INNOVATIVE CLEAN COAL TECHNOLOGY (ICCT)

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

Technical Progress Report
Second Quarter 1992

DOE Contract Number
DE-FC22-90PC89653

SCS Contract Number
C-91-000028

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared by:

Southern Company Services, Inc.
800 Shades Creek Parkway
Birmingham, Alabama 35209

Cleared by DOE Patent Counsel on August 20, 1992

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

LEGAL NOTICE

This report was prepared by Southern Company Services, Inc. pursuant to a cooperative agreement partially funded by the U.S. Department of Energy and neither Southern Company Services, Inc. nor any of its subcontractors nor the U.S. Department of Energy, nor any person acting on behalf of either:

- (a) Makes any warranty or representation, express or implied with respect to the accuracy, completeness, or usefulness of the information contained in this report, or process disclosed in this report may not infringe privately-owned rights; or
- (b) Assumes any liabilities with respect to the use of, or for damages resulting from the use of, any information, apparatus, method or process disclosed in this report.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. Department of Energy. The views and opinion of authors expressed herein do not necessarily state or reflect those of the U.S. Department of Energy.

EXECUTIVE SUMMARY

This quarterly report discusses the technical progress of a U. S. Department of Energy (DOE) Innovative Clean Coal Technology (ICCT) Project demonstrating advanced tangentially-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from a coal-fired boiler. The project is being conducted at Gulf Power Company's Plant Lansing Smith Unit 2 located near Panama City, Florida. The primary objective of this demonstration is to determine the long-term effects of commercially available tangentially-fired low NO_x combustion technologies on NO_x emissions and boiler performance. A target of achieving fifty percent NO_x reduction using combustion modifications has been established for the project.

The stepwise approach that is being used to evaluate the NO_x control technologies requires three plant outages to successively install the test instrumentation and the different levels of the low NO_x concentric firing system (LNCFS). Following each outage, a series of four groups of tests are performed. These are (1) diagnostic, (2) performance, (3) long-term, and (4) verification. These tests are used to quantify the NO_x reductions of each technology and evaluate the effects of those reductions on other combustion parameters such as particulate characteristics and boiler efficiency.

This technical progress report presents the LNCFS Level I short-term data collected during this quarter. In addition, a comparison of all the long-term emissions data that have been collected to date is included.

TABLE OF CONTENTS

1.	INTRODUCTION.....	1
2.	DEMONSTRATED TECHNOLOGIES	4
3.	UNIT DESCRIPTION.....	8
4.	PROJECT DESCRIPTION	8
5.	PROJECT STATUS.....	10
5.1.	Phase I Setup and Pre Retrofit.....	10
5.1.1.	Baseline Characterization	10
5.2.	Phase II LNCFS Level II Retrofit and Testing.....	12
5.2.1.	LNCFS Level II Retrofit.....	12
5.2.2.	LNCFS Level II Characterization.....	12
5.3.	Phase III LNCFS Level III Retrofit and LNCFS Levels I and III Testing...15	
5.3.1.	LNCFS Level III Installation	15
5.3.2.	LNCFS Level III Characterization	15
5.3.3.	LNCFS Level I Characterization.....	17
5.4.	Data Comparison.....	18
5.5.	Unit Operations	24
6.	FUTURE PLANS	25
7.	ACKNOWLEDGMENTS.....	25
8.	APPENDIX A	
9.	APPENDIX B	

1. INTRODUCTION

This document discusses the technical progress of a U. S. Department of Energy (DOE) Innovative Clean Coal Technology (ICCT) Project demonstrating advanced tangentially-fired combustion techniques for the reduction of nitrogen oxide (NO_x) emissions from coal-fired boilers. The project is being conducted at Gulf Power Company's Plant Lansing Smith near Panama City, Florida.

The project is being managed by Southern Company Services, Inc. (SCS) on behalf of the project co-funders: The Southern electric system, the U. S. Department of Energy (DOE), and the Electric Power Research Institute. In addition to SCS, The Southern electric system includes five electric operating companies: Alabama Power, Georgia Power, Gulf Power, Mississippi Power, and Savannah Electric and Power. SCS provides engineering and research services to the Southern electric system. Through cost sharing in the installed low NO_x retrofit technology, Asea Brown Boveri Combustion Engineering Services (ABB CE) is also participating as a project co-funder.

The Clean Coal Technology Program is a jointly funded effort between government and industry to move the most promising advanced coal-based technologies from the research and development stage to the commercial marketplace. The Clean Coal effort sponsors projects which are different from traditional research and development programs sponsored by the DOE. The traditional projects focused on long-range, high-risk, high-payoff technologies with the DOE providing the majority of the funding. In contrast, the goal of Clean Coal Projects is to demonstrate commercially feasible advanced coal-based technologies which have already reached the "proof-of-concept" stage. As a result, the Clean Coal projects are jointly funded endeavors between the government and the private sector which are conducted as Cooperative Agreements in which the industrial participant contributes at least fifty percent of the total project cost.

ABB CE's Low NO_x Bulk Furnace Staging (LNBFS) System and Low NO_x Concentric Firing System (LNCFS) are demonstrated in stepwise fashion. These systems incorporate the concepts of advanced overfire air (AOFA), clustered coal nozzles, and offset air. A complete description of the installed technologies is provided in the following section.

The primary objective of the Plant Lansing Smith demonstration is to determine the long-term effects of commercially available tangentially-fired low NO_x combustion technologies on NO_x emissions and boiler performance. Short-term tests of each technology are also being performed to provide engineering information about emissions and performance trends. A target of achieving

fifty percent NOx reduction using combustion modifications has been established for the project. Through modifications shown in Figure 1, the project seeks to address the following objectives:

1. Demonstrate in a logical stepwise fashion the short-term NOx reduction capabilities of the following advanced low NOx combustion technologies:
 - a. Low NOx Bulk Furnace Staging (LNBFS)
 - b. Low NOx Concentric Firing System (LNCFS) Levels I, II, and III
2. Determine the dynamic long-term emissions characteristics of each of these combustion NOx reduction methods using sophisticated statistical techniques.
3. Evaluate the progressive cost effectiveness (i.e., dollars per ton NOx removed) of the low NOx combustion techniques tested.
4. Determine the effects on other combustion parameters (e.g., CO production, carbon carryover, particulate characteristics) of applying the NOx reduction methods listed above.

Figure 1. Plant Lansing Smith Unit 2 Boiler

2. DEMONSTRATED TECHNOLOGIES

As shown in the Statement of Work (SOW) revised in December 1991, four different low NO_x combustion technologies offered by ABB Combustion Engineering (ABB CE) for tangentially-fired boilers are planned for this demonstration. The demonstration of these technologies progresses in the most logical manner from an engineering and construction viewpoint. During Phase I of the project, the baseline conditions of the unit will be studied. During Phase II, the Low NO_x Bulk Furnace Staging (LNBFS) system and the Low NO_x Concentric Firing System (LNCFS) Level II will be demonstrated. Finally, LNCFS Levels I and III will be demonstrated during Phase III.

The concept of overfire air is demonstrated in all of these systems. In LNCFS Level I, a Close-Coupled Overfire Air (CCOFA) system is integrated directly into the windbox. Compared to the baseline configuration, LNCFS Level I is arranged by exchanging the highest coal nozzle with the air nozzle immediately below it. This configuration provides the NO_x reducing advantages of an overfire air system without major pressure part modifications to the boiler.

In LNBFS and LNCFS Level II, a Separated Overfire Air (SOFA) system is used. This is an advanced overfire air system having backpressuring and flow measurement capabilities. The air supply ductwork for the SOFA is taken off from the secondary air duct and routed to the corners of the furnace above the existing windbox. The inlet pressure to the SOFA system can be increased above windbox pressure using dampers downstream of the takeoff in the secondary air duct. The intent of operating at a higher pressure is to increase the quantity and injection velocity of the overfire air into the furnace. A multicell venturi is used to measure the amount of air flow through the SOFA system. LNCFS Level III utilizes both CCOFA and SOFA.

In addition to overfire air, the LNCFS incorporates other NO_x reducing techniques into the combustion process. Using offset air, two concentric circular combustion regions are formed. The inner region contains the majority of the coal thereby being fuel rich. This region is surrounded by a fuel lean zone containing combustion air. For this demonstration, the size of this outer circle of combustion air will be varied using adjustable offset air nozzles. The separation of air and coal at the burner level further reduces the production of NO_x.

The LNBFS consists of a standard tangentially-fired windbox with a SOFA system. This technology will be demonstrated by repositioning the offset air nozzles in the main windbox to be

in line with the fuel nozzles. No other modifications to the windbox will be required. Due to the limits of the project schedule, LNBFS will be demonstrated using short-term diagnostic tests only.

When the SOW for this project was prepared in June 1990, ABB CE offered the following low NOx combustion systems:

- 1) Low NOx Concentric Firing System (LNCFS)
- 2) Concentric Clustered Tangential Firing System (CCTFS)

Since that time, the technologies which ABB CE offers to the public have evolved to reflect the results of their most recent knowledge. The equipment that is presently offered comprises a family of technologies called the Low NOx Concentric Firing System Levels I, II, and III as discussed above. These technologies provide a stepwise reduction in NOx emissions with LNCFS Level III providing the greatest reduction.

Although the names of these technologies have changed, the basic concepts for the reduction of NOx emissions have remained constant. The Low NOx Concentric Firing System (LNCFS) included the NOx reduction techniques of overfire air and adjustable offset air nozzles as part of its design. These features are now incorporated into the design of LNCFS Level II.

The Concentric Clustered Tangential Firing System (CCTFS) included two sets of overfire air and clustered coal nozzles. Both LNCFS Levels I and III utilize clustered coal nozzles and overfire air in their design. Research by ABB CE has shown that the use of clustered coal nozzles does not positively or negatively affect the production of nitrogen oxides in a coal-fired boiler. As a result, one set of coal nozzles at the top of the main windbox are clustered to facilitate the addition of the CCOFA system discussed in the section above. This modification allowed the low pressure overfire air system (now designated the CCOFA) to be integrated directly into the windbox. This design change reduced the number of pressure part modifications required to install this low NOx combustion technology. No significant design changes to the high pressure overfire air system (now designated the SOFA) were made.

Figure 2: Demonstrated Technologies

Figure 3: Concentric Firing System

3. UNIT DESCRIPTION

Plant Lansing Smith Unit 2, owned and operated by Gulf Power Company, utilizes a tangentially-fired boiler (aspect ratio = 1.5 width/depth) rated at 180 MW with the capability to provide loads of up to 200 MW. The boiler is a Combustion Engineering radiant reheat, natural circulation steam generator which came on line in 1967. It is designed for continuous indoor service to deliver 1,306,000 pounds of steam per hour at normal rated load, a pressure of 1800 psig, and a temperature of 1000°F at the superheater and the reheater outlets. Five Combustion Engineering Raymond Bowl mills equipped with exhausters at the outlet of each mill deliver pulverized coal (66.5% C, 9.9% H₂O, 4.6% H, 1.4% N, 2.8% S, 6.3% O, 8.5% ash, 0.1% Cl; HHV = 11,886 Btu/lb, FC = 46.0%, VM = 35.6%) through twenty tangential coal nozzles with five nozzles at each corner of the furnace. The unit is equipped with Ljungstrom air preheaters and two forced-draft fans which deliver all the combustion air to the boiler. Exhaust gases are treated with both hot- and cold-side electrostatic precipitators. Although originally designed for pressurized furnace operation, the unit was converted to balanced-draft operation in 1976.

4. PROJECT DESCRIPTION

In order to accomplish the project objectives, a Statement of Work (SOW) was developed which included the Work Breakdown Structure (WBS) found in Table 1. The WBS is designed around a chronological flow of the project. The chronology requires design, construction, and operation activities in each of the first three phases following project award. Although this project structure is inconsistent with the typical ICCT project phase structure of (1) permitting and design, (2) construction, and (3) operation, it prevents phases from starting and stopping several times during the project.

The stepwise approach to evaluating the NO_x control technologies requires that three plant outages be used to successively install (1) the test instrumentation and new air heater baskets, (2) the LNCFS Level II, and (3) the LNCFS Levels I and III. These outages are scheduled to coincide with existing plant outages in the fall of 1990, spring of 1991, and the fall of 1991.

The Data Acquisition System (DAS) for the Lansing Smith Unit 2 ICCT project is a custom designed microcomputer based system used to collect, format, calculate, store, and transmit data derived from power plant mechanical, thermal, and fluid processes. The extensive process data selected for input to the DAS has in common a relationship with either boiler performance or boiler exhaust gas properties. This system includes two continuous emissions monitoring systems (NO_x, SO₂, O₂, THC, CO) with a multi-point flue gas sampling and conditioning system, an acoustic

Table 1: Work Breakdown Structure			
Phase	Task	Description	Scheduled Date
0		Pre-Award Activities	
I		Setup and Pre-Retrofit	
	1.1.1	Project Management and Reports	9/90 - 3/91
	1.1.2	Site Preparation	10/90 - 11/90
	1.1.3	Flow Modeling	9/90 - 7/91
	1.1.4	Instrumentation	8/90 - 12/90
	1.1.5	Baseline Characterization	11/90 - 3/91
II		LNCFS Level II Retrofit	
	1.2.1	Project Management and Reports	4/91 - 9/91
	1.2.2	LNCFS Level II Installation	4/91 - 5/91
	1.2.3	LNBFS and LNCFS Level II Characterization	5/91 - 9/91
	1.2.4	Chemical Emissions Testing	9/91 - 12/91
III		LNCFS Level III Retrofit	
	1.3.1	Project Management and Reports	9/91 - 1/93
	1.3.2	LNCFS Level III Installation	9/91 - 10/91
	1.3.3	LNCFS Levels I and III Characterization	10/91 - 8/92
	1.3.4	Chemical Emissions Testing	12/91 - 9/92
IV		Final Reporting and Disposition	
	1.4.1	Project Management and Reports	8/92 - 9/93
	1.4.2	Disposition	11/92

pyrometry and thermal mapping system, furnace tube heat flux transducers, and boiler efficiency instrumentation. The instrumentation system is designed to provide data collection flexibility to meet the schedule and needs of the various testing efforts throughout the demonstration program. A summary of the type of data collected is shown in Table 2.

Following each outage, a series of four groups of tests are performed. These are (1) diagnostic, (2) performance, (3) long-term, and (4) verification. The diagnostic, performance, and verification tests consist of short-term data collection during carefully established operating conditions. The diagnostic tests are designed to map the effects of changes in boiler operation on NO_x emissions. The performance tests evaluate a more comprehensive set of boiler and combustion performance indicators. The results from these tests will include particulate characteristics, boiler efficiency, and boiler outlet emissions. Mill performance and air flow distribution are also tested. The verification tests will be used to characterize any changes that might have occurred during long-term testing.

As stated previously, the primary objective of the demonstration is to collect long-term, statistically significant quantities of data under normal operating conditions with and without the various NO_x reduction technologies. Earlier demonstrations of emissions control technologies have relied solely

Table 2: Plant Data Points	
Boiler Drum Pressure	Superheat Outlet Pressure
Cold Reheat Pressure	Hot Reheat Pressure
Barometric Pressure	Superheat Spray Flow
Reheat Spray Flow	Main Steam Flow
Feedwater Flow	Coal Flows
Secondary Air Flows	Tempering Air Flows
Main Steam Temperatures	Cold Reheat Temperature
Hot Reheat Temperature	Feedwater Temperature
Desuperheater Outlet Temp.	Desuperheater Inlet Temp.
Economizer Outlet Temp.	Air Heater Air Inlet Temp.
Air Heater Air Outlet Temp.	Ambient Temperature
BFP Discharge Temperature	Relative Humidity
Stack NOx	Stack SO2
Stack O2	Stack Opacity

on data from a matrix of carefully established short-term (one to four hour) tests. However boilers are not typically operated in this manner considering plant equipment inconsistencies and economic dispatch strategies. Therefore, statistical analysis methods for long-term data have been developed that can be used to determine the achievable emissions limit or emission tonnage of a control technology. These analysis methods have been developed over the past fifteen years by the Control Technology Committee of the Utility Air Regulatory Group (UARG). Because the uncertainty in the analysis methods is reduced with increasing data set size, UARG recommends that acceptable results can be achieved with data sets of at least 51 days with each day containing at least 18 valid hourly averages.

5. PROJECT STATUS

5.1. Phase I Setup and Pre Retrofit

5.1.1. Baseline Characterization

Baseline tests were completed in March 1990. A summary of the baseline long-term test results is shown in Table 3. Seventy-five days of long-term data were collected generating an average NOx emission level of 0.62 lb/MBtu. Figure 4 shows that baseline NOx emissions decreased slightly with decreases in unit load and ranged from 0.64 lb/MBtu at full load to 0.55 lb/MBtu at minimum load. The bands about the mean represent the 95 percentiles of the data set. Ninety-five percent of the long-term data fall below the upper limit and 5 percent of the data fall below the lower limit. These limits show that NOx emissions varied by as much as 0.2 lb/MBtu for a given load point during normal load-dispatched operations. The final version of the Phase I Baseline Topical Report was issued in the first quarter 1992.

Table 3. Baseline, LNCFS Level II and LNCFS Level III Long-Term Test Results.						
Unit Configuration	Baseline		LNCFS II		LNCFS III	
	Mean	RSD %	Mean	RSD %	Mean	RSD %
Number of Daily Averaged Values	75	-	55	-	71	-
Average Load (MW)	155	14.8	172	7.1	141	15.1
Average NO _x Emissions	0.62	5.8	0.41	6.9	0.39	9.7
Average O ₂ Level (at stack)	6.55	11.6	6.50	8.8	7.56	7.8
30 Day Achievable Emission Limit	0.68	-	0.45	-	0.44	-
NO _x Annual Achievable Emission Limit	0.63	-	0.41	-	0.40	-

* RSD = Relative Standard Deviation = 100 * Standard Deviation / Mean
 NO_x emissions are in lb/MBtu

Figure 4: Baseline Long-Term NO_x Emissions Results

5.2. Phase II LNCFS Level II Retrofit and Testing

5.2.1. LNCFS Level II Retrofit

LNCFS Level II was installed during a three week outage that began on March 29, 1991. During that outage, craft laborers worked seven days a week with two ten-hour shifts per day. The remaining four hours of the day were reserved for x-raying welds in the furnace walls. During peak work loads, as many as seventy craft laborers per shift were involved in the retrofit. A full furnace scaffold was installed to expedite the job.

Due to the scope of the work required to be performed during the outage, the SOFA ductwork was hung in place prior to the unit coming off line. The installation of the SOFA windboxes required significant pressure part modifications to each corner of the boiler above the main windbox. Preassembled bent tube panels were welded into the four 10 feet high by 4 feet wide holes cut in the boiler. The SOFA windboxes with three sets of air nozzles were inserted into the 5 feet high by 2 feet wide openings in the tube panels. Each nozzle has its own automatically controlled damper to provide regulation of the flow to the SOFA ports. The yaw adjustment on each SOFA nozzle is manually adjustable. The three nozzles tilt in unison via automatic controls linked to the tilting of the nozzles in the main windbox.

The critical path for this outage was the modification to the main windboxes. The windboxes were completely stripped of coal nozzles, auxiliary air nozzles, tilt linkages, and all bearings and bushings. After removing this equipment, the partition plates and windbox turning vanes were inspected for warpage and wear. When necessary, these parts were replaced or refurbished. Additional partition plates were installed in the top and bottom auxiliary air compartments. All of the partition plates were cut back approximately three inches to allow greater tilting mobility of the new coal and air nozzles. All coal nozzles and tips were replaced, Rockwell couplings were installed in the fuel lines to relieve fuel pipe loadings on the windbox, and four elevations of flame scanners were installed including a cooling air system with a dedicated fan. The windbox tilting mechanism was completely replaced. The offset air nozzles in the main windbox have the capability to move in the horizontal direction by a manual adjustment. The air and coal nozzles tilt in unison via automatic controls.

5.2.2. LNCFS Level II Characterization

Prior to testing, the LNCFS Level II system was optimized for performance and NO_x emissions by engineers from ABB CE. A portion of this process required the proper positioning of the three

adjustable SOFA nozzles and the adjustable offset air nozzles in the main windbox. The optimized configuration for these nozzles with respect to the injection angle of the coal nozzles is shown in Table 4. The optimum tilt position for the SOFA nozzles was determined to be 0°. Tilt position for the main windbox varies to maintain unit reheat and superheat temperatures.

LNCFS Level II tests were completed in October 1991. A summary of the long-term test results is shown with the baseline results in Table 3. Fifty-five days of long-term data were collected generating an average emission level of 0.41 lb/MBtu. Long-term NO_x emissions over the entire load range are shown in Figure 5 and range from 0.39 lb/MBtu (full load) to 0.57 lb/MBtu (minimum load). When operating with LNCFS Level II, NO_x emissions varied by as much as 0.3 lb/MBtu at individual load values. The trend of increasing NO_x emissions with decreases in load is consistent with previously reported data for low NO_x combustion equipment on T-fired boilers.

Table 4: Optimized Orientation of SOFA and Offset Air Nozzles With Respect to the Coal Nozzles for LNCFS Level II (Positive indicates Rotation with the Fireball).				
Corner/ elevation	Right Front	Right Rear	Left Front	Left Rear
SOFA Top	+15°	-15°	+15°	+15°
SOFA Middle	0°	-15°	0°	0°
SOFA Lower	-15°	-15°	-15°	-15°
Offset Air	+22°	+22°	+22°	+22°

Figure 5: LNCFS Level II Long-Term NOx Emissions Results

5.3. Phase III LNCFS Level III Retrofit and LNCFS Levels I and III Testing

5.3.1. LNCFS Level III Installation

LNCFS Level III was installed during a two week outage that began in October 1991. During that outage, craft laborers worked five days a week with two ten-hour shifts per day. An average of thirty-six craft laborers per day were involved in the retrofit. A full furnace scaffold was installed to expedite the job.

During the two week outage, the CCOFA air ports were installed in the top of the main windbox. This modification required the reconfiguration of the top three windbox compartments in each corner of the boiler. The existing coal compartment and the two auxiliary air compartments in the top of the windbox were replaced with one stationary auxiliary air compartment, one coal compartment and two CCOFA compartments. To facilitate the relocation of the coal nozzle to a lower elevation, coal piping, ignitors, flame scanners, and platform steel in each corner were also relocated.

5.3.2. LNCFS Level III Characterization

Prior to testing, the LNCFS Level III system was optimized for performance and NO_x emissions by engineers from ABB CE. This process required the proper positioning of the three adjustable SOFA nozzles and the adjustable offset air nozzles in the main windbox. The final configuration for these nozzles with respect to the injection angle of the coal nozzles is shown in Table 5. The CCOFA nozzles are in line with the coal nozzles.

LNCFS Level III testing began in November 1991, and was completed in March 1992. The short-term test data are included in the **Technical Progress Report, Fourth Quarter 1991**. A summary of the long-term test results is shown with the baseline and LNCFS Level II results in Table 3. Seventy-one days of long-term data were collected generating an average emission level of 0.39 lb/MBtu. Long-term NO_x emissions over the entire load range are shown in Figure 6 and range from 0.32 lb/MBtu (140 MW) to 0.60 lb/MBtu (minimum load). When operating with LNCFS Level III, NO_x emissions varied by 0.3 lb/MBtu at minimum load values. However, the variations in emissions at full load were much less than the variations in the baseline or LNCFS Level II data.

Table 5: Optimized Orientation of SOFA, CCOFA, and Offset Air Nozzles With Respect to the Coal Nozzles for LNCFS Level III (Positive Indicates Rotation with the Fireball).				
Corner/ elevation	Right Front	Right Rear	Left Front	Left Rear
SOFA Top	+12°	-12°	+12°	+12°
SOFA Middle	0°	-12°	0°	0°
SOFA Lower	-12°	-12°	-12°	-12°
Offset Air	+16°	+16°	+16°	+16°

Figure 6: LNCFS Level III Long-Term NOx Emissions Results

5.3.3. LNCFS Level I Characterization

The LNCFS Level I technology is being tested by closing the dampers of the SOFA system used for LNCFS Level III. In order to maintain the material integrity of the SOFA nozzles, a minimum amount of leakage flow is maintained through the SOFA ductwork. According to ABB CE, the effect of this leakage flow is to reduce NO_x emissions below those of a true LNCFS Level I system.

In addition, the secondary air nozzles of a true LNCFS Level I system would provide a larger exit area. This difference in secondary air nozzle design is required to pass all of the secondary air through the main windbox with the appropriate design velocities for the furnace dimensions and the fuel being fired. The design of the Level I system at Plant Smith results in a higher velocity through the secondary air nozzles than a true Level I system. The effect of this Level I simulation, with its associated higher mixing velocities, may cause NO_x emissions to be higher than normal and carbon loss to be lower than normal. The potential exists for the SOFA leakage effect of decreasing NO_x emissions and the nozzle design effects of increasing NO_x emissions to negate each other. Although a correction factor is being used to correct for SOFA leakage, no attempt is being made to correct for the nozzle design effects on NO_x emissions.

Prior to testing, the LNCFS Level I system was optimized for performance and NO_x emissions by engineers from ABB CE. Optimization of the system resulted in the CCOFA ports being positioned in line with the fuel nozzles. The position of the offset air nozzles was determined to be the same as the LNCFS Level III configuration.

A portion of the LNCFS Level I diagnostic tests involved the characterization of the SOFA leakage effects on NO_x emissions. These tests showed that the leakage effects are only significant at full load. At minimum loads, the effect on NO_x emissions is less than 0.1 percent. At full load, the leakage effects reduce unit NO_x emissions by 4.6 percent.

LNCFS Level I short-term tests were completed during this quarter. A summary of the results is presented in Table A-1.

The continuous emissions monitor (CEM) passed certification. A copy of the certification report is included in Appendix B.

5.4. Data Comparison

The following section compares the long-term NOx emissions results from baseline, LNCFS Level II, and LNCFS Level III. The LNCFS Level I long-term NOx emissions data will be included in the technical progress report for the third quarter 1992.

Figure 7 compares the averages of the baseline, LNCFS Level II, and LNCFS Level III long-term NOx emissions data. At full load, both LNCFS Level II and LNCFS Level III provide substantial NOx reductions over the baseline values. LNCFS Level II provides a maximum NOx reduction of 40 percent at 190 MW and LNCFS Level III provides a maximum NOx reduction of 48 percent at 160 MW. At minimum load, NOx reduction is near zero percent for both LNCFS Level II and Level III.

Figure 8 compares the baseline, LNCFS Level II, and LNCFS Level III excess oxygen requirements. These measurements were taken at the boiler economizer outlet using a multi-point grid of in-situ oxygen analyzers. During baseline operation, full load excess oxygen levels were near 3.5 percent. As load decreased, excess oxygen requirements increased to 7.0 percent at minimum load. Excess oxygen levels for LNCFS Levels II and III were greater than the baseline levels. LNCFS Level II excess oxygen levels ranged from 4.0 percent at full load to 7.5 percent at low load. LNCFS Level III excess oxygen levels ranged from 3.8 percent to 7.1 percent.

During low load LNCFS Level II operations at Plant Smith, excess air levels were higher than full load levels to maintain unit reheat and superheat temperatures (Fig. 8). Also the main coal and air nozzles were tilted upward to assist in maintaining steam temperatures. This mode of normal operation could have contributed to the increase in NOx emission at lower loads (Fig. 7). Following the long-term LNCFS Level II tests, ABB CE conducted a series of tests to determine if NOx emissions at lower loads could be reduced. The results indicated that increasing SOFA flows above ABB CE's previously optimized levels and reducing excess oxygen levels decrease low load NOx emissions to the full load values. These results have not been substantiated with long-term operation.

Figure 9 compares the CO emissions measured during each phase of long-term testing. In a manner similar to the NOx emissions measurements, these values were taken at the stack with the CEM and have been corrected to a 3 percent O2 level. The CO emissions during operation of

LNCFS Level III were greater than baseline or LNCFS Level II values. Maximum CO emissions with LNCFS Level III occurred at the same load value where the NOx reduction was greatest. It is anticipated that these CO emissions could be reduced with extended operational experience.

Figure 10 compares the flyash loss-on-ignition (LOI) percentages measured during each set of performance tests. These measurements were made using EPA's Method 17 isokinetic sampling technique traversing multiple points at the economizer outlet of the boiler. LOI values during operation of LNCFS Level I were consistent with the baseline values. LOI values for operation with LNCFS Level II are below those of baseline values for all load levels tested. Baseline tests were not conducted at 200 MW. LOI levels with LNCFS Level III were greater than baseline levels. These higher values were confirmed during a short test series of LNCFS Level III.

Mill performance levels during each set of tests are shown in Table 6. Fuel fineness was measured using an isokinetic sampler at the exhaust outlet of each mill. The isokinetic sampling method has consistently resulted in lower fineness results than ABB CE's recommended method for collecting fuel samples. While the ABB CE procedure is not an isokinetic sampling method, it is widely recognized as the standard for the collection of fuel samples on CE mills. Data from both testing methods are shown.

During LNCFS Level II tests, mill performance levels were greater than the baseline values and during LNCFS Level III tests mill performance levels were lower. As a result, the effect of decreases and increases in LOI levels cannot be attributed solely to the performance of LNCFS Levels II and III, respectively. Due to concern over the increased LOI values with LNCFS Level III, additional LOI tests were conducted in May 1992. These results are also shown in Figure 10 and are labeled 'LNCFS III (retested).' Based on the isokinetic fuel sampling method (Table 6), fineness levels were 2.5 percent on 50 mesh and 56 percent through 200 mesh. Measurements taken by plant personnel using ABB CE's recommended method showed that the fineness was 1.1 percent on 50 mesh and 71 percent through 200 mesh during the LNCFS Level III retest.

Figure 7: Comparison of Baseline, LNCFS Level II, and LNCFS Level III Long-Term NOx Emissions Results

Figure 8: Comparison of Baseline, LNCFS Level II, and Level III Long-Term Excess Oxygen Levels

Figure 9: Comparison of Baseline, LNCFS Level II, and Level III Long-Term CO Levels

Figure 10: Comparison of Baseline, LNCFS Level I, LNCFS Level II, and Level III LOI Results

Table 6: Coal Flow Weighted Mill Performance at Full Load (180 MW) Using Isokinetic Fuel and Flyash Sampling Techniques at the Exhauster Outlet.

	Percent Left on 50 Mesh		Percent Passing 200 Mesh	
	Isokinetic Method *	ABB CE Rec'd Method ‡	Isokinetic Method *	ABB CE Rec'd Method ‡
Baseline	2.7	2.4	58.9	68.6
LNCFS Level II	2.0	0.8	n/a	n/a
LNCFS Level III	3.2	1.3	55.7	75.3
LNCFS Level I	2.9	1.1	55.4	71.6
LNCFS Level III (retest)	2.5	1.1	55.5	71.6

* Mill Coal Flow Weighted Average

‡ Simple Average

5.5. Unit Operations

In the baseline configuration of the boiler, the coal and air nozzles were fixed in the horizontal position since the tilting mechanisms were inoperable. During the outage to install LNCFS Level II, the burner tilting system was completely replaced. As a result, unit operators reported that the tilt mechanisms allowed better control of reheat and superheat temperatures with all three levels of the LNCFS.

Other than the tilt improvements, unit operation with LNCFS Level I was reported to be similar to baseline conditions. Fireball rotation, furnace clarity (visibility), flame brightness, and flexibility in unit operations did not change appreciably from the baseline condition. Unit operations with LNCFS Level II was also reported to provide the flexibility in operations of the baseline configuration. With LNCFS Levels II and III operation, fireball rotation rate slowed, furnace clarity decreased, and flame brightness dimmed. The redirection of secondary air to the SOFA nozzles is the primary reason for the change in fireball rotation rate and the furnace brightness. The extended combustion zone created by the overfire air process resulted in lower furnace gas clarity. With operation of all three levels of LNCFS, there was no increased loading on the precipitator; however, the predominant slagging location moved from the combustion zone of the furnace to the convection pass.

Although there were no effects on unit availability, boiler operation with LNCFS Level III was characterized as more difficult than the baseline, Level I, or Level II configurations. Load transitions that require bringing mills into and out of service generally resulted in spikes of CO and NO_x emissions. Flexibility in unit operations with respect to the range of excess oxygen levels available for operation was more restricted. This characteristic is reflected in the tight band of NO_x emissions generated at each load during LNCFS Level III operation (Fig. 7). Slagging patterns and precipitator loadings with LNCFS Level III were similar to those experienced with Level II.

6. FUTURE PLANS

The following is a quarterly outline of the activities scheduled during the remainder of the project:

QUARTER	ACTIVITY
Third Quarter 1992	Complete LNCFS Level I Verification Tests
Fourth Quarter 1992	Begin Project Disposition Begin Final Reporting
1993	Complete Final Reporting Complete Project Disposition Project Completion

7. ACKNOWLEDGMENTS

The management of this project wish to gratefully acknowledge the support and dedication of the following personnel for their work at the tangentially-fired test site: Mr. J. D. McDonald, Gulf Power Company, and Mr. Lamar Sumerlin, Southern Company Services, for their coordination of the design and retrofit efforts and Mr. James Gibson, full-time Instrumentation Specialist from Spectrum Systems, Inc. We also thank Messrs. Jim Witt, John Sorge, and Jimmy Horton of Southern Company Services for their work coordinating the procurement and installation of the instrumentation at this site. We would also like to recognize the following companies for their outstanding testing and data analysis efforts: Energy Technology Consultants, Inc., Flame Refractories, Inc., Southern Research Institute, W. S. Pitts Consulting, and Radian Corporation.

8. APPENDIX A
LNCFS Level I Short-Term Data

TABLE A-1: Summary of LNCFS Level I Short-Term Operating Conditions and Test Results

test	date	load MW	MOOS	upper ccofa %	lower ccofa %	upper sofa %	center sofa %	lower sofa %	tilt %	CR O2 %	DAS O2 %	NOx ppm	NOx ^ lb/MBtu	CO ppm	comments
78-1	5/14/92	184	AMIS	100	80	0	0	0	2	4.0	2.3	258	0.35	73	low O2
78-2	5/14/92	184	AMIS	100	80	0	0	0	1	4.7	3.1	295	0.40	13	recom O2
78-3	5/14/92	184	AMIS	100	80	0	0	0	1	5.4	4.0	314	0.43	14	High O2
78-4	5/14/92	185	AMIS	100	80	0	0	0	2	4.7	3.1	301	0.41	15	SOFA flow
78-5	5/14/92	183	AMIS	100	80	0	0	0	1	4.9	3.1	290	0.39	16	SOFA flow
79-1	05/15/92	180	AMIS	100	80	0	0	0	3	5.2	4.3	314	0.43	12	Hi O2, HVLOI
79-2	05/15/92	180	AMIS	100	80	0	0	0	3	5.0	3.6	310	0.42	12	Hi O2, HVLOI
79-3	05/15/92	181	AMIS	100	80	0	0	0	3	4.0	3.0	287	0.39	11	recom O2, HVLOI
79-4	05/15/92	180	AMIS	100	80	0	0	0	3	3.5	2.3	267	0.36	40	Low O2, HVLOI
80-1	05/16/92	184	AMIS	100	80	0	0	0	5	5.4	4.1	313	0.43	13	Hi O2, HVLOI
80-2	05/16/92	185	AMIS	100	80	0	0	0	5	4.2	3.0	284	0.39	12	recom O2, HVLOI
80-3	05/16/92	186	AMIS	100	80	0	0	0	5	3.5	2.0	258	0.35	34	low O2, HVLOI
80-4	05/16/92	185	AMIS	100	80	0	0	0	5	3.8	2.5	276	0.38	12	Low O2, HVLOI
81-1	05/17/92	183	AMIS	100	80	0	0	0	10	4.2	3.0	293	0.40	6	Tilt variation
81-2	05/17/92	179	AMIS	100	80	0	0	0	0	4.3	3.1	275	0.37	10	Tilt variation
81-3	05/17/92	180	AMIS	100	80	0	0	0	-10	4.3	3.2	281	0.38	8	Tilt variation
81-4	05/17/92	79	ABC	100	50	0	0	0	3	7.0	7.3	304	0.41	7	Hi O2
81-5	05/17/92	74	ABC	100	50	0	0	0	3	5.8	5.7	270	0.37	7	recom O2
81-6	05/17/92	75	ABC	100	50	0	0	0	3	4.7	4.2	243	0.33	8	Low O2
82-1	05/18/92	197	AMIS	100	80	0	0	0	10	5.9	4.2	338	0.46	17	Hi O2
82-2	05/18/92	113	AB	100	80	0	0	0	10	6.5	6.1	302	0.41	13	Hi O2
82-3	05/18/92	112	AB	100	80	0	0	0	10	5.4	4.7	274	0.37	13	recom O2
82-4	05/18/92	112	AB	100	80	0	0	0	10	4.5	3.7	255	0.35	13	Low O2
83-1	05/19/92	200	AMIS	100	78	0	0	0	5	5.2	3.8	311	0.42	13	recom O2
83-2	05/19/92	132	A	100	78	0	0	0	11	5.7	5.1	296	0.40	9	Hi O2
83-3	05/19/92	133	A	100	78	0	0	0	12	4.7	3.9	266	0.36	10	recom O2
83-4	05/20/92	134	A	100	78	0	0	0	12	3.5	2.4	227	0.31	11	Low O2
83-5	05/20/92	116	AB	100	78	0	0	0	12	5.3	4.6	277	0.38	11	recom O2
84-1	05/20/92	185	AMIS	100	80	0	0	0	-1	4.7	3.6	276	0.38	10	transient variation
84-2	05/20/92	192	AMIS	100	80	0	0	0	-1	4.2	2.8	268	0.37		transient variation
84-3	05/20/92	190	AMIS	100	80	25	25	25	-1	4.3	2.9	245	0.33	18	sofa leakage test
84-4	05/20/92	191	AMIS	100	80	13	13	13	-1	4.2	2.9	259	0.35	13	sofa leakage test
85-1	05/29/92	187	AMIS	100	80	0	0	0	3	4.5	3.0	265	0.36	38	behind air = 10
85-2	05/29/92	187	AMIS	100	80	0	0	0	3	4.5	3.3	283	0.39	7	behind air = 70
85-3	05/29/92	134	A	100	100	0	0	0	3	5.8	5.2	261	0.36	6	Hi O2
85-4	05/29/92	134	A	100	100	0	0	0	3	4.9	4.0	233	0.32	6	recom O2
85-5	05/29/92	136	A	100	100	0	0	0	3	3.9	2.9	212	0.29	22	Low O2
86-1	05/30/92	181	AMIS	100	100	0	0	0	4	4.5	3.2	272	0.37	8	recom O2
86-2	05/30/92	117	AB	100	100	0	0	0	4	6.3	6.0	285	0.39	6	Hi O2
86-3	05/30/92	119	AB	100	100	0	0	0	4	5.5	4.9	263	0.36	5	recom O2
86-4	05/30/92	118	AB	100	100	0	0	0	4	4.4	3.7	240	0.33	10	Low O2
87-1	05/31/92	82	ABC	100	55	0	0	0	7	7.5	7.4	316	0.43	10	Hi O2
87-2	05/31/92	82	ABC	100	55	0	0	0	7	5.8	5.6	281	0.38	9	recom O2
87-3	06/01/92	80	ABC	100	55	0	0	0	7	5.0	4.5	253	0.34	9	Low O2
88-1	06/01/92	183	AMIS	100	100	0	0	0	6	4.5	3.1	269	0.37	8	recom O2
88-2	06/01/92	183	AMIS	100	100	0	0	0	6	4.5	3.2	268	0.37	10	sofa leakage test
88-3	06/01/92	129	A	100	100	0	0	0	6	5.1	4.4	260	0.35	5	sofa leakage test
89-1	06/02/92	197	AMIS	100	100	0	0	0	3	5.1	4.0	291	0.40	14	Hi O2
89-2	06/02/92	200	AMIS	100	100	0	0	0	3	4.8	3.0	276	0.38	14	recom O2
89-3	06/02/92	200	AMIS	100	100	0	0	0	3	4.2	2.2	259	0.35	18	Low O2
90-1	06/08/92	198	AMIS	100	100	0	0	0	7	4.6	2.6	265	0.36	11	tilt variation
90-2	06/08/92	199	AMIS	100	100	0	0	0	11	4.7	2.4	278	0.38	9	tilt variation
90-3	06/08/92	201	AMIS	100	100	0	0	0	3	4.6	2.4	266	0.36	11	tilt variation
90-4	06/08/92	198	AMIS	100	100	0	0	0	-3	4.6	2.6	267	0.36	11	tilt variation
90-5	06/08/92	198	AMIS	100	100	0	0	0	7	4.8	2.7	270	0.37	12	tilt variation

TABLE A-1: Summary of LNCFS Level I Short-Term Operating Conditions and Test Results (continued)

[illegible]

9. APPENDIX B
CEM Certification Report

CERTIFICATION TESTING

UNIT #2

GULF POWER COMPANY

PLANT SMITH

CERTIFICATION TESTING

UNIT #2

GULF POWER COMPANY

PLANT SMITH

June 25, 1992

Prepared by:

Spectrum Systems, Inc.
Pensacola, Florida

AMETEX/TERMOX O2 ANALYZER S/N C068052B-2

WESTERN RESEARCH SO2 ANALYZER S/N 90-721AT2-7629-6

TECO NOx ANALYZER S/N 28345-231

TABLE OF CONTENTS

- I. INTRODUCTION
- II. INSTALLATION DESCRIPTION AND START UP
- III. SUMMARY
- IV. DISCUSSION OF RESULTS
 - CALIBRATION DRIFT TEST
 - CALIBRATION ERROR TEST
 - RELATIVE ACCURACY
 - LOG OF OPERATIONS
 - PERFORMANCE TEST RESULTS
- V. APPENDIX
 - NOTICE OF FIELD CERTIFICATION
 - REPORT CERTIFICATION
 - MATHEMATICAL EXPLANATION
 - REFERENCE METHOD TEST REPORT
 - APPENDIX A - CALCULATION OF AVERAGE EMISSIONS
 - APPENDIX B - SYSTEM CALIBRATION BIAS AND DRIFT CALCULATIONS
 - APPENDIX C - MEASUREMENT SYSTEMS PERFORMANCE TESTS
 - APPENDIX D - CONTINUOUS EMISSIONS MONITORING SYSTEMS OUTPUT DATA
 - APPENDIX E - STRIP CHART RECORDINGS
 - APPENDIX F - CALIBRATION GAS CERTIFICATES OF ANALYSIS
 - APPENDIX G - EPA TEST METHODS AND SPECIFICATIONS

I. INTRODUCTION

Spectrum Systems, Inc. was contracted by Southern Company Services, Inc., to conduct a Performance Evaluation of the Plant Smith Continuous Emission Monitoring Systems (CEMS), comprised of an Ametex/Thermox Model FCA-LX O₂ Analyzer, Serial Number CO68052B-2; Western Research Model 721AT2 SO₂ Analyzer, Serial Number 90-721AT2-7629-6; and a Thermo Environmental Model 10 NO_x Analyzer, Serial Number 10 A/R-28345-231. The KVB extractive system monitors the exhaust gas duct as well as several intermediate ducts, on command. Reference Method Tests were performed on the stack gas stream at a point adjacent to the extractive analyzer probe to determine instrument accuracies. The installation was made on the multi-fuel boiler located on Unit #2 at the Plant Smith facility. This certification was performed in accordance with the emission monitoring requirements as promulgated on May 25, 1984, by the Environmental Protection Agency. Field tests were conducted from 06/20/92 through 06/27/92. The instrument operated continuously throughout the operational test period without maintenance or service. During the relative accuracy test period, the boiler was operated at greater than 50% of normal load. Results in this report include data from a diluent monitor since reporting is required in a mass emission output format. The diluent monitor was also certified during this test.

II. INSTALLATION DESCRIPTION

The instruments were installed on the exhaust stack and main exhaust duct of the Unit #2 Boiler located at the Plant Smith facility. Further installation information can be obtained from the affected facility. The initial start-up was on October, 30, 1990, for the KVB system. The effluent gases are assumed to be representative in accordance with para. 3.1.1. of the referenced specification since the monitor location is more than eight

diameters downstream of the nearest control device and in the centroidal area of the effluent stream. These monitoring systems are used to evaluate the effects of NO_x reduction procedures under test at the facility.

III. SUMMARY

Test results of the Performance Evaluation are presented in Table III-1 A. These results are based on data obtained in Panama City, Florida, during normal operation at the facility. The test results clearly show that the KVB continuous emissions monitor is in conformance with all requirements of "Performance Specifications and Specification Test Procedures for Sulphur Dioxide and Nitrogen Oxides Continuous Emission Monitoring Systems in Stationary Sources."

IV. DISCUSSION OF RESULTS

Calibration Drift Test

Calibration drift was tested in accordance with paragraph 1 of Performance Specification 2. Both SO₂/NO_x monitors are designed to provide automatically timed zero and span calibration checks at 24 hour intervals throughout the required 7 consecutive days. The zero value is determined by mechanically introducing to the probe measurement cavity or sample probe a supply of zero air, thereby producing a zero condition that checks the analyzer's internal components and all electronic circuitry including the radiation source and detector assembly. The span of the system is checked with a calibration gas equivalent to between a 50 and 90 percent deflection of span concentration, utilizing the instruments measurement cavity in a manner similar to that described above. Adjustments were not made on the gas monitor or the diluent monitor during the Calibration Drift Test. Twenty-four (24) hour results were calculated by taking the daily recorded monitor response and

subtracting this reading from the reference value. Daily calibration drift tests are contained in the reports entitled, "Lansing Smith Unit 2 Clean Coal Project", Valve Group 199, 200 and 201, taken from the plant reporting data acquisition system and found in Appendix D of this report.

Calibration Drift Test Results

Results of the two (2) point Calibration Drift Test are as follows:

Sulphur Dioxide and Nitrogen Oxide stack gas monitor and the oxygen diluent monitor calibration drift for the seven (7) consecutive day period did not exceed 2.5% of the zero or span value for pollutant parameters, or 0.5% oxygen by volume for the diluent monitor for any given day. Drift test results are displayed in tabular formats (see Table IV-1 through IV-3).

Federal Register specifications permit calibration drift to be less than equal to 2.5% of span for sulphur dioxide and nitric oxide and 0.5 % O₂ by volume for diluent oxygen for each 24 hour period of the seven (7) day calibration drift test. The test data used in calculating these results is presented on Table IV-1 through IV-3 .

Calibration Error Test

A calibration error test or cylinder gas audit was performed in accordance with the QA guideline contained in the Title 40 Part 60 Appendix F of Code of Federal Regulations. This test was used to assess the accuracy of each CEMS prior to the reference method testing procedures. No adjustments were made to the CEMS as a result of the gas audits.

Relative Accuracy

Relative Accuracy is defined in the Federal Register as "the degree of correctness with which the continuous monitoring system yields the value of gas concentration of a sample relative to the value given by a defined reference method." The defined reference method, in this case, is EPA Reference Methods 3A, 6 and 7E. Nine sets of tests were performed on January 6, 1992, at a point established in accordance with Section 7.1 of the Federal Register. Additional details can be found in the appendix of this report.

The accuracy is reported as an error and is the sum of the absolute mean value of the difference between the reference test and the combined readings, plus a 95% confidence interval of the differences, expressed as a percentage of the mean combined reference value. The analyzer's average response was determined from the computer printouts corresponding to the time period the relative accuracy tests were performed.

When using computer printouts for comparisons to the reference methods, one minute instrument averages were used, corresponding to the time frame of stack gas samples. The method for arriving at the comparison of LBS/MMBTU is obtained by using a formula that calculates the emission output based on raw PPM, the percent of oxygen, and moisture factor. The formulas used for conversion are explained in the Appendix, under the section entitled, "Mathematical Explanation."

The relative accuracy is displayed in Table IV-4 and IV-5. Federal Register specifications limit the allowable error to 20% of the mean calculated reference method value.

LOG OF OPERATIONS

KVB SYSTEM S/N 505270

Model and Manufacturer	KVB Model 50 Extractive
Instrument Serial Number	505270 - Cabinet 90-721AT27629-6-SO2 10A/R-28345-231-NOx
Diluent Serial Number	Ametek CO68052B-2
Initial Start-up	10/30/90
Start of Performance Calibration	06/20/92
Start of Calibration Drift Test	06/20/92
End of Calibration Drift Test	06/27/92
Start of Relative Accuracy Test	06/25/92
End of Relative Accuracy Test	06/25/92

DOE/SOUTHERN COMPANY SERVICES, INC
 INNOVATIVE CLEAN COAL TECHNOLOGY PROJECT
 GULF POWER - PLANT LANSING SMITH - UNIT TWO

EQUIPMENT INVENTORY - CEM SYSTEM

SYSTEM	MANUFACTURER	SERIAL NUMBER	MODEL	RANGE	
KVB-O2	AMETEX/THERMOX	C068052B-2	FCA-LX	0-25PCT	
KVB-SO2	WESTERN RES.	90-721AT2-7629-6	721AT2	0-2500PPM	
KVB-NOx	TECO	28345-231	10A/R	0-1000PPM	
KVB-THC	BECKMAN IND.	1001234	400A	0-100PPM	
KVB-CO	SIEMENS	7HB1L22-1CA13-1BA1	21P	0-300PPM	A05-300
CABINET	KVB	EN505270			
DATA LOGGER	KAYE 1	0008329	L4PM	NEMA-LINK	4+
DATA LOGGER	KAYE 2	008330	L4PM	NEMA-LINK	4+
DAS	GATEWAY 2000	82922/AG424R	386 PC		
OFFICE	GATEWAY 2000	82921/AG424R	386 PC		
TAPE DRIVE	IRWIN	C20020646 DM-21	445	40 MEG.	
YOKOGAWA O2	YOKOGAWA	8076JA038	AV8G	0-25 %	
PYROMETERS	S.E.I.	05	31AP	P/N 000455	
TAPE DRIVE	IRWIN	00004761	A120E-02	40 MEG	
UPS	PAMA SYS. INC	613706	MM600SS/1	0-600 WATTS	

TABLE III-1A
PERFORMANCE TEST RESULTS
KVB SYSTEM (S/N 505270)

	<i>Monitor Performance</i>	<i>EPA Specifications</i>
SO2 Instrument Serial Number	90-721AT2-7629-6	
NOx Instrument Serial Number	10 A/R-28345-251	
Diluent Serial Number	CO68052B-2	
Calibration Period	seven (7) consecutive days	seven (7) consecutive days
NOx Analyzer Cal. Drift (Lo pt. 0-20%)	0.00% largest daily difference (NOx)	less than or equal to 2.5% span per day
SO2 Analyzer Cal. Drift (Lo pt. 0-20%)	2.16% largest daily difference (NOx)	less than or equal to 2.5% span per day
Diluent Oxygen Analyzer (Downscale checkpoint)	0.10% largest daily difference (O2)	less than or equal to 0.5% O2 by volume per day
SO2 Analyzer Cal. Drift (Hi pt. 50-100%)	.44% largest daily difference (NOx)	less than or equal to 2.5% span per day
NOx Analyzer Cal. Drift (Hi pt. 50-100%)	1.10% largest daily difference (NOx)	less than or equal to 2.5% span per day
Diluent Oxygen Analyzer (Upscale checkpoint)	0.00% largest daily difference (O2)	less than or equal to 0.5% O2 by volume per day
System Relative Accuracy computed in lbs/Mbtu (SO2)	2.63%	less than or equal to 20%
System Relative Accuracy computed in lbs/Mbtu (NOx)	4.34%	less than or equal to 20%

TABLE IV - 1

CALIBRATION DRIFT DETERMINATION
 DOE/SOUTHERN COMPANY SERVICES, INC.
 INNOVATIVE CLEAN COAL TECHNOLOGY PROJECT
 GULF POWER COMPANY - PLANT LANSING SMITH UNIT TWO

SYSTEM	KVB	GAS	SO2
MANUFACTURER	WESTERN RESEARCH	SPAN VALUE	2500PPM
MODEL	721-AT	OPERATOR	JW GIBSON
SERIAL NUMBER	90-721AT2-7629-6		

=====

SPAN DRIFT

DAY	DATE	TIME	CALIBRATION VALUE PPM	MONITOR VALUE PPM	DIFFERENCE IN PPM	PERCENT OF SPAN VALUE
START	20-Jun-92	03:11 AM	1470	1469	-1	-0.04%
1	21-Jun-92	08:54 AM	1470	1468	-2	-0.08%
2	22-Jun-92	08:54 AM	1470	1473	3	0.12%
3	23-Jun-92	08:54 AM	1470	1481	11	0.44%
4	24-Jun-92	08:54 AM	1470	1469	-1	-0.04%
5	25-Jun-92	07:33 AM	1470	1464	-6	-0.24%
6	26-Jun-92	08:54 AM	1470	1465	-5	-0.20%
7	27-Jun-92	08:54 AM	1470	1466	-4	-0.16%

=====

ZERO DRIFT

DAY	DATE	TIME	CALIBRATION VALUE PPM	MONITOR VALUE PPM	DIFFERENCE IN PPM	PERCENT OF SPAN VALUE
START	20-Jun-92	03:04 AM	0	47	47	1.88%
1	21-Jun-92	08:46 AM	0	49	49	1.96%
2	22-Jun-92	08:46 AM	0	46	46	1.84%
3	23-Jun-92	08:46 AM	0	39	39	1.56%
4	24-Jun-92	08:46 AM	0	43	43	1.72%
5	25-Jun-92	07:26 AM	0	36	36	1.44%
6	26-Jun-92	08:46 AM	0	54	54	2.16%
7	27-Jun-92	08:46 AM	0	51	51	2.04%

=====

%SPAN = ((INSTRUMENT RESPONSE - EXPECTED CONCENTRATION)/SPAN VALUE)*100

TABLE IV - 2

CALIBRATION DRIFT DETERMINATION
DOE/SOUTHERN COMPANY SERVICES, INC.
INNOVATIVE CLEAN COAL TECHNOLOGY PROJECT
GULF POWER COMPANY - PLANT LANSING SMITH UNIT TWO

SYSTEM	KVB	GAS	NOx
MANUFACTURER	THERMO ENVIRONMENTAL	SPAN VALUE	1000PPM
MODEL	10	OPERATOR	JW GIBSON
SERIAL NUMBER	10A/R-28345-231		

=====

SPAN DRIFT

DAY	DATE	TIME	CALIBRATION VALUE PPM	MONITOR VALUE PPM	DIFFERENCE IN PPM	PERCENT OF SPAN VALUE
START	20-Jun-92	03:11 AM	749	747	-2	-0.20%
1	21-Jun-92	08:54 AM	749	752	3	0.30%
2	22-Jun-92	08:54 AM	749	755	6	0.60%
3	23-Jun-92	08:54 AM	749	760	11	1.10%
4	24-Jun-92	08:54 AM	749	754	5	0.50%
5	25-Jun-92	07:33 AM	749	753	4	0.40%
6	26-Jun-92	08:54 AM	749	753	4	0.40%
7	27-Jun-92	08:54 AM	749	751	2	0.20%

=====

ZERO DRIFT

DAY	DATE	TIME	CALIBRATION VALUE PPM	MONITOR VALUE PPM	DIFFERENCE IN PPM	PERCENT OF SPAN VALUE
START	20-Jun-92	03:04 AM	0	0	0	0.00%
1	21-Jun-92	08:46 AM	0	0	0	0.00%
2	22-Jun-92	08:46 AM	0	0	0	0.00%
3	23-Jun-92	08:46 AM	0	0	0	0.00%
4	24-Jun-92	08:46 AM	0	0	0	0.00%
5	25-Jun-92	07:26 AM	0	0	0	0.00%
6	26-Jun-92	08:46 AM	0	0	0	0.00%
7	27-Jun-92	08:46 AM	0	0	0	0.00%

=====

%SPAN = ((INSTRUMENT RESPONSE-EXPECTED CONCENTRATION)/SPAN VALUE)*100

TABLE IV - 3

CALIBRATION DRIFT DETERMINATION
 DOE/SOUTHERN COMPANY SERVICES, INC.
 INNOVATIVE CLEAN COAL TECHNOLOGY PROJECT
 GULF POWER COMPANY - PLANT LANSING SMITH UNIT TWO

SYSTEM	KVB	GAS	O2
MANUFACTURER	AMETEK	SPAN VALUE	25PCT
MODEL	FCA-LX	OPERATOR	JW GIBSON
SERIAL NUMBER	C068052B-2		

=====

SPAN DRIFT

DAY	DATE	TIME	CALIBRATION VALUE PCT	MONITOR VALUE PCT	DIFFERENCE	TOTAL ERROR
START	20-Jun-92	03:04 AM	19.90	19.90	0.00	0.00%
1	21-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%
2	22-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%
3	23-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%
4	24-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%
5	25-Jun-92	07:26 AM	19.90	19.90	0.00	0.00%
6	26-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%
7	27-Jun-92	08:46 AM	19.90	19.90	0.00	0.00%

=====

ZERO DRIFT

DAY	DATE	IME	CALIBRATION VALUE PCT	MONITOR VALUE PCT	DIFFERENCE	TOTAL ERROR
START	20-Jun-92	03:11 AM	0.00	0.10	0.10	0.10%
1	21-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%
2	22-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%
3	23-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%
4	24-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%
5	25-Jun-92	07:33 AM	0.00	0.10	0.10	0.10%
6	26-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%
7	27-Jun-92	08:54 AM	0.00	0.10	0.10	0.10%

=====

MAXIMUM ALLOWANCE ERROR = PLUS OR MINUS 0.5% O2 BY VOLUME

CEM RELATIVE ACCURACY DATA

RELATIVE ACCURACY DETERMINATION

SPECTRUM SYSTEMS INC.
PENSACOLA, FLORIDA 32526-7808

DATE - JUNE 25 1992
SOURCE - GULF POWER SMITH

CEM SERIAL NUMBERS

SO2	7629-6
NOX	28345-231
O2	C068052B-2
CO2	
CO	

CEM	DRY
RM	DRY

Run Number	Run Start Time	SO2 PPM			NOX PPM			O2 %			CO2 %			CO PPM		
		RM-6C	CEM	DIFF	RM-7E	CEM	DIFF	RM-3A	CEM	DIFF	RM-3A	CEM	DIFF	RM-10	CEM	DIFF
1	11:53	1921.1	2081.20		223.8	231.70		6.87	5.76							
2	12:28	1887.4	2080.20		223.7	230.40		6.91	5.81							
3	13:09	1882.1	2071.50		219.7	228.70		6.85	5.82							
4	13:44	1891.7	2089.60		222.7	231.00		6.82	5.74							
5	14:18	1899.3	2095.80		223.1	230.30		6.82	5.70							
6	14:55	1904.3	2100.00		222.6	231.10		6.72	5.63							
7	15:30	1899.9	2098.10		222.2	229.60		6.75	5.67							
8	16:09	1899.8	2083.70		218.1	227.90		6.79	5.75							
9	16:42	1906.7	2096.70		222.5	229.00		6.79	5.69							
AVERAGE		1899.14	2088.53		222.04	229.67		6.81	5.73							

Run Number	Run Start Time	SO2 #/MMBTU			NOX #/MMBTU			CO* PPM		
		RM-6C	CEM	DIFF	RM-7E	CEM	DIFF	RM-10	CEM	DIFF
1	11:53	4.65	4.66	-0.02	0.3883	0.3735	0.0158			
2	12:28	4.58	4.68	-0.10	0.3901	0.3726	0.0174			
3	13:09	4.55	4.66	-0.11	0.3818	0.3701	0.0117			
4	13:44	4.56	4.68	-0.12	0.3860	0.3719	0.0141			
5	14:18	4.58	4.68	-0.10	0.3868	0.3698	0.0170			
6	14:55	4.56	4.67	-0.11	0.3831	0.3694	0.0138			
7	15:30	4.56	4.67	-0.12	0.3833	0.3679	0.0153			
8	16:09	4.57	4.67	-0.10	0.3773	0.3671	0.0101			
9	16:42	4.58	4.68	-0.09	0.3848	0.3674	0.0173			
AVERAGE		4.575	4.671	-0.097	0.3847	0.3700	0.0147			
CONFIDENCE COEFFICIENT				0.024			0.0020			
RELATIVE ACCURACY				2.63			4.34			

END

**DATE
FILMED**

3 / 22 / 93