, lower carbon monoxide emission rates were observed than during baseline testing.

- Generally low levels of total hydrocarbon (THC) emissions were found during Phase 2 long-term testing (0.0005 to 0.002 lb/MMBtu). No clear trends in the level of THC emissions as a function of operating conditions were apparent.

- Sulfur dioxide emissions during both Phases 1 and 2 were comparable. No trends were observed in SO_2 emission rates versus operating conditions. Although SO_2 emissions can be expected to vary with coal sulfur content, the large data scatter and the small variation in coal sulfur content made it impossible to verify the existence of a relationship.

- AOFA operation did not appear to have any impact on the ratio of SO_3 to SO_2 concentration relative to baseline operation. It did not appear to have an impact on the resistivity of the fly ash entering the ESP. Based on these factors, ESP efficiency during AOFA operation can be expected to be similar to baseline operation. However, other variables such as increases flue gas flow rate may impact the ability of the existing ESP to control particulate emissions and/or opacity, based on design capacity limitations.

- Aqueous stream monitoring showed no exceedances of permit limits for any of the monitored parameters during the Phase 2 testing period.

APPENDIX A

Phase 2 EMP Monitoring Data

Summary Tables

LIST OF TABLES

Table A-1

Economizer Outlet Gas Short-Term Test Results

Test No.	Date	Load, MW	OFA Damper, %	O_2, vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	CO, ppmv	CO, lb/MMBtu
DIAGNOSTIC TESTS								
23-1	23-May-90	478	52					
24-1	11-Jun-90	482	52	2.1	899	1.28	43	0.035
24-2	11-Jun-90	480	52	2.6	954	1.36	15	0.013
25-1	12-Jun-90	475	52	2.8	801	1.14	10	0.009
25-2	12-Jun-90	478	52	2.6	810	1.16	11	0.009
25-3	12-Jun-90	478	1	2.5	875	1.25	14	0.012
25-4	12-Jun-90	479	10	2.5	825	1.18	14	0.012
25-5	12-Jun-90	476	25	2.4	783	1.12	16	0.013
25-6	12-Jun-90	475	100	2.4	665	0.95	17	0.015
26-1	13-Jun-90	478	0	2.1	794	1.13	74	0.061
26-2	13-Jun-90	478	50	2.8	635	0.91	14	0.012
27-1	15-Jun-90	480	6	2.4	642	0.92	48	0.040
27-2	15-Jun-90	478	6	2.3	661	0.94	13	0.011
27-3	15-Jun-90	478	7	2.3	684	0.98	15	0.013
27-4	16-Jun-90	475	7	2.3	689	0.98	12	0.010
27-5	16-Jun-90	476	7	2.7	751	1.07	12	0.010
28-1	16-Jun-90	482	7	2.6	742	1.06	14	0.012
28-2	16-Jun-90	483	20	2.7	700	1.00	17	0.014
28-3	16-Jun-90	483	35	2.9	650	0.93	17	0.015
28-4	16-Jun-90	480	51	2.8	583	0.83	17	0.014
28-5	16-Jun-90	482	51	2.3	551	0.79	22	0.018
29-1	17-Jun-90	405	5	4.4	786	1.12	11	0.010
29-2	17-Jun-90	405	14	4.3	771	1.10	11	0.010
29-3	18-Jun-90	408	30	4.1	697	1.00	11	0.010
29-4	18-Jun-90	408	39	4.4	651	0.93	11	0.010

Table A-1 (Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	CO, ppmv	CO, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)								
30-1	19-Jun-90	487	5	2.5	811	1.16	14	0.012
30-2	19-Jun-90	487	4	2.7	877	1.25	13	0.011
30-3	19-Jun-90	487	30	2.5	716	1.02	16	0.014
31-1	20-Jun-90	482	5	2.4	802	1.15	19	0.016
31-2	20-Jun-90	487	5	2.0	763	1.09	56	0.046
31-3	20-Jun-90	490	5	2.1	795	1.14	46	0.038
31-4	20-Jun-90	490	30	2.2	705	1.01	28	0.024
32-1	21-Jun-90	485	4	2.5	712	1.02	12	0.010
32-2	21-Jun-90	485	20	2.7	636	0.91	16	0.014
32-3	21-Jun-90	482	50	2.9	583	0.83	14	0.012
33-1	25-Jun-90	308	5	4.1	726	1.04	10	0.010
33-2	26-Jun-90	300	25	4.1	695	0.99	11	0.010
33-3	26-Jun-90	302	50	4.2	647	0.92	9	0.008
33-4	26-Jun-90	310	75	4.0	623	0.89	10	0.009
33-5	26-Jun-90	302	75	3.3	572	0.82	21	0.018
34-1	26-Jun-90	290	5	4.0	613	0.88	6	0.005
34-2	26-Jun-90	305	50	4.2	554	0.79	6	0.005
34-3	27-Jun-90	295	50	3.2	478	0.68	8	0.007
34-4	27-Jun-90	295	50	3.5	506	0.72	6	0.006
34-5	27-Jun-90	390	50	3.4	526	0.75	12	0.011
34-6	27-Jun-90	390	35	3.3	527	0.75	25	0.022
34-7	27-Jun-90	390	20	3.2	549	0.78	50	0.044
34-8	27-Jun-90	390	5	3.0	562	0.80	88	0.077
35-1	26-Jun-90	405	5	3.4	636	0.91	10	0.009

Table A-1 (Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, vol% (dry)	NO_x, ppm @ 3% O_2	NO_x, lb/MMBtu	CO, ppm	CO, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)								
35-2	27-Jun-90	405	25	3.3	580	0.83	16	0.014
35-3	28-Jun-90	402	50	3.4	543	0.78	18	0.016
35-4	28-Jun-90	407	50	3.1	532	0.76	47	0.041
35-5	28-Jun-90	410	50	3.9	565	0.81	14	0.013
35-6	28-Jun-90	407	75	3.5	532	0.76	27	0.024
35-7	28-Jun-90	410	5	3.0	628	0.90	32	0.028
36-1	29-Jun-90	475	5	2.8	657	0.94	20	0.017
36-2	29-Jun-90	475	25	2.9	592	0.85	32	0.027
36-3	29-Jun-90	480	50	3.0	539	0.77	20	0.017
36-4	29-Jun-90	480	75	2.9	513	0.73	30	0.026
46-1	14-Aug-90	300	50	3.5	472	0.67	68	0.061
46-2	14-Aug-90	300	50	4.9	556	0.79	10	0.009
46-3	14-Aug-90	300	50	5.1	624	0.89	9	0.008
46-4	14-Aug-90	300	50	5.6	671	0.96	8	0.008
47-1	14-Aug-90	400	50	3.4	569	0.81	26	0.023
47-2	14-Aug-90	400	50	3.7	560	0.80	92	0.083
47-3	15-Aug-90	400	50	3.5	581	0.83	69	0.062
47-4	15-Aug-90	400	50	4.0	607	0.87	10	0.009
47-5	15-Aug-90	400	50	4.6	637	0.91	10	0.010
48-1	15-Aug-90	455	50	2.5	502	0.72	64	0.054
48-2	15-Aug-90	455	50	3.2	559	0.80	18	0.016
48-3	15-Aug-90	455	50	3.9	604	0.86	11	0.010
48-4	15-Aug-90	455	50	4.3	624	0.89	14	0.013
48-5	15-Aug-90	450	35	4.3	735	1.05	17	0.016

Table A-1 (Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, vol% (dry)	NO_x, ppm @ 3% O_2	NO_x, lb/MMBtu	CO, ppm	CO, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)								
48-6	15-Aug-90	450	20					
48-7	15-Aug-90	450	5					
48-8	15-Aug-90	450	0					
49-1	16-Aug-90	475	5	2.8	673	0.96	15	0.013
49-2	16-Aug-90	480	20	2.9	620	0.89	23	0.020
49-3	16-Aug-90	482	35	3.1	580	0.83	19	0.016
49-4	16-Aug-90	482	50	3.2	551	0.79	15	0.013
49-5	16-Aug-90	480	50	3.6	567	0.81	17	0.015
49-6	16-Aug-90	485	50	4.3	615	0.88	19	0.017
PERFORMANCE TESTS								
37-1	10-Jul-90	480	75	3.3	516	0.74	54	0.048
37-2	10-Jul-90	480	75	2.9	535	0.76	36	0.031
37-3	10-Jul-90	480	75	3.1	539	0.77	26	0.023
38-1	11-Jul-90	485	75	4.1	609	0.87	14	0.013
38-2	11-Jul-90	488	75	3.8	596	0.85	13	0.012
38-3	11-Jul-90	488	75	4.0	597	0.85	16	0.015
39-1	12-Jul-90	400	50	3.9	552	0.79	18	0.016
39-2	13-Jul-90	400	50	4.2	562	0.80	12	0.012
40-1	13-Jul-90	405	50	3.8	541	0.77	23	0.021
40-2	14-Jul-90	408	50	3.7	534	0.76	22	0.020
40-3	14-Jul-90	405	50	3.6	537	0.77	26	0.024
41-1	14-Jul-90	298	50	5.8	622	0.89	8	0.008
41-2	15-Jul-90	297	50	6.0	642	0.92	8	0.009
42-1	15-Jul-90	300	50	5.4	605	0.86	8	0.008

Table A-1 (Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, vol% (dry)	NO_x, ppm @ 3% O_2	NO_x, lb/MMBtu	CO, ppm	CO, lb/MMBtu
PERFORMANCE TESTS (Continued)								
42-2	16-Jul-90	300	50	5.3	611	0.87	8	0.008
42-3	16-Jul-90	300	50	5.3	611	0.87	8	0.008
43-1	17-Jul-90	487	50	4.0	699	1.00	13	0.012
43-2	17-Jul-90	487	50	4.1	700	1.00	11	0.010
43-3	17-Jul-90	487	50	3.9	685	0.98	15	0.013
44-1	18-Jul-90	487	50	3.9	650	0.93	13	0.012
44-2	18-Jul-90	487	50	3.8	658	0.94	12	0.011
45-1	18-Jul-90	489	1	3.8	890	1.27	13	0.012
VERIFICATION TESTS								
52-1	22-Feb-91	395	50	5.7	594	0.85	72	0.073
52-2	22-Feb-91	398	50	5.0	552	0.79	194	0.190
52-3	22-Feb-91	398	50	6.3	657	0.94	11	0.011
53-1	23-Feb-91	402	50	5.3	592	0.85	119	0.119
53-2	23-Feb-91	402	50	4.8	555	0.79	212	0.205
53-3	23-Feb-91	402	50	5.8	625	0.89	82	0.085
54-1	25-Feb-91	480	50	3.7	612	0.87	10	0.009
54-2	25-Feb-91	480	50	2.8	545	0.78	56	0.048
54-3	25-Feb-91	480	50	3.1	566	0.81	46	0.040
54-4	25-Feb-91	480	50	4.4	701	1.00	15	0.014
54-5	25-Feb-91	480	50	3.7	634	0.91	32	0.029
55-1	26-Feb-91	481	50	3.8	624	0.89	25	0.023
55-2	26-Feb-91	480	25	4.4	761	1.09	21	0.020
56-1	27-Feb-91	480	50	4.1	687	0.98	102	0.094
57-1	28-Feb-91	480	50	3.2	655	0.94	160	0.141

Table A-2

Preheater Outlet Gas Short-Term Test Results

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	CO, ppmv	CO, lb/MMBtu
PERFORMANCE TESTS								
37-1	10-Jul-90	480	75	6.4	510	0.73	49	0.052
38-1	11-Jul-90	485	75	7.3	600	0.86	7	0.008
38-3	11-Jul-90	488	75	7.0	584	0.83	8	0.009
39-1	12-Jul-90	400	50	7.2	545	0.78	15	0.017
40-1	13-Jul-90	405	50	7.0	533	0.76	20	0.023
40-3	14-Jul-90	405	50	6.9	529	0.76	31	0.034
41-1	14-Jul-90	298	50	8.9	621	0.89	5	0.007
42-1	15-Jul-90	300	50	8.5	594	0.85	5	0.007
42-3	16-Jul-90	300	50	7.8	609	0.87	5	0.006
43-1	17-Jul-90	487	50	7.3	695	0.99	6	0.007
43-3	17-Jul-90	487	50	7.2	684	0.98	7	0.007
44-1	18-Jul-90	487	50	7.2	653	0.93	6	0.007
45-1	18-Jul-90	489	1	7.3	890	1.27	7	0.009

Table A-3

Stack Gas Short-Term Test Results

Test No.	Date	Load, MW	OFA Damper, %	O_2 Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
DIAGNOSTIC TESTS												
24-1	11-Jun-90	482	52	4.9	895	1.28	1,128	2.24	31	0.030	3	0.00167
24-2	11-Jun-90	480	52	5.3	952	1.36	1,066	2.12	12	0.012	3	0.00171
25-1	12-Jun-90	475	52	5.3	792	1.13	1,135	2.26	9	0.009	2	0.00114
25-2	12-Jun-90	478	52	5.2	801	1.14	1,106	2.20	9	0.008	2	0.00113
25-3	12-Jun-90	478	1	5.1	861	1.23	1,074	2.13	11	0.011	3	0.00169
25-4	12-Jun-90	479	10	5.3	821	1.17	1,092	2.17	12	0.011	3	0.00171
25-5	12-Jun-90	476	25	5.1	780	1.11	1,138	2.26	14	0.014	3	0.00141
25-6	12-Jun-90	475	100	5.1	657	0.94	1,175	2.34	13	0.013	3	0.00169
26-1	13-Jun-90	478	0	4.8	777	1.11	1,109	2.20	48	0.046	2	0.00110
26-2	13-Jun-90	478	50	5.5	625	0.89	1,082	2.15	9	0.009	2	0.00115
27-1	15-Jun-90	480	6	5.5	651	0.93	1,242	2.47	26	0.026	4	0.00202
27-2	15-Jun-90	478	6	5.2	655	0.94	1,231	2.45	13	0.012	2	0.00114
27-3	15-Jun-90	478	7	5.2	677	0.97	1,198	2.38	12	0.011	2	0.00114
27-4	16-Jun-90	475	7	5.1	674	0.96	1,201	2.39	8	0.008	2	0.00084
27-5	16-Jun-90	476	7	5.4	732	1.05	1,157	2.30	7	0.007	2	0.00086

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)												
28-1	16-Jun-90	482	7	5.4	729	1.04	1,067	2.12	1	0.011	3	0.00172
28-2	16-Jun-90	483	20	5.5	687	0.98	1,058	2.10	12	0.012	3	0.00173
28-3	16-Jun-90	483	35	5.6	639	0.91	1,080	2.15	12	0.012	3	0.00146
28-4	16-Jun-90	480	51	5.3	561	0.80	1,109	2.20	12	0.011	2	0.00114
28-5	16-Jun-90	482	51	4.9	530	0.76	1,131	2.25	19	0.018	2	0.00111
29-1	17-Jun-90	405	5	6.9	780	1.11	1,029	2.05	8	0.008	2	0.00127
29-2	17-Jun-90	405	14	6.8	762	1.09	1,059	2.10	7	0.008	2	0.00126
29-3	18-Jun-90	408	30	6.7	687	0.98	1,090	2.17	7	0.007	2	0.00125
29-4	18-Jun-90	408	39	6.8	640	0.91	1,108	2.20	7	0.007	1	0.00063
30-1	19-Jun-90	487	5	5.4	804	1.15	1,107	2.20	12	0.012	2	0.00086
30-2	19-Jun-90	487	4	5.6	876	1.25	1,043	2.07	10	0.010	3	0.00174
30-3	19-Jun-90	487	30	5.4	712	1.02	1,097	2.18	14	0.014	3	0.00172
31-1	20-Jun-90	482	5	4.2	803	1.15	1,186	2.36	10	0.009	2	0.00080
31-2	20-Jun-90	487	5	5.0	757	1.08	1,161	2.31	34	0.033	2	0.00112
31-3	20-Jun-90	490	5	5.1	783	1.12	1,204	2.39	34	0.033	2	0.00112
31-4	20-Jun-90	490	30	5.1	686	0.98	1,298	2.58	27	0.026	1	0.00056

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)												
32-1	21-Jun-90	485	4	5.4	698	1.00	1,299	2.58	9	0.009	1	0.00057
32-2	21-Jun-90	485	20	5.2	620	0.89	1,273	2.53	9	0.009	1	0.00057
32-3	21-Jun-90	482	50	5.4	566	0.81	1,283	2.55	10	0.010	1	0.00057
33-1	25-Jun-90	308	5	6.9	713	1.02	1,407	2.80	9	0.010	2	0.00095
33-2	26-Jun-90	300	25	6.9	674	0.96	1,420	2.82	9	0.010	1	0.00063
33-3	26-Jun-90	302	50	6.8	632	0.90	1,439	2.86	9	0.009	1	0.00063
33-4	26-Jun-90	310	75	6.7	608	0.87	1,424	2.83	8	0.009	1	0.00063
33-5	26-Jun-90	302	75	6.2	561	0.80	1,411	2.81	14	0.015	1	0.00061
34-1	26-Jun-90	290	5	6.9	601	0.86	1,351	2.68	5	0.006	2	0.00095
34-2	26-Jun-90	305	50	7.0	550	0.79	1,346	2.67	5	0.006	1	0.00064
34-3	27-Jun-90	295	50	6.2	473	0.68	1,388	2.76	7	0.007	1	0.00061
34-4	27-Jun-90	295	50	6.5	506	0.72	1,380	2.74	5	0.005	1	0.00062
34-5	27-Jun-90	390	50	6.3	518	0.74	1,372	2.73	8	0.009	1	0.00061
34-6	27-Jun-90	390	35	6.1	514	0.73	1,388	2.76	15	0.016	1	0.00060
34-7	27-Jun-90	390	20	6.1	536	0.77	1,389	2.76	53	0.056	1	0.00060
34-8	27-Jun-90	390	5	6.0	547	0.78	1,375	2.73	75	0.078	1	0.00060
35-1	26-Jun-90	405	5	6.3	613	0.88	1,317	2.62	11	0.012	2	0.00092

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)												
35-2	27-Jun-90	405	25	6.2	565	0.81	1,329	2.64	12	0.012	1	0.00061
35-3	28-Jun-90	402	50	6.3	531	0.76	1,329	2.64	12	0.012	1	0.00061
35-4	28-Jun-90	407	50	5.9	514	0.73	1,319	2.62	53	0.055	1	0.00059
35-5	28-Jun-90	410	50	6.6	560	0.80	1,297	2.58	9	0.009	1	0.00062
36-1	29-Jun-90	475	5	5.8	641	0.92	1,283	2.55	15	0.015	1	0.00059
36-2	29-Jun-90	475	25	5.8	595	0.85	1,308	2.60	22	0.022	1	0.00059
36-3	29-Jun-90	480	50	5.9	532	0.76	1,317	2.62	16	0.017	1	0.00059
36-4	29-Jun-90	480	75	5.7	513	0.73	1,320	2.62	21	0.021	1	0.00059
46-1	14-Aug-90	300	50	6.4	472	0.67	1,139	2.26	74	0.079	1	0.00061
46-2	14-Aug-90	300	50	7.1	560	0.80	1,052	2.09	8	0.009	1	0.00065
46-3	14-Aug-90	300	50	7.7	619	0.88	965	1.92	7	0.008	1	0.00067
46-4	14-Aug-90	300	50	8.1	677	0.97	919	1.83	7	0.008	1	0.00070
47-1	14-Aug-90	400	50	6.0	560	0.80	694	1.38	30	0.031	1	0.00060
47-2	14-Aug-90	400	50	6.1	568	0.81	676	1.34	57	0.059	1	0.00060
47-3	15-Aug-90	400	50	6.0	568	0.81	649	1.29	41	0.043	1	0.00060
47-4	15-Aug-90	400	50	6.6	597	0.85	639	1.27	8	0.009	1	0.00062
47-5	15-Aug-90	400	50	7.1	635	0.91	626	1.24	7	0.008	1	0.00064

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol % (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
DIAGNOSTIC TESTS - (Continued)												
48-1	15-Aug-90	455	50	5.4	503	0.72	905	1.80	61	0.061	1	0.00057
48-2	15-Aug-90	455	50	6.0	556	0.79	812	1.61	10	0.010	1	0.00060
48-3	15-Aug-90	455	50	6.4	590	0.84	797	1.58	8	0.008	1	0.00061
48-4	15-Aug-90	455	50	6.9	635	0.91	737	1.46	6	0.007	1	0.00064
48-5	15-Aug-90	450	35	6.9	746	1.07	1,073	2.13	6	0.007	1	0.00064
49-1	16-Aug-90	475	5	5.6	661	0.94	1,180	2.35	12	0.012	(1)	–
49-2	16-Aug-90	480	20	5.7	626	0.89	1,286	2.56	10	0.010	1	0.00059
49-3	16-Aug-90	482	35	5.7	581	0.83	1,292	2.57	10	0.011	1	0.00059
49-4	16-Aug-90	482	50	5.8	553	0.79	1,273	2.53	9	0.009	1	0.00059
49-5	16-Aug-90	480	50	6.3	573	0.82	1,318	2.62	9	0.009	1	0.00061
49-6	16-Aug-90	485	50	6.8	617	0.88	1,277	2.54	9	0.010	1	0.00063
PERFORMANCE TESTS												
37-1	10-Jul-90	480	75	5.8	509	0.73	1,358	2.70	54	0.056	2	0.00108
37-2	10-Jul-90	480	75	5.8	530	0.76	1,351	2.69	11	0.011	1	0.00059
38-1	11-Jul-90	485	75	6.7	609	0.87	1,224	2.43	8	0.008	1	0.00073
38-2	11-Jul-90	488	75	6.5	587	0.84	1,201	2.39	9	0.009	1	0.00062
38-3	11-Jul-90	488	75	6.5	593	0.85	1,206	2.40	8	0.009	1	0.00062

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol % (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
PERFORMANCE TESTS - (Continued)												
39-1	12-Jul-90	400	50	6.5	544	0.78	1,307	2.60	15	0.016	1	0.00072
39-2	13-Jul-90	400	50	6.9	547	0.78	1,348	2.68	10	0.011	1	0.00064
40-1	13-Jul-90	405	50	6.4	529	0.76	1,261	2.51	21	0.022	1	0.00072
40-2	14-Jul-90	408	50	6.3	521	0.74	1,215	2.42	23	0.025	1	0.00061
40-3	14-Jul-90	405	50	6.3	527	0.75	1,211	2.41	38	0.040	1	0.00061
41-1	14-Jul-90	298	50	8.3	624	0.89	1,162	2.31	6	0.008	1	0.00085
41-2	15-Jul-90	297	50	8.4	645	0.92	1,176	2.34	7	0.008	1	0.00071
42-1	15-Jul-90	300	50	8.0	606	0.87	1,271	2.53	5	0.007	1	0.00083
42-2	16-Jul-90	300	50	7.9	605	0.86	1,227	2.44	6	0.007	1	0.00069
42-3	16-Jul-90	300	50	8.3	598	0.85	1,187	2.36	6	0.007	1	0.00071
43-1	17-Jul-90	487	50	6.7	699	1.00	1,020	2.03	6	0.007	1	0.00073
43-2	17-Jul-90	487	50	6.7	693	0.99	1,052	2.09	8	0.008	1	0.00063
43-3	17-Jul-90	487	50	6.7	690	0.99	1,035	2.06	7	0.008	1	0.00063
44-1	18-Jul-90	487	50	6.6	652	0.93	1,043	2.07	7	0.007	1	0.00075
45-1	18-Jul-90	489	1	6.6	898	1.28	885	1.76	8	0.008	1	0.00062

Table A-3

(Continued)

Test No.	Date	Load, MW	OFA Damper, %	O_2, Vol% (dry)	NO_x, ppmv @ 3% O_2	NO_x, lb/MMBtu	SO_2, ppmv @ 3% O_2	SO_2, lb/MMBtu	CO, ppmv	CO, lb/MMBtu	THC, ppmv	THC, lb/MMBtu
VERIFICATION TESTS												
52-1	22-Feb-91	395	50	8.1	589	0.84	1,080	2.15	83	0.101	3	0.00209
52-2	22-Feb-91	398	50	7.6	544	0.78	1,128	2.24	251	0.292	3	0.00200
52-3	22-Feb-91	398	50	8.6	648	0.93	1,095	2.18	7	0.009	3	0.00216
53-1	23-Feb-91	402	50	7.8	574	0.82	1,349	2.68	217	0.258	2	0.00136
53-2	23-Feb-91	402	50	7.4	542	0.77	1,372	2.73	315	0.363	2	0.00132
53-3	23-Feb-91	402	50	8.3	620	0.89	1,337	2.66	65	0.079	2	0.00141
54-1	25-Feb-91	480	50	6.7	613	0.88	1,267	2.52	7	0.007	2	0.00125
54-2	25-Feb-91	480	50	5.9	541	0.77	1,467	2.92	54	0.056	2	0.00119
54-3	25-Feb-91	480	50	6.1	555	0.79	1,526	3.03	50	0.053	2	0.00120
54-4	25-Feb-91	480	50	6.7	702	1.00	1,573	3.13	9	0.010	2	0.00126
54-5	25-Feb-91	480	50	6.7	629	0.90	1,627	3.23	13	0.014	2	0.00125
55-1	26-Feb-91	481	50	6.8	621	0.89	1,410	2.80	20	0.021	1	0.00063
55-2	26-Feb-91	480	25	6.8	766	1.09	1,325	2.63	21	0.023	2	0.00126
56-1	27-Feb-91	480	50	6.4	699	1.00	1,082	2.15	83	0.088	2	0.00098
57-1	28-Feb-91	480	50	6.2	642	0.92	1,245	2.48	290	0.307	2	0.00097

Table A-4

Preheater Outlet Gas Sulfur Species

Test No.	Date	Load	% O_2	AOFA Damper, %	Duct	Gas Temp., deg. F	SO_3, ppmv	SO_2, ppmv
37	7-10-90	480	6.4	75	East	271	1.2	1,035
						284	1.4	1,050
						282	1.5	1,050
						286	1.8	1,056
38	7-11-90	480	7.2	75	West	266	2.1	855
						266	2.9	868
						267	3.2	871
						268	3.4	883
39	7-12-90	400	7.2	50	West	242	1.7	800
						242	2.0	810
						243	2.1	818
						242	2.4	817
40	7-13-90	400	7.0	50	East	225	1.1	943
						229	1.2	931
						230	1.3	924
						231	1.2	934
41	7-14-90	300	8.9	50	West	246	1.6	756
						247	2.2	747
						247	2.4	739
						246	2.6	739
42	7-15-90	300	8.2	50	East	230	1.8	718
						229	2.2	719
						228	2.2	715
						228	2.3	703
43	7-17-90	480	7.2	50	East	265	1.8	764
						267	2.2	768
						269	2.4	763
						272	2.5	762
44	7-18-90	480	7.2	50	West	266	1.9	792
						266	2.5	797
						268	2.6	786
						268	2.7	791

Table A-5

Preheater Outlet Gas PM Loading

Test	Load, MW	AOFA Damper, %	O_2, vol%	PM Loading gr/dscf
37	480	75	6.4	2.7536 2.8598 2.6091
39	400	50	7.2	2.7536 2.7399
41	300	50	8.9	1.7407 1.9272 1.7508
43-44	480	50	7.2	1.9386 2.8654 3.1644
45	480	0	7.3	2.6392 2.9982

Table A-6

Preheater Outlet Gas Carbon and LOI

Test No.	Load, MW	AOFA Damper, %	O_2, vol%	Carbon, wt%	LOI, wt%
37	480	75	3.0	10.0	10.8
39	400	50	3.8	8.7	10.2
41	300	50	5.4	5.0	7.1
43-44	480	50	3.9	9.6	9.6
45	480	0	3.8	6.3	5.4

Table A-7

Preheater Outlet In-Situ Ash Resistivity

Test	Date	Load, NW	AOFA Damper, %	Duct	APH Gas Temp, F	Dust Layer, mm	Spark Method	V-I Method
37	07/10/90	480	75	East	303	1.28	$9.1x10^9$	$1.4x10^{10}$
					306	1.01	$4.9x10^9$	$4.6x10^{10}$
					307	0.67	$8.4x10^9$	$5.6x10^{10}$
					305	1.14	$7.6x10^9$	$3.9x10^{10}$
38	07/11/90	480	75	West	271	0.51	$5.7x10^9$	$3.4x10^{10}$
					274	0.66	$4.9x10^9$	$3.3x10^{10}$
					277	0.6	$1.0x10^{10}$	$3.1x10^{10}$
					273	0.62	$6.9x10^9$	$1.5x10^{10}$
39	07/12/90	400	50	West	251	1.00	$1.9x10^9$	$9.0x10^9$
					251	0.47	$2.4x10^9$	$2.2x10^{10}$
					252	0.67	$1.2x10^9$	$4.0x10^{10}$
40	07/13/90	400	50	East	284	0.95	$4.4x10^{10}$	$1.6x10^{10}$
					285	1.78	$3.8x10^9$	$7.5x10^9$
					285	0.66	$9.1x10^9$	$3.0x10^{10}$
					286	0.55	$3.8x10^9$	$3.6x10^{10}$
41	07/14/90	300	50	East	285	0.81	$3.3x10^9$	$2.1x10^{10}$
					286	0.94	$3.7x10^9$	$4.8x10^9$
					284	1.43	$2.9x10^9$	$5.2x10^9$
42	07/15/90	300	50	West	247	0.88	$1.0x10^9$	$1.8x10^{10}$
					246	1.05	$3.9x10^9$	$3.3x10^{10}$
					245	0.96	$2.6x10^9$	$2.9x10^{10}$
					247	0.98	$4.9x10^9$	$2.6x10^{10}$
43	07/17/90	480	50	West	274	0.82	$5.5x10^{10}$	$1.0x10^{11}$
					277	0.75	$2.3x10^{10}$	$5.5x10^{10}$
					280	0.8	$7.9x10^{10}$	$7.7x10^{10}$
					280	0.75	$6.2x10^{10}$	$8.4x10^{10}$

Table A-7

(Continued)

Test	Date	Load, MW	AOFA Damper, %	Duct	APH Gas Temp, F	Dust Layer, mm	Spark Method	V-I Method
44	07/18/90	480	50	East	299	1.18	$2.2x10^{10}$	$3.4x10^{10}$
					301	1.11	$2.4x10^{10}$	$1.8x10^{10}$
45	07/18/90	480	0	East	302	0.84	$2.0x10^{10}$	$7.7x10^{9}$
					302	0.98	$8.6x10^{10}$	$2.1x10^{10}$

Table A-8

Coal Feed Proximate/Ultimate Analyses

Test No.	Date	Time	H_2O, wt%	C, wt%	H, wt%	N, wt%	Cl, wt%	S, wt%	Ash, wt%	O, wt%	HHV, Btu/lb
PERFORMANCE TESTS											
37-1	07/10/90	0840	4.44	73.77	4.79	1.33	0.088	1.72	9.58	4.38	13050
37-2	07/10/90	1200	4.46	73.25	4.73	1.43	0.058	1.73	10.02	4.38	12933
37-3	07/10/90	1515	5.07	72.74	4.74	1.38	0.068	1.77	9.75	4.57	12895
37-3	07/10/90	1515	4.95	72.16	4.54	1.49	0.040	1.71	9.76	5.39	12914
38-1	07/11/90	1215	5.00	74.20	4.70	1.42	0.058	1.75	8.82	4.11	13177
38-2	07/11/90	1420	5.40	73.75	4.65	1.35	0.087	1.72	8.94	4.18	13065
38-3	07/11/90	1700	5.15	74.76	4.69	1.21	0.087	1.71	8.46	4.02	13224
39-1	07/12/90	2200	5.31	73.44	4.69	1.34	0.077	1.71	8.97	4.54	12990
39-2	07/13/90	0100	5.08	74.19	4.79	1.43	0.087	1.57	8.65	4.29	13119
39-3	07/13/90	0500	5.12	72.46	4.79	1.47	0.078	1.82	9.46	4.88	12832
40-1	07/13/90	2130	6.29	72.75	4.75	1.42	0.086	1.64	8.62	4.54	12925
40-2	07/14/90	0130	5.82	73.19	4.77	1.38	0.058	1.65	8.80	4.40	12936
40-3	07/14/90	0400	5.81	73.18	4.85	1.43	0.048	1.67	8.38	4.68	12994
41-1	07/14/90	2200	6.63	73.30	4.80	1.39	0.047	1.59	8.24	4.06	13039
41-1	07/14/90	2200	6.16	72.85	4.53	1.44	0.030	1.60	8.30	5.12	13088
41-2	07/15/90	0100	7.34	72.83	4.78	1.39	0.047	1.61	7.85	4.20	12944
41-3	07/15/90	0320	7.45	72.36	4.73	1.39	0.028	1.58	7.97	4.53	12851
42-1	07/15/90	2200	6.23	73.03	4.78	1.43	0.038	1.62	8.27	4.64	13010
42-2	07/16/90	0030	6.04	72.59	4.79	1.49	0.048	1.63	8.70	4.74	12939
42-3	07/16/90	0300	6.62	72.37	4.75	1.48	0.066	1.65	8.38	4.74	12907
43-1	07/17/90	0900	5.99	72.89	4.78	1.51	0.057	1.59	8.53	4.72	12966
43-2	07/17/90	1100	6.84	72.53	4.63	1.51	0.057	1.44	8.05	5.00	12832
43-3	07/17/90	1500	4.93	75.38	4.83	1.42	0.048	1.55	7.53	4.36	13435
44-1	07/18/90	0900	5.30	72.24	4.63	1.44	0.038	1.55	10.20	4.30	12864
44-2	07/18/90	1200	4.11	73.37	4.72	1.49	0.029	1.55	10.01	4.76	13096
44-2	07/18/90	1200	4.17	73.46	4.58	1.52	0.020	1.56	9.86	4.85	13112
44-3	07/18/90	1630	5.40	72.48	4.65	1.46	0.038	1.50	10.15	4.35	12867

Table A-8 (Continued)

Test No.	Date	Time	H_2O, wt%	C, wt%	H, wt%	N, wt%	Cl, wt%	S, wt%	Ash, wt%	O, wt%	HHV, Btu/lb
LONG-TERM TESTS											
LongTerm	10/17/90	-	4.87	73.16	4.65	1.54	0.03	1.32	9.63	4.82	12949
LongTerm	10/18/90	-	5.19	72.12	4.71	1.46	0.03	1.33	10.07	5.12	12829
LongTerm	10/19/90	-	6.38	72.26	4.65	1.39	0.03	1.57	8.59	5.15	12869
50-1	10/24/90	-	2.42	74.97	4.91	1.46	0.03	1.44	9.83	4.97	13361
50-1	10/24/90	-	2.06	75.80	4.86	1.57	0.01	1.44	9.30	4.97	13454
LongTerm	10/25/90	-	2.51	74.26	4.83	1.44	0.03	1.24	10.93	4.80	13194
LongTerm	01/17/91	-	3.54	72.89	4.69	1.47	0.03	1.72	10.88	4.82	12957
LongTerm	01/25/91	-	5.31	74.00	4.77	1.40	0.03	1.78	8.38	4.36	13252
LongTerm	02/04/91	-	3.36	73.51	4.69	1.47	0.02	1.46	10.39	5.12	13083
LongTerm	02/05/91	-	4.37	73.09	4.71	1.41	0.03	1.57	10.40	4.45	13013
LongTerm	02/11/91	-	5.09	72.60	4.64	1.43	0.03	1.65	10.30	4.29	12931
LongTerm	02/18/91	-	2.54	75.18	4.87	1.54	0.03	1.54	9.44	4.88	13343
LongTerm	03/05/91	-	1.75	82.63	1.96	1.07	0.04	0.63	9.68	2.29	13043
LongTerm	03/05/91	-	2.74	70.58	4.69	1.52	0.03	1.80	8.68	10.00	12325
LongTerm	03/06/91	0620	3.28	73.95	4.90	1.52	0.05	1.77	9.66	4.91	13190
LongTerm	03/07/91	-	3.71	73.84	4.83	1.49	0.06	1.58	8.69	5.85	13174
VERIFICATION TESTS											
52	02/22/91	-	3.12	74.68	4.87	1.57	0.04	1.45	9.64	4.67	13248
53	02/23/91	-	4.26	73.67	4.79	1.40	0.03	1.53	9.85	4.50	13063
54	02/25/91	-	7.38	71.36	4.69	1.40	0.03	1.64	9.42	4.11	12707
55	02/26/91	-	3.12	74.64	4.89	1.47	0.04	1.58	9.26	5.04	13258
55	02/26/91	-	3.18	76.69	4.62	1.49	0.03	1.54	9.67	2.81	13283
-	02/27/91	-	3.27	74.31	4.82	1.47	0.02	1.51	9.78	4.85	13232
-	02/28/91	-	3.43	73.81	4.83	1.50	0.05	1.50	9.58	5.36	13155

Table A-9

Bottom Ash LOI Data

Test No.	Date	Load, MW	AOFA Damper, %	O2, vol%	LOI, wt%
37-2	10-Jul-90	480	75	2.9	10.43
38-2	11-Jul-90	488	75	3.8	0.66
39-2	13-Jul-90	400	50	4.2	0.44
40-2	14-Jul-90	408	50	3.7	-0.15
41-2	15-Jul-90	297	50	5.8	0.45
42-2	16-Jul-90	300	50	5.4	0.30
43-2	17-Jul-90	487	50	4.0	2.54
44-2	18-Jul-90	487	50	3.8	0.60
45-1	18-Jul-90	489	1	3.8	8.46

Table A-10

ESP Fly Ash -- LOI Analyses

					ESP Inlet (A-Side)			ESP Outlet (B-Side)		
Test No.	Date	Load, MW	AOFA Damper, %	O2, vol%	East	West	Average	East	West	Average
DIAGNOSTIC TESTS										
28-1	06/16/90	482	7	2.6			12.91			12.50
28-5	06/17/90	482	51	2.3			6.88			7.50
PERFORMANCE TESTS										
37-2	07/10/90	480	75	2.9	23.33	6.40	14.87	7.00	11.95	9.48
38-2	07/11/90	488	75	3.8	15.57	6.01	10.79	3.17	14.17	8.67
39-2	07/13/90	400	50	4.2	31.62	24.45	28.04	8.30	9.50	8.90
40-2	07/14/90	408	50	3.7	27.73	44.88	36.31	22.23	11.30	16.77
41-2	07/15/90	297	50	5.8	13.34	7.27	10.31	8.20	7.73	7.97
42-2	07/16/90	300	50	5.4	22.24	4.37	13.31	4.78	9.06	6.92
43-2	07/17/90	487	50	4.0	14.71	7.77	11.24	3.84	9.44	6.64
44-2	07/18/90	487	50	3.8	12.67	5.10	8.89	6.49	5.00	5.75
45-1	07/18/90	489	1	3.8	11.58	11.12	11.35	3.35	9.91	6.63

Table A-11

CEGRIT Fly Ash LOI Data

Test No.	Date	Time	Load, MW	AOFA Damper, %	O2, vol%	LOI, wt%	
						East	West
Diagnostic Tests							
28-1	16-Jun-90	1540-1730	482	7	2.6	-	5.21
28-3	16-Jun-90	2100-0014	483	35	2.7	-	4.29
Performance Tests							
37-1	10-Jul-90	0815-1045	480	75	3.0	9.34	4.76
37-2,3,4	10-Jul-90	1340-1800	480	75	3.0	10.82	3.88
38-1	11-Jul-90	1005-1210	485	75	4.1	8.36	4.66
38-2	11-Jul-90	1345-1555	488	75	3.8	8.80	5.03
38-3	11-Jul-90	1555-1835	488	75	4.1	8.87	4.68
38-3A	11-Jul-90	1845-2000	488	75	4.1	1.07	0.88
39-1	12-Jul-90	2120-2345	400	50	3.9	10.82	3.23
39-2	13-Jul-90	0010	400	50	4.2	11.37	2.64
40-1	13-Jul-90	2110-2315	405	50	3.8	13.45	4.99
40-2	14-Jul-90	0045-0240	408	50	3.7	13.50	5.15
40-3	14-Jul-90	0340-0500	405	50	3.7	15.16	5.85
41-1	14-Jul-90	2130-2325	298	50	4.8	3.27	4.36
41-2	15-Jul-90	0100-0300	297	50	5.8	3.43	2.17
42-1	15-Jul-90	2200-2345	300	50	5.4	3.78	2.77
42-2,3	16-Jul-90	0100-0415	300	50	5.4	3.33	2.44
43-1	17-Jul-90	0820-1030	487	50	4.0	8.64	3.67
43-2	17-Jul-90	1030-1430	487	50	4.0	7.15	3.59
43-3	17-Jul-90	1430-1630	487	50	3.9	6.57	3.69
44-1	18-Jul-90	0810-1030	487	50	3.6	8.18	3.98
44-2	18-Jul-90	1030-1425	487	50	3.8	9.43	3.58
45-1	18-Jul-90	1430-1815	489	1	3.8	7.19	3.23
Long-Term Tests							
Long Term	10/17/90	0800-1535				2.33	3.43
Long Term	10/18/90	0730-1430				3.79	1.94

Table A-11 (Continued)

Test No.	Date	Time	Load, MW	AOFA Damper, %	O2, vol%	LOI, wt%	
						East	West
Long-Term Tests (Continued)							
Long Term	10/19/90	0730-1400					
Long Term	10/23/90	0730-0800				6.43	1.53
50-1	10/24/90	0800-1415				4.70	1.56
Long Term	10/25/90	0700-1400				5.14	2.31
51-1	10/26/90	0800-1500				8.18	3.27
Long Term	01/17/91	0800-1540				10.15	3.28
Long Term	01/25/91	0930-1600				3.32	3.05
Long Term	02/04/91	0900-1530				4.98	2.97
Long Term	02/05/91	1000-1630				3.88	2.29
Long Term	02/06/91	0900-1600				5.54	4.85
Long Term	02/07/91	0900-1615				9.03	3.31
Long Term	02/08/91	0800-1230				7.70	3.57
Long Term	02/11/91	0715-1630				4.05	3.29
Long Term	02/12/91	1000-1600				5.39	3.46
Long Term	02/13/91	0750-1545				3.71	3.28
Verification Tests							
52-1	02/22/91	0800-0840	395	50	5.5	7.71	2.40
52-2	02/22/91	0930-1015	398	50	5.0	11.90	-
52-3	02/22/91	1315-1515	398	50	6.2	6.07	-
53-1	02/23/91	0735-0940	402	50	5.2	8.56	-
53-2	02/23/91	1010-1040	402	50	4.8	12.34	2.12
53-3	02/23/91	1040-1225	402	50	5.7	7.98	1.69
54-1	02/25/91	0730-1005	480	50	3.7	8.58	3.57
54-2	02/25/91	1050-1210	480	50	2.8	9.90	3.88
54-4	02/25/91	1400-1525	480	50	4.3	2.89	2.03
55-1	02/26/91	0800-1025	481	50	3.9	12.53	3.09
57-1	02/28/91	0740-1500	480	50	3.3	11.72	2.93

Table A-12

Long-Term Stack Gas Monitoring -- Daily Averages

						CO		THC	
Sequential Day[a]	Date	Average Load, MW	O_2, vol%	NO_x lb/MMBtu	SO_2 lb/MMBtu	ppmv @ 3% O_2	lb/ MMBtu	ppmv @ 3% O_2	lb/ MMBtu
4	17-Oct-90	463.129	6.857	0.990	1.722	11.144	0.0097	0.000	0.0000
5	18-Oct-90	448.273	6.874	1.008	1.730	8.770	0.0076	0.000	0.0000
10	23-Oct-90	446.628	7.071	0.973	1.824	16.144	0.0140	1.297	0.0006
11	24-Oct-90	410.708	7.767	0.964	1.751	8.559	0.0074	1.346	0.0007
12	25-Oct-90	425.915	7.128	0.920	1.854	9.685	0.0084	0.375	0.0002
13	26-Oct-90	388.552	7.261	0.926	1.738	8.884	0.0077	0.225	0.0001
14	27-Oct-90	433.713	6.868	0.937	1.892	11.460	0.0100	0.462	0.0002
15	28-Oct-90	447.272	6.587	0.946	2.333	8.393	0.0073	0.501	0.0002
16	29-Oct-90	466.646	6.190	1.009	2.305	7.635	0.0066	0.600	0.0003
17	30-Oct-90	472.086	6.419	1.040	1.563	8.198	0.0071	0.884	0.0004
20	02-Nov-90	443.859	6.989	0.847	1.744	14.744	0.0128	17.626	0.0088
24	06-Nov-90	445.675	6.398	0.880	1.767	11.603	0.0101	2.635	0.0013
25	07-Nov-90	430.631	6.338	0.866	1.927	11.170	0.0097	2.393	0.0012
26	08-Nov-90	424.846	6.395	0.871	1.673	8.905	0.0077	1.603	0.0008
27	09-Nov-90	427.357	6.537	0.891	1.623	7.601	0.0066	2.145	0.0011
28	10-Nov-90	410.159	6.315	0.777	2.337	11.396	0.0099	3.263	0.0016
30	12-Nov-90	452.271	6.507	0.780	2.534	12.378	0.0108	10.721	0.0053
31	13-Nov-90	451.844	6.592	0.874	2.052	10.912	0.0095	4.064	0.0020

Table A-12 (Continued)

						CO		THC	
Sequential Day[a]	Date	Average Load, MW	O_2, vol%	NO_x lb/MMBtu	SO_2 lb/MMBtu	ppmv @ 3% O_2	lb/ MMBtu	ppmv @ 3% O_2	lb/ MMBtu
32	14-Nov-90	438.868	6.671	0.875	2.051	10.237	0.0089	3.017	0.0015
33	15-Nov-90	460.655	6.626	0.918	1.858	8.667	0.0075	3.155	0.0016
34	16-Nov-90	454.701	6.330	0.861	2.018	9.177	0.0080	2.585	0.0013
35	17-Nov-90	410.859	7.007	0.860	1.942	10.186	0.0089	2.608	0.0013
36	18-Nov-90	438.735	6.414	0.879	2.279	6.838	0.0059	2.354	0.0012
37	19-Nov-90	455.057	6.223	0.940	2.040	5.629	0.0049	1.345	0.0007
38	20-Nov-90	426.695	6.710	0.922	2.007	4.769	0.0041	1.265	0.0006
39	21-Nov-90	445.444	6.330	0.899	2.131	6.031	0.0052	1.226	0.0006
40	22-Nov-90	370.368	7.167	0.888	1.700	6.807	0.0059	1.296	0.0006
41	23-Nov-90	403.930	6.658	0.865	1.375	10.392	0.0090	1.205	0.0006
42	24-Nov-90	438.505	6.386	0.885	1.566	10.893	0.0095	1.221	0.0006
43	25-Nov-90	453.814	6.357	0.941	1.734	10.440	0.0091	1.200	0.0006
44	26-Nov-90	463.053	6.356	0.950	1.689	9.091	0.0079	1.211	0.0006
45	27-Nov-90	448.265	6.846	0.858	2.044	3.309	0.0029	0.498	0.0002
46	28-Nov-90	463.791	6.386	0.811	2.571	7.666	0.0067	0.000	0.0000
47	29-Nov-90	434.250	7.880	0.971	2.608	16.002	0.0139	0.000	0.0000
48	30-Nov-90	457.381	7.768	0.965	2.864	18.503	0.0161	0.000	0.0000
49	01-Dec-90	457.267	8.055	1.050	2.323	15.983	0.0139	0.000	0.0000
50	02-Dec-90	425.015	8.086	1.027	1.528	15.527	0.0135	0.000	0.0000

Table A-12 (Continued)

						CO		THC	
Sequential Day[a]	Date	Average Load, MW	O_2, vol%	NO_x lb/MMBtu	SO_2 lb/MMBtu	ppmv @ 3% O_2	lb/ MMBtu	ppmv @ 3% O_2	lb/ MMBtu
51	03-Dec-90	394.746	7.025	0.884	1.578	20.741	0.0180	0.752	0.0004
52	04-Dec-90	360.144	6.552	0.803	2.027	21.662	0.0188	0.816	0.0004
53	05-Dec-90	447.750	5.928	0.871	1.950	8.902	0.0077	0.000	0.0000
54	06-Dec-90	470.589	5.106	0.845	2.232	8.291	0.0072	0.001	0.0000
55	07-Dec-90	404.600	6.545	0.906	2.189	10.074	0.0088	2.667	0.0013
56	08-Dec-90	422.729	7.220	0.982	2.321	12.095	0.0105	1.312	0.0007
57	09-Dec-90	460.427	6.772	1.083	2.505	18.895	0.0164	1.267	0.0006
58	10-Dec-90	449.607	6.818	1.069	2.296	12.021	0.0105	0.631	0.0003
59	11-Dec-90	454.560	6.391	1.045	2.093	10.014	0.0087	0.000	0.0000
60	12-Dec-90	416.570	7.246	1.023	2.111	11.932	0.0104	0.000	0.0000
61	13-Dec-90	434.039	7.310	1.092	2.164	8.403	0.0073	0.000	0.0000
66	18-Dec-90	248.407	9.371	0.916	2.527	9.485	0.0082	4.482	0.0022
70	22-Dec-90	358.349	7.635	0.839	2.619	7.303	0.0064	4.701	0.0023
71	23-Dec-90	366.436	8.033	0.948	2.384	3.795	0.0033	0.001	0.0000
72	24-Dec-90	376.099	8.113	0.948	2.552	6.536	0.0057	0.434	0.0002
89	10-Jan-91	290.708	6.978	0.706	1.581	14.826	0.0129	5.136	0.0026
98	19-Jan-91	262.088	7.640	0.848	2.132	13.500	0.0117	1.354	0.0007
99	20-Jan-91	221.410	8.212	0.871	2.124	10.201	0.0089	1.416	0.0007
100	21-Jan-91	308.620	7.316	0.878	2.098	14.479	0.0126	1.575	0.0008

Table A-12 (Continued)

						CO		THC	
Sequential Day[a]	Date	Average Load, MW	O_2, vol%	NO_x lb/MMBtu	SO_2 lb/MMBtu	ppmv @ 3% O_2	lb/ MMBtu	ppmv @ 3% O_2	lb/ MMBtu
101	22-Jan-91	346.033	7.574	0.926	1.996	12.535	0.0109	1.353	0.0007
102	23-Jan-91	356.019	7.833	1.035	2.154	7.207	0.0063	11.870	0.0059
103	24-Jan-91	373.444	7.311	0.948	2.247	7.750	0.0067	1.347	0.0007
104	25-Jan-91	351.180	7.015	0.863	2.254	14.447	0.0126	1.311	0.0007
116	06-Feb-91	358.253	6.983	0.883	2.138	21.068	0.0183	3.959	0.0020
117	07-Feb-91	310.369	7.402	0.904	2.207	6.379	0.0055	3.018	0.0015
118	08-Feb-91	302.718	7.531	0.921	2.195	6.141	0.0053	2.763	0.0014
119	09-Feb-91	286.327	7.113	0.885	2.146	7.392	0.0064	2.223	0.0011
120	10-Feb-91	252.587	8.232	0.957	2.074	6.392	0.0056	2.412	0.0012
121	11-Feb-91	347.735	8.025	0.983	2.186	19.066	0.0166	2.814	0.0014
122	12-Feb-91	346.304	8.646	0.946	2.203	11.679	0.0102	2.399	0.0012
123	13-Feb-91	315.152	8.492	0.971	1.941	8.658	0.0075	2.628	0.0013
124	14-Feb-91	304.094	8.714	0.911	1.970	7.593	0.0066	1.666	0.0008
125	15-Feb-91	327.714	9.048	1.036	2.096	7.058	0.0061	1.535	0.0008
127	17-Feb-91	282.946	9.466	0.945	1.773	5.678	0.0049	1.580	0.0008
130	20-Feb-91	318.147	8.730	0.861	2.216	23.802	0.0207	5.665	0.0028
131	21-Feb-91	299.250	8.824	0.818	2.044	15.999	0.0139	3.364	0.0017
133	23-Feb-91	263.918	9.254	0.878	2.458	25.850	0.0225	2.175	0.0011
134	24-Feb-91	259.651	8.921	0.913	2.398	7.027	0.0061	1.595	0.0008

Table A-12 (Continued)

						CO		THC	
Sequential Day[a]	Date	Average Load, MW	O_2, vol%	NO_x lb/MMBtu	SO_2 lb/MMBtu	ppmv @ 3% O_2	lb/ MMBtu	ppmv @ 3% O_2	lb/ MMBtu
139	01-Mar-91	305.776	8.632	0.854	2.406	13.511	0.0117	1.503	0.0007
140	02-Mar-91	242.167	9.728	0.936	2.581	13.065	0.0114	1.649	0.0008
141	03-Mar-91	388.946	8.422	0.982	2.166	29.566	0.0257	1.459	0.0007
142	04-Mar-91	398.451	8.090	0.994	1.833	25.876	0.0225	1.425	0.0007
143	05-Mar-91	387.873	7.541	0.933	2.101	12.054	0.0105	1.378	0.0007
144	06-Mar-91	387.089	7.153	0.867	2.090	15.272	0.0133	1.323	0.0007
145	07-Mar-91	391.407	7.373	0.935	2.309	15.279	0.0133	1.344	0.0007
146	08-Mar-91	395.928	8.218	0.975	2.361	8.063	0.0070	1.481	0.0007

[a] Note: Only days with at least 18 hours of valid monitoring data are included.