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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
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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 quarterly update discusses the installation of the LNCFS Level III technology. Outage, manpower, and time requirements are discussed. Following the installation of LNCFS Level III, short-term testing was begun. Results of tests completed during this quarter are presented. These data include the diagnostic and performance test results. Preliminary test data show that NO_x emission levels with LNCFS Level III have been reduced by as much as 48 percent over baseline conditions.

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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 (NOx) 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 NOx 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 NOx Bulk Furnace Staging (LNBFS) System and Low NOx 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 NOx combustion technologies on NOx 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 NO_x 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 NO_x reduction capabilities of the following advanced low NO_x combustion technologies:
 - a. Low NO_x Bulk Furnace Staging (LNBFS)
 - b. Low NO_x Concentric Firing System (LNCFS) Levels I, II, and III
2. Determine the dynamic long-term emissions characteristics of each of these combustion NO_x reduction methods using sophisticated statistical techniques.
3. Evaluate the progressive cost effectiveness (i.e., dollars per ton NO_x removed) of the low NO_x combustion techniques tested.
4. Determine the effects on other combustion parameters (e.g., CO production, carbon carryover, particulate characteristics) of applying the NO_x 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 is a 180 MW tangentially-fired boiler owned and operated by Gulf Power Company. The unit is located in Lynn Haven, Florida, near Panama City. The boiler is a Combustion Engineering radiant reheat, natural circulation steam generator. 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. It is fired with pulverized coal through twenty tangential coal nozzles with five nozzles at each corner. Five Combustion Engineering Raymond Bowl mills equipped with exhausters at the outlet of each mill deliver coal to the furnace. The unit is equipped with Ljungstrom air preheaters and two forced-draft fans which deliver all the combustion air to the boiler. 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, an 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 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.

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

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 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

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

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

5.1.3. Task 1.1.5 Baseline Characterization

The final version of the Phase I Baseline Topical Report will be issued in the first quarter 1992.

5.2. Phase II LNCFS Level II Retrofit

5.2.2. Task 1.2.3 LNBFS and LNCFS Level II Characterization

Short-term testing of LNCFS Level II and LNBFS were completed in previous quarters. Results from additional short-term tests conducted by ABB CE prior to the outage to install LNCFS Level III and a summary of the long-term testing statistical analysis results of LNCFS Level II are presented in the following sections.

Prior to the unit coming off line for the installation of LNCFS Level III, ABB CE conducted a series of tests to determine if NOx emissions could be reduced below those measured during the long-term test phase (discussed in the next section). Results from these short-term tests showed that by increasing overfire air flows and by maintaining burner tilts in a horizontal position, NOx emissions could be reduced at lower loads. However, this alternate operation strategy negatively impacts boiler operation. Unit superheat and reheat temperatures are decreased below optimum values. During normal operations, burner tilts are directed upward to maintain steam temperatures and total air flow is increased to aid in heat transfer through the superheat and reheat sections. The effects of these NOx reductions on plant performance variables such as carbon loss and unit efficiency were not quantified during these tests. A copy of the test report is provided in Appendix A.

5.2.2.2. LNCFS Level II Long-Term Testing

Long-term testing of LNCFS Level II began on June 23, 1991, and was completed in September 1991. The NOx emissions for each day during that period are reported in the previous quarterly report (**Technical Progress Report, Third Quarter 1991**). The results of the statistical analysis of the data and a comparison to the baseline data set follow.

Figure 5 shows the average of the LNCFS Level II long-term data as a function of load. The 95 percentile and 5 percentiles of this data are shown as the upper and lower bounds of the shaded area of the graph. For comparison, Figure 6 shows the baseline long-term test results. Both figures show that NOx emissions vary as much as 0.2 lb/MBtu at one load point.

The achievable NOx emissions for the baseline and LNCFS Level II NOx data have been calculated on a 30 day rolling average and an annual basis. The achievable emissions limit rate on a 30 day rolling average is based on 1 exceedance per ten years. This limit is derived from a statistical analysis of twenty-four hour average data and assumes that (1) the operating conditions during which the data were collected are representative of future operating conditions, (2) the statistical properties of the twenty-four hour averages are the true population values, and (3) an average emission of one exceedance per ten years will occur. The achievable emission limit on a yearly average was determined assuming a 95 percent compliance rate. Table 3 shows the statistical properties of the twenty-four hour average data from the baseline and LNCFS Level II tests. The twenty-four hour average values were computed only when at least 18 hours of data were present.

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

Figure 6: Baseline Long-Term NOx Emissions Results

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

* RSD = Relative Standard Deviation = 100 * Standard Deviation / Mean

5.1. Phase III LNCFS Level III Retrofit

5.1.3. Task 1.3.2 LNCFS Level III Installation

Installation of LNCFS Level III was completed during a two week outage ending in November 1991. Because a majority of the equipment required for LNCFS Level III was installed during the LNCFS Level II outage in April 1991, the amount of work required to complete the installation was minimal. The close coupled overfire air (CCOFA) nozzles were installed in the upper portion of the main windbox and the top two elevations of coal nozzles were clustered below them. To facilitate the relocation of the upper elevation of coal nozzles, the respective fuel lines and flame scanners had to be relocated as well. ABB CE's report on the activities completed during the outage is provided in Appendix B.

5.1.3. Task 1.3.3 LNCFS Levels I and III Characterization

During this quarter, short-term test of LNCFS Level III were conducted. Long-term testing of LNCFS Level III will begin in the first quarter 1992.

5.2.2.1. LNCFS Level III Short-Term Testing

Start up and optimization tests of the new LNCFS Level III system were conducted by ABB Combustion Engineering Services following the end of the outage. After these tests were completed, short-term testing began. Through early January 1992, 68 diagnostic and 8 performance tests have been conducted. The data from these tests are summarized in Appendix C. The NO_x emissions characteristics of these tests are shown in Figure 7 with the short term data from the previous test phases. LNCFS Level III NO_x emissions varied by as much 0.1 lb/MBtu at similar loads. Additional details about this data will be presented in the topical report on the performance of LNCFS Level III to be issued later this year.

Figure 7. Short-Term NOx Emissions Characteristics

6. FUTURE PLANS

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

QUARTER	ACTIVITY
First Quarter 1992	Continue Long-Term LNCFS Level I and III Tests
Second Quarter 1992	Complete Long-Term LNCFS Level I and III Tests Verification Tests of LNCFS Level I and III Configuration
Third and Fourth Quarters 1992 1993	Complete Final Reporting 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.

APPENDIX A
ABB CE LNCFS Level II
Low Load Test Report

Inter-Office Correspondence

A. Allen

8453-2402

Southern Company Services- Gulf Power
Lansing Smith Station Unit #2
Low NOx DOE Project - LNCFS Level II
Contract # 14664
PSS # 52589

RE: Low Load Operation Testing conducted on 10/18-20/91

Introduction

Testing was performed on these dates in order to identify the operational modes that would yield improved performance of the LNCFS Level II system. The primary intent was to identify operating schemes that produce low NOx operation at low loads without adverse impacts on existing plant thermal performance. The secondary intent was to determine the amount of trade-off between steam temperatures and NOx emission performance at low loads, if it was concluded that a trade-off was necessary.

Flyash samples were taken for each of these tests, however the analysis is unavailable at the time of this report. Please note that Southern Company Services has approved only INTERNAL USE of this data by ABB CE.

Conclusions

Based on the attached board data and emission data provided by Southern Company, the following conclusions were reached:

1) Significant improvements in low load NOx emissions can be made through using higher quantities of overfire air than is presently used in automatic operation.

2) Data on the steam temperatures at the two loads tested is somewhat contradictory for the higher OFA flow tests. At 70 MW the reheat outlet was 14 degrees lower with higher OFA flow, where at 115 MW the higher OFA flow test showed a reheat outlet that was 31 degrees higher. This may have been primarily due to differences in furnace seasoning rates at the different loads.

3) The lowest NOx emissions achieved at 70 MW (.321 lb/MMBtu) was when the tilts are run in a horizontal position. This showed a loss of 25 degrees of reheat temperature from the baseline test.

4) The tendency for this unit to generate higher NOx at low loads is due to a combination of:

- a) Insufficient OFA quantity (resulting in high firing zone stoichiometry).
- b) Very High Excess Air operation combined with tilts upward (resulting in lower residence time in low stoichiometric conditions).

5) The automatic control of the SOFA dampers for Level II should be revised to reflect the attached graph #3.

Discussion

A total of eight tests were run to conduct the investigation (See attachments for complete data). The test numbering is consistent with the original test matrix dated 10/24/91. Test #8 was an additional abbreviated test conducted at the end of the testing period. The following are the basic configurations and results of the tests:

Test #	Load (MW)	Purpose	OFA Dampers (Top,M,Bott)	Tilts (deg.)	NOx (lb/MMBtu)
1	70	Baseline	Auto(0,0,10)	+15	.512
2	70	High OFA Flow	30,100,100	+15	.363
3	70	Sep & End OFA	0,100,100	+15	.399
4	70	Lower Excess Air	0,0,100	+15	.408
8	70	Horizontal Tilt	0,0,100	0	.321
5	115	Baseline	Auto(0,58,100)	+12	.373
6	115	High OFA Flow	100,100,100	+12	.326
7	115	Lower Excess Air	100,100,100	+12	.312

The attached Graph #1 shows the above NOx values plotted in relation to reported long term data results and short term tests conducted during the initial set up in April '91. Graph #2 shows the reheat steam temperatures for each of the above tests.

The test data shows that NOx emissions are consistently lower during lower load operation when the amount of overfire air is increased. The result of test #8, in comparison to test #3 & #4, can be explained by an increase in residence time in the furnace. The increase in furnace residence time was realized by adjusting the tilts to the horizontal firing position.

In regard to the impact of the tested operating modes on reheat outlet steam temperatures, the results are somewhat inconclusive. Higher SOFA flow rates at the 70 MW load tested showed a reheat outlet temperature of 920 deg. F. (Test #2), down 14 degrees from the baseline (Test #1). At the 115 MW load, the high SOFA flow test showed a reheat outlet temperature of 964 degrees F., up 34 degrees from the baseline (Test #5). Some of

this increase at the 115 MW load was probably due to seasoning of the furnace walls during the time period between the data runs (approximately six hours). At 70 MW, there was approximately five hours between data runs, however the seasoning rates could be different enough to explain the different result. Further testing at low load would be required to prove or dismiss this theory.

Test # 1-

This test was run to establish a 70 MW baseline for comparison to the other configurations. The OFA dampers were left in automatic control, and functioned according to the original characterization provided. The "normal" mode of operation at this load is to run high excess air rates and tilts at +15 to achieve higher reheat outlet steam temperature for plant thermal performance. Main windbox dampers are positioned to maintain 4.5 in. wg. windbox to furnace differential pressure (DP). This windbox to furnace differential is maintained at this high setting in order to maintain ignition points and fuel transport conditions.

Test #2-

For test #2, the OFA dampers were taken into manual control and slowly opened over a period of several hours. Flame stability was successfully maintained during this period. Flame appearance in the furnace camera was noticeably different, however ignition points on the individual elevations in service were maintaining a stable condition.

Opening of the SOFA elevations required closing of the main windbox dampers to maintain the windbox/furnace DP. When the full open position was reached on the bottom two SOFA elevations and the top SOFA was open 30%, the windbox/furnace DP reduced to 3.5". Further opening of the SOFA was not possible without further deterioration of the DP and an adverse affect on ignition stability. The unit was allowed to stabilize, and the data reflects this point.

NOx decreases were noted whenever the SOFA damper opening resulted in a significant change in SOFA flow.

Test #3-

This test involved shifting the location of the OFA by closing the top SOFA elevation and opening the top end air compartment 100%. In comparison to the test #2 condition of all SOFA, the NOx increased. No further testing of end air use was conducted.

Test #4-

In order to reduce the excess air from the settings of test #2 it was necessary to close off the top two elevations of SOFA in order to keep control of the windbox/furnace DP. In the resulting set up (bottom SOFA open 100%, O2 reduced to 5.8%, and windbox/furnace DP at 4") the NOx emission was higher than test #2. Therefore, a reduction of excess air at this load does not yield a positive result in comparison to an increase of SOFA at baseline excess air conditions.

Test #8-

This was an abbreviated test conducted after test #4, just prior to returning the unit to load dispatch. The only change made to the operating parameters was to change the tilts from a +15 position to 0 (horizontal). NOx emission significantly decreased from the test #4 result and produced an even lower value than test #2 (+15 tilt, high SOFA flow, higher excess air). This condition produced the lowest NOx at 70 MW, but resulted in a very significant loss of reheat steam temperature (28 degrees in comparison to test #4).

Test #5-

This test was run to establish a 115 MW baseline for comparison. The OFA dampers were left in automatic control, and functioned according to the original characterization provided. The "normal" mode of operation at this load is to run high excess air rates and tilts at +12 to achieve higher reheat outlet steam temperature for plant thermal performance. Main windbox dampers are positioned to maintain 4.5 in. wg. windbox to furnace differential pressure (DP). This windbox to furnace differential is maintained at this high setting in order to maintain ignition points and fuel transport conditions.

Test #6-

For this test, the SOFA dampers were slowly opened and the main windbox dampers were closed to maintain the 4.5" windbox/furnace DP. It was possible at this load to fully open the SOFA while keeping furnace conditions stable. Again, NOx decreases were noted when the damper opening resulted in a significant SOFA flow increase. The data represents the stabilized condition at full open on the three SOFA elevations.

Test #7-

This test represents the same conditions as test #6, but operating at a lower level of excess air. A slight reduction of NOx from test #6 was measured.

Result of Low Load Tests

SCS-Gulf Power Lansing Smith #2

LNCFS Level II

Graph #1

Low Load Reheat Outlet Temperature

SCS - Gulf Power Lansing Smith #2
LNCFS Level II

Graph #2

GRAPH #3

GULF POWER CO
LANSING SMITH UNIT 2
LOW NO_x DEMONSTRATION
OPTIMIZATION TEST

TEST NO.	LL1	LL2	LL3	LL4	LL8	LL5	LL6	LL7
DATE	10/19/91	10/20/91	10/20/91	10/20/91	10/20/91	10/18/91	10/19/91	10/19/91
TIME	22:30	03:45	04:55	06:30	07:30	22:50	04:45	05:20

LOAD	MW	70	70	70	70	70	115	115	115
THROTTLE PRESSURE	LB/IN2	1800	1800	1800	1800	1800	1800	1800	1800
ECON (FW) IN TEMP	F	377	377	377	378	377	418	419	419
ECON OUT TEMP	F	NA	NA	NA	NA	NA	NA	NA	NA
SH OUT TEMP	F	1001/1005	995/999	993/996	998/1002	997/1001	994/991	999/988	996/985
SH DESH IN TEMP	F	807/808	814/814	824/825	817/820	799/792	829/831	867/867	855/855
SH DESH OUT TEMP	F	763/771	767/771	759/771	740/762	783/783	800/799	768/762	766/755
RH OUT TEMP	F	934	920	922	937	909	933	964	962
RH DESH IN TEMP	F	574	569	566	571	566	621	621	621
RH DESH OUT TEMP	F	571/566	567/562	564/560	570/565	566/567	617/609	619/613	620/613
O2 (BOARD)	%	6.5/5.9	6.5/5.4	6.6/5.7	5.0/4.7	5.5/5.0	5.8/4.8	5.1/4.2	4.5/3.4
SEC+HOT PRIM. AIR F	LB/HR	330000	340000	350000	310000	310000	610000	610000	560000
TILT POS	DEG	+15	+15	+15	+15	0	+12	+12	+12
ELEV. IN SERVICE	---	D,E	D,E	D,E	D,E	D,E	C,D,E	C,D,E	C,D,E
WINDBOX/FURN dP	"H2O	4.5	3.5	3.5	4	4	4.5	4.5	4.5
WINDBOX PRESSURE	"H2O	4	3	3	3.5	3.5	4	4	4
FURNACE PRESSURE	"H2O	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
TOTAL FUEL FIRED	KLB/HR	53	54	53	53	53	82	85	84

FLOWS

FEEDWATER	KLB/HR	453	453	444	454	474	742	722	718
MAIN STEAM	KLB/HR	496	501	499	499	507	799	800	795
FW MAKEUP	LB/MIN	58	2.9	3.7	5.4	6.1	39	42	55
SH DESH SPRAY	KLB/HR	12	14	19	20	6	20	48	45
RH DESH SPRAY	KLB/HR	2.7	2.3	2.6	2.3	2.1	2.7	2.4	2.6

PRESSURES

ECON IN PRESS	LB/IN2	NA	NA	NA	NA	NA	NA	NA	NA
STEAM DRUM	LB/IN2	1840	1845	1844	1842	1837	1900	1901	1898
SH OUT	LB/IN2	1796	1802	1799	1800	1793	1902	1899	1898

RH IN	LB/IN2	170	172	173	173	174	286	288	287
(COLD RH @ TURB)									
RH OUT	LB/IN2	160	163	163	163	163	270	273	272
(HOT RH @ TURB)									

SH SPRAY VALVE PO %	24/36	25/40	31/52	36/66	1.6/3.1	21	45/81	42/79
RH SPRAY VALVE PO %	0/0	0/0	0/0	0/0	0/0	0	0	0

APH TEMPERATURES

GAS IN	F	518/515	493/487	492/486	492/485	485/481	565/560	559/552	557/550
GAS OUT	F	256/268	241/254	239/253	243/255	242/255	265/280	260/275	261/275
AIR IN	F	103/141	100/140	99/139	100/143	100/141	104/143	101/141	101/142
AIR OUT	F	478/476	448/446	445/443	447/445	444/442	497/497	489/490	491/490
AMBIANT AIR TEMP	F	59	58	59	59	59	62	59	59

PULVERIZER DATA

MILL OUT TEMPS

A	F	NA	NA	NA	NA	NA	NA	NA	NA
B	F	NA	NA	NA	NA	NA	NA	NA	NA
C	F	NA	NA	NA	NA	NA	148	149	149
D	F	146	147	148	148	148	148	148	146
E	F	146	147	148	146	146	146	147	146

MILL LOADING

A	KLB/HR	NA	NA	NA	NA	NA	NA	NA	NA
B	KLB/HR	NA	NA	NA	NA	NA	NA	NA	NA
C	KLB/HR	NA	NA	NA	NA	NA	30	30	30
D	KLB/HR	32	32	32	32	33	34	34	34
E	KLB/HR	30	30	30	30	31	35	35	35

MILL POWER

A	AMPS	NA	NA	NA	NA	NA	NA	NA	NA
B	AMPS	NA	NA	NA	NA	NA	NA	NA	NA
C	AMPS	NA	NA	NA	NA	NA	35	35	35
D	AMPS	35	37	37	37	37	35	35	35
E	AMPS	32	32	34	34	34	34	34	34

BOWL dP

A	"H2O	NA	NA	NA	NA	NA	NA	NA	NA
B	"H2O	NA	NA	NA	NA	NA	NA	NA	NA
C	"H2O	NA	NA	NA	NA	NA	7.5	7.5	7.5
D	"H2O	7	7	7	7	7	7.5	7.5	7.5
E	"H2O	6.5	6.5	6.5	6.5	6.5	7	7	7

MILL IN TEMPS

A F
B F
C F
D F
E F

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA

HOT AIR DAMPER POS
(PRIMARY AIR)

A %
B %
C %
D %
E %

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	87	78	89
92	98	99	95	98	94	77	99	
90	91	93	93	96	92	76	98	

COLD AIR DAMPER POS
(TEMPERING AIR)

A %
B %
C %
D %
E %

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	51	52	54
46	49	50	46	46	55	57	58	
42	47	48	44	43	51	54	55	

MILL AIR FLOW

A LB/HR
B LB/HR
C LB/HR
D LB/HR
E LB/HR

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA

MILL CLASSIFIER
POSITION

A
B
C
D
E

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	3	3	3	
4	4	4	4	4	4	4	4	
4	4	4	4	4	4	4	4	

MILL EXH/FURN dP

A "H2O
B "H2O
C "H2O
D "H2O
E "H2O

NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	15	15	15	
16	15	15	15	15	15	15	15	
13	13	13	13.2	13.5	14.5	14.5	14.5	

COAL FINENESS

A % ON 50 %
A % THRU 100 %
A % THRU 200 %

B % ON 50 %
B % THRU 100 %
B % THRU 200 %

C % ON 50 %
C % THRU 100 %
C % THRU 200 %

D % ON 50 %
D % THRU 100 %
D % THRU 200 %

E % ON 50 %
E % THRU 100 %
E % THRU 200 %

NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA
NA	NA	NA	NA	NA	NA	NA	NA

FD FAN DATA

DAMPER POS %
FAN SPEED RPM
OUTLET PRESS "H2O
AMPS

ID FAN DATA
INLET VANE POS %
OUT VANE POS %
IN PRESS "H2O
OUTLET PRESS LB/IN2
AMPS

BFP MOTOR SPEED RPM
BFP AMPS

100/100	100/100	100/100	100/100	100/100	100/100	100/100	100/100
450/444	399/405	394/398	401/414	413/417	577/583	590	553/543
4/4	3/3	3/3	3.5/3.0	3.5/3.0	6.0/6.0	6.0/6.0	
48/48	42/42	40/42	40/42	40/42	60/60	60/60	52/55
20/30	20/28	20/28	19/27	20/27	32/40	32/40	30/30
100/100	100/100	100/100	100/100	100/100	100/100	100/100	100/100
-15/-10	-16/-11	-16/-11	-16/-11	-17/-11	-10/-10	-11/-10	-12/-10
NA	NA	NA	NA	NA	NA	NA	NA
70/90	120/135	102/140	110/115	140/120	140/150	140/150	150/140
2792/2806	2792/2806	2790/2812	2790/2806	2790/2809	2940	2940	2941
160/170	165/170	165/170	160/170	170/170	200/200	200/200	200/200

SECONDARY AIR/
FUEL AIR DAMPER
POSITION

EE %
E %
DE %

8	0	100	0	0	18	10	10
25	16	16	17	16	15	12	12
10	0	0	0	0	15	9	9

IGNITIONS POINTS

RF CORNER	FT	3-8	0-6	0-6	0-6	0-6	0-2	3-6	3-6
RR CORNER	FT	1-6	0-6	0-6	0-6	0-6	0-2	3-6	3-6
LR CORNER	FT	0-6	0-6	0-6	0-6	0-6	0-2	3-6	3-6
LF CORNER	FT	3-8	0-6	0-6	0-6	0-6	0-2	3-6	3-6
OTHER:									
OFA FOIL DP	IN.WG.	.17/.21	1.02/0.95	.73/.74	.5/.49	NA	1.2/1.2	2.05/2.09	1.82/1.81
OFA FLOW (curve)	LBS/HR	99000	225000	194000	160000	160000	250000	326000	308000
BOILER EFF.(BOARD) %		88.6	86.6	87.2	87.7	85.3	87	86	86
EXCESS AIR (calc.) %		45	42	45	38	37	34	32	25
% OFA		21	36	32	31	31	26	32	32

Note: %OFA is calculated assuming a tempering air ratio provided by Southern Company

Tempering air = Sec.& Hot Primary Air/6.3

Example: Test LL1

Total Air Flow = 330,000 + (330,000/6.3) + 99,000 = 481,380

% OFA = 99,000/481,380 = 20.6%

APPENDIX B
ABB CE LNCFS Level III Outage Report

ABB\ICE SERVICES INC.

CONSTRUCTION SERVICES

GULF POWER COMPANY – LANSING SMITH PLANT

SOUTHPORT,FLORIDA

CONTRACT – 13790

UNIT #2

LOW NOX DEMONSTRATION PROJECT – PHASE III

I. INTRODUCTION

II. SCOPE

III. OUTAGE

A. PREOUTAGE

B. OUTAGE

C. POST OUTAGE

IV. MAJOR PROBLEMS ENCOUNTERED

V. OUTSTANDING ITEMS

VI. SUMMARY

VII. ATTACHMENTS

I. Introduction

During the period of September 16, 1991 to November 14, 1991 ABB/CE Construction Services successfully completed the LNCFS Phase III retrofit of Gulf Power Company's Lansing Smith Unit #2. The report will summarize all phases of the outage from receiving material to demobilization.

II. Scope Ref: Appendix A

The LNCFS Phase III retrofit consisted of the installation of the following equipment:

Burner Systems

1. Eight (8) new adjustable offset secondary air nozzle tips.
2. One (1) lot replacement, linkages and hardware as required to reconfigure the windbox compartments and damper arrangements.
3. One (1) lot ignitor air piping, fuel oil and atomizing air piping to relocate the top ignitor elevation.
4. One (1) lot coal piping modifications as required to realign the existing coal piping with the new coal elevation.
5. One (1) lot platform steel.

Instrumentation and Controls

1. Eight (8) overfire air damper drives.

III. Outage Ref: Appendix B for CPM Schedule

Pre-outage

Due to the outage schedule changes the Pre-outage activities were performed in two (2) Phases. The electrical pre-outage work was performed during the period of September 16, 1991 to September 26, 1991. The mechanical pre-outage work was performed during the period of October 21, 1991 to October 25, 1991. All Pre-outage activities were performed working eight (8) hours per day, five (5) days per week.

Pre-outage activities consisted of the following:

- a) Inventory material
- b) Complete all electrical conduit and wiring that would not interfere with plant operation
- c) Job set-up
- d) Stage material in plant for easy access at the time of installation
- e) Make final review of installation drawings and finalize construction plans

Outage

The unit was removed from service on schedule the evening of October 25, 1991.

The schedule called for the unit to return to service on November 9, 1991. Due to balance of plant problems the unit was returned to service on November 12, 1991. The LNCFS Phase III modifications were completed and the boiler was released to Gulf Power Company on November 8, 1991.

During the outage period the work schedule was five (5) days per week, ten (10) hours per day, two (2) shifts per day. The average manpower loading was thirty-six (36) men per day.

The LNCFS III modification required the top three (3) windbox compartments to be reconfigured. The existing one (1) coal compartment and two (2) auxiliary air compartments were reconfigured to one (1) stationary auxiliary compartment, one (1) coal compartment and two (2) overfire air compartments. Since the new coal compartment is at the lower elevation the coal piping, ignitor elevation, flame scanner and platform steel had to be modified. A full furnace scaffold was installed to expedite the windbox work.

In conjunction with ABB/CE Technical Services the electric and control portions of this project were installed and commissioned with no major problems.

Post Outage

The post outage period consisted of four (4) days working eight (8) hours per day, five (5) days per week. The post outage activities were as follows:

- a) Remove materials and equipment from the plant
- b) Clean and paint work areas
- c) Inventory tools and equipment
- d) Complete paperwork and move equipment offsite

IV. Major Problems Encountered

Construction activities on this project were conducted with no major problems encountered.

V. Outstanding Items

The outstanding items from Phase II - furnace observation system, boiler room lighting, and impulse lines were all taken care of. At this time there are no outstanding items on Phase I, II or III.

VI. Summary

The installation of LNCFS Phase III on Gulf Power Company's Lansing Smith Unit #2 can be considered extremely successful. The outage was completed on schedule and the equipment is performing as designed.

LNCFS LEVEL 2

LNCFS LEVEL 3

VIEW "F"
(SHT.2,A-I)

LNCFS LEVEL 3

APPENDIX B

GULF POWER COMPANY
 UNITING UNIT #2
 LUGS PHASE III
 5 DAYS 10 HOURS 2 SHIFTS

10/20							10/27							11/3							11/10						
S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S

APPENDIX C
LNCFS Level III
Short-Term Data

TABLE C-1: Summary of LNCFS Level III Short-Term Operating Conditions and Test Results

TEST	DATE	LOAD MW	MOOS	Upper ccofa %	Lower ccofa %	Upper SOFA %	Middle SOFA %	Lower SOFA %	CR O2 %	DAS O2 %	NOx ppm	NOx lb/MBtu	CO ppm	Type of Test
55-1	12/5/91	179	none	82	30	100	100	100	5.2	5.4	257	0.35	26	diagnostic
55-2	12/5/91	180	none	82	20	100	100	100	4.9	5.1	248	0.34	58	diagnostic
55-3	12/5/91	180	none	82	20	100	100	100	5.4	5.8	264	0.36	15	diagnostic
55-4	12/5/91	180	none	82	20	100	100	100	5.8	6.6	300	0.41	5	diagnostic
55-5	12/5/91	179	none	82	20	100	100	100	6.7	7.5	323	0.44	7	diagnostic
55-6	12/5/91	180	none	83	20	100	100	100	5.8	6.3	283	0.39	6	diagnostic
56-1	12/6/91	182	none	86	20	100	100	100	4.1	4.1	224	0.31	109	diagnostic
56-2	12/6/91	182	none	85	20	100	100	100	4.7	4.6	241	0.33	26	diagnostic
56-3	12/6/91	182	none	85	20	100	100	100	5.5	5.7	269	0.37	33	diagnostic
56-4	12/6/91	182	none	85	20	100	100	100	6.2	6.7	293	0.40	15	diagnostic
56-5	12/6/91	183	none	86	20	100	100	100	5.8	6.6	284	0.39	15	diagnostic
56-6	12/6/91	183	none	86	20	100	100	100	5.0	5.2	253	0.34	17	diagnostic
57-1	12/7/91	179	none	83	20	100	100	100	4.3	4.3	235	0.32	110	diagnostic
57-2	12/7/91	179	none	82	20	100	100	100	4.8	4.8	252	0.34	26	diagnostic
57-3	12/7/91	179	none	83	20	100	100	100	5.7	5.8	273	0.37	20	diagnostic
57-4	12/7/91	179	none	83	20	100	100	100	6.2	6.9	302	0.41	15	diagnostic
57-5	12/7/91	179	none	82	20	100	100	100	6.1	6.6	304	0.41	14	diagnostic
57-6	12/7/91	180	none	83	20	100	100	100	5.5	6.1	284	0.39	14	diagnostic
57-7	12/7/91	179	none	83	20	100	100	100	5.2	5.1	256	0.35	32	diagnostic
58-1	12/8/91	114	none	20	20	100	100	0						invalid test
58-2	12/8/91	115	none	20	20	100	100	0	4.2	4.2	220	0.30	11	diagnostic
58-3	12/8/91	115	none	20	20	100	100	0	3.5	3.1	212	0.29	12	diagnostic
58-4	12/8/91	115	none	20	20	100	100	0	4.8	4.3	234	0.32	13	diagnostic
58-5	12/8/91	115	none	20	20	100	100	0	5.4	4.9	250	0.34	9	diagnostic
58-6	12/8/91	116	none	20	20	100	100	0	5.8	5.6	262	0.36	9	diagnostic
59-1	12/9/91	136	A	41	20	100	100	27	4.4	3.8	215	0.29	45	diagnostic
59-2	12/9/91	137	A	41	20	100	100	24	5.0	4.4	230	0.31	11	diagnostic
59-3	12/9/91	138	A	41	20	100	100	26	5.5	5.0	247	0.34	11	diagnostic
59-4	12/9/91	139	A	41	20	100	100	23	6.1	5.9	279	0.38	9	diagnostic
59-5	12/9/91	138	AB	41	20	100	100	25	6.3	5.9	261	0.36	11	diagnostic
59-6	12/9/91	138	AB	41	20	100	100	25	4.4	3.9	234	0.32	18	diagnostic
60-1	12/10/91	182	none	85	20	100	100	100	3.7	2.7	219	0.30	79	diagnostic
60-2	12/10/91	181	none	85	20	100	100	100	4.4	3.7	242	0.33	18	diagnostic
60-3	12/10/91	182	none	85	20	100	100	100	5.4	4.7	273	0.37	10	diagnostic
60-4	12/10/91	181	none	85	20	100	100	100	6.3	5.6	296	0.40	13	diagnostic
61-1	12/11/91	134	A	38	20	100	100	100	6.1	5.8	276	0.38	11	diagnostic
61-2	12/11/91	135	A	40	20	100	100	100	4.1	3.5	219	0.30	16	diagnostic
61-3	12/11/91	136	AB	39	20	11	100	100	4.1	3.4	250	0.34	62	diagnostic
61-4	12/11/91	137	AB	38	20	10	100	100	5.2	4.6	271	0.37	13	diagnostic
61-5	12/11/91	136	AB	38	20	12	100	100	6.5	6.0	284	0.39	11	diagnostic
62-1	12/12/91	180	none	83	20	100	100	100	4.5	4.0	231	0.32	15	performance
62-2	12/12/91	182	none	82	20	100	100	100	4.6	4.0	234	0.32	14	performance
63-1	12/13/91	180	none	84	20	100	100	100	4.4	4.0	222	0.30	12	performance
63-2	12/13/91	179	none	83	20	100	100	100	4.5	4.1	227	0.31	11	performance
64-1	12/14/91	112	AB	20	20	-8	100	100	5.5	5.2	229	0.31	8	performance
64-2	12/14/91	113	AB	18	20	-8	100	100	5.5	5.2	231	0.32	7	performance
65-1	12/15/91	113	AB	18	20	-8	100	100	5.5	5.3	241	0.33	7	performance
65-2	12/15/91	113	AB	18	20	-8	100	100	5.6	5.3	238	0.32	4	performance
66-1	12/17/91	135	A	43	20	31	100	100	5.0	4.6	216	0.29	11	performance
66-2	12/17/91	137	A	41	20	25	100	100	5.1	4.5	216	0.29	11	performance

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

TEST	DATE	LOAD MW	MOOS	Upper ccofa %	Lower ccofa %	Upper SOFA %	Middle SOFA %	Lower SOFA %	CR O2 %	DAS O2 %	NOx ppm	NOx lb/MBtu	CO ppm	Type of Test
67-1	12/18/91	133	A	39	20	24	100	100	5.1	4.6	216	0.29	12	performance
67-2	12/18/91	136	A	41	20	24	100	100	5.1	4.4	213	0.29	10	performance
67-3	12/18/91	181	none	85	20	100	100	100	4.5					invalid test
68-1	12/19/91	181	none	85	20	100	100	100	4.4	3.9	226	0.31	17	performance
68-2	12/19/91	180	none	82	20	100	100	100	4.6	4.0	229	0.31	15	performance
68-2	12/19/91	180	none	82	20	100	100	100	4.6	4.0	229	0.31	15	performance
69-1	12/20/91	199	none	100	20	100	100	100	4.4	3.8	234	0.32	13	performance
69-2	12/20/91	200	none	100	20	100	100	100	4.2	3.5	229	0.31	16	performance
70-1	01/08/92	180	none	84	20	100	100	100	4.5	3.8	225	0.31	16	diagnostic
70-2	01/08/92	180	none	83	20	100	100	100	4.9	4.2	242	0.33	57	diagnostic
70-3	01/08/92	180	none	83	20	100	100	100	4.7	4.0	245	0.33	32	diagnostic
70-4	01/08/92	179	none	83	20	100	100	100	4.4	3.8	218	0.30	13	diagnostic
70-5	01/08/92	178	none	84	20	100	100	100	4.6	3.8	207	0.28	18	diagnostic
71-1	01/09/92	176	none	84	20	100	100	100	4.4	4.1	221	0.30	17	diagnostic
71-2	01/09/92	177	none	83	20	67	67	67	4.6	4.0	222	0.30	18	diagnostic
71-3	01/09/92	177	none	81	20	33	33	33	4.4	4.0	234	0.32	54	diagnostic
71-4	01/09/92	176	none	80	20	15	15	15	4.3	4.1	263	0.36	47	diagnostic
71-5	01/09/92	177	none	79	20	-8	-6	-5	4.4	5.9	283	0.39	45	diagnostic
71-6	01/09/92	177	none	100	100	-8	-6	-5	4.5	4.0	289	0.39	13	diagnostic
72-1	01/10/92	134	A	42	20	35	100	100	4.8	4.5	202	0.28	13	diagnostic
72-2	01/10/92	138	A	42	20	27	100	100	5.1	4.7	248	0.34	12	diagnostic
72-3	01/10/92	138	A	41	20	26	100	100	5.0	4.7	233	0.32	12	diagnostic
72-4	01/10/92	133	A	42	20	29	100	100	4.9	4.8	209	0.28	10	diagnostic
73-1	01/11/92	135	A	42	20	32	100	100	4.8	4.5	204	0.28	9	diagnostic
73-2	01/11/92	136	A	42	20	-8	50	50	4.7	4.7	222	0.30	9	diagnostic
73-3	01/11/92	136	A	41	20	-8	25	25	4.5	4.7	254	0.35	16	diagnostic
73-4	01/11/92	135	A	40	20	-8	-8	-8	5.1	4.6	289	0.39	6	diagnostic
74-1	01/12/92	68	ABC	-8	20	-8	-8	10	5.6	5.8	330	0.45	9	diagnostic
74-2	01/12/92	68	ABC	-8	20	-8	-8	12	5.0	4.8	300	0.41	10	diagnostic
74-3	01/12/92	68	ABC	-8	20	-8	-8	10	6.3	6.4	360	0.49	11	diagnostic
74-4	01/12/92	68	ABC	-8	20	-8	-8	10	7.2	3.7	385	0.52	13	diagnostic
74-5	01/12/92	82	ABC	-8	20	-8	17	65	5.5	5.7	233	0.32	15	diagnostic
75-1	01/13/92	80	ABC	-8	20	-8	5.9	59	5.5	5.8	250	0.34	12	diagnostic
75-2	01/13/92	82	ABC	-8	20	-8	-8	-8	5.7	5.8	327	0.45	11	diagnostic
75-3	01/13/92	69	ABC	-8	20	-8	-8	-8	6.0	6.1	354	0.48	7	diagnostic
75-4	01/13/92	69	ABC	-8	20	-8	-8	10	5.9	6.2	354	0.48	9	diagnostic
75-5	01/13/92	68	ABC	-8	20	-8	-8	40	6.1	6.2	295	0.40	10	diagnostic

Legend:

- MW = megawatts
- MOOS = mills out of service
- ccofa = close coupled overfire air
- SOFA = separated overfire air
- CR = control room
- O2 = oxygen
- DAS = data acquisition system
- CO = carbon monoxide

END

**DATE
FILMED
9 / 3 / 92**