INNOVATIVE CLEAN COAL TECHNOLOGY (ICCT)

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

Final Public Design Report

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Prepared by:

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

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EXECUTIVE SUMMARY

This report presents the design information utilized by the participants of the Innovative Clean Coal Technology (ICCT) project demonstrating advanced tangentially-fired combustion techniques for the reduction of nitrogen oxide (NOx) emissions from a coal-fired boiler. The purpose of this project was to study the NOx emissions characteristics of the ABB C-E Services (ABB CE) Low NOx Concentric Firing System (LNCFS) Levels I, II, and III. These technologies were installed and tested in a stepwise fashion at Gulf Power Company's Plant Lansing Smith Unit 2.

The project sponsors include the U. S. Department of Energy (DOE), the Electric Power Research Institute (EPRI), and The Southern Company. The DOE oversees the project through the Office of Clean Coal Technology located at the Pittsburgh Energy Technology Center. EPRI provides technical input to the project management team. Southern Company Services manages the project on behalf of The Southern Company, which includes five electric operating companies serving Alabama, Georgia, Florida, and Mississippi. ABB CE is co-funding the project by sharing in the cost of the low NOx combustion technology.

The objective of this report is to provide the design information utilized by the project participants to install the low NOx combustion equipment. This report includes the introduction to the instruction manual provided by ABB C-E Services, the specification developed by Southern Company Services to solicit bids for the equipment, and the proposal prepared by ABB Combustion Engineering Services, Inc. Due to their proprietary nature, copies of the design drawings from the project are not included in this report.

The specification includes the scope of work, a listing of the applicable codes and standards to be applied to the design process, the design, fabrication, and erection requirements for the low NOx combustion technology, and the criteria by which the equipment will be judged once installed. The proposal from ABB Combustion Engineering Services includes a general discussion of tangentially-fired boilers, a description of the low NOx combustion technologies including a list of major equipment, and a discussion of NOx control.

Due to the retrofit nature of this project, all design reports were submitted to the DOE following completion of the low NOx combustion retrofits. As a result, this final design report is very similar to the preliminary design report. The preliminary design report is more comprehensive in nature than originally planned.

TABLE OF CONTENTS

INSTRUCTION MANUAL

FOSSIL SERVICES

GULF POWER COMPANY
LANSING SMITH NO. 2
PANAMA CITY, FLORIDA

ORIGINAL C-E CONTRACT 14664

FS NO. 846768
FS CONTRACT NO. 52589

LOW NOx CONCENTRIC FIRING SYSTEM

COPY NO. ______
ASSIGNED TO ______________________________

ABB Combustion Engineering Services

ASEA BROWN BOVERI

GULF POWER COMPANY
LANSING SMITH NO. 2
PANAMA CITY, FLORIDA

LOW NOx CONCENTRIC FIRING SYSTEM (LNCFS)

FS No. 846768
Contract No. 52589

TABLE OF CONTENTS

INTRODUCTION

This instruction manual has been prepared to serve as a guide in operating and maintaining Boiler and Auxiliary Equipment furnished by this company. It is not intended to cover all possible variations in equipment nor to provide for specific problems which may arise. Should additional information be required, this company or its field representatives should be contacted.

It must be recognized that no amount of written instructions can replace intelligent thinking and reasoning on the part of the boiler operators, especially when coping with unforeseen operating conditions. It is the operators responsibility to become thoroughly familiar not only with the immediate steam generating equipment but also with all pertinent control equipment. Satisfactory performance and safety depend to a great extent on proper functioning of controls and auxiliary equipment.

Operation and performance of any auxiliary equipment and controls not furnished by this company is the sole responsibility of the operating personnel.

ABB COMBUSTION ENGINEERING, INC. – FIELD OFFICES

For Parts or Service contact ABB CE's local field office or ABB CE, Windsor (203) 688–1911.

STATE	CITY	ADDRESS (phone) (fax)	SALES SYSTEMS	SALES SERVICES	TECHNICAL SERVICES	CONSTRUCTION SERVICES
AL	BIRMINGHAM 35243	31 Inverness Center Pkwy P.O. Box 43020	(205) 991–2832 (205) 995–5482	(205) 995–5481 (205) 995–5482	(205) 995–5470 (205) 995–5482	(205) 995–5480 (205) 995–5482
AZ	PHOENIX 85021	10050 N. 25th Drive Suite 304		(602)944–3300 (602)944–1783		
CA	LOS ANGELES (Irvine) 92715–8525	5 Park Plaza Suite 206	(714) 955–1711 (714) 955–0216			
CO	DENVER (Englewood) 80112	23 Inverness Way East Suite 110		(303) 799–6413 (303) 799–4950	(303) 799–6413 (303) 799–4950	(303) 799–6413 (303) 799–4950
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DC	WASHINGTON 20005–5074	1101 15th Street, N.W. Suite 500		(202) 429–9196 (202) 429–9199		
	WASHINGTON (Woodbridge, VA) 22192	11842 Critton Circle			(703) 491–5246	 (703) 491–7930
	WASHINGTON (Midlothian, VA)	13204 Lady Ashley Road		(804) 379–4158 (804) 794–4098		
GA	ATLANTA 30338	1200 Ashwood Parkway, N.E. Suite 510	(404) 394–2616 (404) 399–6446	(404) 394–2616 (404) 399–6446	(404) 394–2616 (404) 399–6446	(404) 394–2616 (404) 399–6446
IN	GREENWOOD 46143–9518	1432 Demaree Road			(317) 535–8065 (317) 535–8065	
IL	CHICAGO (Lisle) 60532	650 Warrenville Road Suite 100	(708) 719–9800 (708) 719–9889	(708) 719–9800 (708) 719–988	(708) 719–9800 (708) 719–988	
	CHICAGO (Huntley) 60142	11313 Smith Drive				(708) 669–3393 (708) 669–5057
KS	KANSAS CITY (Overland Park) 66211	4400 College Blvd Suite 100	(913) 491–6511 (913) 491–6515	(913) 491–6511 (913) 491–6515	(913) 491–6511 (913) 491–6515	(913) 491–6511 (913) 491–6515
LA	NEW ORLEANS (Metairie) 70002	2540 Severn Ave. Suite 300	(504) 885–9091 (504) 885–9106		(504) 885–9091 (504) 885–9106	(504) 885–9101 (504) 885–9106
MA	BOSTON (Hopkinton) 01748	87 Elm Street	(508) 435–6911 (508) 435–9091	(508) 435–6911 (508) 435–9091	(508) 435–6911 (508) 435–9091	(508) 435–6911 (508) 435–9091
ME	PORTLAND 04101	35 Melbourne Street			(207)871–8058 (207)871–8058	
MI	DETROIT (Troy) 48084	1700 W. Big Beaver Suite 340		(313)649–4996 (313)649–5027		

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MO	ST LOUIS (Ballwin) 63011	611 Golfview Drive P.O. Box 1422		(314) 394–2825 (314) 394–5921		
	ST LOUIS 63021	942 Gervas Street			(314) 2259–9533 (314) 2259–9533	
NC	CHARLOTTE 28217	1337 Hundred Oaks Drive SuiteA	(704) 527–9400 (704) 527–9178	(704) 527–9400 (704) 527–9178	(704) 527–9400 (704) 527–9178	(704) 527–9400 (704) 527–9178
NY	NEW YORK (Roseland, NJ) 07068	7 Becker Farm Road P.O.Box 550	(201) 992–1178 (201) 992–2392	(201) 992–1178 (201) 992–2392	.(201) 992–1178 (201) 992–2392	.(201) 992–1178 (201) 992–2392
	ROCHESTER 14611	95 Ames Street		(716) 235–5000x3195 (716) 235–1207	(716) 235–5000x3195 (716) 235–1207	
OH	CINCINNATI 45242–4190	6840 Ashfield Drive		(513) 984–6920 (513) 984–2569	(513) 984–6920 (513) 984–2569	(513) 984–6920 (513) 984–2569
OR	PORTLAND 97201	1800 S.W. First Ave Suite 530	(503) 224–9132 (503) 225–0616	(503) 224–9132 (503) 225–0616	(503) 224–9132 (503) 225–0616	
	PORTLAND (Troutdale) 97060	2360N.W. Marine Drive				(503) 669–1591 (503) 669–0710
PA	PHILADELPHIA (Valley Forge) 19482–0854	P.O. Box 854 (901 East 8th Avenue King of Prussia, 19406)	(215) 354–9000 (215) 354–9012	(215) 354–9000 (215) 354–9012	(215) 354–9000 (215) 354–9012	(215) 354–9000 (215) 354–9012
PA	PITTSBURGH (Monroeville) 15235	300 Penn Center Blvd Suite 232		(412) 823–5513 (412) 823–5516	(412) 823–5513 (412) 823–5516	(412) 823–5513 (412) 823–5516
TX	DALLAS 75240	Wellington Center Suite 650 L.B. 71 14643 Dallas Parkway	(214) 385–7571 (214) 385–2903	(214) 385–9901 (214) 385–2903	(214) 385–0142 (214) 385–2903	(214) 385–0142 (214) 385–2903
	HOUSTON 77040	7600 West Tidwell Suite 210	(713) 939–7911 (713) 939–8754	(713) 939–7911 (713) 939–8754		(713) 939–8657 (713) 939–8754
	HOUSTON 77029	1101 Pleasantville Drive, Bldg. B				(713) 672–8433 (713) 672–0272
INTERNATIONAL						
	WINDSOR, CT. 06095–500	1000 Prospect Hill Road P. O. Box 500	(203) 285–3020 (203) 285–9615	(203) 285–9615	(203) 285–5360 (203) 285–9918	(203) 285–5046 (203) 285–9656

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GULF POWER COMPANY
LANSING SMITH STEAM PLANT
UNIT NO. 2

ORIGINAL C–E CONTRACT NO. 14664
FS CONTRACT NO. 52589

TILTING TANGENTIAL FIRING SYSTEM
CONVERSION TO
LOW NOx CONCENTRIC FIRING SYSTEM (LNCFS)

TABLE OF CONTENTS

DESCRIPTIONS

ILLUSTRATIONS AND REFERENCE DRAWINGS

TILTING TANGENTIAL FIRING SYSTEM
CONVERSION TO
LOW NO_x CONCENTRIC FIRING SYSTEM (LNCFS)

CONVENTIONAL TANGENTIAL FIRING

In a tangential firing system, the fuel and air are introduced into the furnace through four windbox assemblies located in the furnace corners. The windbox nozzles direct the fuel and air streams toward a firing circle in the center of the furnace. The windbox is designed to distribute all of the supporting combustion air into the furnace through three distinct zones:

1. Primary air, which is the portion used to dry and transport pulverized coal from the pulverizers to the furnace.

2. Fuel air, which is the portion of secondary air admitted to the furnace through the air annulus around the fuel nozzles.

3. Auxiliary air, which is the balance of the secondary air required to complete combustion. It is injected into the furnace through the air nozzles located in separate compartments between each fuel elevation.

Tangential firing is a unique fuel/air delivery system by virtue of the firing trajectory offset of approximately 6° from the furnace center. This feature allows a small part of the total kinetic energy of the fuel and air streams to rotate the gases in the furnace. The speed of rotation is known as swirl and is expressed as the ratio of radial momentum to axial momentum. Conventional tangential firing, without offset auxiliary air nozzles, results in low swirl effect. With the addition of offset concentric air nozzles, a quantity of auxiliary air is directed farther away from the furnace center thus creating a concentric circle of auxiliary air around the fireball.

LOW NOx CONCENTRIC FIRING SYSTEM (LNCFS)

The Low NOx Concentric Firing System (LNCFS) maximizes the NOx reduction capabilities of existing tangential firing systems while minimizing unit modifications. LNCFS uses a combination of two techniques to reduce NOx. These are bulk furnace staging and early controlled coal devolatilization.

Bulk furnace staging takes a portion of the combustion air, which is introduced at the fuel burning zone, and diverts it to retard air and fuel mixing. With conventional tangential firing, the introduction of excess combustion air during the early stages of coal devolatilization contributes significantly to the formation of NOx. LNCFS maximizes the bulk staging concept by using both overfire air and concentric firing.

Overfire air is a technique which produces staged combustion by introducing secondary air above the primary firing zone. This is accomplished by installing an additional, smaller (three–elevation) windbox above each existing windbox. Concentric firing takes some of the secondary (auxiliary) air which is admitted in the main firing zone and diverts it away from the coal stream. In this manner, combustion stoichiometry is reduced by preventing the fuel stream from entraining with the air stream during the initial stages of combustion. Fuel nitrogen conversion is reduced, while maintaining appropriate oxidizing conditions along the furnace walls. This is accomplished by modifying the windbox compartments with installation of offset air nozzles.

Another important design feature incorporated into LNCFS is the technique of early fuel ignition. Initiating the combustion point very close to the fuel nozzle produces a stable volatile matter flame which is more easily controlled under sub–stoichiometric firing conditions. Two–piece "flame attachment" type coal nozzle tips are used to promote this strong primary flame.

WINDBOX ASSEMBLIES

Modified Existing Windboxes

The fuel firing equipment consists of four tilting tangential windbox assemblies. Each windbox assembly is approximately 21 feet high, with a 18 inch opening for the fuel and air nozzle tips.

Each windbox is divided into 11 major horizontal sections or compartments. Starting at the top compartment, the arrangement in each corner is as follows. The top compartment now contains one straight (non–offset) adjustable air nozzle tip. The original arrangement had two adjustable nozzle tips at this location which served the same function. In addition, another compartment partition plate was added at the top of this compartment to create a 2" high air passage at the top of the windbox. This was also done at the bottom of the lowest windbox compartment. Where the air from these passages enters the furnace, a deflector plate has been installed which diverts the flow upward at the top of the windbox and downward at the bottom of the windbox. This design is incorporated to assist in slag prevention.

The next compartment below the top air compartment contains one two–piece "flame attachment" type adjustable coal nozzle tip. Only the style of the nozzle tip is changed at this elevation. Below the topmost coal elevation is a compartment containing two new adjustable offset air nozzle tips. This and all the other adjustable offset air nozzle tips have an adjustable (– 8° to + 22°) yaw to create the concentric circle of auxiliary air around the fireball. The arrangement is repeated with a coal compartment, an offset air compartment, a coal compartment, an offset air compartment, a coal compartment an oil/air compartment and another coal compartment. Below the lowest coal compartment is the bottom compartment of the windbox which contains one straight (non–offset) adjustable air nozzle tip. This compartment also has the additional air passage below it, as previously described.

Combustion air (secondary air) is admitted to the air and fuel compartments (around the fuel nozzles) through sets of louvre dampers. There are two dampers at each top and bottom air compartment, two dampers at each coal compartment, two dampers at each oil/air compartment and one damper at each offset air compartment. Each set of dampers is driven by a pneumatic actuator located at the side of the windbox. The dampers at the offset air compartments adjacent to the same oil/air compartment are linked together and driven by one actuator. This is also true of the damper pairs at the coal compartments. The air passages at the top and bottom of the windbox are undampered.

New Overfire Air Windboxes

The overfire air equipment consists of four new tilting tangential windbox assemblies. The windbox assemblies are approximately 5 feet high, with a 18 inch opening for the air nozzle tips. Air for the overfire air windboxes comes from the windbox connecting duct for the existing windboxes. Each windbox is divided into 3 major horizontal sections or compartments. The nozzle tip arrangement is the same in each compartment of all four windboxes. Each compartment is equipped with an adjustable nozzle tip which can be manually yawed 15° left or 15° right. Optimum yaw settings should be determined during equipment commissioning and can be modified during operation of the unit as required. At the top and bottom of the windbox, a partition plate is installed to create a 2" high air passage. Where the air from these passages enters the furnace, a deflector plate is installed which diverts the flow upward at the top of the windbox and downward at the bottom of the windbox. This design is incorporated to assist in slag prevention.

AIR AND FUEL NOZZLE TILTS

The air and fuel streams of the main windboxes are vertically adjustable by means of the movable nozzle tips in each windbox compartment. All of the nozzle tips are designed for an upward tilt of 30° and downward tilt of 30° (approximately 60 degrees total. The nozzles are driven by connecting links and bell cranks in each windbox compartment. Some of the nozzle tips are internally linked to each other. These in turn are connected to three drive linkage sections which are externally connected. The tilt drive cylinder, (at the bottom of the windbox, positions the nozzle tips of one corner as indicated by the control system. The tilt drive cylinders at each corner of the furnace operate in unison so that all nozzle tips are tilted equally.

OVERFIRE AIR NOZZLE TILTS

The air streams of the overfire air windboxes are also vertically adjustable by means of the movable nozzle tips in each windbox compartment. All three elevations of air nozzle tips are designed for an upward tilt of 30° and downward tilt of 30° (approximately 60 degrees total . The nozzles are driven by internal connecting links and bell cranks in each windbox compartment. These in turn are connected to the external tilt mechanism. The tilt drive cylinder, on the side of the windbox, positions the nozzle tips of one corner as indicated by the control system. The tilt drive cylinders at each corner of the furnace operate in unison so that all nozzle tips are tilted equally. Optimum tilt settings should be determined during operation of the unit as discussed under "Air Flow Distribution".

AIR FLOW CONTROL AND DISTRIBUTION

Total air flow control is accomplished by regulating fan inlet control dampers. Air distribution is accomplished by means of the individual compartment dampers.

Total Air Flow

To ensure safe light–off conditions, pre–operational purge air flow (at least 30% of full load air flow) is maintained during the entire warm–up period, and until the unit is on line and air flow must be increased to accommodate further load increases. To provide proper air distribution for purging and suitable air velocities for lighting off, all auxiliary air dampers should be open when purging, lighting off and during warm–up.

After the unit is on line, the total required air (total air flow) is a function of unit load. Proper air flow at a given load depends on the characteristics of the fuel fired and the amount of excess air required (see note) to satisfactorily burn the fuel. Excess air can best be determined through flue gas analysis (Orsat measurements).

NOTE

The optimum amount of excess air for a particular unit, at a given load and with a given fuel, must be determined by experience. This is best done through observation of furnace conditions.

Air Flow Distribution

The function of the windbox compartment dampers is to proportion the amount of secondary air admitted to an elevation of fuel compartments in relationship to that admitted to adjacent elevations of fuel and auxiliary air compartments.

Windbox compartment damper positioning affects the air distribution as follows: Opening up the fuel–air dampers or closing down the auxiliary–air dampers increases the air flow around the fuel nozzle. Closing down the fuel– air dampers or opening the auxiliary–air dampers decreases the air flow directly around the fuel stream.

Proper distribution of secondary air is important for furnace stability when lighting off individual fuel nozzles, when firing at low rates, and for achieving optimum combustion conditions in the furnace at all loads.

Proper distribution of secondary air also has an effect on the emission of pollutants from the unit. As unit load increases and the upper elevations of fuel nozzles are placed in service, the quantity of nitrogen oxides (NO_x)

produced in a furnace increases (due to the oxidation of nitrogen in the fuel and air). The quantity of NO_x produced can be reduced by limiting the amount of air admitted to the furnace adjacent to the fuel, and increasing the quantity of air admitted above the fire (overfire air). When the unit has reached a predetermined load (usually near 45%), the overfire air dampers should ramp open as a function of unit load. At Maximum Continuous Rating (MCR), up to 20% of total air flow is admitted to the furnace as overfire air. The optimum ratio of overfire air to fuel and auxiliary air, as well as the optimum tilt position of the overfire air nozzles, which will produce a minimum NOx emission consistent with satisfactory furnace performance, must be determined through flue gas testing during operation of the unit (see Note).

NOTE

Testing of the overfire air system can only be performed when the unit is capable of full load operation at or near design excess air levels, and after NO_x measuring devices are installed and operable. Tests must be conducted at several predetermined loads such as full load (MCR), 80% MCR, 60% MCR, etc. All overfire air controls must remain on manual until the system has been thoroughly tested and optimum settings have been established. The overfire air dampers should remain slightly open at all loads to prevent possible overheating of the air nozzles and the system.

The correct proportioning of air between fuel compartments and auxiliary air compartments depends primarily on the burning characteristics of the fuel. It influences the degree of mixing, the rapidity of combustion and the flame pattern within the furnace. The optimum distribution of air for each unit and fuel used must be determined by experience.

The windbox compartment dampers are provided with pneumatic actuators so they may be operated by a control system. If on automatic control, the system modulates the auxiliary–air dampers to maintain a pre–set windbox–to–furnace differential pressure.

When lighting off an elevation on manual control, the auxiliary–air dampers should be opened 20% to 40% prior to lighting off. They should be kept at this position until the fuel–air dampers are opened.

The fuel–air dampers should be closed when lighting off an elevation. Once ignition of the main fuel is established, the fuel–air dampers should be opened to approximately 20% damper position. A simplified step ramp may be incorporated to optimize performance.

Once the fuel–air dampers are positioned, additional damper adjustments should be made (if necessary) with the auxiliary–air dampers only. When changing damper positioning, an entire elevation should be adjusted simultaneously, so that damper positioning at any one elevation is identical in all windboxes.

SUGGESTED OPERATIONAL GUIDELINES FOR THE LNCFS WINDBOXES

Figures 1 and 2 indicate suggested operational guidelines for the operation of the LNCFS windboxes at the Lansing Smith Station. ***These are preliminary guidelines and will be modified to reflect actual operation experienced during commissioning. The general guidelines are:.***

1. Fuel air dampers will be ramped to feeder speed. The type of ramp required will be field determined.
2. Auxiliary air/offset air nozzle tip dampers will ramp to maintain windbox–to–furnace differential.
3. Overfire air dampers will ramp with load.
4. The top end air compartment will require a separate control logic circuit, because this compartment will be operated independently from the main windbox dampers.

WARNING

AT NO TIME SHOULD THIS CONTROL GUIDELINE OVERRIDE SAFE UNIT OPERATING CONDITIONS.

It is important to note several points concerning this graph. There are overlaps indicated for the number of mills in service and the number of separated overfire air (SOFA) elevations in service. A more definitive load point must be determined over a long operating history. Also, the auxiliary air compartments (including the bottom end air compartments) are being used to control windbox–to–furnace pressure. The top end air compartments will perform the same function up to some load (approximately 65–70% MCR) at which time they should be ramped to 100% open and remain there throughout the remaining load range. The O_2 curve shown is representative only. There may be some iterative process to compromise windbox–to–furnace pressure and boiler O_2. Below a given load point (shown at 40% MCR for illustration),O_2 will not be easily maintained.

WINDBOX MAINTENANCE

During fabrication of the new windbox components all pivot pins and bearing surfaces of the components inside the windbox are sprayed with a coating of high temperature lubricant (see note). When a windbox is being overhauled or the parts are accessible, the lubricant coating should be reapplied to all link pins, bell crank stationary pins and other pivots. The surfaces to be lubricated should first be cleaned and free of grease. The spray should be applied from a distance of 6 to 12 inches for 2 to 4 seconds.

NOTE

The lubricant used is a tungsten disulfide (WS_2) powder with an inorganic binder supplied in aerosol form (CERAC formula SP110 or equivalent is recommended).

Maintenance of windbox assemblies normally consists of replacement of adjustable nozzle tips and adjustment of tilting mechanism.

1. Removal of air, oil/air and overfire air adjustable nozzle tips.
    a. Remove access panel on front of windbox
    b. In the oil/air compartments, if the nozzle tips are to be removed the turning vanes and the oil guns must first be removed. Remove the tack welds holding the turning vane clips to the top and bottom partition plates.
    c. Disconnect tilt linkage at bell crank by removing rear locknut. In the oil/air compartments also disconnect the nozzle tip connecting bars.

d. On the overfire air nozzles, disconnect the tilt linkage and the yaw linkage at their respective bell cranks by removing rear locknut.

e. To remove pivot pins, remove pipe plug or cover plate from inside of nozzle tip. Insert 1/4 – 20 NC bolt in hole tapped in pivot pin to assist in its removal.

f. Adjustable nozzle tips may be taken out through the furnace or through the front access panel. Removal through the furnace is usually easier.

2. Replacement of the air, oil/air, and overfire air adjustable nozzle tips.

a. Replacement is made by reverse of procedure "A",

b. Points to check during and after replacement.

(1) Holes for pins to be 1/64 to 1/32 larger than pins.

(2) Clearances around adjustable nozzle tips should be 3/8" with 1/4" minimum between tips and compartment plates, and 1/2" with 1/4" minimum on sides between tips and channels.

(3) In order to attain the above clearances, it may be necessary to grind the flare of the adjustable nozzle tip.

3. Assembly and adjustment of tilt linkage.

NOTE

For access to the various compartments, remove the front panels or go into the windbox compartments through the windbox louvre dampers.

a. Set the bell crank inside each compartments in a horizontal position. Since the bell cranks in the compartments are connected to common bars, they must all be in the same position.

b. Run down a nut onto the bolt portion of the link attached to the adjustable nozzle tip. Then, install a lock washer.

c. Insert link bolt through the pivot pin on the bell crank. Install a lock washer and a nut. Run the nut down to bring the nozzle tip up to a horizontal position.

d. Run the first nut back until the pivot pin is secured between the nuts and lock washers.

e. When all compartments have been linked and adjusted to horizontal, run the tilts through their full range of travel (min. range 28°) checking to ensure sufficient clearances are maintained at all tilt positions.

f. In the oil/air compartments, intermediate links are used to connect the nozzle tips together. Check to make sure the links do not contact the adjustable nozzle tips as they approach the full extent of their travel. If contact occurs, it may be necessary to increase the size of the clearance notch in the adjustable nozzle tips.

g. Check keys and key slots in main drive shaft and levers. Replace any worn parts.

4. Repair or removal of coal nozzle and adjustable coal nozzle tip.

NOTE

The new coal nozzle tips installed are a two–piece design with a removable section on the fireside. This is the area most often affected by normal warpage, burning or other wear. The new design reduces maintenance costs and downtime for repairs. Since, if replacement of the removable section is required, it eliminates the need for removal of the entire coal nozzle from the furnace (disconnection of coal pipe, linkage, coal nozzle, removal of pivot pins, etc.).

a. Cut the welds securing the tabs of the removable section to the body section. Grind off the welded area on the body section to allow a new removable section , with tabs attached, to be correctly positioned. Locate the new section and weld it into position.

NOTE

If replacement of the nozzle tip removable section is not sufficient to repair the coal nozzle, it must be removed and rebuilt as described in the following steps.

b. Remove the coal pipe elbow and any horizontal pipe at the burner in front of the coal nozzle.

c. Remove nuts from studs around the coal nozzle at the removal door on the windbox.

d. Remove access door.

e. Disconnect tilt linkage in compartment.

f. Remove bolt attaching lug on nozzle to tie angle near front of windbox.

g. The complete coal nozzle assembly may now be pulled out of windbox.

h. Remove pivot pins to detach the coal nozzle tips from the coal nozzle.

5. Replacement of coal nozzle assembly.

   a. Replacement is made by reverse of "D".

   b. Points to check during and after replacement.

      (1) Holes for pins to be 1/64" to 1/32" larger than pins.

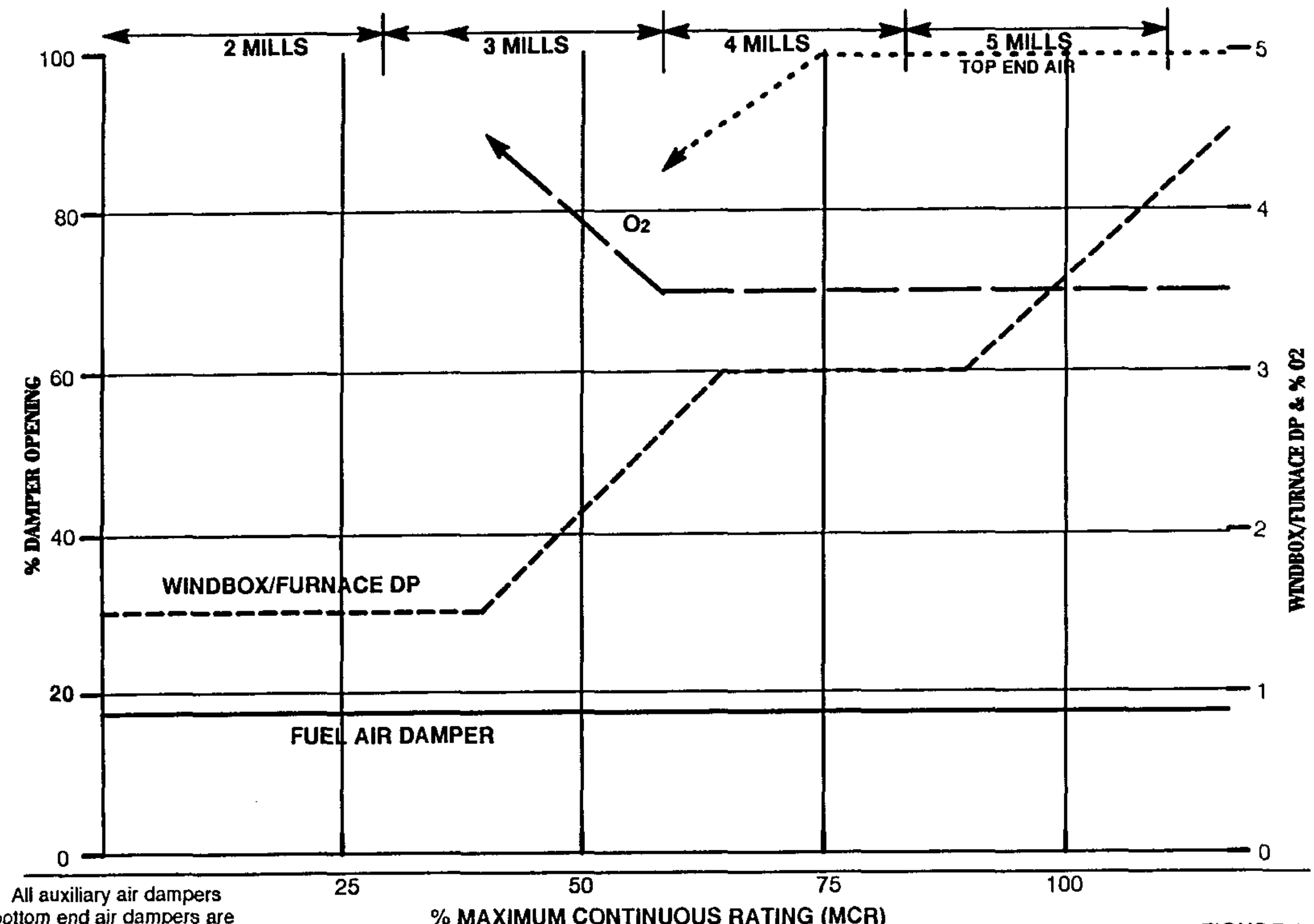
      (2) Seal plate should fit on the coal nozzle with 0.109" maximum clearance between seal plate and coal nozzle on all four sides and a minimum clearance of 0.078" on the side and 0.033" top and bottom. With pivot pins inserted, seal plate should make its full travel without binding.

      (3) The adjustable coal nozzle tip should fit over the seal with 0.16" maximum and 0.07" minimum clearance on all sides.

      (4) The coal nozzle should be checked to make sure that the nozzle support lug and tilt mechanism is on the correct side.

      (5) When nozzle and tip assembly have been installed in the windbox assembly, make sure 1/2" with 1/4" minimum clearance is maintained between tip and compartment plate, at top and bottom and 3/8" with 3/16" minimum is maintained on each side.

(6) The coal nozzle pins (domed) serve as a centering device for the assembly. The maximum allowable clearance between the domed surface and the windbox sides is 0.19".

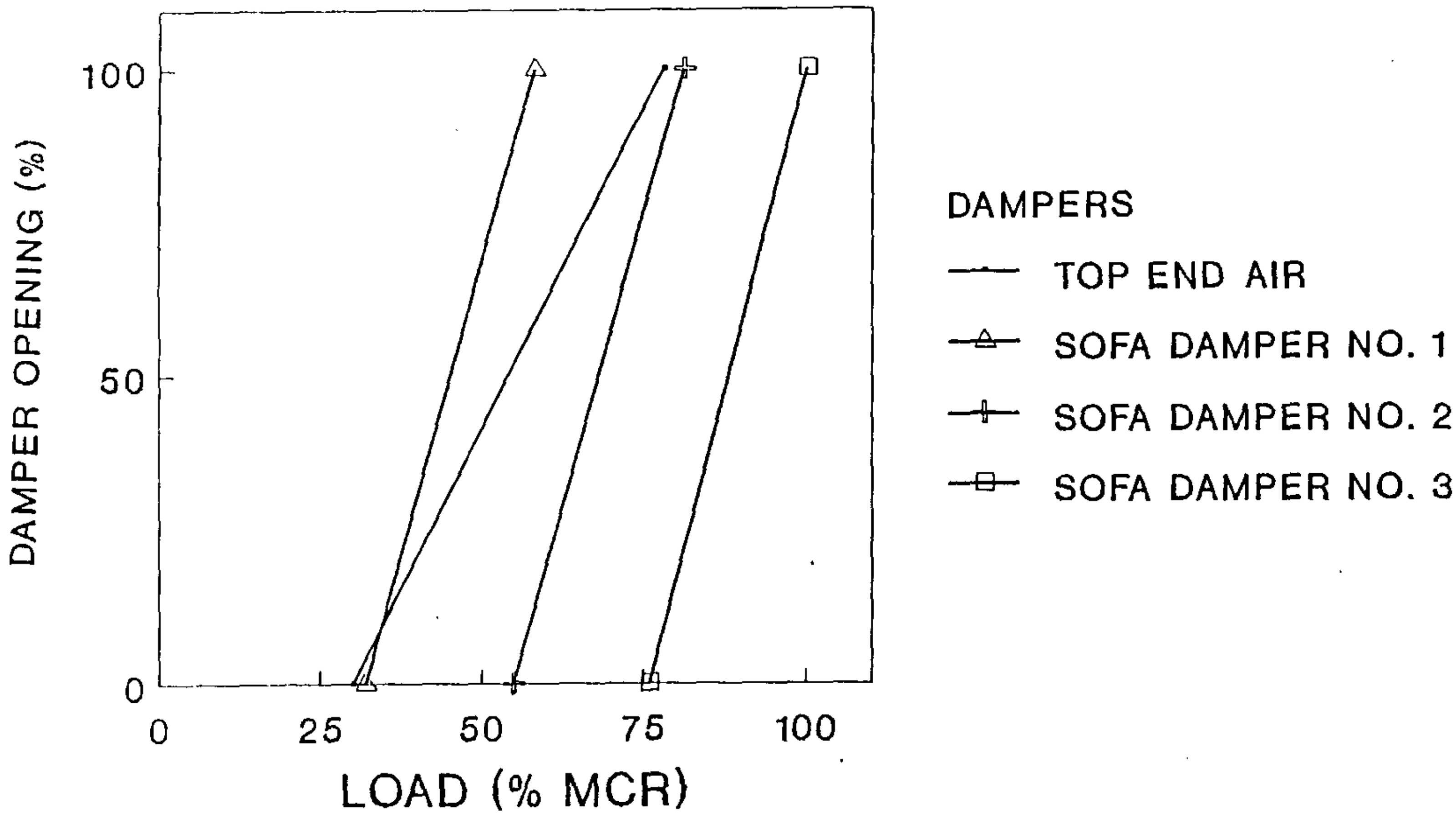


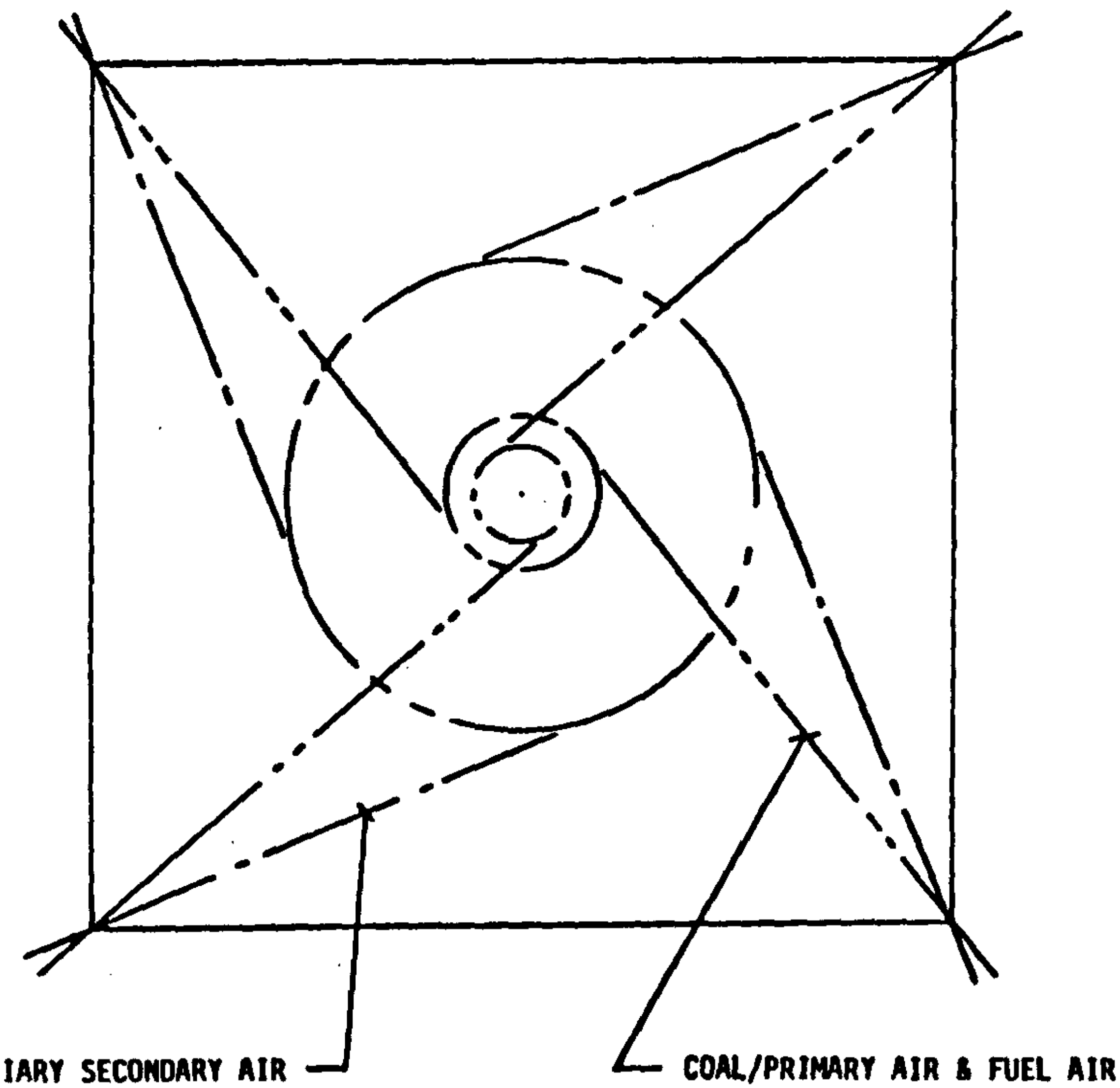
Note: All auxiliary air dampers and bottom end air dampers are controlled as a function of windbox/furnace delta-P

FIGURE 1

GULF POWER COMPANY
LANSING SMITH STATION UNIT NO. 2
Preliminary

SEPARATED OVERFIRE AIR
PRELIMINARY DAMPER CURVES





PRINCIPLE OF OFFSET AIR NOZZLE TIPS

THIS INQUIRY CONTAINS QUALITY CLASS E ITEMS

INQUIRY NO. SS GUTF-1

Southern Company Services, Inc.

BIRMINGHAM, ALABAMA

SPECIFICATIONS

FOR

ADVANCED TANGENTIALLY-FIRED COMBUSTION MODIFICATIONS FOR REDUCED NOx EMMISIONS

FOR

PLANT LANSING SMITH - UNIT 2

OF

GULF POWER COMPANY

PREPARED BY A. L. Sumerlin /M. D. Nelson DATE 2-9-89

REVIEWED BY E. G. Murray DATE 2-9-89

APPROVED BY E. G. Murray DATE 2-13-89

REVISIONS:

No.	Description	By	Reviewed	Date
0	Issued For Bids	ALS	[illegible]	2/13/89
1	Issued Addendum No. 1	ALS	[illegible]	4/13/89
2	Issued Addendum No. 2	ALS	[illegible]	3/28/90
3	Issued Addendum No. 3	ALS	[illegible]	4/30/90
4	Issued Addendum No. 4	ALS	[illegible]	6/18/91
5	Issued Addendum No. 5	ALS	[illegible]	9/04/91

Form No. 9-365A

ADDENDUM

NO. 5

TO

INQUIRY NO. GUTF-1

ADVANCED TANGENTIALLY-FIRED COMBUSTION MODIFICATIONS

FOR

REDUCED NOx EMISSIONS

FOR

PLANT SMITH UNIT NO. 2

OF

GULF POWER COMPANY

The following provisions include revisions to Revision 4 of Inquiry No. GUTF-1 since Addendum No. 4 was issued on June 18, 1991.

Paragraph 5.5, sub-part 10, Page 29 - Clarification is added concerning the addition of new flame holder coal nozzle tips during the installation of the LNCFS Level III.

The addition of new coal nozzle tips will be at the discretion of the Vendor based on his assessment of the new tips that were installed during the Phase II outage.

/ALS
F: A. L. Sumerlin
T: ADDM 5/T-FIRED COMB MOD 0545S (W/O FANS)
9/04/91

SPECIFICATION

CONTENTS

INQUIRY NO. GUTF - 1

ADVANCED TANGENTIALLY-FIRED COMBUSTION MODIFICATIONS

FOR REDUCED NO_x EMISSIONS

PLANT SMITH - UNIT NO. 2

TECHNICAL SPECIFICATIONS

1.0 SCOPE

1.1 General

1.1.1 This specification and all related attachments cover modifications to the burner system on the Combustion Engineering boiler at Gulf Power Company's Plant Smith Unit No. 2. The modifications are to be included in a demonstration program where a series of NO_x reduction technologies are retrofitted to the Smith unit. The technologies are commercial designs with a high probability of successfully demonstrating substantial NO_x reductions without any serious adverse effects. The program is designed to comprehensively document the incremental NO_x reductions of each successive technology over sufficient time period to demonstrate both the NO_x reduction achieved and any effects (adverse or beneficial) upon the operation of the unit. The NO_x control technologies to be evaluated by this program are Combustion Engineering, Inc. proprietary Low NO_x Firing Systems known as the Low NO_x Concentric Firing System (LNCFS). Both the Department of Energy and the Electric Power Research Institute will be actively involved in the demonstration program along with Southern Company and Gulf Power Company. Energy Technology Consultants, Inc. will be responsible for the overall testing activities.

1.1.2 The demonstration program will be performed at full scale on Plant Smith Unit 2, a 180 MW Combustion Engineering boiler owned by Gulf Power Company and is located in Lynn Haven, Florida, near Panama City. Plant Smith Unit 2 is a nominal 180 MW output unit with a Combustion Engineering reheat type natural circulation steam generator, designed for indoor service to deliver 1,306,000 pounds of steam per hour continuously at normal rated load at a pressure of 1875 psig and a temperature of 1000°F at the superheater outlet and a temperature of 1000°F at the reheater outlet. The unit was placed in commercial operation on June 1, 1967. Plant Smith Unit 2 is fired with pulverized coal through twenty (20) Combustion Engineering tilting-tangential burners, with five (5) burners located in each corner of the boiler. The unit was originally designed for pressurized furnace operation, but was converted to balanced draft operation in 1976.

1.1.3 The retrofit of LNCFS Levels I, II and III will be performed in sequence (Note: for cost and schedule considerations, the LNCFS Level Level II will be installed first). The sequence of the major elements of the program are provided below and are divided into three phases:

Phase 1 - Air preheater element replacement, site preparation and pre-retrofit testing (baseline characterization)

Phase 2 - LNCFS Level II retrofit installation and post-retrofit testing (with and without Separated Over Fire Air (SOFA))

Phase 3 - Level III Retrofit Installation and post-retrofit testing (with and without SOFA to simulate LNCFS Level 1)

Phase 1 will involve windbox and duct flow modeling, site preparation, instrumentation, diagnostic testing, air preheater basket replacement, minor equipment modifications and baseline testing. One important purpose of a part of this phase is to establish boiler operating conditions that are representative of the typical Combustion Engineering tangentially-fired boiler. Once these conditions are established short-term parametric testing will be performed to establish trends and to perform measurements of parameters that cannot be obtained during dynamic mode operation. With the trends established, long-term continuous measurements will be made to establish emission and operational trends while the unit is under control of load dispatch for normal operation. The design of the LNCFS Levels II and III will also be completed during the Phase I portion of the project.

Phase 2 will involve installation and testing of the LNCFS Level II. Both short-term parametric and long-term continuous tests will be performed in a similar manner as in Phase 1 with and without SOFA being in service. It is understood that SOFA is an integral part of the LNCFS Level II Firing System, and that not utilizing SOFA in conjunction with the LNCFS Level II represents an aberrant firing condition.

Phase 3 will involve installation and testing of LNCFS Level III both with and without SOFA to simulate LNCFS Level I. It is understood that SOFA is an integral part of the LNCFS Level III Firing System, and that not utilizing SOFA in conjunction with the LNCFS Level III represents an aberrant firing system.

1.2 <u>Work Included</u>

The Vendor (or Combustion Engineering/CE) shall design, fabricate, deliver, erect and commission the Vendor's material scope of supply as defined herein. The Vendor's scope of supply shall also include receiving, unloading and storage of Vendor supplied materials at the Purchaser's plant site. The Vendor's material scope of supply shall include the following:

1.2.1 Phase 1 - Baseline

a. Air preheater elements; hot, intermediate and cold.

1.2.2 Phase 2 - Low NO_x Concentric Firing System (LNCFS) Level II

a. Separated Overfire air (SOFA) windboxes.

b. Offset furnace corner tube assemblies, refractory and lagging.

c. SOFA ductwork system, including carbon steel ducts, hangers and required support steel, insulation and lagging, turning vanes, access doors, dampers, secondary air duct dampers, limit switches, actuators and drive mechanisms.

d. Coal nozzles and LNCFS Level II flame holder coal nozzle tips. Coal pipe modifications including the addition of Rockwell couplings.

e. Offset air nozzle tips.

f. Tilt linkage, electric drive units for tilt linkage, miscellaneous platework and hardware as required to modify the existing windboxes.

g. Secondary air control system hardware and interfaces as required.

h. Observation ports.

1.2.3 Phase 3 - Low NO_x Concentric Firing System (LNCFS) Level III, and Level I (simulated).

a. Close coupled overfire air windboxes.

b. Offset furnace corner tube assemblies, refractory, insulation and lagging.

c. Ductwork system, including carbon steel ducts, hangers and required support steel insulation and lagging, turning vanes, access doors, dampers, limit switches, actuators and drive mechanisms (installed during Phase II).

d. Coal firing equipment modifications. Coal pipe modifications as required for clustering coal burners, etc. with the installation of the LNCFS Level III flame holder coal nozzle tips.

e. Offset air nozzle modifications.

f. Tilt linkage, electric drive units for tilt linkage, miscellaneous platework and hardware as required to modify the existing windboxes.

g. Materials as required to relocate the existing flame scanners, ignitors and warmup oil guns as required.

h. Secondary air control system hardware and interfaces as required.

1.2.4 Burner Observation System (to be installed during Phase 2)

a. Furnace video camera, with remote color monitor, and associated mounting hardware and interfaces as required.

1.2.5 Flame Scanner System (to be installed during Phase 2)

a. Four elevations of main flame scanners, each consisting of four scanner heads and guidepipes, connected wiring and one scanner chassis.

b. Scanner cooling air system.

c. Flame intensity meters.

1.2.6 Brickwork, refractory, insulation, and lagging

1.2.7 Instrumentation and controls

1.2.8 Motor control centers

1.2.9 Wiring and conduit

1.2.10 Access structures

1.2.11 Piping and valves complete with hangers and insulation - per "Piping Specifications" for Lansing Smith Steam Plant

1.2.12 Structural support steel

1.2.13 Foundations or foundation modifications

1.2.14 Flow modeling

1.2.15 Any special tools required for erection, startup, or maintenance

1.2.16 Recommendations for baseline conditions

1.2.17 General arrangement and installation drawings and engineering data to support design review

1.2.18 Operation and maintenance manuals

1.2.19 Delivery of equipment and materials

1.2.20 Erection superintendent

1.2.21 Technical services site representation

1.2.22 Operator training program by Vendor's technical services

1.2.23 Complete field erection and unloading of all Vendor supplied equipment and materials, including removal and storage of existing equipment and materials.

1.2.24 Upon failure to meet unit operating performance guarantees, restoration of the unit to a point at which the performance conditions are met.

1.2.25 Air compressors required for the erection of unit modifications and/or restoration.

1.3 <u>Work Excluded</u>

The Purchaser shall furnish the following equipment and services during construction and testing phase of project:

1.3.1 AC and DC power

1.3.2 Deleted

1.3.3 Construction power - Power provided to Vendor, if Vendor's erection option is accepted, shall be 575 volts, three phase located at a central panel as specified by the Project's Construction Manager. Any and all transformers (must not be PCB filled), disconnects, wiring, distribution panels, etc., required to distribute construction power for use is the Vendor's responsibility. All transformer oil will have non-detectable levels of PCBs (less than 2 ppm PCB).

1.3.4 Baseline and performance testing

1.4 <u>Terminal Points</u>

Terminal points for Vendor's scope of supply shall be clearly identified in Vendor's proposal.

2.0 APPLICABLE DOCUMENTS

2.1 <u>Codes and Standards</u>

The following codes and standards are applicable to the various components within the scope of the specified equipment and materials (latest addenda and revisions in effect at the date of the Vendor's proposal shall be applicable).

2.1.1 American Society of Mechanical Engineers (ASME)

2.1.1.1 Steam tables

2.1.1.2 Boiler and Pressure Vessel Code, Section I, Power Boilers

2.1.1.3 Boiler and Pressure Vessel Code, Section II, Material Specifications.

2.1.1.4 Boiler and Pressure Vessel Code, Section V, Nondestructive Examination

2.1.1.5 Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications

2.1.1.6 Boiler 31.1 Power Piping

2.1.1.7 Power Test Code PTC 4.1

2.1.2 *American Society for Testing and Materials (ASTM)*

2.1.2.1 Materials specifications for appropriate product forms

2.1.3 American Gear Manufacturer's Association (AGMA)

2.1.4 American Institute of Steel Construction (AISC)

2.1.5 American Iron and Steel Institute

2.1.6 National Fire Protection Association (NFPA)

2.1.7 National Board of Fire Underwriters

2.1.8 National Electrical Manufacturer Association (NEMA)

2.1.9 Insulated Power Cable Engineer's Association (IPCEA)

2.1.10 National Electrical Code (NEC)

2.1.11 Institute of Electrical and Electronics Engineers (IEEE)

2.1.12 Tubular Exchange Manufacturer's Association (TEMA)

2.1.13 Uniform Building Code (UBC)

2.1.14 Air Moving and Conditioning Association (AMCA)

2.1.15 Steel Structures Painting Council (SSPC)

2.1.16 Industrial Gas Cleaning Institute (IGCI)

2.1.17 American Welding Society (AWS)

2.1.17.1 D1.1, *Structural Welding Code*, Steel

2.1.17.2 D1.3, Specifications for Welding Sheet Steel in Structures

2.1.18 Hydraulic Institute (HI)

2.1.19 American National Standards Institute (ANSI)

2.1.19.1 B31.1 Power Piping Code

2.1.19.2 S1.4-71, Specification for Sound Level Meters

2.1.19.3 A58.1-72 Minimum Design Loads in Building and Other Structures

2.1.20 National Bureau of Standards

2.1.21 Anti-Friction Bearing Manufacturer's Association (AFBMA)

2.1.22 Heat Exchange Institute (HEI)

2.1.23 Code of Federal Regulations (CFR)

2.1.23.1 Department of Labor's Occupational Safety and Health Act of 1970 (OSHA); Construction Industry Standards and Interpretations, Volume III, dated July 1980.

2.1.23.2 40 CFR Part 60, Appendix A, Methods 5, 6, 7, and 10, and Appendix B, Performance Specification 1.

2.1.24 Underwriter's Laboratories, Inc. (UL)

2.1.25 Environmental Protection Agency (EPA) with the exclusion of unit operation 2

2.1.26 Laws, regulations, and safety codes relating to power boilers installed in the State of Florida, exclusive of environmental effects. 2 3

2.1.27 Omission of any codes or standards does not relieve the Vendor of his responsibility to follow all applicable codes and standards.

The Vendor shall state in his proposal any additional codes and standards used in the design/fabrication process including any nondestructive examination (NDE) procedures.

Should codes or standards be revised after the issue of these specifications, the Vendor should inform the Purchaser immediately upon receipt of such information. Before adoption of any subsequent issue, or case ruling, the Vendor shall discuss the effect of these requirements with the Purchaser and proceed with material and/or fabrication changes only after the Purchaser's approval.

2.1.28 All Southern Company Services and Gulf Power Company specifications and requirements that are attached to this Inquiry as designated by the "Inquiry Contents for Inquiry No. GUTF-1" and Section 2.2 Documentation.

2.2 Documentation

The following documents are included as supplements to these specifications and will be a part of the final contract agreement:

2.2.1 Drawing Submittal Specification, dated February 5, 1979

2.2.2 Vendor Document Submittal Schedule to Engineering Office (Form No. 9-446C)

2.2.3 Instructions to Vendors Supplying Installation/Erection Drawings, dated February 7, 1978

2.2.4 General Specifications for Induction Electric Motors, Revision 5

2.2.5 Supplier Quality Program Requirements |2

2.2.6 Supplier Quality Program Requirements Erection/Installation |2

2.2.7 Vendor Deviation Request Form

2.2.8 Proposal Letter Form

2.2.9 Specifications for General Purpose Control Equipment

2.2.10 Preliminary Motor Data Form

2.2.11 Replacement of Ductwork Insulation

2.2.12 Asbestos Handling, Removal and Disposal on Plant Property

2.2.13 General Specifications for Electrical Work

2.2.14 General Specification for Power, Control & Instrumentation Cable

2.2.15 General Concrete Specifications

2.2.16 General Painting Specifications

2.2.17 Piping Specifications

2.2.18 Inquiry Drawings

2.3 <u>General Terms And Conditions</u>

The attached "General Terms and Conditions" form an integral part of these specifications and the vendor shall comply with and agree to all conditions as set forth therein. In addition, the Vendor shall understand and agree that the documents in Paragraph 2.2 shall be included in and form a part of the final contract.

2.4 Foreign Material and Equipment

All material/equipment shall be supplied by domestic suppliers. If any of the material/equipment is unavailable from domestic suppliers or if significant delay in the manufacturing schedule would result from this requirement, the Vendor shall so clearly state this as an exception to the specification. The Vendor may be given an evaluation penalty if foreign material and/or equipment are proposed.

3.0 DESIGN REQUIREMENTS

It is not the intent of this document to specify completely all details of design and fabrication; however, the equipment shall be complete within the limits of this specification and it shall conform to accepted electric utility industry standards of engineering, design, and fabrication.

3.1 General

The objectives of the NO_x reduction program at Plant Smith are as follows:

- Demonstrate in a logical stepwise fashion the performance of various advanced low NO_x combustion technologies.
- Determine the dynamic long-term NO_x emission characteristics using sophisticated statistical techniques.
- Evaluate the progressive cost-effectiveness ($/ton NO_x removed) of the low NO_x combustion technologies.

The design of the equipment and material included in the Vendor's scope of supply shall be consistent with these program objectives.

3.2 Original Equipment Design Basis

3.2.1 Boiler

Plant Smith Unit No. 2 is a Combustion Engineering reheat type, natural circulation steam generator unit, designed for indoor service to deliver 1,306,000 lbs. of steam per hour continuously at normal rated load at a pressure of 1875 PSIG and a temperature of 1000°F at the superheater outlet and a temperature of 1000°F at the reheater outlet. The unit is fired with pulverized coal and originally designed for pressurized furnace operation but was converted to balanced draft in 1976. The unit is equipped with two (2) Ljunstrom type secondary air heaters and two (2) steam coil air heaters, two (2) forced draft fans, two (2) induced draft fans and five (5) pulverizer exhausters taking suction from the pulverizers fed by gravimetric feeders. Table No. II 3.1-2 provides details of the boiler design parameters.

3.2.2 Pulverizers

The pulverizers consist of five (5) size 623 RPS Raymond Bowl pulverizers (top feed). See Drawing NE-644062-2 for arrangement.

Each pulverizer supplies coal to one (1) burner level. There are four (4) burners per level.

Fuel pipe is 12" diameter from the exhauster outlet to the burner inlet.

Mill capacity of each pulverizer is 40,000 lbs/hr based on the following coal characteristics:

Grindability - 55 HGU
Fineness - 70%-200 MESH
Feed Size - 1-1/2"
Total Moisture - 8.5%

3.2.3 Burners

Burners consist of twenty (20) Combustion Engineering tilting tangential type coal burners with air control regulators. The forty-four (44) burner air regulators are equipped with dampers, frames and Hagan air operated mechanisms with board mounted sub-panels for adjusting the amount of air entering the furnace.

Burner arrangement is tangential firing with five (5) burners in each corner.

Refer to attached drawings for elevation and location of equipment.

3.2.4 Fuel

Design for the original equipment was based on the fuel specified below:

Kind - Bituminous Coal
Grindability (Hardgrove) - 55
Size - 1-1/2"

<u>Proximate Analysis - %</u>

Moisture - 8.5
Volatile matter - 38.0
Fixed carbon - 45.0
Ash - 8.5
Softening temperature of ash - 2100°F

Ultimate Analysis

Percent by - Weight
Ash - 8.5
S - 3.7
H_2 - 4.7
C - 66.6
H_2O - 8.5
N_2 - 1.2
O_2 - 6.8
Btu/lb as fired - 12,000

3.2.5 Particulate Control Equipment

Particulate control equipment for Plant Smith Unit No. 2 consists of Buell hot-side, retrofit electrostatic precipitators, designed for outdoor operation and to handle flue gases having a design temperature of 670°F. The precipitators were designed to provide not less than 99.1 percent overall collector efficiency on a continuous basis, when supplied with 1,100,000 cfm of flue gas entering the collectors at a temperature of 670°F. The hot-side precipitators operate in series with the original cold side precipitators manufactured by American Standard.

3.3 Design Conditions

The Vendor's equipment shall be designed to achieve optimum NO_x reduction levels while maintaining the design boiler performance conditions as presented in Table No. II 3.1-2. 2

Slagging tendencies during the demonstration program shall be no greater than those identified during baseline testing with the fuel specified in Section 3.4.

3.4 Fuel

3.4.1 The fuel representative of that being burned at Plant Smith Unit 2 is the Pyro and Peabody #2 coal. Attachment A contains pertinent information on this coal.

3.4.2 The equipment supplied by the Vendor shall be designed to achieve optimum NO_x reduction levels and satisfy all guarantees identified by these specifications while firing any coals which fall into the following ranges of properties:

Proximate Analysis (As Received)

Moisture	12% maximum
Ash	13% maximum
Volatile Matter	32% minimum
Btu/lb	11,350 minimum

2

Ultimate Analysis (As Received)

Moisture	3% - 12%
Carbon	65% - 75%
Hydrogen	3% - 5%
Nitrogen	0.5% - 1.5%
Chlorine	0.0% - 0.1%
Sulfur	0.5% - 3%
Ash	5% - 13%
Oxygen	3% - 10%

3.5 Close Coupled Overfire Air System (CCOFA) and Separated Pressure Overfire Air System (SOFA)

3.5.1 The CCOFA system and the SOFA system shall be properly designed with a great deal of flexibility to achieve maximum NO_x reductions.

3.5.2 The Vendor shall supply a complete and working system for CCOFA and SOFA which includes but is not limited to the items listed in Section 1.2.

3.5.3 Delete

3.5.4 The Vendor's proposal shall include a detailed description of the proposed CCOFA system and the SOFA system and is encouraged to propose creative, state-of-the-art concepts including vertical and horizontal tilting capability, multiple OFA levels, separate ducting and high OFA flow capability.

3.6 Low NO_x Concentric Firing System (LNCFS) Levels I, II & III Systems

3.6.1 Each firing system shall be designed to provide optimum NO_x reductions.

3.6.2 The Vendor shall supply a complete and working system which includes but is not limited to the items listed in Section 1.2.2 (LNCFS Level II) and 1.2.3 (LNCFS Levels III & I).

3.6.3 Each Low NO_x firing system shall be designed to provide efficient and stable firing conditions while significantly reducing the NO_x generated by the existing firing system. The Low NO_x firing systems shall incorporate proven Low No_x firing design principles, such as staged combustion and rapid coal devolatilization, without compromising the operating ease and flexibility expected for comparable steam generating equipment. The firing system shall be designed to duplicate, as closely as possible, the original thermal design parameters of the steam generator.

The Low NO_x firing systems shall have an effective design to provide combustion air distribution and flow control. In addition, the systems shall be designed so as to minimize the risk of furnace pressure part damage due to sub-stoichiometric conditions in the combustion zone.

3.6.4 With the exception of yaw adjustments in the main windboxes and OFA windboxes and the backpressure dampers in the secondary air ducts, all manually or automatically controlled devices (dampers, vanes, burner tilts, etc.) shall be equipped with electric drive units capable of receiving 4-20ma control signals. The overfire air electric tilt drive units and one overfire air damper electric positioner per overfire air elevation shall also be equipped with position feedback hardware capable of providing a 4-20ma signal that is proportional to drive unit position.

3.6.5 Delete

3.6.6 The system shall be designed to provide for a burner turn down of at least 3 to 1.

3.6.7 The Vendor's proposal shall include a complete description of the proposed LNCFS Systems.

3.7 Auxiliary Air

3.7.1 The auxiliary air compartments and turning vanes included with the LNCFS shall be properly designed to protect the furnace sidewalls and hopper zone from a reducing atmosphere.

3.7.2 The Vendor's proposal shall include a complete discussion of the auxiliary air system supply and the method that is utilized in protecting the furnace walls from reducing atmospheres.

3.8 Burner Observation System

3.8.1 Flame observation ports shall be provided by the Vendor for each of the four corners at two (2) elevations for a total of eight (8) observation ports.

3.8.2 Flame observation ports will be selected to provide a good view of burner flames with minimal modifications to existing equipment.

3.8.3 Platforms to access observation ports shall also be provided in accordance with these specifications by the Vendor.

3.8.4 The Vendor shall supply a complete and working system which includes but is not limited to the items listed in Section 1.2.

3.8.5 The Vendor's proposal shall include a complete description of the proposed burner observation system including recommended locations for video cameras.

3.9 Flame Scanners

3.9.1 Flame scanners shall be provided by the Vendor to monitor the five main coal elevations and single warmup oil elevation.

3.9.2 Main flame scanners shall also be provided by the Vendor. Flame scanners for main coal flame shall be provided with additional contact outputs for use by the Purchaser.

3.9.3 The Vendor shall supply a complete and working system which includes but is not limited to the items listed in Section 1.2.5.

3.9.4 The Vendor's proposal shall include a complete description of the proposed flame scanner system.

3.10 HPOFA "High Set Air" Booster Fans

3.10.1 Through 3.10.12 - deleted

3.11 Dampers

3.11.1 The dampers (except for windbox air dampers) shall be opposed leaf design. The dampers shall be designed for a maximum of 5% leakage, or the minimum required for system component protection from overheating. The structural design of inlet and discharge dampers shall be adequate to withstand forces generated by the forced draft fans at shutoff. The number of damper blades shall be held to a minimum after satisfying structural requirements.

3.11.2 The structural design shall also consider the dynamic loading due to aerodynamically induced disturbances. The damper leaf and shaft assemblies shall be designed so that their natural frequencies do not coincide with any anticipated aerodynamic frequencies.

3.11.3 The damper bearings (except for windbox air damper bearings) shall be permanently lubricated sleeve type of carbon steel or an approved bronze alloy. The bearings shall be graphite lubricated Dodge or an approved equal and are to be mounted on plates welded to the flanges of the channel frame, providing a space between the packing and the bearing which is adequate to keep fly ash from entering the bearing directly from the packing. Shaft packing shall be replaceable without having to disturb bearings or the lever arms. Also, the damper bearings shall be replaceable without disturbing positioning arms or other equipment. The shaft seal shall be adequate to prevent air or gas infiltration in either direction.

3.11.4 Necessary linkages (except for windbox air dampers) for operating the dampers shall be furnished, including connecting arm for control drive linkage. The drive shaft on which the connection arm is placed shall be extended an adequate distance to prevent interference with insulation. If a double inlet fan is supplied, a common drive shaft passing through the inlet boxes shall be provided to control both dampers. Lever arms on the ends of the blade shafts shall be easily removable to make it possible to replace the bearings. (Welding is not an acceptable method of connection). Bushings in the lever arms and/or connecting arms shall be fabricated from bronze. Die stamps and permanent match marks shall be made to identify respective shaft and lever arm positions, in the absence of interchangeability. Operating bars connecting the damper lever arms shall be made from flat bars. 2

3.11.5 Blade shafts up to two inches in diameter shall be round solid bars. Larger diameter blade shafts can be made from pipe with not less than 1/4 inch wall thickness. A saw cut or similar permanent marking shall be made in the lever arm end of the blade shafts to indicate the position of blades within the damper frame. Other alternate permanent methods of providing external reference to the position of the blades shall be considered if they do not involve welding on the shafts and lever arms. Such welding shall be avoided because of possible damage to the bearings. Large surface area washers made from plate shall be installed on the shafts to maintain clearance between the ends of the blades and the inside of the frames. Tie pipe struts shall be used to further assure that clearance will be maintained.

3.11.6 Damper frames (with the exception of windbox dampers) shall be marked to indicate the direction of gas flow and the proper position and orientation with respect to the fan. A stop shall be used to prevent overstroking and can be mounted either internally or externally. If internally, bar stops shall be welded inside the frame at both ends of each blade in the damper. If external, the Vendor shall supply a complete description of method used to prevent overstroking. Damper frames should be provided with lifting lugs for use with wire rope slings. 2

3.11.7 There shall be no cast iron components in the damper assembly.

3.11.8 General arrangement drawings of the dampers (with the exception of windbox dampers) shall be submitted by the Vendor in accordance with the attached "Instructions to Vendors Supplying Installation/Erection Drawings" which are a part of these Specifications. 2

3.11.9 Two limit switches (by Namco, Square D, Allen Bradley or Cutler-Hammer) - except for the windbox air dampers-shall be supplied per damper assembly (for open and closed indication).

3.12 Electrical Equipment

3.12.1 Electric motors furnished with this Inquiry shall be designed in accordance with the "General Specification for Induction Electric Motors - Standard Design" attached to these Specifications. All motors shall be of the high efficiency type, except small motors which operate intermittently, such as for damper drives. Motors shall have the following ratings:

HP	System Voltage	Nominal Nameplate Voltage and Phase
201 and Up	4160 V	4000 V 3 PH
0.5 through 200	600 V	550 V 3 PH
Below 0.5	120 V	115 V 1 PH

Approved manufacturers for 4,000 volt motors are General Electric, Siemens, Electric Machinery, Louis Allis, and Westinghouse.

Approved manufacturers for 550 and 115 volt motors are General Electric, Siemens, Reliance Electric, and Louis Allis.

The Vendor is to complete and submit with the proposal a "Preliminary Motor Data" form for each motor to be supplied by the Vendor. After a purchase order is issued, the Vendor shall also complete and submit final motor data on the "Induction Motor Descriptive Data" form included in the "General Specification for Induction Electric Motors - Standard Design" document.

3.12.2 Conduit, wiring, and starters shall be furnished by the Vendor and shall be designed in accordance with the "General Specifications for Electrical Work" and "General Specification for Power, Control & Instrumentation Cable".

3.12.3 Control equipment furnished shall be designed in accordance with the "General Purpose Control Equipment" document.

3.13 Ductwork

3.13.1 Ductwork, dampers, and expansion joints in the Vendor's scope shall be conservatively designed in accordance with the applicable rules of AISC and the "Replacement of Ductwork Insulation" specifications.

3.13.2 All combustion air and flue gas ducts shall be welded construction fabricated from 3/16" steel plate, suitably stiffened and reinforced, and shall be provided with necessary access doors, turning vanes and expansion joints. 2

3.13.3 The lagging on all horizontal ductwork surfaces shall be designed to provide adequate drainage.

3.13.4 All duct stiffening if possible shall be external.

3.14 <u>Setting, Insulation and Lagging</u>

3.14.1 The Vendor shall provide complete setting for the modifications as required, including all necessary firebrick, refractory tile, plastic refractory, insulation, tile supports, supporting steel, casing, lagging and all other necessary materials to make a complete gas tight envelope for enclosing the boiler.

3.14.2 The exterior surfaces of insulation shall have a surface temperature not exceeding 130°F when exposed to an ambient temperature of 80°F and air velocity of 50 feet per minute.

3.14.3 Lagging shall be fluted aluminum and furnished in accordance with the "Replacement of Ductwork Insulation" specifications.

3.14.4 No asbestos insulation will be acceptable. The Vendor shall be required to provide a statement in the proposal that no asbestos is contained in insulation materials provided for these modifications.

3.14.5 The Vendor's proposal shall completely describe the setting, insulation, and lagging to be provided.

3.14.6 The Vendor shall strictly adhere to the "Asbestos Handling, Removal and Disposal on Plant Property" specifications for any existing asbestos materials encountered during the retrofit installations.

3.15 <u>Civil Structural Steel and Concrete Foundations</u>

3.15.1 The Vendor shall supply any support steel required for support of the Vendor's equipment.

3.15.2 The Vendor shall supply all platforms, walkways, ladders, and stairways required for access to the Vendor supplied equipment and materials. The Vendor's arrangement drawings submitted with the proposal shall identify access structure locations.

3.15.3 Design and fabrication shall be in accordance with the requirements of the following principal codes:

- AISC — American Institute of Steel Construction, "Manual of Steel Construction", 8th Edition.
- AISC — American Institute of Steel Construction, Code of Standard practices for Steel Buildings and Bridges, effective September 1, 1976.

- AISC Quality Criteria and Inspection Standards, 1980
- AWS D1.1.89 - American Welding Society - Structural Welding Code - Steel

Materials supplied under these Specifications shall conform to the following standard specifications of the American Society for Testing and Materials or other reference specification, as applicable:

ASTM A6-83	General Requirements for Rolled Steel Plates, Shapes, Sheet Piling, and Bars for Structural Use.
ASTM A36-81A	Structural Steel
ASTM A108-81	Steel Bars, Carbon, Cold-Finished, Standard Quality (Conveyor Pins - Grade 1045)
ASTM A153-82	Zinc Coating (Hot-Dip) on Iron and Steel Hardware (Class C)
ASTM A307-83A	Carbon Steel Externally Threaded Standard Fasteners
ASTM A325-83C	High-Strength Bolts for Structural Joints
ASTM A490-83A	Heat-Treated Steel Structural Bolts, 150 Ksi Minimum Tensil Strength
ASTM A569-72	Steel Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip, Commercial Quality (R 1979)

- Hot-rolled steel shapes and plates shall be ASTM-A36
- High strength bolts shall be ASTM-A325 and/or ASTM-A490
- Machine bolts shall be ASTM-A307
- Painting and surface preparation shall be a commercial blast SSPC-SP6 with an inorganic zinc primer
- Grating platform shall be 1-1/4" x 3/16" welded grating bars. Stair treads shall be similar with checkered plate nosing.
- Handrails shall be 1-1/4 inch pipe and shall be painted according to plant paint specifications attached.

3.15.4 Structural welding shall conform to the Structural Welding Code AWS D1.1-83.

3.15.5 Workmanship furnished by the Vendor shall conform to the following as applicable:

- AISC American Institute of Steel Construction, "Manual of Steel Construction", 8th Edition.
- AISC American Institute of Steel Construction, Code of Standard practices for Steel Buildings and Bridges, effective September 1, 1976.
- AISC Quality Criteria and Inspection Standards, 1980
- AWS D1.1.89 - American Welding Society - Structural Welding Code - Steel
- SSPC Steel Structures Painting Council Specifications

3.15.6 Additional specific design requirements for the structural steel will supplement these specifications as a result of the Purchaser's structural review of the additional loads imposed on the existing boiler house steel by the ductwork and concrete foundations if required for the Low No_x burner modifications. The Purchaser's structural review will be based on design and loading data engineered by the Vendor and submitted to the Purchaser in a timely manner to fully support the Purchaser's structural review. | 2

3.15.7 Concrete foundations, if required for the modifications shall be furnished in accordance with the attached "General Concrete Specifications". | 2

3.16 Instrumentation and Controls

3.16.1 The Vendor shall provide a complete system for control and monitoring of the equipment included in the Vendor's scope of supply. Automatic or modulating controls including Vendor supplied burner tilt controls shall integrate new control functions with the existing combustion control system. New control hardware, if required, shall be Westinghouse W.D.P.F. equipment compatible with the plant's existing combustion control hardware. Acceptance of any alternative control hardware proposed by the Vendor will require written approval by the Purchaser. All control devices such as controllers, manual/auto stations, on-off push buttons, alarms, primary instruments, transmitters and indicators shall be provided by the Vendor. The Vendor shall also supply all enclosures, interconnecting wiring, conduit, and cable trays (as required). | 2

3.16.2 The Vendor's instrumentation and controls systems shall comply with the attached document entitled "General Purpose Control Equipment".

3.16.3 Any control panel supplied by the Vendor shall include a double-pole circuit breaker for each 125 V DC incoming feeder and a single pole circuit breaker for each 120 V AC incoming feeder. The circuit breaker shall have suitable rating for short circuit as well as overload protection. 600 V power circuits for various valve or damper drive units shall be individually protected by molded case breakers.

3.16.4 Loss of power of any voltage level used within the Vendor's equipment shall be detected and individually annunciated or indicated within the logic cabinets, with engineering, plant personnel and other designated agents of common power failure alarm contacts for the main control room. Direct current power supplies shall be fully diode protected so that back-feeding from one supply to another will be impossible. All fuses and circuit breakers shall be monitored for loss of power, and contacts provided for alarm.

3.16.5 The Vendor shall supply complete systems for control both locally and also in the Purchaser's boiler control room. The Vendor shall work closely with engineering, plant personnel and other designated agents of the Purchaser to assure that the instrumentation and controls for the Purchaser's boiler control room are located and mounted in a manner which is acceptable to both the Vendor and the Purchaser. The Purchaser's site representative shall be closely involved in this effort.

3.16.6 Functional control diagrams, logic diagrams, and written descriptions describing the equipment manufacturer's intended method of safe and efficient operating requirements and control shall be provided by the Vendor in the proposal. The proposal shall include a complete list of all parameters to be monitored and/or controlled. The proposal shall also state which parameters are manual versus automatic and which are local versus remote.

3.16.7 The Vendor's proposal shall include a complete description of the instrumentation and control systems.

3.17 <u>Air Preheater Elements</u>

3.17.1 The Vendor shall replace the existing air preheater dense-pack type elements with new Type DL elements in the hot, intermediate and cold sections of the air preheater. The new basketed elements will allow the existing forced draft fans to provide air at adequate pressure and velocity to the SOFA system.

3.17.2 The Type DL elements shall heat the primary and secondary air such that the elements operate in accordance with the performance guarantees stated in Paragraph 9.2.1. In his proposal, the Vendor shall provide guaranteed performance data for the air preheater with the new Type DL elements.

3.18 Flow Modeling

3.18.1 The Vendor shall perform a flow model study of the baseline condition, LNCFS Levels II & III firing systems, including the windbox nozzle configurations, overfire air configurations and ductwork, furnace, and high temperature superheater and reheater sections. Backpass convective sections will not be included as they have no effect on in-furnace flow and mixing. The model shall encompass the unit from the hopper through the furnace outlet.

3.18.2 The furnace model shall be constructed to a 1:12 scale (overfire air duct system constructed to a 1:6 scale) and fabricated of 1/2 inch Plexiglas. The internal heat transfer surfaces shall be fabricated of sheet metal and perforated plate.

3.18.3 Characterization of the existing flow distribution is an important element in designing the scale model of the system. It must be demonstrated that the scale model adequately represents the flow patterns that exist within the full-scale system. While it is not possible on the full-scale system to take all of the necessary flow measurements to fully characterize the flow patterns, sufficient measurements will taken by the Purchaser to allow a first order approximation for validation of the scale model. Scale model validation will consist of comparing model flow distributions (velocity vectors) with full-scale values measured at specific locations and under known flow conditions (total mass flows in each duct). Any disparities between the model and the full-scale flow characteristics shall be corrected by physical modification of the scale model and/or velocity correction algorithms.

3.18.4 The following paragraphs provide guidance for the flow modeling technique to be utilized:

(a) To properly model the flow distribution, the internal geometry and flow restrictions must be accurately reproduced. Geometric scaling of the internal geometry must be performed in great detail and all minor restrictions, such as supports, ribs, piping, and other obstructions, that are larger than approximately one-half foot in cross-sectional dimension must be included to obtain accurate reproduction of the flow paths and distribution. The Reynolds number (which represents the ratio of inertial to viscous forces in the flow field) need not be simulated exactly in the model since the duct flow is turbulent. However, in order to obtain measurable levels of velocity and pressure drop, velocities on the order of the field unit must be achieved in the model. This corresponds to Reynolds numbers well in excess of the minimum recommended level of 15,000.

(b) The scale of the model must be large enough for the model structure to be crafted accurately and simply. Also, it must be large enough to allow definition and detail of flow patterns. Yet the model must be small enough to construct easily, to accommodate available flow visualization techniques, and to achieve velocity levels that allow accurate velocity and pressure drop measurement. Taking these factors into consideration, a geometric scaling factor of approximately 1/10th is appropriate along with a flow capacity up to 8,000 scfm.

(c) The short-term combustion air flow measurements shall be used to provide the furnace flow conditions, windbox flow distribution and the duct inlet conditions to assist in model development and verification where possible. The Vendor shall specify what flow measurement method(s) will be utilized to quantify the degree of change in flow patterns and velocities that results from the design modifications. The Vendor shall include in this specification visualization techniques that will be applied as well as the actual measurement devices specified for the flow modeling.

3.18.5 The Vendor shall include in the proposal a complete detailed description of the scope of flow modeling proposed for this project. The Vendor shall state in the proposal if a scale model of the burner will be utilized or if the flow and pressure drop characteristics of the burner will be approximated by other means. A complete discussion shall be included in the Vendor's proposed visual and quantitative measurement techniques for the flow modeling. The Purchaser shall solicit flow model proposals from approved flow model Vendors for evaluation along with the Vendor's flow model proposal.

3.19 <u>Replacement Parts</u> 2

3.19.1 Delete

3.19.2 A complete list of recommended spare parts shall be furnished in accordance with the contract VDSS. This list is to include the description of part, part number, itemized pricing and approximate lead times. The Purchaser shall retain the right to select or reject any parts so listed without affecting any other provisions of the order. 3

3.19.3 The Vendor shall provide a recommended maintenance schedule for use in determining operation and maintenance and replacement parts requirements. 2

3.20 <u>Tools</u>

3.20.1 A complete set of any special tools required for the operation and/or maintenance of the equipment proposed shall be furnished as a part of the equipment.

3.21 Sound Data

The Vendor shall include in his proposal the predicted sound power levels (re 10^{-12} watts) for all major equipment (such as fans, pumps, motors, pump and motor assemblies, valves, controls, etc., that comprise an operable package) proposed in response to this Inquiry when the equipment is operating at the condition which produces the maximum sound power level. The predicted sound level at a distance of one meter from the equipment boundary and one and one-half meters above base level shall not exceed an A-weighted sound pressure level of 85 dBA in a free field. The Vendor shall:

(a) List maximum predicted sound power level

(b) List operating conditions at which maximum noise level occurs.

3.22 Occupational Safety and Health Act of 1970 (OSHA)

All equipment, materials, erection procedures, etc., required by these Specifications shall be in compliance with the Federal Occupational Safety and Health Act of 1970.

3.23 Training

The Vendor shall outline in his proposal a recommended training program, including the number of training hours that will be required to prepare the Purchaser's personnel to operate and maintain the equipment supplied by the Vendor.

4.0 FABRICATION REQUIREMENTS

4.1 Welding Procedures

4.1.1 All welding procedures, welders and welding operators for the boiler tube assemblies shall be qualified in strict accordance with ASME Boiler and Pressure Vessel Code, Section IX. Welding of structural steel shall be according to the provisions of the structural steel specifications.

4.1.2 After award, the successful Vendor shall make available his welding, heat treating, and special process procedures for review by the Purchaser at the Vendor's manufacturing facility, if requested.

4.2 Tube Welding

4.2.1 The outside diameter and inside diameter of the tubes shall be free of all scale prior to welding.

4.2.2 All tube ends shall have machined end preparation for field welds.

4.3 <u>Shop Assembly</u>

4.3.1 Shop assembly of the system furnished shall be optimized with respect to shipping limitations and easy handling within the confines of the building, boiler and its accessories.

4.3.2 Vendor shall maximize the number of shop pre-assemblies, as applicable, to minimize the number of field welds.

4.4 <u>Cleanliness and Preparation for Shipment</u>

4.4.1 The shop assembled assemblies will be stored by the Vendor out of doors; therefore, all exposed surfaces on equipment and materials furnished shall be adequately painted, flushed, or otherwise treated to prevent atmospheric corrosion during shipment, storage, and field erection.

4.4.2 Tube assemblies shall be thoroughly drained and dried after the shop hydrostatic test. Tubes shall be shipped and protected with their internals in a condition ready to be placed in service.

4.4.3 Tube ends shall be provided with closures to prevent damage and entrance of foreign material during handling, shipment, and storage. No finished-machine surfaces shall be left unprotected.

4.5 <u>Materials</u>

The materials of construction used shall be those which, based on past experience, have proven most desirable for this particular application. The Vendor shall be responsible for all materials used in the design of this equipment.

4.6 <u>Painting and Weather Protection</u>

The Vendor shall prepare all articles for shipment in such a manner that they will be reasonably protected from any damage in handling and transit. All exposed surfaces on equipment and materials furnished shall be adequately painted, slushed, or otherwise treated to prevent atmospheric corrosion during shipment, storage and field erection. The Vendor shall take steps to protect all material surfaces until final field painting is completed. Any openings in equipment shall be provided with a closure to prevent the entrance of foreign material. No threads or finished-machine surfaces shall be left unprotected.

4.7 Cleaning of Metal Parts

Vendor shall make available a complete description of the cleaning, in the form of shot blasting, sand blasting, grit blasting, acid cleaning, pickling, etc., that he proposes to do in his shops for review by the Purchaser at the Vendor's shop, if required. The Vendor shall also make available both his mandatory requirements for field cleaning and his recommendations for field cleaning and disposal of any waste materials.

4.8 Other Requirements

The Vendor shall fulfill all other fabrication requirements included elsewhere in this Specification.

5.0 ERECTION

5.1 Field Erection

Purchaser desires that complete field erection be quoted as follows:

5.1.1 All equipment and materials furnished by the Vendor shall be erected in place by the Vendor. The Vendor shall be responsible for insuring that all start-up problems that may occur with the retrofits are resolved before the start of the formal test program. The Vendor will be allowed a reasonable time for resolving start-up problems and fine tuning required for the retrofits, but these activities should not exceed two weeks duration. The Vendor shall provide adequate covered storage space for Vendor's equipment, materials, erection tools, etc., in a salt water environment. In addition, the Vendor shall provide adequate coverage for any burners, windbox components, tubes, duct, piping, steel, etc., that is to be removed from the unit to prepare for the specified retrofits. Since there is a possibility that it will be necessary to use some or all of this equipment after the retrofits, the equipment shall be stored under covered storage to avoid any degradation from its present condition. Unloading and storage of materials and equipment shall be done by the Vendor. The Vendor's storage area will be within a reasonable distance of the area in which the Vendor's equipment will be installed. The Vendor shall furnish temporary construction buildings as required for field office, tool rooms, covered storage, etc.

5.1.2 The Vendor shall furnish all tools, hoists, jacks, or other erection equipment required. The Vendor shall furnish all scaffolding and the labor for the erection of the equipment.

5.1.3 The Vendor shall be responsible for storage of original equipment and materials which may be utilized later to restore the unit to its original condition.

5.1.4 Each Vendor shall submit with his proposal a proposed schedule (including bar chart) of construction showing the dates for start of construction, progress of work, etc. Boiler outages that are greater than specified below for each retrofit are not acceptable. Current schedule for modifications is anticipated to be as follows: 2

- Air preheater elements and site preparation outage - October, 1990 (two week outage)
- LNCFS Level II installation - April, 1991 (three week outage)
- LNCFS Level III and Level I (simulated) installation - October, 1991 (two week outage)

5.1.5 The Purchaser's inspector shall have free access to the work at all times during the process of the erection.

5.1.6 The Vendor shall state in the erection proposal any equipment and/or services that will have to be supplied by the Purchaser for the erection of supplied equipment.

5.1.7 The Vendor's proposal shall include the proper removal and disposal of any asbestos containing materials which are impacted by the modifications. The attached general insulation removal specifications provide specific requirements to be followed by the Vendor.

5.2 Technical Direction of Installation

Delete

5.3 SOFA Retrofit

The following is a general listing of activities which may be required during the installation of the CCOFA and SOFA systems to be installed with the LNCFS. The listing is provided for general information only and is not intended to be all inclusive.

1) Utilizing the results of flow models of the duct system, aerodynamically smooth ductwork, including flow control dampers, will be fabricated for installation in the main supply plenum at each side of the furnace.

2) Furnace lagging will be removed in the location of the installation of the CCOFA and SOFA ports.

3) Sections of the waterwall will be removed to accommodate the CCOFA and SOFA ports.

4) Waterwall tubes will be cut to accommodate shop fabricated bent tube assemblies designed to closely surround the CCOFA and SOFA ports.

5) Refractory material will be installed around the ports to provide a seal between the furnace and the ambient air.

6) Insulating material will be removed from the main air supply plenums to accommodate the CCOFA and SOFA ducts and dampers. (Note: Asbestos materials may be present.)

7) Deleted

8) The duct assembly will be connected to the plenum and the CCOFA port assembly.

9) Insulating material on the ducts and lagging material on the furnace will be replaced. (Note: Asbestos materials may be present.)

10) Limit switches, control indicators, drive mechanisms, power supplies and control systems will be installed for the CCOFA and SOFA assembly as required.

The SOFA duct and dampers will be shop fabricated and assembled on-site. Some minor field modifications may be necessary to accommodate the ductwork to the port and combustion air plenum.

The Vendor's proposal shall include a detailed list of erection activities.

5.4 LNCFS LEVEL II Retrofit

The following is a general listing of activities which may be required during the installation of the Low NO_x Concentric Firing System. The listing is provided for general information only and is not intended to be all inclusive.

1) Removal of existing coal and air nozzles.

2) Installation of new air nozzles.

3) Installation of new burners and flame holder coal nozzle tips.

4) Modifications of the existing windbox to incorporate the new LNCFS Level II firing system.

5) Installation of new separated overfire air windboxes and offset corner tube panels.

6) Installation of a new separated overfire air ductwork system including hangers, supports, insulation and lagging.

7) Installation of new overfire air control system, and interfacing of the new system with the existing combustion control system.

8) Delete

9) Modification of the windbox internals and tilt linkages to incorporate the LNCFS Level II modifications.

Aside from the major changes described above, instrumentation supports, control mechanism drives and arms, removal of casing, etc., will have to be provided by the Vendor.

All of the equipment necessary for the LNCFS Level II installation shall be shop fabricated and installed in the field with minor adjustments for clearances.

5.5 <u>LNCFS Level III Retrofit</u>

The following is a general listing of activities which may be required during the installation of the LNCFS Level III. The listing is provided for general information only and is not intended to be all inclusive.

1) Clustering of the first and second elevations of coal nozzles (top of windbox) to allow for the installation of a close coupled overfire air system.

2) Delete

3) Delete

4) Modification of the windbox internals and tilt linkage to incorporate the LNCFS Level III modifications.

5) Relocation of the existing side ignitors and flame scanners if required for the new coal and oil elevations.

6) Modification of the existing coal piping as required for the new coal elevation locations.

7) Installation of new separated overfire air windboxes and offset corner tube panels.

8) Installation of a new overfire air ductwork system including hangers, supports, insulation and lagging.

9) Installation of a new close coupled overfire air control system, and interfacing of the new system with the existing combustion control system. 4

10) Installation of new LNCFS Level III flame holder coal nozzle tips (at the discretion of the Vendor, if required). 4

(Note: Items 7 and 8 will be carried out during the LNCFS Level II retrofit outage). 4 5

All of the components required for the LNCFS Level III retrofit shall be shop fabricated and field installed with minor modifications to provide sufficient clearances. Aside from the major changes described above, flame scanners, oil ignitor flexible hose, limit switches, control indicators, etc., will be repositioned to provide the necessary safety and control observation capability. 4

6.0 ACCEPTANCE CRITERIA

6.1 Hydrostatic Tests

6.1.1 After completion of erection, all new pressure parts may be hydrostatically tested by the Purchaser. Any gaskets or packing requiring replacement after hydrostatic testing shall be furnished and installed by the Purchaser. 2 3

6.1.2 Shop assemblies shall be hydrostatically tested in the shop in accordance with the ASME Code. These tests shall be witnessed by the Purchaser, if requested.

6.1.3 Field welds for all boiler tube assemblies shall be radiographed. Radiography test report shall be furnished to Purchaser, if requested. 2

6.1.4 All boiler tube assemblies installed by the Vendor may be hydrostatically tested by the Purchaser. Maximum test pressure shall be held for twenty minutes. No leakage in pressure parts installed by the Vendor as part of the LNCFS will be acceptable. 2 4

6.2 Air Tests

6.2.1 Delete 2

6.3 Site Preparation

6.3.1 Before any modifications are implemented, an analysis of the existing equipment will be conducted by the Purchaser. The purpose of this portion of the field evaluation is to correct deficiencies that can be accomplished with minor equipment and instrumentation modifications and repairs. The objective is to eliminate factors that would result in operational or emissions characteristics that are not representative of the majority of tangentially-fired boilers.

6.3.2 To identify deficiencies, a series of diagnostic tests will be conducted by the Purchaser to quantify the operating and equipment status of the Smith Plant. Tests will be performed to evaluate the following:

1) Mill fineness distribution
2) Mill-to-mill coal distribution
3) Air heater cleanliness, and leakage
4) Control device responsiveness
5) Damper operability
6) General dynamic boiler response
7) Air supply system distribution
8) Slagging conditions

During this task, the instrumentation systems will be evaluated for sufficiency with regard to the overall program objectives.

The results of these tests will be used to, if necessary, recommend changes that are consistent with normal maintenance practices of utility operation. No major equipment modifications are planned. However, if needed, changes will be made to provide the following operating conditions:

1) Insure coal-fineness is within specifications
2) Insure that coal distribution to all burners is acceptably uniform
3) Insure burner and air supply control mechanisms function adequately
4) Verify that dynamic boiler controls function adequately
5) Verify and calibrate critical existing plant instrumentation

6.3.3 Subsequent to the completion of the equipment repairs, the boiler will be brought back on line. Since some modifications may be made that can affect the operation of the boiler, re-establishment of acceptable operating modes will need to be performed. In addition, as a result of observations during the initial emission characterization, other operational changes may need to be implemented. During this short effort, gaseous measurements will be made using the continuous monitoring system in the manual mode. The configuration that is established will be used during the subsequent baseline characterization tests.

6.4 Flow Modeling

6.4.1 Since the CCOFA and SOFA concepts depend upon good upper furnace mixing, subscale flow modeling will be performed by the Vendor to insure that the injection velocity and flow distribution is sufficient. Flow modeling will be performed to design the system to insure that the burners, duct and injection nozzles are aerodymancially efficient. This will include the following:

1) Evaluation of air supply distribution measurements performed during the emissions characterizations described above

2) Construction of a 1:12 scale Plexiglas furnace, windbox duct and CCOFA and SOFA port flow model (SOFA duct system is constructed at 1:6 scale)

3) Flow testing to verify locations of turning vanes, duct geometry and CCOFA and SOFA nozzle configurations

4) Design of CCOFA and SOFA configuration for installation in the Smith unit

6.4.2 The design of the CCOFA and SOFA flow models will be coordinated with the existing boiler windbox design and location relative to pipes, platforms, etc., to insure that the designs are compatible.

6.4.3 The Purchaser shall have the right to witness the flow modeling and shall have final approval of the recommended scope.

6.5 Instrumentation

The following new boiler instrumentation and test equipment will be installed and certified on the unit prior to the baseline test phase:

1) Gas Analysis System
2) On-line LOI Monitor
3) Heat Flux Monitors
4) Flame Observation System
5) Flame Scanners
6) Continuous Emissions Monitor
7) Data Acquisition System

Included in this task is the startup and certification of each piece of instrumentation. The Vendor shall be responsible for the supply, installation, startup and certification of Item 4 - Flame Observation System and Item 5 - Flame Scanners. Items 1, 2, 3, 6 and 7 are the responsibility of the Purchaser.

6.6 Baseline Characterization (Pre-retrofit Testing)

6.6.1 Short-Term Baseline Tests: A comprehensive series of tests will be performed by the Purchaser to characterize the emissions and performance of the boiler in a configuration representative of similar tangentially-fired coal-fired boilers. These characterizations will be performed with the boiler on manual and off load dispatch for most of the the testing. Steady-state conditions will be established during these one to four hour test durations.

The following types of characterizations will be performed using the short-term data:

1) NO_x emissions as a function of load, excess oxygen, burner tilt, mills-in-service, combustion airflow bias and other parameters that are shown to influence NO_x emissions based upon data from this data collection effort

2) Precipitator inlet particle loading, size, carbon content and SO_3 at a number of acceptable firing conditions which are representative of long-term normal operation

3) ASME PTC 4.1 Short-form Boiler Efficiency will be characterized at the same conditions as 2) above and at selected points from 1) above

4) Other environmental and safety parameters required to satisfy the program criteria

Measurement of the following parameters will be evaluated to allow determination of the above short-term characteristics:

1) NO, O_2, CO, HC, SO_2, opacity

2) Particulates, particulate size, carbon content, SO_3 and resistivity

3) Coal particle size, mill coal distribution, pulverized coal samples

4) Furnace exit gas temperatures, CO and ash samples

5) Boiler tube temperatures, furnace heat flux, boiler heat balances

6) Gaseous temperatures and pressures throughout the boiler

7) Other selected parameters which are determined to enhance the characterizations.

Baseline unit performance for the Vendor's performance guarantees will be established during the Short-Term Baseline Tests. 2

All tests will be performed at steady-state conditions for periods of one to four hours each.

6.6.2 Long-Term Baseline Characterization: Subsequent to the Short-Term Baseline Characterization, the unit will be run under load dispatch control for a period of no less than eleven weeks. Load dispatch will be according to the Southern Company system standard practices. During the eleven week period, monitoring of the emission and performance data will be accomplished by the Purchaser using the Purchaser's Data Analysis System (DAS). Following the eleven week period, a one week period of abbreviated testing will be performed to assess whether significant changes have occurred during the long-term period.

Statistical analyses will be performed to characterize the following types of information:

1) The average emission level of the baseline NO_x emissions

2) Response Surface models of the NO_x as a function of load and excess oxygen

3) Response Surface Models of performance related parameters

4) Achievable 30-day emission levels for the actual load scenario

5) Achievable 30-day emission levels for simulated load scenarios

Measurements that will be made during the eleven week long-term test sequence to make these characterizations will include:

1) NO, CO, O_2, HC, SO_2
2) Measurements for ASME PTC 4.1
3) Selected tube and gaseous temperatures and pressures

All of these measurements will be automatically, continuously recorded by the DAS and logged computer diskettes as 6 to 10 minute averages for future analysis.

6.6.3 Subsequent to the eleven week long-term testing, a short test period of approximately one week will be used to determine if significant changes in operating conditions have taken place. The tests performed by the Purchaser during this period will be an abbreviated form of the short-term tests described previously.

6.6.4 Based upon the results of the baseline characterization, the Purchaser and Vendor shall mutually agree upon performance goals to be established as minimum performance parameters which are to be achieved or bettered in post-retrofit testing. The following goals for reduction in NO_x emissions have been established for the project: 2 2

32% reduction in NO_x emissions for the LNCFS Level I

40% reduction in NO_x emissions for the LNCFS Level II 2

50% reduction in NO_x emissions for the LNCFS Level III 2

6.7 <u>CCOFA Characterization</u>

6.7.1 Delete

6.7.2 Delete

6.7.3 Delete 2

6.7.4 Delete

6.7.5 Delete

6.7.6 Delete

6.8 <u>LNCFS Level II Characterization</u>

6.8.1 This portion of the field evaluation of the total program is designed to evaluate the characteristics of the Low NO_x Concentric Firing System (LNCFS) Level II implemented on the Smith unit. 2

The LNCFS Level II retrofit is expected to last for a period of approximately three (3) weeks. During the outage of the LNCFS Level II installation, slag deposits will be gathered by the Purchaser for future analysis. Ultrasonic measurements of tube wall thickness will be made by the Purchaser at numerous points within the furnace zone. A limited amount of tube wall thickness measurements will be made by the Purchaser using tube sections extracted from the furnace walls at strategic locations that show previous accelerated thickness decreases.

6.8.2 LNCFS Level II Tuneup:

Subsequent to the completion of installation of the LNCFS Level II, the boiler will be brought back on line. Since some modifications may be made that can affect the operation of the boiler, re-establishment of acceptable operating modes will need to be performed. In addition, other operational changes may need to be implemented. During this short effort, gaseous measurements will be made using the continuous monitoring system in the manual mode. The configuration established in this element will be used during the subsequent short-term characterization.

6.8.3 Short-Term LNCFS Level II Tests: 14

A comprehensive series of tests will be performed by the Purchaser to characterize the emissions and performance of the boiler in a configuration representative of similar tangential coal-fired boilers. These characterizations will be performed with the boiler on manual and off-load dispatch for most of the testing. Steady-state conditions will be established during these one to four hour test durations.

The following types of characterizations will be performed using short-term data:

1) NO_X emissions as a function of load, excess oxygen, burner tilt, mills-in-service, combustion airflow bias and other parameters that are shown to influence NO_X emissions

2) Precipitator inlet particle loading, size, carbon content and SO_3 data at a number of acceptable firing conditions which are representative of long-term normal operation

3) ASME PTC 4.1 Short-form Boiler Efficiency will be characterized at the same conditions as number 2) above and at selected points from number 1) above

4) Other environmental and safety parameters required to satisfy the criteria

Measurements of the following parameters will be evaluated to allow determination of the above characteristics:

1) NO, O_2, CO, HC, SO_2, opacity

2) Particulates, particulate size, carbon content, SO_3 and resistivity

3) Coal particle size, mill coal distribution, pulverized coal samples

4) Furnace exit gas temperatures, CO and ash samples

5) Boiler tube temperatures, furnace heat flux, boiler heat balances

6) Gaseous temperatures and pressures throughout the boiler

7) Other selected parameters which are determined to enhance the characterizations

All tests will be performed at steady-state conditions for periods of one to four hours each.

6.8.4 Verification of Vendor's performance guarantees shall be performed during the Short-Term LNCFS testing.

6.8.5 Long-Term LNCFS Level II Characterization

Subsequent to the Short-Term LNCFS Level II Characterization, the unit will be run under load dispatch control for a period of no less than eleven weeks. During the eleven week period, monitoring of the emission and performance data will be accomplished by the Purchaser using the Data Analysis System. Following the eleven week period, a one week period of abbreviated testing will be performed by the Purchaser to access whether significant changes had occurred during the long-term testing.

Statistical analyses will be performed to characterize the following types of information:

1) The average emission level of the retrofit NO_x emissions

2) Response Surface models of the NO_x as a function of load and excess oxygen

3) Response Surface Models of retrofit performance related parameters

4) Response Surface Model of the NO_x reduction from the baseline characterizations

5) Response Surface Model of the difference in performance related parameters in baseline conditions and the condition above

6) Achievable 30-day emission levels for the actual load scenario

7) Achievable 30-day emission levels for simulated load scenarios

Measurements that will be made during the eleven week long-term test sequence will include:

1) NO, CO, O_2, HC, SO_2

2) Measurements for ASME PTC 4.1

3) Selected tube and gaseous temperatures and pressures

All of these measurements will be automatically, continuously recorded by the DAS and logged on computer diskettes as 6 to 10 minute averages for future analysis.

Measurements that will be made during the subsequent one week period test sequence will include:

1) NO, CO, O_2, HC, SO_2, opacity

2) Measurements for ASME PTC 4.1

3) Selected tube and gaseous temperatures and pressures

4) Particulates, particulate size, carbon loss

5) Furnace exit gas temperatures, CO and ash samples

Items number 1), 2) and 3) will be measured using the GAS in the manual mode. Items 4) and 5) are extractive intermittent data.

6.8.6 Subsequent to the eleven week long-term testing, a short test period of approximately one week will be used to determine if significant changes in operating conditions have taken place. The tests performed by the Purchaser during this period will be an abbreviated form of the short-term tests described previously.

Note: Delete

6.9 <u>LNCFS Level III Characterization</u>

6.9.1 This portion of the field evaluation of the program will evaluate the characteristics of the LNCFS Level III when implemented on the Smith unit. During this effort, the LNCFS Level III will be operated with various quantities of OFA to evaluate the impact on the entire system.

The LNCFS Level III retrofit is expected to last for a period of approximately two (2) weeks. During the outage for the LNCFS Level III installation, slag deposits will be gathered for future analysis. Ultrasonic measurements of tube wall thickness will be made by the Purchaser at numerous points within the furnace zone. A limited amount of tube wall thickness measurements will be made by the Purchaser using tube sections extracted from the furnace walls at strategic locations that show previous accelerated thickness decreases.

6.9.2 LNCFS Level III Tune-up

Subsequent to the completion of installation of the LNCFS Level III, the boiler will be brought back on line. Since some modifications may be made that can affect the operation of the boiler, re-establishment of acceptable operating modes will need to be performed. In addition, other operational changes may need to be implemented. During this short effort, gaseous measurements will be made by the Purchaser using the continuous monitoring system in the manual mode. The configuration established in this element will be used during the subsequent short-term characterization.

6.9.3 Short-Term LNCFS Level III Tests

A comprehensive series of tests will be performed by the Purchaser to characterize the emissions and performance of the boiler in a configuration selected during the tune-up. These characterizations will be performed with the boiler on manual and off load dispatch for most of the testing. Steady-state conditions will be established during these one to four hour test durations.

The following types of characterizations will be performed using short term data:

1) NO_x emissions as a function of load, excess oxygen, burner tilt, mills-in-service, combustion airflow bias and other parameters that are shown to influence NO_x emissions

2) Precipitator inlet particle loading, size, carbon content and SO_3 data at a number of acceptable firing conditions which are representative of long-term normal operation

3) ASME PTC 4.1 Short-form Boiler Efficiency will be characterized at the same conditions as number 2) above and at selected points from number 1) above

4) Other environmental and safety parameters required to satisfy the criteria

Measurements of the following parameters will be evaluated to allow determination of the above characteristics:

1) NO, O_2, CO, HC, SO_2, opacity

2) Particulates, particulate size, carbon content, SO_3 and resistivity

3) Coal particle size, mill coal distribution, pulverized coal samples

4) Furnace exit gas temperatures, CO and ash samples

5) Boiler tube temperatures, furnace heat flux, boiler heat balances

6) Gaseous temperatures and pressures throughout the boiler

7) Other selected parameters which are determined to enhance the characterizations

All tests will be performed at steady-state conditions for periods of one to four hours each.

6.9.4 Verification of Vendor's performance guarantees shall be performed during the short term LNCFS Level III testing. 4

6.9.5 Long-Term LNCFS Level III Characterization 4

Subsequent to the Short-Term LNCFS Level III Characterization, the 4
unit will be run under load dispatch control for a period of no less than eleven weeks. During the eleven week period, monitoring of the emission and performance data will be accomplished by the Purchaser using the Data Analysis System (DAS). Following the eleven week period, a one week period of abbreviated testing by the Purchaser will be performed to access whether significant changes had occurred during the long-term testing.

Statistical analyses will be performed to characterize the following types of information:

1) The average emission level of the retrofit NO_x emissions

2) Response Surface Models of the NO_x as a function of load and excess oxygen

3) Response Surface Models of retrofit performance related parameters

4) Response Surface Model of the NO_x reduction from the baseline characterizations

5) Response Surface Model of the difference in performance related parameters in the baseline conditions and the conditions above

6) Achievable 30-day emission levels for the actual load scenario

7) Achievable 30-day emission levels for simulated load

Measurements that will be made during the eleven week long-term test sequence will include:

1) NO, CO, O_2, HC, SO_2

2) Measurements for ASME PTC 4.1

3) Selected tube and gaseous temperatures and pressures

All of these measurements will be automatically, continuously recorded by the DAS and logged on computer diskettes as 6 to 10 minute averages for future analysis.

Measurements that will be made during the subsequent one week period test sequence will include:

1) NO, CO, O_2, HC, SO_2, opacity

2) Measurements for ASME PTC 4.1

3) Selected tube and gaseous temperatures and pressures particulate size, carbon loss

5) Furnace exit gas temperatures, CO and ash samples

Items number 1), 2) and 3) will be measured using the CMS in the manual mode. Items 4) and 5) are extractive intermittent data.

6.9.6 Subsequent to the eleven week long-term testing, a short test period of approximately one week will be used to determine if significant changes in operating conditions have taken place. The tests performed by the Purchaser during this period will be an abbreviated form of the short-term tests described previously.

6.10 <u>LNCFS Level I Characterization</u>

6.10.1 Subsequent to the completion of the Level III long-term characterization, the LNCFS Level I system will be simulated for short-term evaluations. Since some modifications may be made that can affect the operation of the boiler, re-establishment of acceptable operating modes will need to be performed. In addition, other operational changes may need to be implemented. During this short effort, gaseous measurements will be made by the Purchaser using the continuous monitoring system in the manual mode. The configuration established in this element will be used during the subsequent short-term characterization.

6.10.2 Short-Term Characterization LNCFS Level III + SOFA

A comprehensive series of tests will be performed by the Purchaser to characterize the emissions and performance of the boiler in a configuration selected during the tune-up. These characterizations will be performed with the boiler on manual and off load dispatch for most of the testing. Steady-state conditions will be established during these one to four hour test durations.

The following types of characterizations will be performed using short term data:

1) NO_x emissions as a function of load, excess oxygen, burner tilt, mills-in-service, combustion airflow bias and other parameters that are shown to influence NO_x emissions

2) Precipitator inlet particle loading, size, carbon content and SO_3 data at a number of acceptable firing conditions which are representative of long-term normal operation

3) ASME PTC 4.1 Short-form Boiler Efficiency will be characterized at the same conditions as number 2) above and at selected points from number 1) above

4) Other environmental and safety parameters required to satisfy the EHSS criteria

Measurements of the following parameters will be evaluated to allow determination of the above characteristics:

1) NO, O_2, CO, HC, SO_2, opacity

2) Particulates, particulate size, carbon content, SO_3 and resistivity

3) Coal particle size, mill coal distribution, pulverized coal samples

4) Furnace exit gas temperatures, CO and ash samples

5) Boiler tube temperatures, furnace heat flux, boiler heat balances

6) Gaseous temperatures and pressures throughout the boiler

7) Other selected parameters which are determined to enhance the characterizations

All tests will be performed at steady-state conditions for periods of one to four hours each. |2

6.10.3 Delete

3) Selected tube and gaseous temperatures and pressures

4) Particulates, particulate size, carbon loss

5) Furnace exit gas temperatures, CO and ash samples

Items number 1), 2) and 3) will be measured using the CMS in the manual mode. Items 4) and 5) are extractive intermittent data.

6.10.5 Subsequent to the eleven week long-term testing, a short test period of approximately one week will be used to determine if significant changes in operating conditions have taken place. The tests performed by the Purchaser during this period will be an abbreviated form of the short-term tests described previously.

6.11 Vendor Participation

The responsibly for overall testing activities will be subcontracted by the Purchaser to Energy Technology Consultants, Inc. (ETEC). Participation by the Vendor in evaluating the test program and results is encouraged but is not required. The Vendor shall include a detailed discussion of how and to what extent the Vendor would prefer to be involved in the testing program. It should be understood however, that while the Purchaser will consider any input provided by the Vendor, any final decisions concerning the test program or results of the test program shall ultimately be made by the Purchaser. 2

7.0 QUALITY ASSURANCE

7.1 General

The Vendor shall comply with the attached documents entitled "Supplier Quality Assurance Requirements", which are a part of these specifications, or shall submit his Quality Assurance Program requirements for review by the Purchaser. The following SQAR's will apply to the specified equipment: 2

	EQUIPMENT	SQAR
(a)	Complete System	2
(b)	Erection	2A

Purchaser QA requirements are supplementary to the tests, inspections and other specified quality assurance and quality control provisions set forth elsewhere in these Specifications and other contractural documents. 2

7.1.1 Quality Assurance Control

The Vendor shall submit with the proposal a description of the Quality Assurance Control Programs which will be followed to insure meeting the requirements of this Inquiry and the applicable codes.

7.2 Exceptions to Quality Assurance Requirements

The Vendor shall secure written permission for any deviations from the provisions of the attached SQAR's unless otherwise provided in the Specifications.

8.0 DOCUMENTATION AND DATA SUBMITTAL TO PURCHASER BY VENDOR

8.1 Documentation Delivered to Jobsite

8.1.1 Documentation required upon delivery of equipment/material shall be developed and provided in accordance with the attached Supplier Quality Assurance Requirements Supplement referenced in Paragraph 7.0. The Vendor shall transmit all required documentation in accordance with project correspondence routine provided with the purchase order. 2

8.1.2 The following documentation shall also be supplied and any additional records generated by activities of the QA program for the specified equipment shall be listed in the proposal for the option of the Purchaser to include same in the required list of documentation.

a) Delete 2
b) List of applicable codes used in furnishing the material/equipment (if required)
c) Delete
d) Delete 2
e) Delete
f) QA documentation check list
g) Mill test reports with applicable material specifications for pressure parts, tubes, headers, pipes, fan shafts (not applicable), and fan wheels (not applicable)
h) Ultrasonic examination reports 3
i) Delete
j) Heat treating charts
k) Weld repair reports
l) Delete 3
m) Final scanner air motor data sheets
n) Final list of all cooling water and compressed air flow requirements and pressure drops

o) Delete 2
p) Logic diagrams
q) Delete 2
r) Radiographic test reports

These shall be listed in a QA documentation check list.

Documentation shall be transmitted to the jobsite upon or prior to the arrival of the equipment at the jobsite. The documentation shall always be identified as to the shipment it represents for traceability. In cases of separate shipments, documentation representing each shipment shall be furnished.

8.2 Documentation Delivered to Engineering Office

8.2.1 Drawings and other documents submitted to the engineering office for review, approval, information, record, etc., shall be in accordance with the attached Drawing Submittal Specification and Vendor Document Submittal Schedule to Engineering Office which are part of these Specifications. The Vendor will be required to furnish Southern Company Services a complete set of arrangement drawings for approval.

8.2.2 The Vendor shall use the Vendor Deviation Request (Form 9-1306) to secure written approval from the Purchaser for any deviation from these Specifications or the purchase order. A copy of the form is attached and also will be supplied to the Vendor as an attachment to the purchase order.

8.2.3 Instruction books covering the subject equipment shall be provided by the Vendor. The instruction books shall also include recommended preventative maintenance schedules and clear instructions for all maintenance procedures. Final payment may be withheld pending receipt and approval of instruction books in the quantities and time-frame as defined in these Specifications and by the attached VDSS, which is a part of these Specifications.

These instruction books shall be submitted as follows:

a) Four (4) copies for review and approval 30 days before shipment. 2

b) Twenty (20) final (approved) copies (with review comments incorporated) upon shipment. 2

8.2.4 The instruction books shall provide detailed and specific information (not typical) for the equipment to be furnished. Advertising brochures or technical information on other equipment shall not be included as part of the instruction books. The instruction books shall be bound in a durable folder or cover that is suitable for field use. Information contained in the instruction books shall include, but not be limited to:

a) Jobsite storage requirements
b) Jobsite handling requirements
c) Assembly and dismantling instructions
d) Assembly drawings showing internals
e) Complete parts lists
f) Material of the various components
g) Installation instructions
h) Operating instructions
i) Maintenance instructions
j) Repair information
k) Test reports and certifications as described in Paragraph 6.1
l) Any other information required to assure proper installation, startup, operation, and maintenance of the equipment

8.2.5 The Vendor shall include in his preliminary proposal arrangement drawings showing the general arrangement of the proposed equipment. 2

8.3 Distribution of Correspondence

After an award, the correspondence routing to be followed by the Vendor shall be as noted on the Vendor Correspondence Procedures Form which will be attached to the purchase order.

9.0 WARRANTIES AND GUARANTEES

9.1 Warranty

9.1.1 Refer to Section II of General Terms and Conditions.

9.1.2 The Vendor's material, design and workmanship warranties are based on operation of the LNCFS Levels I, II & III Systems in accordance with the Vendor's intended mode of operation. While brief periods of non-standard operation are to be expected in a test program of this magnitude, the Purchaser is aware that any extended operation of the LNCFS firing systems in a manner inconsistent with the intended operation of the system compromises the safety, performance, and mechanical integrity of the firing system. Any extended operation of the firing system inconsistent with the intended operation will void the material, engineering and workmanship warranties provided with these firing systems. 2 14

9.2 Performance Guarantees

9.2.1 PHASE I Air Heater Basket Replacement

Following replacement of the air heater baskets in Phase I, the CE Air Preheater Bi-Sector Performance will be as follows: 2

If the heat transfer surface, i.e. an element configuration of 27.5" 22 GA DL, 23.5" 22 GA DL, and 12.0" 22 GA DL, is installed in accordance with the plans and specifications, and under the direct supervision of the CE, Inc. Construction Services Representative, and provided that any components being replaced and all heating elements are of the CE Air Preheater Company, Inc., supply and components not being replaced and the structure of the air preheaters are in commercially sound and clean condition, CE guarantees that when delivering 1,449,200 pounds of air per hour at entering temperature of 92°F the air preheaters will reduce the temperature of 672°F to an average exit temperature of 274°F + or - 8°F based on firing Bit. coal and a specific heat ratio of 0.940.

The test limitation period for this guarantee shall expire on the earlier of sixty (60) days of operation, or ninety (90) calendar days after startup of the unit following retrofit of the equipment. To establish noncompliance, the customer shall at his expense conduct a test consistent with the air heater test code, ASME-PTC 4.3. 2

9.2.2 PHASE II and PHASE III - LNCFS Levels I, II & III

Operating conditions established during Phase I Short Term Baseline Tests ("Baseline Tests") in accordance with Table 1 and with the retrofitted airheater baskets shall represent the baseline for the following guarantees: boiler efficiency, carbon monoxide, and carbon in flyash. However, CE will design the low NO_x combustion systems to allow the boiler to operate under the present turbine valves-wide-open conditions.

Following installation of LNCFS Level II in Phase II and LNCFS Level III and simulated LNCFS Level I (w/SOFA out of service) in Phase III, boiler performance will be as follows:

9.2.3 <u>Steam Flow</u> - Steam Flow shall be able to achieve 100% MCR.

9.2.4 Boiler Efficiency - Boiler efficiency shall not decrease from baseline boiler efficiency, provided that CE shall be allowed up to a 1.0% manufacturer's margin (which includes the carbon in flyash loss discussed below) without penalty in comparison to the boiler efficiency achieved during Baseline Tests.

9.2.5 <u>Carbon Monoxide</u> - Carbon Monoxide shall not increase by more than 50 ppmv above the carbon monoxide level achieved during Baseline Tests. 2

9.2.6 <u>Carbon in Flyash</u> - Under optimum NO_x reduction conditions, the carbon in flyash shall constitute a boiler efficiency loss of not more than 0.3% boiler efficiency above the loss associated with the level of carbon in flyash determined in the Baseline Tests. However, under minimal NO_x reduction conditions while operating with the same equipment, the carbon in flyash shall constitute a boiler efficiency loss of not more than 0.12% boiler efficiency above the loss associated with the level of carbon in flyash determined in the Baseline Tests. Carbon in Flyash levels shall be determined in accordance with ASTM procedures applied to samples collected in accordance with EPA test methods.

The above guarantees for Steam Flow, Boiler Efficiency, Carbon Monoxide, and Carbon in the Flyash are contingent on unit operation in accordance with the following criteria:

1) The unit is firing fuel within the same fuel specification as fired during the Baseline Tests.

2) All pulverizers are operating in accordance with manufactures instructions and the average fineness as measured at the outlet of the pulverizers is less than 1.5% on 50 mesh. 2

3) All balance of plant equipment, not included in the modification, that can effect the outcome of the test to achieve the above performance criteria, is in the same general condition as during performance of the Baseline Tests.

4) The unit is operated with no major unusual circumstances, i.e., top feedwater heaters out of service; or inability to use SH and RH spray to full capacity; no hindrances due to incapacitated FD and ID fans, precipitators, coal feeders, pulverizers, ash handling systems, sootblowers, and boiler controls.

5) The unit is operated in accordance with the conditions found in Table 1.

TABLE 1

BOILER AND COMBUSTION SYSTEM
OPERATION SETPOINTS FOR PERFORMANCE GUARANTEES

	Approximate Operating Condition		
Operation	Phase I	Phase II	Phase III
Steam Flow - lb/hr	1,306,000	same	same
Steam Pressure - psig	1875	same	same
Steam Temperature - deg. F/deg. F	1000/1000	1000/1000	1000/1000
Mills in Service	5	5	5
Mill Loading	Equal	Equal	Equal
Windbox to Furnace DP - in. H_2O	3.5-4.0	*	*
Windbox Dampers			
Fuel (operating)	Equal	*	*
Auxiliary Air	Equal	*	*
Windbox Tilts	Min. RH Spray	*	*
Auxiliary Equipment	Normal	*	*
Excess Oxygen at Econ Outlet - (%)	3.3	*	*

* Field adjusted per CE recommendation

Performance testing during the Phase II Short Term LNCFS Level II testing and during the Phase III Short Term LNCFS Levels III & I testing (collectively, "Performance Tests"), shall be completed for the appropriate phase within the earlier of sixty (60) days of operation or 90 calendar days from startup following retrofit of the equipment. The Performance Guarantees shall be deemed to have been accepted if the Purchaser fails to conduct the Performance Tests within the period specified above. CE's representative shall be provided access to test records and after completion of the Performance Tests CE will be provided a copy of the test data and results.

9.2.7 REMEDIES

9.2.7.1 Phase I Air Heater Basket Replacement

CE's liability for failure to meet the air heater Performance Guarantee shall be limited to the necessary repairs or replacements or modifications to permit such performance or at CE's option in lieu thereof, CE may pay the Purchaser as liquidated damages in full satisfaction of the inability to meet this Performance Guarantee, a sum equal to one-tenth of the purchase price for the airheater baskets.

9.2.7.2 Phase II LNCFS Level II and Phase III LNCFS Levels III & I

Should the Performance Tests demonstrate that CE has failed to meet any of the Phase II or Phase III Performance Guarantees, then, on occurrence of the earliest of completion of Performance Tests, sixty (60) days of operation from startup or ninety (90) calendar days from startup, the Purchaser shall decide from the following options:

1) Invoke CE to correct the combustion system deficiencies by operational adjustment or repair in place, or by replacement of defective parts F.O.B. Lansing Smith plant site, so that the boiler performance will be capable of meeting the following:

Steam Flow - Steam Flow shall be able to achieve 100% MCR.

Boiler Efficiency - Boiler efficiency shall not decrease from baseline boiler efficiency, provided that CE shall be allowed up to a 1.0% manufacturer's margin (which includes the carbon in flyash loss discussed below) without penalty in comparison to the boiler efficiency achieved during the Baseline Tests.

Carbon Monoxide - Carbon monoxide shall not increase by more than 50 ppmv above the carbon monoxide level achieved during Baseline Tests.

Carbon in Flyash - Under optimum NO_X reduction conditions, the carbon in flyash shall constitute a boiler efficiency loss of not more than 0.3% boiler efficiency above the loss associated with the level of carbon in flyash determined in the Baseline Tests. However, under minimal NO_X reduction conditions while operating with the same equipment, the carbon in flyash shall constitute a boiler efficiency loss of not more than 0.12% boiler efficiency above the loss associated with the level of carbon in flyash determined in the Baseline Tests. Carbon in Flyash levels shall be determined in accordance with ASTM procedures applied to samples collected in accordance with EPA test methods.

CE will provide erection requirements necessary to effect the repairs on a straight-time basis. CE will be responsible for any escalation of CE's costs caused by project delays directly caused by CE's failure to meet the Performance Guarantees.

In exercising the correction option, Purchaser agrees to either make the unit available to CE as soon as the corrective measures (material and/or labor and/or procedure) have been prepared, or, reach mutual agreement with CE as to a defined scope of corrective measures to be taken prior to continuing with the project test program, thereby allowing Purchaser to schedule the corrective work scope in accordance with system operations.

NOTE: For Phase II installation only -

Provided that a decision shall not have been made to delete Phase III, CE shall at its expense adjust the LNCFS Level II equipment, following the Phase II installation, towards achievement of the Performance Guarantees, such expense being limited to the expenses to perform adjustment of LNCFS Level II equipment in order that it may achieve its optimum performance.

OR

2) Operate the unit as is, thereby relieving CE of any adjustment and/or repair and/or replacement liability for Performance Guarantees in Phase II following Phase II installation, or for Performance Guarantees in Phase II and Phase III following Phase III installation.

THE GUARANTEES SET FORTH IN THE PARAGRAPH HEREOF ENTITLED PERFORMANCE GUARANTEES ARE THE SOLE PERFORMANCE GUARANTEES MADE BY CE WITH RESPECT TO THE EQUIPMENT AND NO OTHER GUARANTEES OF PERFORMANCE, WHETHER WRITTEN, ORAL, EXPRESSED OR IMPLIED BY LAW SHALL APPLY. THE PURCHASER'S EXCLUSIVE REMEDY AND CE'S SOLE OBLIGATION FOR FAILURE TO MEET THE PERFORMANCE GUARANTEES SHALL BE THOSE STATED IN THIS PARAGRAPH.

Ten percent (10%) of the total contract price will be retained by the Purchaser until all guarantees have been satisfied by successful completion of testing in accordance with Section 16 of The General Terms and Conditions.

10.0 EQUIPMENT IDENTIFICATION

10.1 Tagging

All the equipment furnished under this Inquiry shall be described in material lists. Material lists shall be supplied to the Purchaser before any equipment is shipped to the plant site.

11.0 SHIPPING, HANDLING AND STORAGE

11.1 Shipping

One month prior to shipment, the Vendor shall notify the Purchaser of the approximate shipping date of the equipment and materials. If the Purchaser is responsible for the erection, the Vendor's technical representative shall be responsible for receiving each shipment of the equipment and material to be shipped until completion of all shipments. The Vendor, if awarded the erection contract, shall be responsible for receiving all equipment, materials, supplies, etc.

11.2 Handling

The Vendor shall submit recommendations for handling at the construction site within the time span stated in the Vendor Document Submittal Schedule attached. These recommendations shall include such data as locations of balance point and lift points, type of hoisting sling and method of attachment, susceptibility to shock damage, and precautions concerning possible contamination. If dimensions and locations are not easily defined otherwise, a drawing or sketch shall be included. The Vendor, if awarded the erection contract, shall be responsible for the handling of all equipment, materials, supplies, etc.

11.3 Jobsite Storage

The Vendor shall submit recommendations for jobsite storage requirements within the time span stated in the Vendor Document Submittal Schedule attached. The recommendations shall cover such items as inside or outside storage, temperature and humidity control, and any other precaution the Vendor considers pertinent to ensure the integrity of the equipment or material. The erection contractor shall store all materials and equipment in accordance with the manufacturer's recommendations. The Vendor, if awarded the erection contract shall be responsible for the storage of all equipment, materials, supplies, etc. in accordance with Manufacturer's recommendations.

12.0 EQUIPMENT (MATERIAL) DELIVERY

12.1 Plant Location

Buyer's plant is located in Lynn Haven, Florida.

12.2 Shipping Address

12.2.1 Shipments should be consigned to:

J. A. Babbitt
Plant Smith
6804 County Road 2300
Panama City, FL 32405

12.2.2 The mailing address at the site is:

Plant Smith
P. O. Box 1210
Lynn Haven, Florida 32444

12.2.3 All equipment and materials shall be shipped F.O.B. Plant Smith.

12.2.4 The Vendor is responsible for the delivery of all material, equipment, supplies, etc. within the scope of the Vendor's supply to Plant Smith, Lynn Haven, Florida.

12.3 Delivery Schedule

The project schedule will not be finalized until agreements are reached between the parties involved in the demonstration program. Figure No. II. 3.5-9, Rev 1 presents a milestone schedule for the demonstration program. The Vendor's proposal shall be based upon supporting fully the requirements of this schedule. A contract date of March 31, 1990 should be assumed. The Vendor's proposal should clearly identify any potential problem areas associated with complying with the schedule.

Before a contract is signed with the successful Vendor, the Vendor shall commit to a firm delivery schedule that will absolutely insure that all materials required for the retrofits will be at the plant site before the date of the scheduled plant outage.

12.4 Expediting

The Vendor shall afford the Purchaser's expediting personnel, free of cost, access to procurement and fabrication records so that the expediter may ascertain the status of work in progress.

12.5 Deferment

Refer to Section 8 of the General Terms and Conditions.

12.6 Termination

Refer to Section 5 and 6 of the General Terms and Conditions.

12.7 Assignment of Contract

In the event of an order for the equipment covered by this Inquiry, it shall be understood and agreed that the Purchaser will retain the right to assign this equipment to any one of the operating companies affiliated with The Southern Company and such assignment will not alter the basic terms and conditions of the order.

13.0 VENDOR'S PROPOSAL

13.1 Site Visit

Before submitting a proposal, the Vendor must visit the plant site and examine the existing equipment and site layout. Information concerning equipment modifications over the past few years may be available, but it is the Vendor's responsibility to resolve any issues concerning the condition, design and suitability of the existing equipment. Arrangements for the site visit should be coordinated through the Project Retrofit Coordinator, Mr. J. A. Babbitt at Plant Smith (904) 265-2185 or through the Project Manager, Mr. S. M. Wilson at Southern Company Services (205) 877-7835. 2

A prebid conference will be scheduled at Plant Smith for each Vendor to discuss his proposal. Each Vendor must attend this meeting for his proposal to be acceptable to the Purchaser.

13.2 Use of Proposal Form

13.2.1 All Vendors must use the Proposal Letter Form included with this Inquiry. Where descriptive information is requested for which there is insufficient space provided in the Proposal Form, the information shall be attached to the proposal and reference shall be made in the Proposal Letter Form as to where it can be found.

13.2.2 The submittal of a proposal constitutes a commitment by the Vendor to furnish the designated documents within the time frame established on the Vendor Document Submittal Schedule submitted with the Vendor's proposal. 2

13.3 Submittals

13.3.1 The Vendor shall submit ten (10) copies of his proposal in accordance with the transmittal letter's instructions together with any additional information required by the attached Vendor Document Submittal Schedule to:

Mr. S. M. Wilson
Southern Company Services
Post Office Box 2625
Birmingham, Alabama 35202

13.3.2 The Purchaser requires that the Vendor's proposal be valid for a period of 90 days. The Vendor's proposal should include pricing which is firm through delivery, based upon the outage dates stated in this specification. 2

13.4 Alternates

All base bids shall be in accordance with the Purchaser's Specifications, related attachments, and accompanying documents and any alternate shall be submitted as a separate proposal in accordance with Paragraph 13.2.

The Vendor shall only offer alternates which he is convinced from experience will insure a reliable installation. In the case of alternates which have not to date been used extensively in the United States, the Vendor is required to submit with his proposal a statement or statements outlining why he feels the alternate will provide a reliable and efficient installation. The Vendor shall also include a listing of installations where equipment of similar size, rating, and application is now being used and a listing of persons to contact which can serve as references for the quoted alternates.

13.5 Exceptions

Any exceptions to the Specifications, related attachments and accompanying documents shall be clearly stated in the space provided in the Proposal Letter Form. If any requirements cannot be fulfilled, the Vendor shall state his reasons in detail and propose a reasonable alternate. The vendor shall reference the specific paragraph or sentence in the bid documents that exception is being taken to and shall show specifically how such paragraph or sentence shall be modified or rewritten. If there are not exceptions, the Vendor should state NO EXCEPTIONS in the space provided. The Vendor's standard commercial terms are not to be included in the proposal. Inclusion of such could result in disqualification of the bid.

13.6 Qualification of Vendor

The equipment offered in response to this Inquiry shall be of the highest quality in materials and workmanship and shall be capable (from demonstrated experience) of full compliance with the Specification requirements as related to capacity, performance, and design adequacy. The Vendor must be able to show that he has manufactured and placed in satisfactory and regular operating service equipment similar in general design and in size, to that covered in this Inquiry.

A list of installations similar to the equipment to be supplied shall be included in the Vendor's proposal.

A list of all subcontractor's which may be used by the Vendor shall be subject to the Purchaser's approval.

13.7 Proposal Requirements

The following items shall be included in the Vendor's proposal:

a) Proposal Letter Form
b) Proposal Drawings/Sketches
c) Delete
d) Delete
e) Delete 2
f) Delete
g) Logic diagrams
h) Delete
i) Complete description of equipment and system being proposed
j) Quality Assurance Program
k) Payment Schedule
l) Delete
m) Training Program Description
n) Delete
o) Delete
p) Delete
q) Erection Schedule
r) Delete
s) Any additional information the Vendor thinks will help evaluate his proposal

13.8 Proposal Evaluations

The Vendor's proposal will be evaluated thoroughly by the Purchaser. It is to the Vendor's benefit to provide as much detailed information as possible within a well organized proposal document. The following will be utilized as input in the proposal evaluation and will determine the successful Vendor:

13.8.1 Conformance with the specified technical requirements.

13.8.2 Conformance with the requirements of the Purchaser's commercial documents.

13.8.3 Purchaser's degree of confidence in the technical and economic feasibility of the technology. This confidence can be earned either because the specific concept has been developed through laboratory and pilot scale evaluations, with increasingly encouraging results at each step, or because the technology is a unique adaptation or evolution of well-proven, existing technologies.

13.8.4 Predicted emission reduction potential and combustion performance of the technology being supplied.

13.8.5 Vendor's prior research, development, and operating experience with regard to the technology being demonstrated.

13.8.6 The degree to which the technology is a potentially commercial product for the stated NO_x control purposes. Some established products may be acceptable if there is a need for further demonstrational support to be adequately characterized.

13.8.7 The degree of marketabilty of the technology if the technical and economic feasibility are demonstrated by the program. This means that a sizable population of feasible application sites are forecast assuming more stringent NO_x emission regulations are developed.

13.8.8 Compliance with the overall objectives of the NO_x reduction program at Plant Smith as stated in Section 3.1.

13.8.9 Suitability for a wide range of applications (boiler type, fuels, etc.).

13.8.10 Expected impact on boiler operation.

13.8.11 Expected impact on operation and performance of system components (fans, precipitators, etc.)

13.8.12 Ability to comply with specified schedule.

13.8.13 The Purchaser's perception of the long term reliability of the equipment and materials.

13.8.14 Vendor's commitment to long term cooperation and technical support.

13.8.15 Vendor's quality assurance program.

13.8.16 Vendor's compliance with the provisions of the recoupment plan as described in the attached D.O.E. Cooperative Agreement Provisions.

13.8.17 Vendor's ability to provide a proposal which is based upon "cost sharing" to the greatest extent possible.

13.8.18 Final evaluated price

14.0 PAYMENT

Payment shall be as specified in The General Terms and Conditions.

ALS/ab
2/13/89
4/13/89
03/28/90
04/30/90
05/16/91
06/03/91
09/04/91
FOLDER: A. L. Sumerlin
TITLE: 6/03/91 SPEC/T-FIRED COMB MOD 0545S (w/o fans)

ABB Combustion Engineering Services, Inc.

proposal

Advanced Tangentially-Fired Combustion Modifications for Reduced NOx Emissions, Plant Smith Unit No. 2 of Gulf Power Company

revision Number 1

April 25, 1991.

TABLE OF CONTENTS

ATTACHMENT ONE

March 27, 1990
Rev. 1: April 25, 199

PROPOSAL

FROM

Combustion Engineering, Inc.

Windsor, CT 06095

(Vendor's name and address to be inserted here)

FOR

ADVANCED TANGENTIALLY-FIRED COMBUSTION MODIFICATIONS

FOR REDUCED NO_x EMISSIONS

PLANT SMITH - UNIT NO. 2

OF

GULF POWER COMPANY

Mr. S. M. Wilson
Southern Company Services
P. O. Box 2625
Birmingham, AL 35202

1.0 SCOPE

In accordance with your inquiry inviting proposals for combustion modifications for reduced NO_x emissions for Plant Smith Unit 2 and subject to all conditions and requirements of your Specifications, all related attachments and accompanying documents in connection therewith, we propose to furnish, deliver, and install the subject equipment for the prices quoted herein. "Option" is understood to be Purchaser's option.

2.0 PRICING

2.1 Proposal I - Air Preheater Modifications

A.	For air preheater baskets, material	$________
B.	For technical direction of installation	$________
C.	For technical direction during start-up and equipment optimization and for operator training	$________
D.	For complete field erection	$________

2.2 Proposal II - Low NOx Concentric Firing System (LNCFS)

A.	For LNCFS system including complete overfire air system (LPOFA and HPOFA), burner observation system and flame scanners complete with all accessories and materials	$________
B.	For technical representative during installation	$________
C.	For technical direction during start-up and equipment optimization and for operator training	$________
D.	For complete field erection	$________
* E.	Portion of 2.2 A-D for LPOFA system which was not included in 1988 proposal	$________

2.3 Proposal III - Concentric Clustered Tangential Firing System (CCTFS or LNCFS III

A.	For CCTFS complete with all accessories and materials	$________ (Includes Costs of $)
B.	For technical representative during installation	$________

All pricing of F.O.B. Plant Site
State of Florida Sales/Use Tax
is excluded

* Purchaser's Option

	C. For technical direction during start-up and equipment optimization and for operator training	$______
	D. For complete field erection	$______ (Includes Costshare of $)
2.4	<u>Proposal VI - Flow Modeling</u>	
	* For flow modeling includes the construction of the model and any subsequent modifications to duplicate the specified phase testing	______
2.5	<u>Termination</u>	
	The latest date for terminating this contract without incurring charges other than engineering and overhead	70 Days after receipt of award but no later than <u>June 26, 1990</u>
2.6	<u>Deferment</u>	
	In the event of deferment up to twelve (12) months, as covered in the specifications, the price adjustment will be	$<u>See Subcontract Agreement</u>
3.0	<u>ESCALATION</u>	
3.1	Material prices quoted are:	<u>100</u> % firm
		______% escalated
3.2	For escalated prices, the following shall apply:	
	A. Indices to be used (include percentages applicable to materials, labor, etc.)	______
	B. Starting date of escalation	______
	C. Base Index Value(s)	______
		______

All pricing is F.O.B. Plant Site
State of Florida Sales/Use Tax is excluded.
* Purchaser's Option

D. Ending date of escalation ______

E. Limits of escalation ______

______

______

F. Method of calculating escalation ______

______

______

4.0 ACCEPTANCE

4.1 Prices quoted shall be valid for acceptance until (The Purchaser requires a minimum of 150 days) July 1, 1990

5.0 TECHNICAL SITE REPRESENTATION

5.1 The pricing included in this proposal is based upon the following site engineering services:

5.1.1 Air Preheater Modifications	Man - Days
A. Technical representative during installation	0
B. Start-up and equipment optimization	0
C. Operator training	0

5.1.2 Low No_x Concentric Fired System (w/LPOFA and HPOFA Systems) including Burner Observation System and Flame Scanners

A. Technical representative during installation	44
B. Start-up and equipment optimization	42
C. Operator training	6

All pricing is F.O.B. Plant Site
State of Florida Sales/Use Tax is excluded.
* Purchaser's Option

Man - Days

5.1.3 Concentric Clustered Tangential Firing System including Burner Observation System and Flame Scanners

A.	Technical representative during installation	28
B.	Start-up and equipment optimization	28
C.	Operator training	4

5.2 Additional site engineering services may be purchased at the following rate $__________/Man-Day

6.0 QUALITY ASSURANCE

In addition to the Quality Assurance Documentation required by Paragraph 7.0 of the "Specifications", we will furnish the following additional documentation which is generated as a result of our Quality Assurance Program

In ~~place of~~ ADDITION TO SOAR-2 and SOAR-2A, CE proposes the attached Quality Assurance Programs.

7.0 SCHEDULE DATES

It is understood and agreed that we will begin and complete shipment of all materials and complete erection (if included in order) in accordance with the delivery requirements specified in Figure I.

7.1 Outline drawings of the equipment will be furnished within (per VDSS) days from date of order.

7.2 If we are awarded the work covered by this Inquiry, we will complete all necessary engineering within (per VDSS) weeks from date of order.

7.3 We will begin manufacturing within Two (2) weeks from receipt of Purchaser's drawing approval.

7.4 Shipment of all items covered by this Inquiry will be completed within N/A weeks from date of order.

7.5 Field erection, if included in order will begin within N/A weeks from date of order and will be completed within N/A weeks from date of order.

7.6 An erection schedule (including bar chart) is included on Page N/A of our proposal.

7.7 Shipment will be made by (state rail or motor freight), ______________

Motor Freight

8.0 DESCRIPTIVE DATA AND ENGINEERING INFORMATION

The following descriptive information and design data are furnished in connection with the advanced tangentially fired combustion modifications offered with the following proposals:

8.1 Low Pressure Overfire Air System (LPOFA) And High Pressure Overfire Air System (HPOFA)

A. Description of modifications to existing windboxes, dampers, damper linkages, waterwall tubes, etc. required before installation of the LPOFA and HPOFA systems ______________

See attached descriptive text

B. Description of shop fabricated bent tube assemblies for overfire air ports and installation of these tube assemblies

See attached descriptive text

C. **Type of refractory, insulation and lagging, duct material to be installed**

Ductwork - ASTM - A36 Carbon Steel

Installation - Mineral Wool (Asbestos Free)

Lagging - Ribbed Aluminum, 0.032" Thick

D. **List of limit switches, control indicators, drive mechanism, etc. to be installed for LPOFA and HPOFA and manufacturer, model number, etc. of each**

To be determined in design phase. All equipment described above will meet the GUTF-I specifications.

E. **A complete description of the LPOFA and HPOFA system to be installed including equipment, retrofit modifications, drawings, details of schedule, etc. is in Section** 8 **of the Vendor's proposal.**

8.2 Low NO_x Concentric Firing System (LNCFS)

A. **Description of modifications to existing windboxes, dampers, damper linkages, air nozzles, etc. required for the LNCFS**

See attached descriptive text

B. **Description of flame diffuser coal nozzle tips**

See attached descriptive text

C. **Description of modifications (to existing burners, ducts, etc.) required for installation the flame diffuser coal nozzles**

See attached descriptive text

D. **Description of auxiliary air nozzles required for the LNCFS**

See attached descriptive text

E. **A complete description of the LNCFS to be installed including equipment, modifications to existing equipment, drawings, details of schedule, etc. is in Section** 8 **of the Vendor's proposal.**

8.3 <u>**Concentric Clustered Tangential Firing System (CCTFS)**</u>

A. **Description of modifications to existing windboxes, dampers, damper linkage, air nozzles, burners, etc. required for the CCTFS**

See attached descriptive text

B. **Description of modifications to coal piping**

See attached descriptive text

C. **Description of modifications to duct work required for the CCTFS/HPOFA System**

See attached descriptive text

D. **Description of modifications to oil guns, ignitors and flame scanners**

See attached descriptive text

E. **Description of burners to be installed for the CCTFS**

See attached descriptive text

8.4 HPOFA "High Set" Booster Fan-Drive Motor Design

8.4 A - 8.4 P deleted

Q. Sound level data for LPOFA and HPOFA system at noisiest operating condition:

Center Frequency Hertz	Decibels, Lw dB re 10^{-12} Watts
31.5	
63	
125	
250	
500	
1000	
2000	
4000	
8000	

Sound levels for LPOFA and HPOFA systems will comply with limitations for 8 hour exposure level as defined by OSHA.

Sound Pressure Level (dBA)	
At 1 Meter	
At 7 Meter	

Performance parameters which produce above power levels:

CFM ____________________

8.5 List of all instruments, flow monitors, flame scanners, controls, electrical requirements, etc. to be provided

To be determined in design phase. All equipment described above will meet the GUTF-I specification.

8.6 **Description of flow model for the project**

See attached descriptive text

8.7 **Shipping weights:** (Estimated - Major Components)

Component	Material
Airheater Baskets	136,000 Lb
OFA Tube Panel Assemblies	10,000 Lb
LPOFA Windboxes	10,000 Lb
HPOFA Windboxes	11,000 Lb
Ductwork	48,000 Lb
Structural Steel	5,000 Lb

8.8 **A complete description of the CCTFS to be installed including equipment, modifications to existing equipment, drawings, details of schedule, etc. is in Section** 8 **of the Vendor's proposal.**

8.9 **Discuss recommended approach to fix low NO_x burner equipment if it is necessary due to problems such as low boiler efficiency, excessive LOI, etc.**

See attached descriptive text

9.0 PERFORMANCE DATA

9.1 Air Preheater Modification

	100%	75%	50%	25%
A. Boiler load	100%	75%	50%	25%
B. Boiler efficiency	89.10	89.63	90.40	90.59
C. Air Flows - lb/hr ($x10^6$)				
FD fan discharge	1.64	1.31	0.93	0.51
Tempering and sealing air	0.04	0.03	0.03	0.02
Entering air heater, primary and secondary	1.56	1.20	0.85	0.45
Leakage through air heater, primary and secondary	0.11	0.10	0.09	0.08
Leaving air heater, primary and secondary	1.45	1.10	0.76	0.37
Primary air entering furnace	0.30	0.24	0.18	0.12
Secondary air entering furnace	1.19	0.89	0.61	0.27
SOFA system air entering furnace	N/A	N/A	N/A	N/A
CCOFA system air entering furnace	N/A	N/A	N/A	N/A
D. Air temperature leaving air heater - °F	565	525	480	430
E. Air velocity leaving SOFA ports - ft/sec	N/A	N/A	N/A	N/A
F. Air velocity leaving CCOFA ports - ft/sec	N/A	N/A	N/A	N/A
G. Furnace exit gas temperature - °F	2150	2040	1880	1610

H. Air pressure drop from steam coil air heater to burners - inches of water				
Ducts	0.50	0.30	0.15	0.10
Dampers	--	--	--	--
Steam coil	0.50	0.30	0.15	0.10
Air heater	3.90	2.20	1.00	0.35
Air meter	0.50	0.30	0.15	0.10
Required at burners	4.00	4.00	3.25	1.50
Total pressure drop from steam coil to burners	9.40	7.10	4.70	2.15
I. Excess air leaving boiler - °F	18	18	18	18
J. Fuel Burned - lbs/hr ($x10^3$)	142.6	102.5	78.2	40.7
K. Heat losses - Btu/lb fuel as fired				
Due to combustible in refuse	30	30	30	30
Due to dry gas to stack	487	427	335	258
Due to water in fuel and water from combustion of hydrogen in fuel	574	566	555	540
Due to moisture in air	12	11	8	7
Due to radiation	25	30	45	90
Due to unconsumed hydrogen, carbon and hydrocarbons	--	--	--	--
Manufacturer's margin	180	180	180	180
Total Loss	1308	1244	1153	1105

L. Heat release in furnace - BTU/hr/cu ft (Note - Vendor shall include drawing showing volume included)	17,400	13,750	9,550	4,940
M. Heat release in furnace - BTU/hr/sq ft (Note - Vendor shall include drawing showing area included)	90,000	69,500	48,300	27,000
N. Flue gas flow - lb/hr ($x10^6$)				
Entering air heater	1.66	1.31	0.91	0.47
Leaving air heater	1.77	1.41	1.00	0.55
O. Flue gas temperature - °F				
Entering air heater	670	595	530	460
Leaving air heater	279	266	249	235
P. Emissions entering air heater				
NO_x - ppm @ 3% O_2	BASE	BASE	BASE	BASE
CO - ppm	<50	<50	<50	<50
SO_2 - ppm	6.17	6.17	6.17	6.17
O_2 - %	3.6	3.6	3.6	3.6
HC - ppm	<10	<10	<10	<10
Q. Emissions leaving air heater				
NO^x -ppm @ 3% O_2	BASE	BASE	BASE	BASE
CO - ppm	<50	<50	<50	<50
SO_2 - ppm	6.17	6.17	6.17	6.17
Particulates - lb/10^6 BTU	--	--	--	--
O_2 - %	4.7	4.9	5.3	6.3
HC - ppm	<10	<10	<10	<10
LOI - %	--	--	--	--

9.2 LNCFS II (WITH SOFA)

A. Boiler load	100%	75%	50%	25%
B. Boiler efficiency	89.10	89.63	90.40	90.59
C. Air Flows - lb/hr ($x10^6$)				
FD fan discharge	1.64	1.31	0.93	0.51
Tempering and sealing air	0.04	0.03	0.03	0.02
Entering air heater, primary and secondary	1.56	1.20	0.85	0.45
Leakage through air heater, primary and secondary	0.11	0.10	0.09	0.08
Leaving air heater, primary and secondary	1.45	1.10	0.76	0.37
Primary air entering furnace	0.30	0.24	0.18	0.12
Secondary air entering furnace	0.90	0.66	0.45	0.19
SOFA system air entering furnace	0.29	0.23	0.16	0.08
CCOFA system air entering furnace	N/A	N/A	N/A	N/A
D. Air temperature leaving air heater - °F	565	525	480	430
E. Air velocity leaving SOFA ports - ft/sec	225	225	225	225
F. Air velocity leaving CCOFA ports - ft/sec	N/A	N/A	N/A	N/A
G. Furnace exit gas temperature - °F	2150	2040	1880	1610

H.	Air pressure drop from steam coil air heater to burners - inches of water				
	Ducts	0.50	0.30	0.15	0.10
	Dampers	--	--	--	--
	Steam coil	0.50	0.30	0.15	0.10
	Air heater	3.90	2.20	1.00	0.35
	Air meter	0.50	0.30	0.15	0.10
	Required at burners	6.00	6.00	4.88	2.25
	Total pressure drop from steam coil to burners	11.40	9.10	6.33	2.90
I.	Excess air leaving boiler - °F	18	18	18	18
J.	Fuel Burned - lbs/hr ($x10^3$)	142.6	102.5	78.2	40.7
K.	Heat losses - Btu/lb fuel as fired				
	Due to combustible in refuse	30	30	30	30
	Due to dry gas to stack	487	427	335	258
	Due to water in fuel and water from combustion of hydrogen in fuel	574	566	555	540
	Due to moisture in air	12	11	8	7
	Due to radiation	25	30	45	90
	Due to unconsumed hydrogen, carbon and hydrocarbons	--	--	--	--
	Manufacturer's margin	180	180	180	180
	Total Loss	1308	1244	1153	1105

L.	Heat release in furnace - BTU/hr/cu ft (Note - Vendor shall include drawing showing volume included)	17,400	13,750	9,550	4,940
M.	Heat release in furnace - BTU/hr/sq ft (Note - Vendor shall include drawing showing area included)	90,000	69,500	48,300	27,000
N.	Flue gas flow - lb/hr ($x10^6$)				
	Entering air heater	1.66	1.31	0.91	0.47
	Leaving air heater	1.77	1.41	1.00	0.55
O.	Flue gas temperature - °F				
	Entering air heater	670	595	530	460
	Leaving air heater	279	266	249	235
P.	Emissions entering air heater				
	NO_x - ppm @ 3% O_2 BASE percentage %	77%	77%	77%	77%
	CO - ppm	<50	<50	<50	<50
	SO_2 - ppm	6.17	6.17	6.17	6.17
	O_2 - %	3.6	3.6	3.6	3.6
	HC - ppm	<10	<10	<10	<10
Q.	Emissions leaving air heater				
	NO^x -ppm @ 3% O_2 Base percentage %	77%	77%	77%	77%
	CO - ppm	<50	<50	<50	<50
	SO_2 - ppm	6.17	6.17	6.17	6.17
	Particulates - lb/10^6 BTU	--	--	--	--
	O_2 - %	4.7	4.9	5.3	6.3
	HC - ppm	<10	<10	<10	<10
	LOI - %	--	--	--	--

9.3 LNCFS II (WITH OUT SOFA)

A.	Boiler load	N/A	75%	50%	25%
B.	Boiler efficiency	N/A	89.63	90.40	90.59
C.	Air Flows - lb/hr ($x10^6$)				
	FD fan discharge	N/A	1.31	0.93	0.51
	Tempering and sealing air	N/A	0.03	0.03	0.02
	Entering air heater, primary and secondary	N/A	1.20	0.85	0.45
	Leakage through air heater, primary and secondary	N/A	0.10	0.09	0.08
	Leaving air heater, primary and secondary	N/A	1.10	0.76	0.37
	Primary air entering furnace	N/A	0.24	0.18	0.12
	Secondary air entering furnace	N/A	0.89	0.61	0.27
	SOFA system air entering furnace	N/A	N/A	N/A	N/A
	CCOFA system air entering furnace	N/A	N/A	N/A	N/A
D.	Air temperature leaving air heater - °F	N/A	525	480	430
E.	Air velocity leaving SOFA ports - ft/sec	N/A	N/A	N/A	N/A
F.	Air velocity leaving CCOFA ports - ft/sec	N/A	N/A	N/A	N/A
G.	Furnace exit gas temperature - °F	N/A	2040	1880	1610

H. Air pressure drop from steam coil air heater to burners - inches of water				
Ducts	N/A	0.30	0.15	0.10
Dampers	N/A	--	--	--
Steam coil	N/A	0.30	0.15	0.10
Air heater	N/A	2.20	1.00	0.35
Air meter	N/A	0.30	0.15	0.10
Required at burners	N/A	4.00	3.25	1.50
Total pressure drop from steam coil to burners	N/A	7.10	4.70	2.15
I. Excess air leaving boiler - °F	N/A	18	18	18
J. Fuel Burned - lbs/hr ($x10^3$)	N/A	102.5	78.2	40.7
K. Heat losses - Btu/lb fuel as fired				
Due to combustible in refuse	N/A	30	30	30
Due to dry gas to stack	N/A	427	335	258
Due to water in fuel and water from combustion of hydrogen in fuel	N/A	566	555	540
Due to moisture in air	N/A	11	8	7
Due to radiation	N/A	30	45	90
Due to unconsumed hydrogen, carbon and hydrocarbons	N/A	--	--	--
Manufacturer's margin	N/A	180	180	180
Total Loss	N/A	1244	1153	1105

L.	Heat release in furnace - BTU/hr/cu ft (Note - Vendor shall include drawing showing volume included)	N/A	13,750	9,550	4,940
M.	Heat release in furnace - BTU/hr/sq ft (Note - Vendor shall include drawing showing area included)	N/A	69,500	48,300	27,000
N.	Flue gas flow - lb/hr ($x10^6$)				
	Entering air heater	N/A	1.31	0.91	0.47
	Leaving air heater	N/A	1.41	1.00	0.55
O.	Flue gas temperature - °F				
	Entering air heater	N/A	595	530	460
	Leaving air heater	N/A	266	249	235
P.	Emissions entering air heater				
	NO_x - ppm @ 3% O_2	N/A	BASE 2	BASE 2	BASE 2
	CO - ppm	N/A	<50	<50	<50
	SO_2 - ppm	N/A	6.17	6.17	6.17
	O_2 - %	N/A	3.6	3.6	3.6
	HC - ppm	N/A	<10	<10	<10
Q.	Emissions leaving air heater				
	NO^x -ppm @ 3% O_2	N/A	BASE 2	BASE 2	BASE 2
	CO - ppm	N/A	<50	<50	<50
	SO_2 - ppm	N/A	6.17	6.17	6.17
	Particulates - lb/10^6 BTU	N/A	--	--	--
	O_2 - %	N/A	4.9	5.3	6.3
	HC - ppm	N/A	<10	<10	<10
	LOI - %	N/A	--	--	--

9.4 LNCFS III (WITH SOFA & CCOFA)

A. Boiler load	100%	75%	50%	25%
B. Boiler efficiency	89.10	89.63	90.40	90.59
C. Air Flows - lb/hr ($x10^6$)				
FD fan discharge	1.64	1.31	0.93	0.51
Tempering and sealing air	0.04	0.03	0.03	0.02
Entering air heater, primary and secondary	1.56	1.20	0.85	0.45
Leakage through air heater, primary and secondary	0.11	0.10	0.09	0.08
Leaving air heater, primary and secondary	1.45	1.10	0.76	0.37
Primary air entering furnace	0.30	0.24	0.18	0.12
Secondary air entering furnace	0.67	0.49	0.33	0.13
SOFA system air entering furnace	0.30	0.23	0.16	0.08
CCOFA system air entering furnace	0.22	0.17	0.12	0.06
D. Air temperature leaving air heater - °F	565	525	480	430
E. Air velocity leaving SOFA ports - ft/sec	225	225	225	225
F. Air velocity leaving CCOFA ports - ft/sec	150	150	150	150
G. Furnace exit gas temperature - °F	2150	2040	1880	1610

H.	Air pressure drop from steam coil air heater to burners - inches of water				
	Ducts	0.50	0.30	0.15	0.10
	Dampers	--	--	--	--
	Steam coil	0.50	0.30	0.15	0.10
	Air heater	3.90	2.20	1.00	0.35
	Air meter	0.50	0.30	0.15	0.10
	Required at burners	6.00	6.00	4.88	2.25
	Total pressure drop from steam coil to burners	11.40	9.10	6.33	2.90
I.	Excess air leaving boiler - °F	18	18	18	18
J.	Fuel Burned - lbs/hr ($x10^3$)	142.6	102.5	78.2	40.7
K.	Heat losses - Btu/lb fuel as fired				
	Due to combustible in refuse	30	30	30	30
	Due to dry gas to stack	487	427	335	258
	Due to water in fuel and water from combustion of hydrogen in fuel	574	566	555	540
	Due to moisture in air	12	11	8	7
	Due to radiation	25	30	45	90
	Due to unconsumed hydrogen, carbon and hydrocarbons	--	--	--	--
	Manufacturer's margin	180	180	180	180
	Total Loss	1308	1244	1153	1105

L. Heat release in furnace - BTU/hr/cu ft (Note - Vendor shall include drawing showing volume included)	17,400	13,750	9,550	4,940
M. Heat release in furnace - BTU/hr/sq ft (Note - Vendor shall include drawing showing area included)	90,000	69,500	48,300	27,000
N. Flue gas flow - lb/hr ($x10^6$)				
Entering air heater	1.66	1.31	0.91	0.47
Leaving air heater	1.77	1.41	1.00	0.55
O. Flue gas temperature - °F				
Entering air heater	670	595	530	460
Leaving air heater	279	266	249	235
P. Emissions entering air heater				
NO_x - ppm @ 3% O_2 BASE percentage %	58%	58%	58%	58%
CO - ppm	<100	<100	<100	<100
SO_2 - ppm	6.17	6.17	6.17	6.17
O_2 - %	3.6	3.6	3.6	3.6
HC - ppm	<20	<20	<20	<20
Q. Emissions leaving air heater				
NO^x -ppm @ 3% O_2 BASE percentage %	58%	58%	58%	58%
CO - ppm	<100	<100	<100	<100
SO_2 - ppm	6.17	6.17	6.17	6.17
Particulates - lb/10^6 BTU	--	--	--	--
O_2 - %	4.7	4.9	5.3	6.3
HC - ppm	<20	<20	<20	<20
LOI - %	--	--	--	--

9.5 LNCFS III (WITH CCOFA & WITH OUT SOFA)

		100%	75%	50%	25%
A.	Boiler load	100%	75%	50%	25%
B.	Boiler efficiency	89.10	89.63	90.40	90.59
C.	Air Flows - lb/hr ($x10^6$)				
	FD fan discharge	1.64	1.31	0.93	0.51
	Tempering and sealing air	0.04	0.03	0.03	0.02
	Entering air heater, primary and secondary	1.56	1.20	0.85	0.45
	Leakage through air heater, primary and secondary	0.11	0.10	0.09	0.08
	Leaving air heater, primary and secondary	1.45	1.10	0.76	0.37
	Primary air entering furnace	0.30	0.24	0.18	0.12
	Secondary air entering furnace	0.97	0.72	0.49	0.21
	SOFA system air entering furnace	N/A	N/A	N/A	N/A
	CCOFA system air entering furnace	0.22	0.17	0.12	0.06
D.	Air temperature leaving air heater - °F	565	525	480	430
E.	Air velocity leaving SOFA ports - ft/sec	N/A	N/A	N/A	N/A
F.	Air velocity leaving CCOFA ports - ft/sec	150	150	150	150
G.	Furnace exit gas temperature - °F	2150	2040	1880	1610

H. Air pressure drop from steam coil air heater to burners - inches of water				
Ducts	0.50	0.30	0.15	0.10
Dampers	--	--	--	--
Steam coil	0.50	0.30	0.15	0.10
Air heater	3.90	2.20	1.00	0.35
Air meter	0.50	0.30	0.15	0.10
Required at burners	4.00	4.00	3.25	1.50
Total pressure drop from steam coil to burners	9.40	7.10	4.70	2.15
I. Excess air leaving boiler - °F	18	18	18	18
J. Fuel Burned - lbs/hr ($x10^3$)	142.6	102.5	78.2	40.7
K. Heat losses - Btu/lb fuel as fired				
Due to combustible in refuse	30	30	30	30
Due to dry gas to stack	487	427	335	258
Due to water in fuel and water from combustion of hydrogen in fuel	574	566	555	540
Due to moisture in air	12	11	8	7
Due to radiation	25	30	45	90
Due to unconsumed hydrogen, carbon and hydrocarbons	--	--	--	--
Manufacturer's margin	180	180	180	180
Total Loss	1308	1244	1153	1105

L.	Heat release in furnace - BTU/hr/cu ft (Note - Vendor shall include drawing showing volume included)	17,400	13,750	9,550	4,940
M.	Heat release in furnace - BTU/hr/sq ft (Note - Vendor shall include drawing showing area included)	90,000	69,500	48,300	27,000
N.	Flue gas flow - lb/hr ($x10^6$)				
	Entering air heater	1.66	1.31	0.91	0.47
	Leaving air heater	1.77	1.41	1.00	0.55
O.	Flue gas temperature - °F				
	Entering air heater	670	595	530	460
	Leaving air heater	279	266	249	235
P.	Emissions entering air heater				
	NO_x - ppm @ 3% O_2 BASE percentage %	75%	75%	75%	75%
	CO - ppm	<50	<50	<50	<50
	SO_2 - ppm	6.17	6.17	6.17	6.17
	O_2 - %	3.6	3.6	3.6	3.6
	HC - ppm	<10	<10	<10	<10
Q.	Emissions leaving air heater				
	NO^x -ppm @ 3% O_2 BASE percentage %	75%	75%	75%	75%
	CO - ppm	<50	<50	<50	<50
	SO_2 - ppm	6.17	6.17	6.17	6.17
	Particulates - lb/10^6 BTU	--	--	--	--
	O_2 - %	4.7	4.9	5.3	6.3
	HC - ppm	<10	<10	<10	<10
	LOI - %	--	--	--	--

10.0 ALTERNATES AND PRICING

The Vendor is requested to address alternate proposals by including either of the following statements: "Having complied with the bidding requirements of your specifications and attachments, we request due consideration to the attached alternate proposals, complete with prices and descriptive data for comparison to the base proposal" or "Having complied with the bidding requirements of your specifications and attachments, we do not offer an alternate proposal".

11.0 EXCEPTIONS

Exceptions shall be noted in accordance with Paragraphs 11.1 and 11.2.

11.1 We have reviewed your Specifications and all Related Attachments. Unless specific exceptions are listed below (or attached to our proposals and referenced below), it is understood that all of the provisions contained therein are acceptable to us:

____________________ without exception

____________________ with exceptions as outlined below:

____

____

____

11.2 The Vendor Submittal Schedule has been reviewed and the required documentation and submittal dates (time frames) are acceptable to us unless listed below:

____

____

____

If there art no exceptions, state "No Exceptions".

No Exceptions

ATTACHMENT TWO

a proposal from
FOSSIL SERVICES

TO

SOUTHERN COMPANY SERVICES

GULF POWER COMPANY

LANSING SMITH STATION

CE CONTRACT NO. 14664

LOW NOX TANGENTIAL FIRING SYSTEMS

PROPOSAL NO. 815376

R. J. COLLETTE DEC 20 1990

Sections 8.0 & 9.0

COMBUSTION ENGINEERING

8.0 DESCRIPTIVE DATA AND ENGINEERING INFORMATION

8.1 OVERVIEW OF TANGENTIAL FIRING SYSTEM

8.1.1 The CE tangential firing system provides an effective means of control for regulating heat absorption in the furnace, superheat, and reheat sections of the boiler. This system has been incorporated in CE steam generators for approximately 40 years and is representative of a large population of utility boilers currently in service. The tangential firing system is a design unique to Combustion Engineering, Inc., boilers whereby the fuel and combustion air are admitted to the boiler furnace from the furnace corners, directed tangentially at an imaginary circle in the furnace center. As the fuel and air are admitted to the furnace and the fuel is combusted, a rotating "fireball" is formed within the furnace. Each furnace corner is equipped with a separate windbox, which consists of vertically stacked compartments in which the fuel and air injection equipment is mounted. These compartments are identified as "elevations", with each level of elevation being identical in each of the windboxes. Figures A and B illustrate a typical CE tangential firing system. Tangential firing systems are traditionally equipped with vertically adjustable compartments (tilting) or with non-adjustable compartments (non-tilting or fixed).

8.1.2 The fuel and air compartments in the windboxes are so constructed as to allow the nozzle tips for these compartments to tilt up and down in unison. This allows the fireball to be moved up and down within the furnace cavity, thus changing the relative heat pickup in the furnace waterwalls, and in turn, the furnace outlet gas temperature. This control of the furnace outlet gas temperature through the use of the tilting firing system provides the capability for changing the superheater and reheater outlet steam temperatures.

The nozzle tilting system is an integral part of each furnace windbox. It consists basically of drive units, nozzle adjusting mechanisms, pivot pins, and adjustable nozzle tips. The tilting tangential system allows the fuel and air nozzle tips to be tilted 30 degrees above and below horizontal. A standard tangential tilting mechanism is depicted in Figure C.

On a corner basis, by energizing the drive unit 1, external connecting rods 2 (attached in series and running vertically along the windbox) are set in motion. At their connections to the windbox are external nozzle adjusting mechanisms 3 which contain shear pins and are keyed onto live shafts running through the windbox casing. Keyed on the internal end of each of these shafts are internal nozzle adjusting mechanisms 4 (bellcranks). Each of these transmit the drives force through a horizontal nozzle adjusting link 5 to a nozzle tip or tips within a windbox compartment. In addition, by way of vertical internal connecting bars 6, the force is sent from these keyed bellcranks to ones located on stationary pivot pins in adjacent compartments. Also attached to the vertical bars 6 are horizontal nozzle adjusting links, which connect to the individual nozzle tip(s) in the associated compartment. In cases where there is more than one nozzle tip in a compartment, vertical nozzle connecting links 7 are utilized to interconnect nozzles. In this case only one horizontal adjusting link is required. Since each of the fuel and air adjustable nozzle tips pivot about their own axis, the drive force reaches the nozzle tip and thereby causes the tips to tilt in unison.

The CE tilting tangential firing system has proven to be an effective and reliable method for the combustion of pulverized coal. However, operational problems have occurred with the tilting mechanisms due to difficulties encountered with field adjustment installation and external coal pipe loading. Over the years, Combustion Engineering has upgraded the designs of these tilting mechanisms, and improved the field installation procedures, resulting in a retrofittable system being available for installation on most units. This latest retrofit package is now considered to be the design standard for all applications, and is offered in most cases in lieu of original equipment for replacement.

8.1.3. In order to determine the contributing factors to operational problems on the older design units, a careful study was undertaken by CE's Fuel Systems Engineering department. Based on numerous site visits and discussions with electric utility operations, maintenance personnel and CE's Field Service Engineers, CE determined the following prominent conditions to adversely impact successful operation of the tilt adjustment mechanisms:

1. Excessive loading on the coal nozzle assemblies as a result of improperly erected or supported coal piping.
2. Faulty fabrication and/or field adjustment of the windbox internal components.
3. Excessive slag formation between the adjustable nozzle tips.
4. Distortion of the nozzle tips due to overheating.

Although the four problem areas above all represent different causes, each generates the same basic result. Generally, most of the problems encountered with the tilting tangential firing system are related to binding of the moving components in the system. If a large force is continued to be applied to the tilt adjustment system in an attempt to overcome the binding, damage will result to the windbox internals. Stationary pivot pins, through-shafts and horizontal adjusting links bend or break. Shear pins fail and, in extreme cases, actual distortion of the windbox structure has been found to occur. Based upon improved engineering designs and upgraded materials, the current engineering designs now utilized by Combustion Engineering have minimized the potential for tilt mechanism adjustment failure due to binding.

8.2 Phase I - Representative Baseline Testing

In order to ensure achievement of the overall goal of this demonstration project, i.e. accurate evaluation of the various stages of retrofittable NOx reduction technology, it is suggested that representative baseline unit operation be established. With the exception of modifications to the airheater, representative baseline unit operation can be achieved via testing the selected unit in its present "as is" condition. The premise for this approach is that the existing unit condition is typical for the majority of pre-NSPS operating units. Rather than restore the units firing system to an "as-new" condition, the "as is" approach gives a more realistic presentation of the results of retrofitting combustion system NOx reduction equipment on existing boilers in terms of both real emission reductions and effects on unit operation.

As indicated in the remark above, an alternative approach to establishing baseline unit operation would be complete firing system restoration. The benefit to be derived would be establishment of an accurate base condition, thereby permitting easy interpretation of the effects of each sequential change carried out during the parametric testing of the NOx reduction systems. The drawback of such a restoration phase of the project is the associated expense. Also, it does skew the data collected in that the actual baseline condition of the unit is not accurately represented. In the case of the above suggested approach, while it is significantly less expensive and provides a more realistic data base, a finite baseline condition would not be available for the parametric data analysis.

8.2.1. Lansing Smith No. 2 - A Representative Unit

The subject unit was originally designed and built as a pressurized furnace boiler. At a later date, the unit was converted to balanced draft operation. This is not unusual for units dating from the mid-1950's up until the early 1970's. Figure D shows the breakdown of balanced draft versus pressurized units sold from 1964 to 1974. Figure E gives a listing of the CE units which were originally sold as pressurized boilers and subsequently converted to balanced draft operation. As can be seen from these figures, the Lansing Smith unit is representative of a significant number of CE tangentially fired boilers.

8.2.2. Pulverizer Air Flow - Status

When this unit was converted to balanced draft operation, the original coal pulverizing system was also modified. It has been observed in several cases in which pulverizers are converted from pressurized to suction operation, mill air flow and/or air flow control becomes a problem. Specifically, the primary air flow drops, thereby effecting a reduction in coal nozzle exit velocities. Consequently ignition of the coal occurs very close to or actually within the coal nozzle tip. This causes overheating of the coal nozzle tips, resulting in coal nozzle deterioration, tilt binding problems, and in some cases, windbox fires.

The method used by most utilities in this situation is to "back-pressure" the secondary air system by placing the secondary air dampers in a more air flow resistant position, thereby reducing the amount of total secondary air passing through the auxiliary air portion of the main windboxes. Air flow to the pulverizers is increased, as the hot air to the mills is taken directly from the hot secondary air supply duct. While this does increase the primary air flow and eliminate the problems described above, it also requires that the unit be operated in a manner that is inconsistent with the original unit design.

In the case of the Lansing Smith unit, the adjustable secondary air nozzle tips windbox have been revised. The original secondary air nozzle tip free area has been reduced in order to back-pressure the air system. In addition to the fact that the secondary air free area of the windbox is not per original design, the blank zones caused by the missing nozzles also fill with slag and restrict the tilting operation of the remaining nozzle tips.

Presently, the subject unit is operating at MCR with an 8.0-8.5 in. w.g. windbox to furnace differential pressure with the fuel air dampers 100% open and the auxiliary air dampers 40% open. The unit is designed to operate with a windbox to furnace differential pressure of 3.0-6.0 in. w.g. As stated above, this excessive windbox pressure is required to provide sufficient mill airflow, and thereby maintain the coal ignition points external to the coal nozzles. Characterization of the baseline emission tests will be partially restricted due to limitation on evaluation of operating variables such as windbox air flow biasing.

For the subject unit, the 8.5 in. w.g. windbox to furnace differential pressure is maintained by diverting most of the secondary airflow to the small free area of the fuel air compartments. Past experience has shown that biasing more airflow towards the fuel ignition point will increase the NOx emissions of the burner.

In addition, this backpressure operation is almost certainly effecting the design mill airflow. Here again, past experience has shown that air/coal transport ratios can have a significant effect on NOx emissions.

8.2.3. Airheater Modifications

As stated in this proposal, pulverizer airflow has been identified as an area of concern for this test program. In order to ensure that there is consistent airflow to the pulverizers throughout all testing phases of this project, modifications to the airheater are suggested in order to reduce the pressure drop through the airheater, resulting in higher available pressure of the airheater outlet for pulverizer air flow and reducing dependency upon windbox operating conditions.

The scope of this phase of the demonstration project has changed from the original design in that the existing forced draft fans are now being used to provide the required boosted pressure for the Separated Overfire Air (SOFA) system rather than installing the two dedicated boost fans originally proposed. It has been determined that the existing FD fans have the capability to operate at the required conditions, however, the air preheaters which are in-line between the FD fans and the OFA system are currently operating at delta-P's which are far above the design air system. In order to be able to utilize the FD fans for the HPOFA system, it is necessary to replace the existing air preheater elements.

The existing elements are the dense-pack type, which were retrofit to the air preheaters at the time when the unit was firing a South African coal with low ash and low sulfur content. These elements are not suitable to the Midwest bituminous coal currently being fired, as is evidenced by the excessive delta-P's and frequent requirements for waterwashing currently being experienced.

All three levels of elements, hot, intermediate and cold, will be replaced to reduce the airheater pressure drop back to its original design and permit the use of the FD fans for the High Pressure Overfire Air System.

The equipment components to be provided for installation prior to establishing baseline unit operation are as follows:

1. Two (2) Sets of basketed air heater hot end heating elements, Type DL, 27 1/2" in depth, fabricated from 22 gage LACR steel.

2. Two (2) Sets of basketed air heater intermediate heating elements, Type DL, 23 1/2" in depth, fabricated from 22 gage LACR steel.

3. Two (2) Sets of basketed air heater cold end heating elements, Type DL, 12" in depth, fabricated from 22 gage LACR steel.

8.3 Phase II - Low NOx Concentric Firing System, Level II (LNCFS II)

The retrofit of a Low NOx Concentric Firing System, Level II (LNCFS II) to Lansing Smith Unit No. 2 in Phase II will include the following combustion system related modifications:

- Rehabilitation/upgrade of tilting tangential system
- Replacement of adjustable air nozzle tips
- Replacement of adjustable coal nozzle tips

- Addition of a Separated Overfire Air System (SOFA)

8.3.1. Windbox and Firing System Rehabilitation

Presently, the tilting nozzle tips on the subject unit are not operable and remain fixed in a horizontal firing position, i.e. simulating CE's fixed tangential firing system. It is advisable to restore the tilting feature to the windboxes in order to not limit the conclusion which can be drawn from some portions of the parametric test program.

In the following sections, a discussion is presented relating to the factor contributing to binding in the tilting system, and the course of action necessary to correct the binding problems.

8.3.1.1. Coal Pipe Loading

Excessive coal pipe loading on the coal nozzle assemblies is a major contributor to tilt mechanism failures. This is a problem typical of units such as Lansing Smith 2, which was constructed in the 1960's. During that time the standard design for coal piping support permitted supporting the vertical coal piping runs in the windbox corners by attaching the coal pipe rigidly to the windbox utilizing cantilever beam type supports, as illustrated in Figure F. The resulting excessive coal pipe loading on the coal nozzle assemblies becomes evident when the differential in thermal expansion between the coal piping (which typically operates at approximately 150 degrees F) and the windbox (which typically operates around 550 degrees F) is not adequately absorbed. The result of this is shown in Figure G. As the windbox expands, the run of coal piping 1 between the coal nozzle assembly 2 and the rigid cantilever beam support 3 does not expand at the same rate. Thus a loading is put upon the windbox at the point where the coal pipe penetrates the rear of the windbox. This point acts as a fulcrum, allowing the entire coal nozzle assembly within the windbox to pivot and come in contact with the upper partition plate in the fuel compartment. As a result, the tilting coal nozzle tip will bind and render the entire tilting mechanism inoperable for that windbox.

In order to eliminate the problem described above, Rockwell pipe couplings will be utilized. These expansion couplings provide for 3/8" linear expansion, in combination with 4 degrees of angular deflection. By cutting the coal pipe between the cantilever support and the inlet elbow and inserting the coupling at this point, a toggle section is then able to compensate for any thermal expansion differential between the windbox and coal piping, as well as correct any coal pipe-coal elbow misalignment up to 4 degrees. This Rockwell coupling installation is shown in Figure H.

8.3.1.2. Mechanical Interference of Windbox Internals

Because of the many adjustable nozzle tips and linkages comprising the tilting tangential system, it is critical that tolerances and clearances be maintained during installation and adjustment to prevent binding due to mechanical interference. The following are several common examples of mechanical interference due to faulty fabrication or improper field adjustment of the windbox internals.

Interferences between auxiliary air nozzle tip lever arms and the horizontal nozzle adjusting links are one such concern, as shown in Figure J. Improper placement of the pin connecting the lug or lever arm on the

nozzle tip can very easily cause binding between the lever arm and the link. This occurs whenever the nozzles are tilted down. The result is that the nozzle tips are kept from tilting fully downward while also producing bending of the horizontal adjusting link.

Another potential for interference is the clearance slots provided for in the partition plates for the internal vertical connecting bars, also shown in Figure J. They have on occasion been found to be undersized or incorrectly placed. During a down tilt, the connecting bars which link the internal bellcranks have hit the edges of these slots which in turn have prohibited that section of nozzle tips interconnected by the bound bar from tilting fully downward.

Because all of the nozzles in any corner are linked together, any binding of one section limits the tilting ability of the entire windbox.

One other problem has been nozzle connecting links binding against the nozzle tips, preventing them from tilting fully throughout their entire range. These vertical links serve the purpose of connecting several nozzle tips, enabling them to be tilted by only one horizontal connecting link. These bars are located close to the nozzle tip pivoting axis and because of this close location, slots are provided on the upper and lower platework of the nozzle tips for connecting link clearance during nozzle tilting. Improper installation of nozzle connecting links, incorrectly located clearance slots and misaligned lever arms are common causes for mechanical binding.

Improper adjustment of both the horizontal adjusting links and the external connecting rods will also lead to tilt binding. Nozzle tips or sections of the windboxes not properly adjusted may restrict the tilting of adjacent nozzle tips which are properly adjusted.

Simply put, careful inspection of the windbox and repair of any damaged or misaligned components is critical to ensure proper operation of the tilting system. This is especially true in the instance of the subject unit, which has been in service for well over twenty years. Figure K illustrates the original windbox configuration with existing partition plate spacing.

8.3.1.3. Restoration of Tilting Mechanisms

In order to ensure the mechanical integrity of the windbox and ensure that existing components will not jeopardize the operation of the tilt system, the following new modifications and materials will be provided:

1. New nozzle adjusting mechanisms located inside the windbox. The new bellcranks will be supplied with cast iron bushings and stainless steel stationary pivot pins. Stiffener bars will also be supplied to be located behind each stainless steel stationary pivot pin to increase web strength and prevent binding.
2. New CORTEN tubular horizontal nozzle adjusting links. These new design links have increased compressive strength at higher temperatures in comparison to the original design flat bar type. CORTEN stiffener bars are also provided to

strengthen the all-thread section of the new links.

3. New vertical nozzle tip connecting links are provided. The new links will be fabricated from CORTEN and will exhibit a higher compressive strength cross-sectional design.
4. New coal nozzle seal plates, fabricated of thinner plate than the original equipment to reduce the potential for binding.
5. Miscellaneous plate and materials as required to restore the windbox to acceptable condition in terms of internal dimensions and structural integrity. Burned, warped and damaged partition plates, channels and structural members will be replaced as deemed prudent.
6. Rockwell expansion couplings will be provided to relieve the coal pipe loadings on the windbox, along with all appropriate gaskets, hardware, and coal piping modifications. The coal pipe modifications will be designed so as to be compatible with the future LNCFS III retrofit (Phase III).
7. New Beck electric tilt drives will be provided in place of the existing pneumatic tilt drive mechanisms.
8. New adjustable auxiliary air nozzle tips (included with LNCFS II Equipment).
9. New adjustable coal nozzle tips (included with LNCFS II Equipment).

8.3.2. Low NOx Concentric Firing System, Level II (LNCFS II)

The Low NOx Concentric Firing System, Level II (LNCFS II) is a system which incorporates offsetting the secondary air from the fuel air/fuel in the main firing zone and the bulk staging of an overfire air (OFA) system. LNCFS II incorporates the use of improved flame-stabilization design coal nozzle assemblies, where applicable, as well as additional site-specific modifications. A discussion of the relationship of NOx formation to the design features of the LNCFS is presented below.

8.3.2.1. Pulverized Coal NOx Formation

Understanding the use of LNCFS as a NOx reduction technique requires a basic understanding of the NOx formation process during the combustion of coal in a steam generator. These nitrogen oxides are known to form within the immediate vicinity of the flame zone by oxidation of both atmospheric nitrogen and nitrogen contained in the fuel. These two distinct nitrogen sources produce NOx known respectively as "thermal NOx" and fuel "NOx".

"Thermal NOx", the formation of nitric oxide via the thermal fixation of atmospheric nitrogen, is produced by a highly temperature sensitive chemical reaction. This rate of formation is exponentially dependent on the temperature and is proportional to the square root of oxygen concentration. The thermal fixation rate can be reduced by limiting the amount of oxygen available to the fuel or by reducing the combustion temperature.

Only a fraction of the fuel nitrogen is converted to NOx. However, "fuel NOx" can represent a significant fraction of the total NOx emitted during the combustion of a high nitrogen content coal in a conventionally fired steam generator. The mechanism by which fuel nitrogen is converted to NOx is highly speculative. It has been shown, however, that the different fuel firing systems utilized by the various manufacturers of steam generating equipment produce significantly different flame structures. These range from highly turbulent burners designed for rapid mixing of fuel and air to the relatively slow mixing tangential firing system used by Combustion Engineering, and furnished on the subject unit.

Early NOx studies showed that this tangential firing system produced approximately one-half the NOx levels emitted by the more highly turbulent firing systems.

Prior to 1972, the conventional CE firing system injected a premixed composition of pulverized coal and 1.5 - 2.0 pounds of primary (transport) air per pound of coal at approximately 85 fps, and typically 4-6 degrees from the furnace diagonal. Immediately surrounding the pulverized coal stream and primary air stream an additional 2.0 pounds (approximately) of air per pound of coal was supplied as fuel air or fuel compartment secondary air. The remaining secondary air required for complete combustion was supplied above and below each coal elevation, parallel to the coal stream, through auxiliary air nozzles at approximately 150 fps. The rate of mixing between the parallel streams of coal and air was relatively slow.

This tangential firing system initially combusts pulverized coal only with the primary air and fuel air to form the primary combustion zone. During this process the coal devolatizes and volatile matter nitrogen is released to form nitric oxide compounds. Due to the short time duration of this zone, the NOx generated within this region is termed "prompt NOx".

As the devolatized coal particles proceed along with combustion flow path, the secondary air injected through the auxiliary air nozzles diffuses into the stream and forms the secondary combustion zone. During this process char combustion occurs, producing both "fuel NOx" and "thermal NOx".

The theoretical air required for the volatile matter in the primary combustion zone is 3-4 pounds air per pound coal. With a 3.5 - 4.0 pound air/pound coal ratio normally supplied to the primary combustion zone, the combustion of volatile matter can go to completion. However, the formation of NOx is throttled by the shortage of any excess oxygen, and the conversion of any fuel bound nitrogen to "prompt NOx" will be limited. The secondary combustion zone requires 7-8 pound air/pound coal to complete the combustion of char. However, the conventional CE design provided a fuel-lean ratio of 8.0 - 10.5 pound air/pound coal for the secondary combustion zone to assure high combustion efficiency. Thus, the combustion of coal with high excess air levels produced a sharp rise in NOx emissions.

8.3.2.2. Using OFA for NOx Control

In order to comply with the New Source Performance Standards established by the Federal government in the early 1970's, Combustion Engineering began incorporating a bulk staging technique known as overfire air (OFA) into the basic firing system design.

Overfire Air is the staging of secondary combustion air, at existing windbox pressure, above the main firing zone. This system is a standard commercial offering of Combustion Engineering as a stand-alone retrofit for NOx reduction. However, it must be appreciated that an overfire air system involves more than simply taking a portion of the secondary air from the main firing zone and injecting it elsewhere. The design of the system requires an evaluation of the main firing system to ensure that the proper nozzle velocities are maintained, that potential changes in heat transfer rates in the boiler are corrected for, and that the overall system will be compatible with the routine operation of the unit.

Overfire air (OFA) is the oldest and most widely used method for reducing NOx emissions in fossil fuel fired steam generators. The concept of overfire air is relatively simple. A quantity of combustion air which would normally be introduced as secondary air in the burner zone is redirected and introduced above the main burner zone. This in turn reduces the amount of available oxygen in the main combustion zone where "prompt NOx" and "thermal NOx" are generated. It is important to understand that the total quantity of combustion air being introduced to the furnace is not being changed, it is merely the distribution of air which is changing.

Since 1971, Combustion Engineering has utilized the OFA staging technique in the design of all new coal firing systems. The technique generally withholds 15-20 percent of the total combustion air conventionally supplied to the furnace fireball or secondary combustion zone, and injects this air above the flame envelope. The air is injected through dedicated overfire air compartments designed to produce the desired nozzle exit velocity at a given design flow. When this OFA concept was originally incorporated into the design of post-NSPS units, the overfire air was introduced into the furnace through compartments located at the top of the main windbox. Subsequent testing has shown that the reduction efficiency of overfire air increases directly with increased separation of the OFA above the main firing zone.

The design parameters for the optimum overfire air system design are based upon furnace configuration, residence time, heat input, fuel burning characteristics, and a variety of additional considerations. Thus, the particular design of the OFA system as well as the maximum amount of secondary air which can be effectively redirected as overfire air must be determined on a site specific basis.

8.3.2.3. The OFA System for LNCFS II

NOTE: The Separated Overfire Air (SOFA) is an advanced overfire air system which utilizes a bulk staging process with the distinction of allowing an air supply system which is operated at pressures above the normal windbox air pressure. The intent of operating at increased pressure is to increase the injection velocity of the overfire air into the furnace. High pressure overfire air is employed when the level of secondary air being diverted as overfire air reaches a point where the main fireball portion of the furnace is at or below stoichiometry, and when carbon carry-over is a concern. The improved air penetration and increased turbulence created by the high velocity injection of the overfire air serves to improve burnout of unreacted combustibles in the gas stream.

The OFA system situated in the furnace wall above and separate from the main windbox will be referred to as the SOFA. A higher pressure air supply from the air heater outlet will be utilized for greater air penetration into the furnace combustion gases. The Separated Overfire Air system proposed for retrofit on the Lansing Smith unit will consist of four dedicated OFA windboxes, each mounted in the furnace corners as shown in Figure L. Each windbox will be equipped with three elevations of tilting tangential overfire air nozzle tips. The SOFA windbox tilt mechanisms will be automatically controlled, with electric positioners, to track in parallel or with bias the tilt position of the main windboxes. The tilt range of both the main windboxes and the SOFA windboxes is +/- 30 degrees.

Figure M depicts a separated overfire air windbox which is similar to that being utilized for this application.

The SOFA system will be designed to provide up to 20% of the total combustion air flow. The air will be directed to the SOFA windboxes directly from the main secondary airheater outlet ducts, as shown in the attached General Arrangement Drawing No. 14664 4E9076. Total overfire air flow will be controlled by the use of windbox dampers at the inlet to each overfire air compartment. These dampers will be controlled automatically with electric operators, with manual override capability from the control room. The dampers will control airflow on an elevation basis, which provides operational flexibility for controlling both total airflow and nozzle exit velocity. The control system and philosophy will be discussed in more detail later in this discussion.

The SOFA nozzle tips are equipped with an adjustable yaw mechanism, similar to that supplied with the LNCFS air nozzle tips. However, the adjustable yaw angle ranges from the standard firing angle to 15 degrees towards the wall in the direction of fireball rotation, and from the standard firing angle to 15 degrees towards the wall opposite the direction of fireball rotation. The yaw adjustments of each nozzle tip are independent, and, as with the LNCFS tips, are mechanical adjustments which can be made without changing unit operation. Figure S illustrates the SOFA windbox assembly and the nozzle tip adjustment capability.

The yaw capability is not intended to be used as a normal operating parameter. It is anticipated that during the optimization testing of the LNCFS II a configuration will be established for the yaw angles which provides the best NOx reduction throughout the entire operating range of the system. Once this configuration is established, the yaw controls will be locked in this position.

Due to the fact that there are three elevations of completely independent nozzle tips, the three tips in any windbox can be yawed at different angles to provide a fan-type effect with the overfire air. A similar OFA arrangement was tested in Combustion Engineering's Kreisinger Development Laboratory in Windsor, Connecticut. The test was conducted in the facility's Boiler Simulation Facility, under actual coal firing conditions. The testing proved both the importance of having the inherent flexibility in the overfire air system to make operational tuning modifications, and showed that the relative positioning of the nozzle tips played an important role in optimizing the NOx reduction efficiency of the system.

As shown in the previously referenced general arrangement drawing, the new SOFA windboxes will be mounted vertically in line with the main windboxes so that the centerline of the windbox will be approximately 10' above the centerline of the uppermost coal elevation in the main windbox. This location for the windbox was developed after evaluating the site specific variables described previously, and the structural configuration and constraints of the boiler. Figure V illustrates the proposed windbox and overfire air system arrangement for the PHASE II test program.

The SOFA system is designed to operate at up to 12" w.g. pressure, the additional boost being provided by the existing forced draft fans. The SOFA ductwork systems will tap into the existing secondary air supply ducts. Parallel blade louver dampers, with dimensions of approximately 10'-0" x 10'-0", will be provided in the secondary air duct immediately downstream of the tie in points for the SOFA ductwork. These dampers will be manually operated to impart bias in secondary air pressure available to the main windboxes in comparison to the air pressure available to the SOFA windboxes. From there, a new dedicated connecting duct will tie into the two SOFA windboxes on each side of the unit. The SOFA ductwork will be constructed of 3/16 inch A-36 or better carbon steel. The ductwork will be provided with all required stiffeners, turning vanes, access doors, hangers, supports, and expansion joints. The ductwork will be shop-assembled to the maximum extent practical.

To accommodate the installation of the overfire air windboxes in the furnace corners, new offset-tube pressure part assemblies will be provided. As shown in Figure N, approximately fifteen waterwall tubes will be removed in each corner for the SOFA windbox installation. The replacement tube panels will be shop-optimized, with tube ends prepped for field installation. All prepped ends will be capped for shipping and storage protection. The tubing material will be equivalent or better grade than the existing tubing, and of compatible diameter and wall thickness. Each tube panel will be approximately twelve feet long, and will include the openings for the SOFA windboxes. The approximate weight of each panel is 1500 pounds.

Each SOFA windbox will consist of a carbon steel shell, divided horizontally into three separate overfire air elevations. Each elevation has an integral overfire air flow control damper, with stainless steel damper shaft and bushings. Each damper has a Foxboro-Jordan electric damper operator, mounted externally on the windbox. Each of the three air compartments is equipped with one stainless steel tilting nozzle tip. The nozzle tips are linked together, and connected back to a tilt control bellcrank, which passes through the side of the windbox and is driven by an electric tilt drive mechanism. The windboxes will be completely shop-fabricated, and shipped with all internal components installed. The windboxes will be shipped loose from the tube panels, to facilitate the pressure part installation.

The connecting ductwork arrangement shown in the general arrangement drawing will be constructed of 3/16" A-36 or equivalent carbon steel, complete with all stiffeners, hangers, supports, and expansion joints. Ductwork sections will be shop-fabricated to the maximum possible extent dictated by shipping restrictions and access around the boiler.

It is imperative for the purposes of testing the system that accurate airflow measurement be obtained for the high pressure overfire air flow. In the high pressure system the ductwork runs are substantially longer and provide an opportunity to install sophisticated measuring equipment. Therefore, CE will utilize a multicell venturi measuring device, similar to that shown in Figure T, in the connecting ductwork. These Combustion Engineering designed multicell venturis have been utilized in utility installations for airflow measurement, and have proven their reliability and accuracy in installations where other types of instrumentation could not produce consistent readings.

The ductwork will be externally insulated and lagged in the field. Insulation shall be asbestos-free mineral wool, lagging shall be 0.032 inch ribbed aluminum, which is compatible with existing lagging.

8.3.2.4. Main Windbox Design for LNCFS II

As stated earlier, one of the basic principles of NOx reduction is the need to withhold large quantities of combustion air from the fuel during the initial stages of combustion. Overfire air is an example of this "bulk staging" technique, whereby air is diverted away from the main combustion zone, and staged vertically above the fireball. LNCFS II features a horizontal staging technique which is incorporated with overfire air to both enhance the effects of overfire air and provide additional air staging during the initial devolatization of the fuel.

The effectiveness of this LNCFS concept has been successfully demonstrated at Utah Power and Light; Hunter Station, and at Central Electric Generating Board's (CEGB) Fiddler's Ferry Station. Published test results showed NOx reductions on the order of 30 to 38%. Both units have continued operation with the LNCFS system in place, with no attributable operational problems.

With Combustion Engineering's traditional tangential firing design, each coal firing elevation is separated by an elevation of secondary air, known as auxiliary or intermediate air. This air provides the oxygen required to complete the combustion of the fuel. As described earlier, tangential firing involves injecting the fuel and air towards an imaginary circle in the center of the furnace. The basic concept of the LNCFS system is to withhold the interaction of the auxiliary air and the unburned fuel as long as possible, while still providing for complete combustion and char burnout. To slow the diffusion mixing process of this auxiliary air, it is injected into the furnace into a larger imaginary firing circle than the fuel stream. Figure O illustrates this concept. The auxiliary air is thus directed away from the fuel stream delaying the fuel jet from entraining this air, thereby reducing the combustion stoichiometry during devolatization and the initial stages of char combustion. This results in very fuel rich primary flames, while maintaining oxidizing conditions along the furnace walls.

This redirected air injection angle is generated through the use of offset air tilting nozzle tips, as shown in Figure P. For typical commercial applications, the degree of offset is fixed. However, for this application, the nozzle tips will be provided with the capability for adjusting the degree of offset (yaw). An adjustable yaw mechanism will be incorporated into the nozzle tip design to allow the yaw to be varied from the existing firing angle to 22 degrees towards the waterwall, in the direction of fireball rotation. This is illustrated in Figure P.

This yaw adjustment is a manual, mechanical adjustment which can be made from the exterior of the windbox, without taking the unit, or elevations of the firing system out of service. However, this should not be considered an operational function. The basic purpose of the adjustable yaw feature is to enable the angle of offset to be field optimized, and once the optimum setting is obtained, the nozzles should be fixed in that position. Field optimization of the offset angles should be a priority following restart of the unit.

Six offset air nozzle tips will be installed in each windbox. In the first auxiliary air compartment, the air nozzle tips above and below the warm-up oil nozzle tips will not be offset, due to the concern for partially diverting the oil gun spray pattern onto the adjacent furnace waterwalls. In the remaining three auxiliary air compartments, each of the nozzle tips will be offset. The nozzle tips in the end air compartments (top and bottom elevations of the windbox) will not be offset.

In addition to the yaw capability, the new air nozzle tips will be connected to the windbox tilting mechanism in the traditional manner, and will thus tilt in conjunction with the fuel nozzle tips, oil nozzle tips, and end air nozzle tips.

As stated earlier, the offset air nozzle tips are part of a NOx reduction system which includes the SOFA. With this in mind, the free areas of the new air nozzle tips have been designed to produce the desired secondary air exit velocities with the new overfire air system in service. In this particular instance, the free areas have been reduced to correct for the 20% airflow which will be diverted from the main windbox.

In certain applications this offset air system have been found to offer an additional benefit in unit performance. By maintaining an oxidizing atmosphere along the furnace waterwalls, the formation of slag is reduced and corrosion potential is minimized. By keeping the waterwalls relatively clean, heat pickup in the waterwall section of the unit is increased, leading to lower furnace outlet temperatures. This becomes particularly important when considering the application of overfire air, which has a tendency to retard combustion in the furnace and thus increase furnace outlet temperature. With the installation of both overfire air and LNCFS, the effects on furnace outlet temperature tend to be offsetting.

Another basic principle of NOx reduction which has become evident from field and laboratory testing is that early fuel ignition contributes significantly to overall NOx reduction. Initiating combustion close to each fuel nozzle produces a primary, volatile matter flame whose stoichiometry can be better controlled. The result is that sub-stoichiometric firing conditions can be achieved early in the combustion process without adversely affecting overall combustion efficiency. This technique is a departure from long standing tangential coal firing philosophy, but has proven to yield significant reductions in NOx emissions without increasing unburned carbon loss.

As stated above, the LNCFS promotes a close, stable ignition by virtue of the system design. However to further promote close ignition, a special two-piece "flame holder" coal nozzle tip will be installed to enhance the initial combustion of the coal. The standard design of this "flame holder" nozzle is shown in Figure Q. The two-piece tip is similar in arrangement to that shown. However, the tip will incorporate an easily removable front face including the splitter plate, and a back half which is mounted on pivot pins to the windbox.

By using the two-piece tip, the "flame holder" portion of the coal nozzle tip can simply be removed from the furnace side and replaced, without having to remove the entire coal nozzle tip. This same concept has been utilized successfully in many standard commercial applications where nozzle high tip wear is a problem. A typical commercial two-piece coal nozzle tip is shown in Figure R.

The success of this "flame holder" tip is directly dependent on having the proper primary air flow and velocity available at the coal nozzle exit, otherwise, combustion could occur within the nozzle tip itself. This, of course, would lead to warping and binding of the coal nozzles, and inhibit operation of the windbox tilting mechanism.

8.3.2.5. Control System for OFA Systems

The proposed control system for the new SOFA system and for the Close Coupled Overfire Air (CCOFA) to be provided in Phase III is a stand-alone control system with a programmable controller, designed to modulate the three elevations of SOFA and the two elevations of CCOFA during Phase III. The SOFA and the CCOFA dampers will be controlled on an elevation basis, with the system being set up to ramp the overfire air flow as a function of load and furnace stoichiometry. Thus, for example over the boiler load range from a minimum set point of around 50% MCR (actual set point to be determined based upon unit testing) to 100% MCR, elevations of SOFA will be brought into service based upon the firing zone stoichiometry. The rate at which the dampers open is variable. When the first elevation of dampers reach their 100% open position, the next elevation will begin ramping open. The programmable controller will permit system in-service testing and optimization in terms of determining the best operating program for the SOFA and CCOFA dampers. The dampers will also have a remote manual override feature in the control room.

The controls system described herein will utilize Taylor MOD 30 microprocessor-based, single loop controllers acting through Foxboro-Jordan electric, linear damper drives for positioning the overfire air dampers. The MOD 30 controllers will be mounted in a NEMA 12, free-standing control cabinet located in the existing control room.

The SOFA and CCOFA flow control system will be fully programmed, debugged and tested at the Vendor's facility prior to shipment. All controllers will be pre-wired to the shop side of terminal blocks for ease of installation.

Figure U is a typical schematic illustration of the proposed overfire air damper controls.

The following are the major components of the control system:

1) One (1) Control cabinet, NEMA 12, approximate dimensions 72"H x 30"W x 24"D, with the following equipment mounted and wired within:

   a) One (1) MOD 30 air flow controller.
   b) Five (5) MOD 30 overfire air controllers - including three (3) for SOFA and two (2) for CCOFA in Phase III.
   c) A/R Power supplies, input controllers, terminal blocks.

2) Twelve (12) Overfire air damper drives, Foxboro-Jordan, LA2420.
3) One (1) MOD 30 portable configurator.

The SOFA and CCOFA control system will be tied into the following output signals from the existing combustion control/burner management system, using signal output contacts to be provided by the Purchaser:

1) Boiler load - using a signal from steam flow transmitter
2) Master fuel trip

Wiring is included for the new overfire air control system from a reliable 120VAC, 60Hz power source (to be provided by the Purchaser).

Typically, cooling air requirements for out of service close-coupled elevations are on the order of   of the total compartment airflow. The SOFA system is designed to handle 20% of the total airflow, therefore, with the SOFA system completely out of service the tramp air in leakage due to cooling amounts to approximately of the design secondary airflow.

8.3.2.6 Major Equipment for LNCFS II

The major equipment components being provided for the Phase II portion of this project are as follows:

1) Four (4) Separated overfire air windboxes, with integral air flow control dampers, tilting adjustable air nozzle tips, electric tilt and damper drives, and all associated damper and nozzle linkage and hardware.
2) Four (4) Waterwall offset tube panels, equal to or exceeding existing waterwall tubing materials, with tube ends prepped and ready for welding to the existing wall tubes.
3) One (1) Lot overfire air connecting ductwork, complete with required stiffeners, expansion joints, turning vanes, hangers and supports. Ductwork to be constructed of 3/16" carbon steel, and externally insulated and lagged.
4) One (1) Lot structural steel, rails, grating, platework and shapes as required to modify existing steel configuration in order to provide access and install the new system.
5) One (1) Lot steam and water piping, insulation and lagging to modify existing sootblower, boiler feedwater piping and hangers, and auxiliary piping in order to accommodate the installation of the new system.

6) One (1) Overfire air control system as described to integrate the control of the new SOFA system into the existing system logic, and provide remote manual operation of the new control dampers in the control room.

7) Forty-four (44) Sets of tilting auxiliary air nozzles, including twenty-four (24) variable offset auxiliary air nozzle tips, constructed of 309 SS, complete with associated linkage and hardware.

8) Twenty (20) Flame holder coal nozzle tips, constructed of 309 SS material or better.

9) Twenty (20) Stationary coal nozzle assemblies, constructed of cast ductile iron.

8.3.3. Additional Equipment to be Retrofit with LNCFS II

In addition to the LNCFS installation during Phase II, Flame Scanner hardware and a Burner Observation System will be installed. The following is a brief description of these two additions to the LNCFS II.

8.3.3.1. Flame Scanner Hardware

The CE Flame ITM system is a self checking system with no moving mechanical parts. An electronic checking circuit continuously monitors the performance of the head assembly and the electronics.

The CE Safe Flame ITM is a flame sensing system which responds in the visible light range of the light spectrum. This feature provides increased sensitivity because of the high efficiency of visible light transmission and is of particular importance on coal fired applications where furnace conditions can adversely affect scanner viewing.

The visible light of the flame is transmitted via fiber optic cable to a photo sensitive device lcoated in the cool zone outside the windbox. An electrical signal is then transmitted to the chassis electronics where the signal is analyzed for frequency and intensity content. Because a frequency component of the emitted light must be sensed in addition to an intensity component, the Safe Flame ITM system will not respond to radiation from hot refractory or slag.

The following outputs are provided for use:

a. Individual corner flame indication on a elevation basis.
b. 2/4 flame indication on a furnace elevation basis.
c. Fault indication of individual scanner head function.

Safe Flame ITM fiber optics and solid state electronics recognize the characteristic frequencies and intensity levels of visible light emitted from the flame front. This light is transmitted from the windbox to electronics outside the boiler via fiber optic cable. Intensity and frequency levels of the light detected by the electronics at the scanner head is converted to a current signal for transmission to a remote signal processing chassis. At the chassis, the current signal is converted to a voltage signal before any analysis is performed. This voltage signal is then simultaneously and indepently examined for its frequency and intensity analysis is a continuous monitoring of the flame signal to ensure the integrity of the scanner head electronics and connecting cable. Proper and accepted proof of flame requires the simultaneous generation of three permissives;

1. No fault
2. A threshold intensity
3. A specific frequency

During the operation of the boiler either the intensity or the frequency content of the canned light may become the dominant factor in distinguishing a flame from background radiation. Safe Flame ITM performance is superior because it breaks the light signal into two distinct component (intensity and frequency). The components have separately adjustable thresholds which permit tailoring the scanner sensitivity to predictable levels of intensity and frequency. Commercial applications have proven that this technique of signal processing produces a positive flame/no flame signal in a predictable and safe manner.

A log amplifier in the scanner head electronics compresses the generated photo-diode current signal. The benefit of this high brightness of this component is that it produces a signal that does not saturate at high brightness levels. This permits the use of measured light magnitude (intensity) as a meaningful signal for flame recognition.

Safe Flame ITM Scanner Head and Chassis Features

- All cards are buffered and have their own test points
- All integrated circuits have sockets
- Integral intensity meters are standard
- Adjustable dead band between pick-up and drop-out signal levels
- Continuous self-checking diagnostics prove the functional accuracy of the scanner and electronics
- Complete solid state system using fiber optics to transmit flame light to a photo-diode (signal then sent to chassis)
- A dual intensity and frequency monitoring circuit to ensure that the light signal being monitored is a flame
- Flame scanner head assembly is located in the tilting air register and tracks the flame axis plus or minus 30 degrees.
- Scanner head electronics feature the inclusion of a transconductance amplifier. This amplifier converts the voltage from the light signal. There are two primary advantages of transmitting a current signal; by nature it is less susceptible to EMI interface in longer cable runs than a voltage signal would allow, it permits use of longer cable runs than a voltage signal, and it permits use of long cables with no signal strength attenuation.

Input power requirements SAFE FLAME ITM System are as follows:

Voltage:	105 to 125 Vac. rms
Current:	0.250 A, rms
Frequency:	50 to 400 Hz.

Wiring (triple shielded) will be installed between the boiler and the SAFE FLAME ITM flame scanner chassis in appropriate cable trays with other low voltage instrumentation cables.

The components as noted in the Material List are to be field installed and wired by the Company. Interfacing or modifications to a burner management system have not been included in this offer.

The following materials will be provided under the scope of this offering:

1)	Sixteen (16)	Safe Flame head assemblies
2)	Sixteen (16)	Flame scanner guide pipes
3)	Four (4)	Safe Flame chassis
4)	Four (4)	Remote meters
5)	One (1)	Lot triple shielded wiring
6)	One (1)	Cooling air system, consisting of: Two (2) 100% capacity fans One (1) In-line filter One (1) Automatic transfer damper One (1) Lot spiral welded piping One (1) Lot hangers, supports and hardware

8.3.3.2. Burner Observation System Hardware

The following materials will be provided under the scope of this offering:

1) One (1) Diamond Electronics Model SC-95 (or comparable) video camera
2) One (1) High temperature housing
3) One (1) Wallbox/camera mounting assy.
4) One (1) Cooling air system, w/ flex hoses, regulator, strainer, manual shutoff valve, and required piping and fittings
5) One (1) Lenstube assembly
6) One (1) DM613/C 13" (or comparable) video monitor
7) One (1) Lot cable, connectors, and misc. hardware as required.

8.4 PHASE III
Low NOx Concentric Firing System, Level III (LNCFS III)

The LNCFS III is a system whereby the upper two pulverized coal elevations, which are traditionally separated by an auxiliary air elevation, are clustered into a pair with minimum separation provided only for flange clearance. Upon relocation of the top pulverized coal elevation downward to a position immediately adjacent to the next coal elevation below, a space is created approximately equal in height to the top end air compartment height and the intermediate auxiliary air compartment height. Into this space are located two overfire air compartments with approximately equal heights. With the secondary air supply to these two OFA compartments being common with the main windbox, this OFA system will be referred to as the Close Coupled Overfire Air System (CCOFA).

In addition to the relocation of the coal nozzle assemblies, an integral part of the LNCFS III is the utilization of offset air nozzle tips, flame holder coal nozzle assemblies, and both Close Coupled and High Pressure Separated overfire air systems.

The offset air nozzle tips which were installed in Phase II have the capability for a wide range of horizontal adjustment. The CCOFA nozzle tips will have the same range of adjustment.

The LNCFS III flame holder coal nozzle tips are similar in concept to the flame attachment tips used in Phase II. The LNCFS III tip utilizes a shear bar device which is designed to minimize fuel air mixing, further enhancing the fuel-rich volatile ignition point zone.

8.4.1. Windbox Internal Modifications

There is additional work which must be performed to incorporate LNCFS III. Due to the fact that the fuel compartments and air compartments are dissimilar in height, when these elevations are swapped the compartment partition plates must be repositioned. The partition plates which are effected are shown in Figure X. Originally, it was thought that the corresponding fuel air and secondary air dampers would also have to be modified to correspond to the change in compartment sizing. However, this secondary air damper arrangement on either side of the repartitioned compartments will be left as is, and the new partition plates will be designed to work with the existing damper arrangement. In addition, a new partition plate and damper will be provided for spacing between the upper two coal elevations due to flange clearance requirements.

8.4.2. Coal Piping Modification

In addition, the coal piping must be modified for the top coal elevations which is being relocated. This is a relatively easy modification, which is accomplished by changing the length of the vertical run of coal piping along the windbox, upstream of the 90 degrees turn inlet elbow to the coal nozzle assembly.

8.4.3. Ignition System Modification

A third modification is required, to the existing ignition system. The unit is equipped with six elevations of ignitors, one adjacent to each of the five coal elevations, and one adjacent to the warm-up oil elevation. It will be necessary to relocate the top elevation of ignitors, that is, those adjacent to the top coal elevation. The top coal elevation is being relocated to the air compartment directly below, and thus the coal compartment centerline will be approximately 2 feet below the centerline of the ignitor. The ignitors were relocated near the new centerline of the relocated coal nozzle. New offset tubes will be provided for the repositioned ignitor openings. The opening which will be left when the ignitor is repositioned will be sealed off with refractory and a steel backing plate.

8.4.4. Other LNCFS III Demonstration

Combustion Engineering has designed a prototype LNCFS III for a 160 Mw utility boiler in Italy, at the Ente Nazionale Energia Elettrica (ENEL) Fusina Station. In this prototype LNCFS III NOx Reduction System, more than one level of clustered coal nozzles has been incorporated in the main windbox. Laboratory testing has been carried out on the 50 million btu/hr Boiler Simulation Facility (BSF) at Combustion Engineering's Kreisinger Development Laboratories. Several different configurations of coal nozzle groupings have been tested, as well as several different overfire air configurations. Test results to date have been encouraging. The full scale retrofit of the Fusina unit was completed in the Fall of 1989.

8.4.5 Major Equipment for LNCFS III

The major equipment being provided to retrofit the LNCFS III to the Lansing Smith unit is as follows:

1) Eight (8) New adjustable offset secondary air nozzle tips (CCOFA), constructed of 309 SS, with required attachments and hardware.
2) Twenty (20) Flame holder assemblies may be attached to the existing coal nozzle tips, constructed of 309 SS. **NOTE:** Replacement of adjustable coal nozzle tip is at the sole discretion of CE, the decision of which will be based upon results of Phase II testing and/or observable wear, on the Phase II adjustable coal nozzle tips.
3) One (1) Lot replacement, linkages and hardware as required to reconfigure the windbox compartments and damper arrangements as described.
4) Four (4) Bent tube offsets to reposition the existing ignitors to the locations required for

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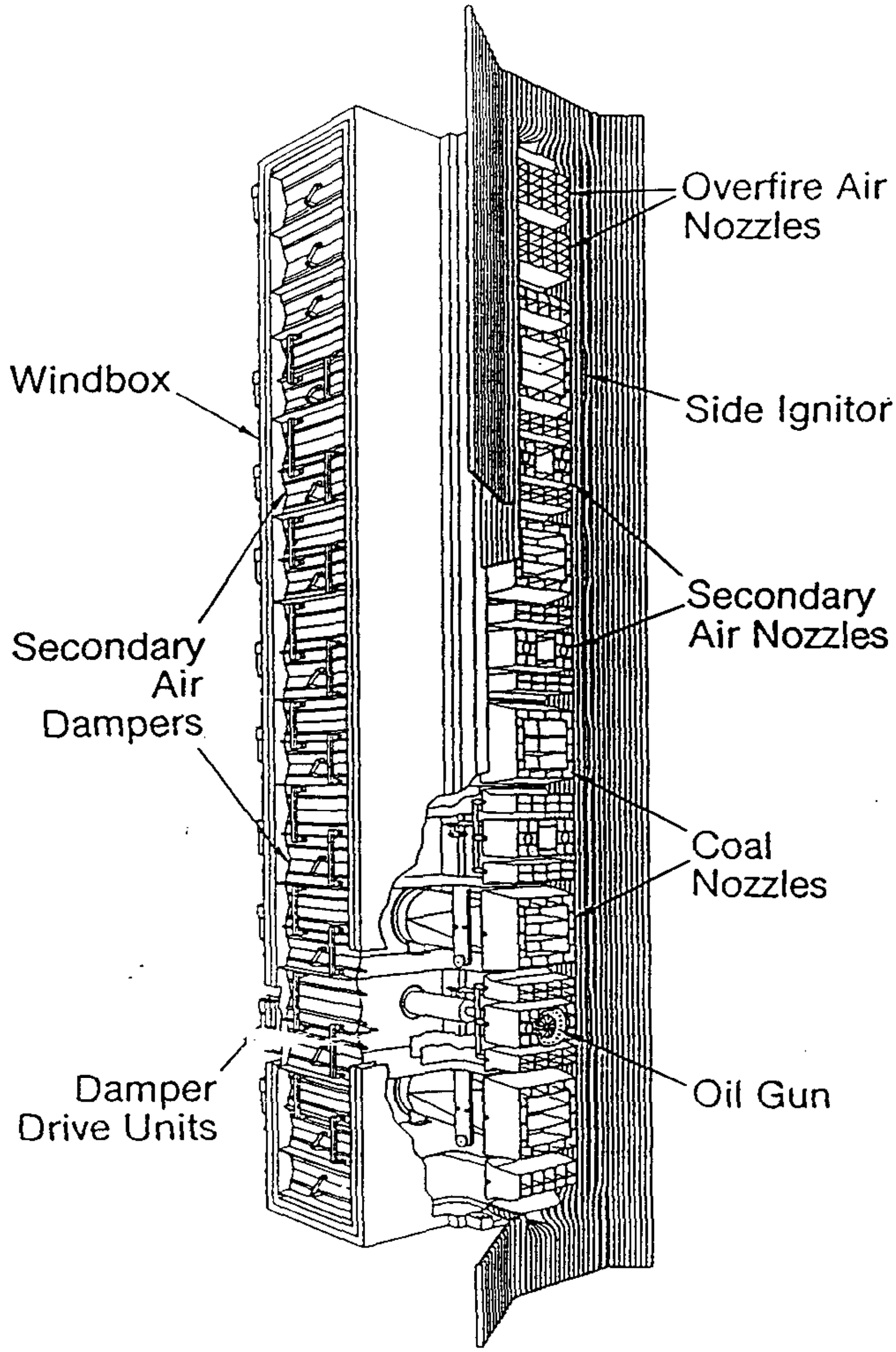
TABLE 1

BOILER AND COMBUSTION SYSTEM
OPERATION SETPOINTS FOR PERFORMANCE GUARANTEES

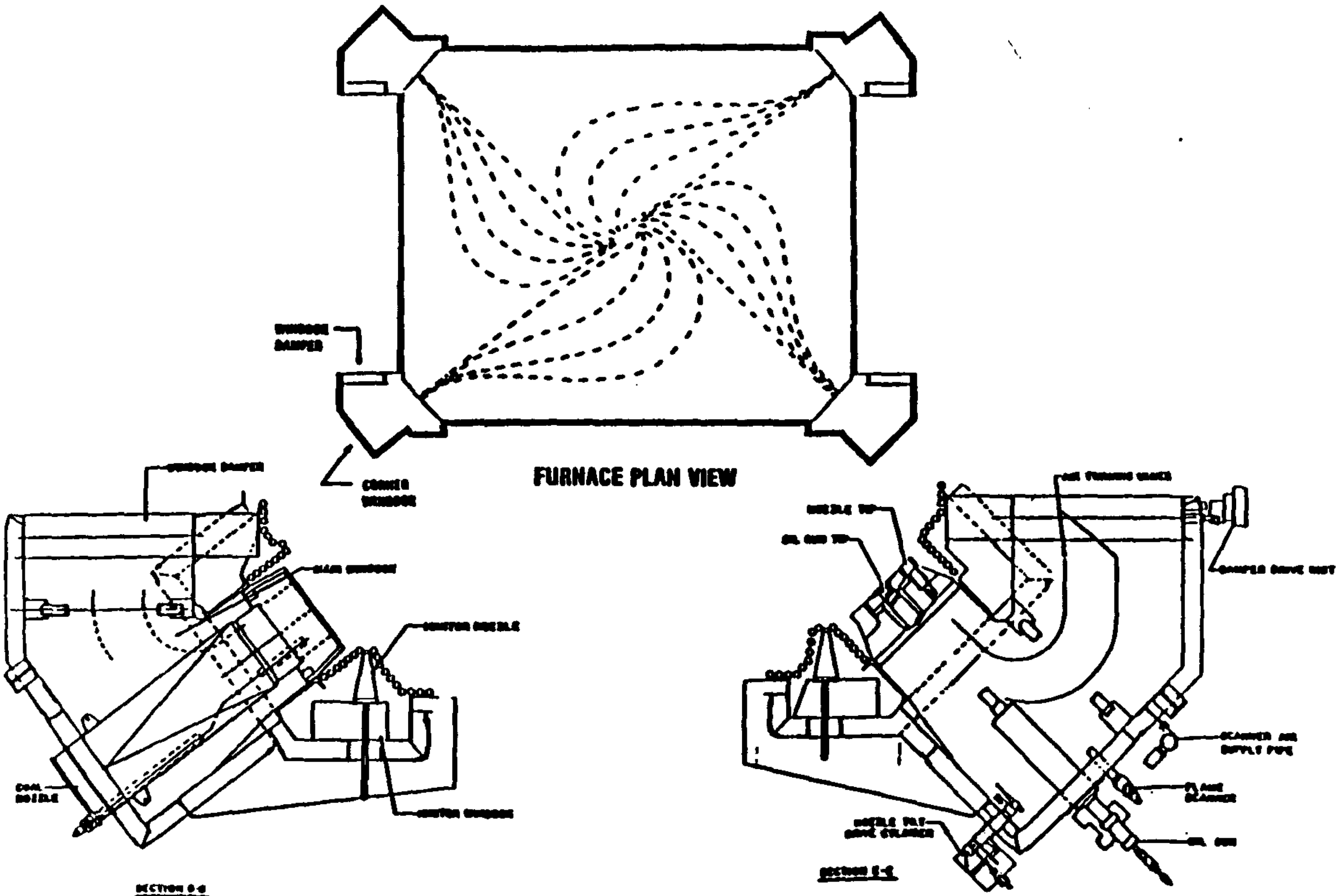
	Approximate Operating Condition		
Operation	Phase I	Phase II	Phase III
Steam Flow - lb/hr	1,306,000	same	same
Steam Pressure - psig	1875	same	same
Steam Temperature - deg. F/deg. F	1000/1000	1000/1000	1000/1000
Mills in Service	5	5	5
Mill Loading	Equal	Equal	Equal
Windbox to Furnace DP - in. H_2O	3.5-4.0	*	*
Windbox Dampers			
Fuel (operating)	Equal	*	*
Auxiliary Air	Equal	*	*
Windbox Tilts	Min. RH Spray	*	*
Auxiliary Equipment	Normal	*	*
Excess Oxygen at Econ Outlet - (%)	3.3	*	*

* Field adjusted per CE recommendation



CUTAWAY VIEW
TYPICAL WINDBOX ASSEMBLY
TILTING TANGENTIAL FIRING SYSTEM

Figure A



WINDBOX
COAL COMPARTMENT

WINDBOX
OIL COMPARTMENT

WINDBOX ARRANGEMENT
TILTING TANGENTIAL FIRING SYSTEM

FIGURE B

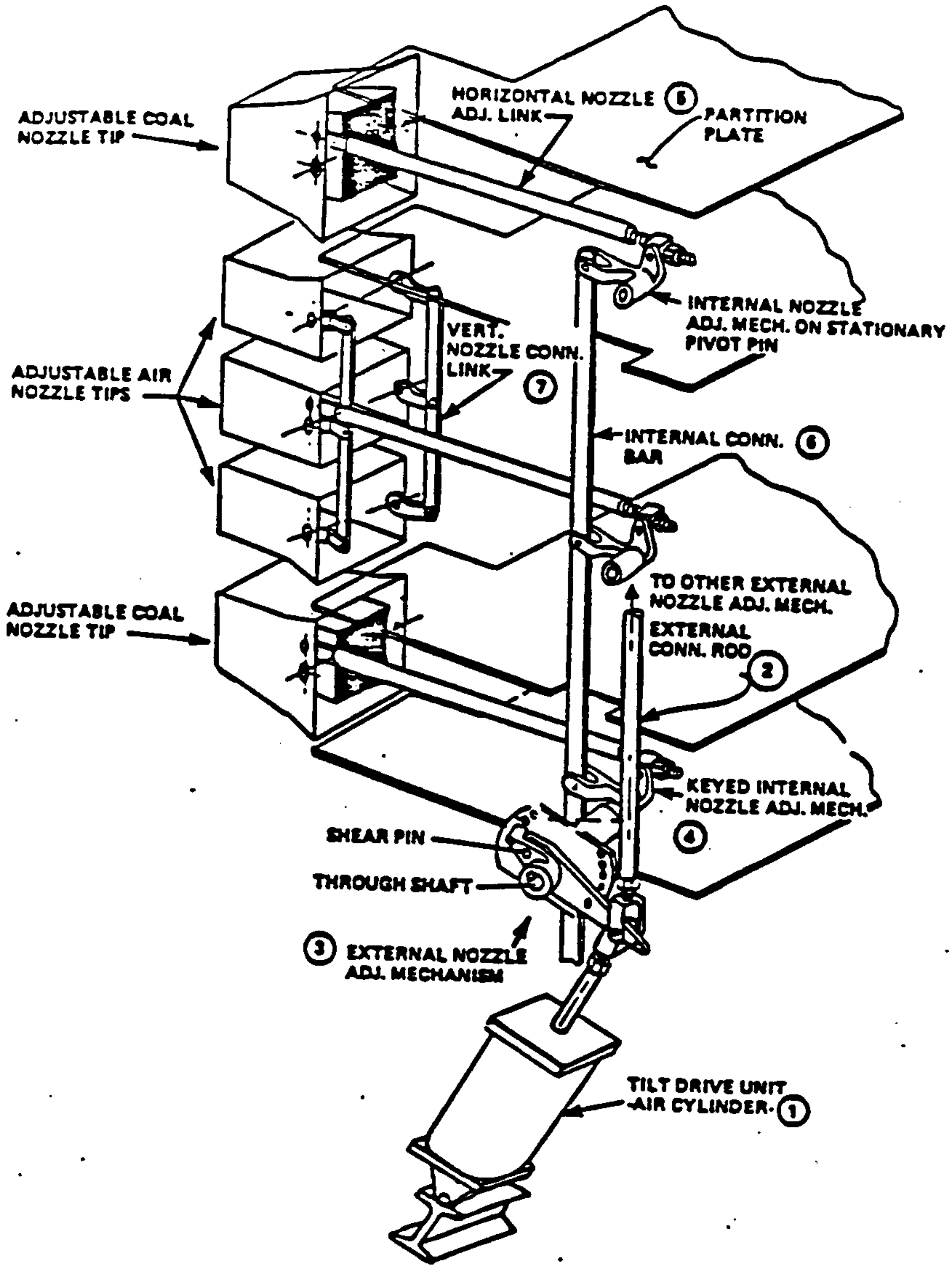

ADJUSTABLE COAL NOZZLE TIP
HORIZONTAL NOZZLE ADJ. LINK
5
PARTITION PLATE
INTERNAL NOZZLE ADJ. MECH. ON STATIONARY PIVOT PIN
VERT. NOZZLE CONN. LINK
7
ADJUSTABLE AIR NOZZLE TIPS
INTERNAL CONN. BAR
6
TO OTHER EXTERNAL NOZZLE ADJ. MECH.
ADJUSTABLE COAL NOZZLE TIP
EXTERNAL CONN. ROD
2
KEYED INTERNAL NOZZLE ADJ. MECH.
4
SHEAR PIN
THROUGH SHAFT
3
EXTERNAL NOZZLE ADJ. MECHANISM
TILT DRIVE UNIT AIR CYLINDER
1

FIGURE 6

Recent years have shown a preference for balanced draft operation over pressurized firing. This has been confirmed both by orders for new equipment and conversions of existing units. This trend is largely a result of efforts to improve availability, reduce operation and maintenance costs, and to alleviate manpower related problems.

The following graph shows the preference for balanced draft operation in new CE units booked during past years. We believe this trend is representative of the entire industry. Although somewhat dated, this graph shows the developing trend at the time when new units were in demand.

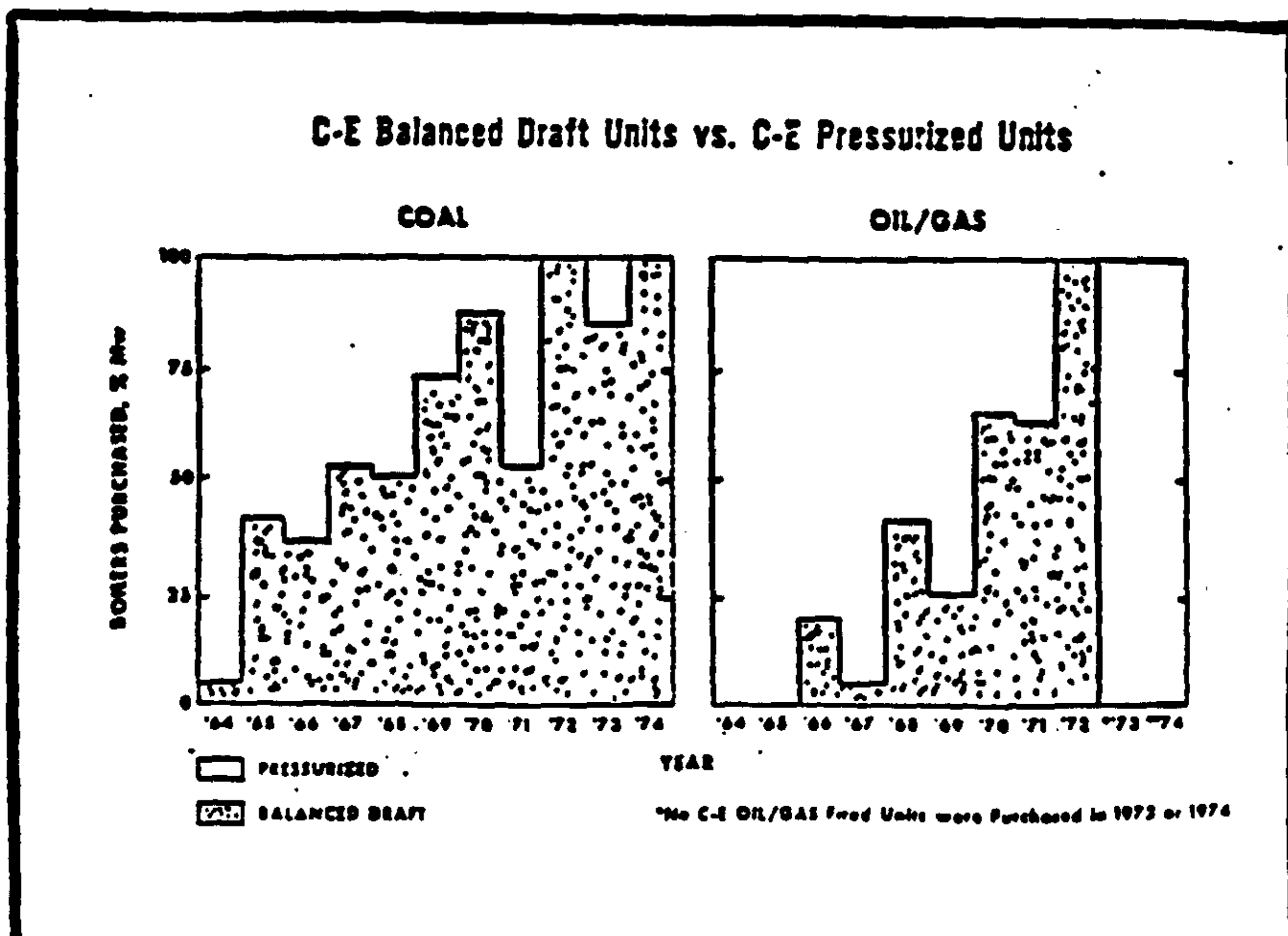


FIGURE 11

CONVERTED CE UNITS

The following CE units have been converted to balanced draft firing:

Utility	Station		Status
Consolidated Edison	Ravenswood 30	(Oil)	1967
Consolidated Edison	Astoria 40	(Oil)	1968
Consolidated Edison	Astoria 50	(Oil)	1969
Long Island Lighting	Northport #1	(Oil)	1971
Long Island Lighting	Northport #2	(Oil)	1972
Commonwealth Edison	Will County #4	(Coal)	1972
Central Hudson G & E	Danskammer #4	(Oil)	1973
Dairyland Power Co-op.	Genoa #1	(Coal)	1973
Indianapolis P & L	Petersburg #1	(Coal)	1973
Monongahela Power	Ft. Martin #1	(Coal)	1973
Carolina P & L	Roxboro #2	(Coal)	1974
Cincinnati Gas & E	Beckjord #6	(Coal)	1974
Commonwealth Edison	Waukegan #8	(Coal)	1974
Kentucky Utilities	E. W. Brown #2	(Coal)	1974
TVA	Widows Creek #8	(Coal)	1974
Alabama Power	Barry #4	(Coal)	1976
Consolidated Edison	Ravenswood 10	(Oil)	1975
Consolidated Edison	Ravenswood 20	(Oil)	1975
*Georgia Power	Wansley #1	(Coal)	1975
*Georgia Power	Wansley #2	(Coal)	1977
Gulf Power	L. Smith #1	(Coal)	1976
Gulf Power	L. Smith #2	(Coal)	1976
Indianapolis P & L	Petersburg #2	(Coal)	1976
Kentucky Utilities	E. Brown #3	(Coal)	1975
*Mississippi Power	Jackson Cnty. #1	(Coal)	1977
*Mississippi Power	Jackson Cnty. #2	(Coal)	1978
Public Serv. of Indiana	Cayuga #1	(Coal)	1976
Public Serv. of Indiana	Cayuga #2	(Coal)	1976
Public Serv. of Indiana	Wabash #6	(Coal)	1975

*New contracts which were modified during erection.

WINDBOX & CANTILEVER BEAM SUPPORTED COAL PIPING

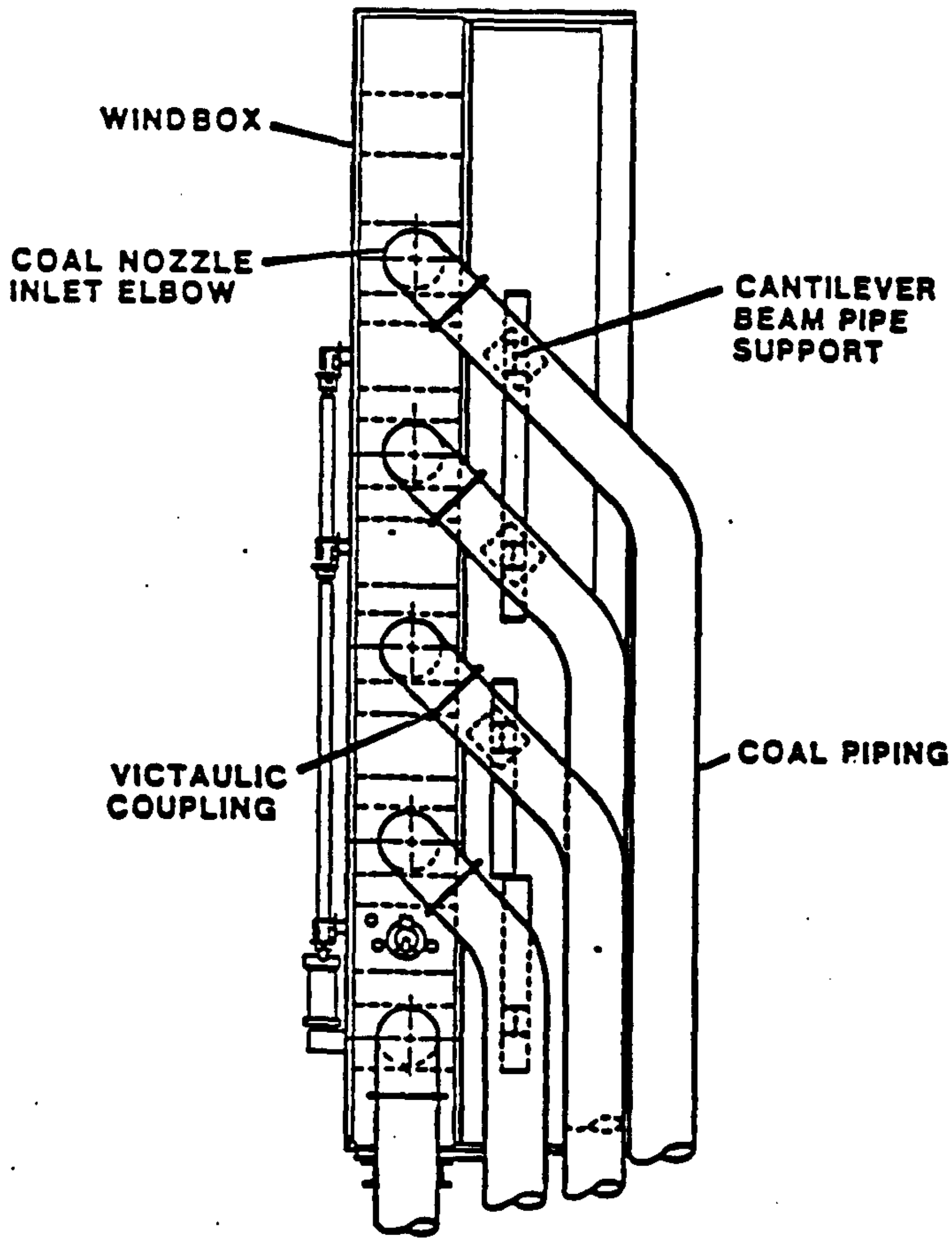


FIGURE F

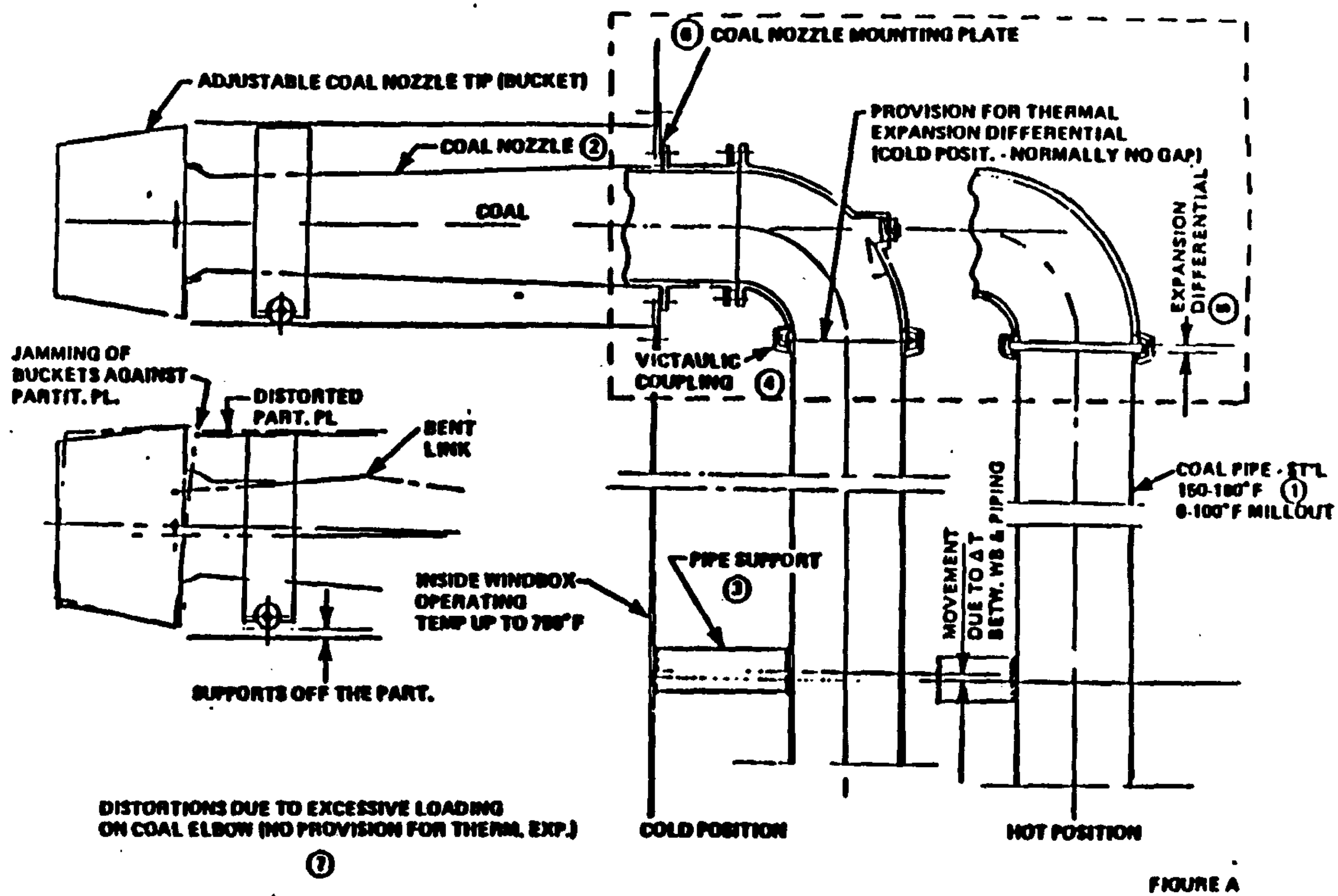


FIGURE A

TYPICAL ARRANGEMENT OF COAL NOZZLE ASSY AND COAL PIPING AT WINDBOX

FIGURE G

COAL PIPE MODIFICATION TO RELIEVE COAL PIPE LOADING FROM COAL NOZZLE ASSEMBLIES

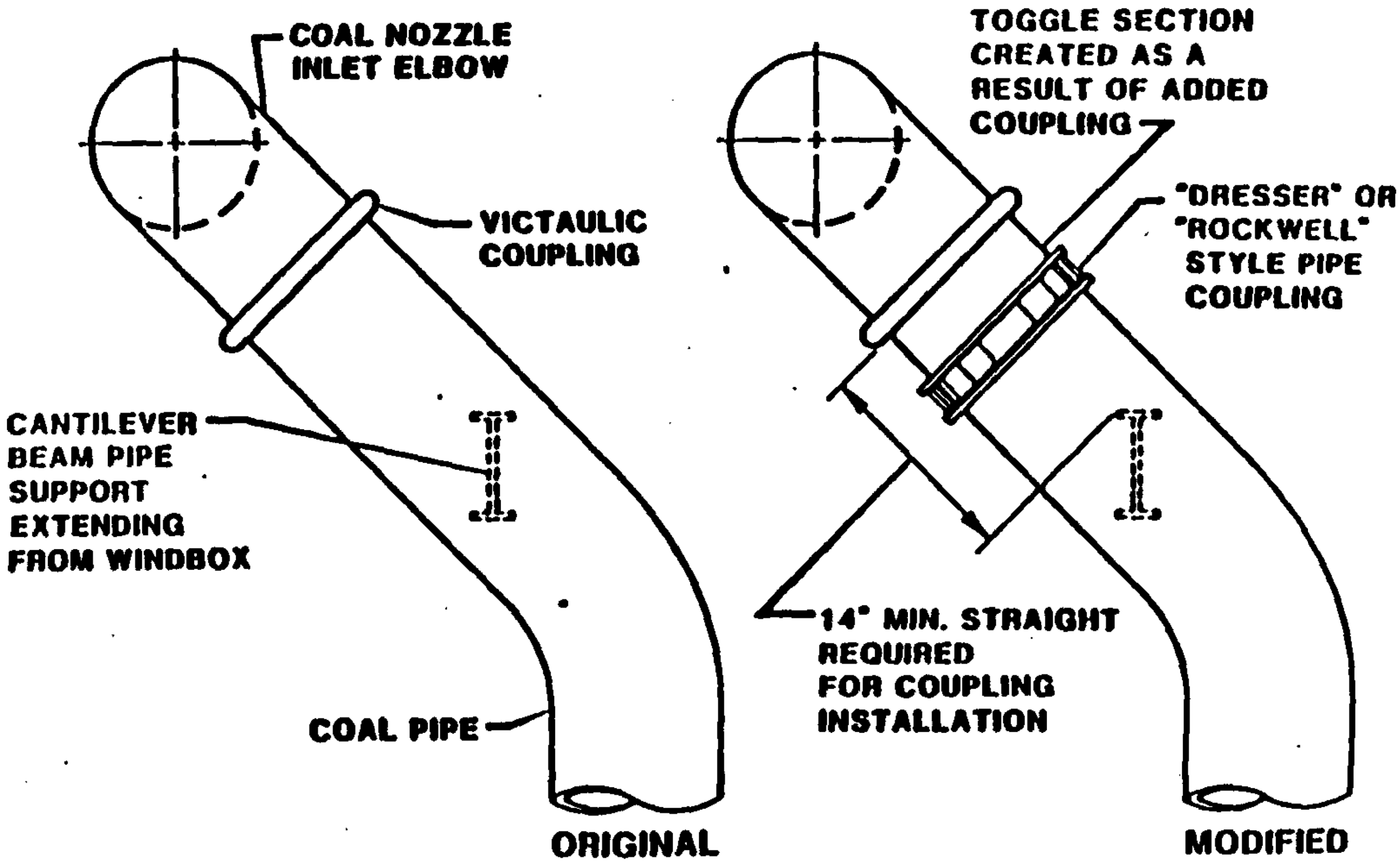
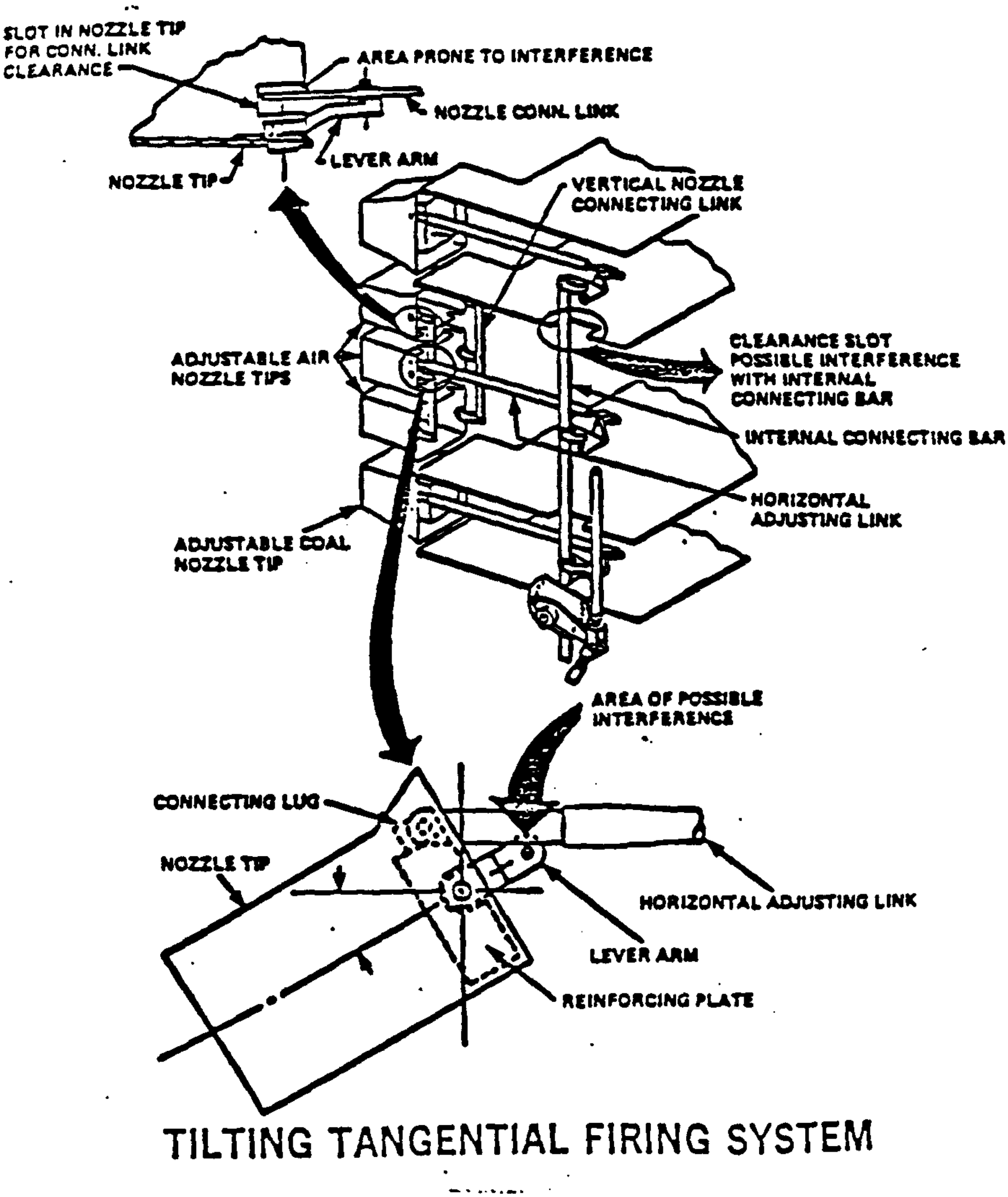


FIGURE H



TILTING TANGENTIAL FIRING SYSTEM

FIGURE

GULF POWER UNIT 2

PROPOSED WINDBOX

PHASE 1 - BASELINE ARRANGEMENT

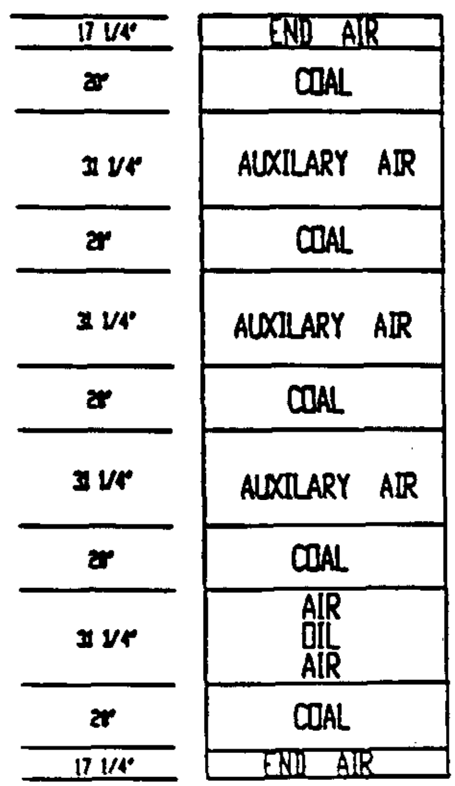
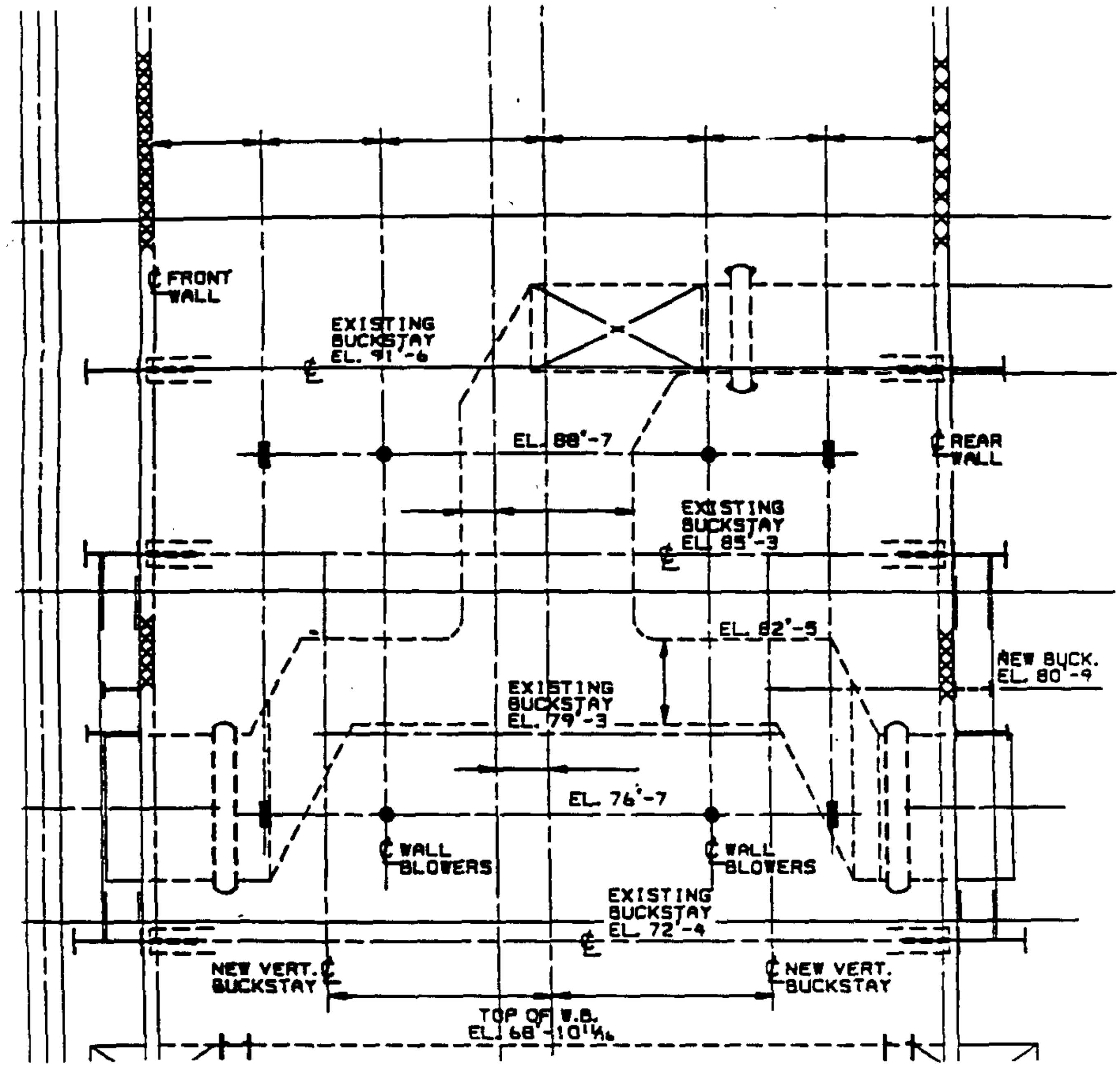


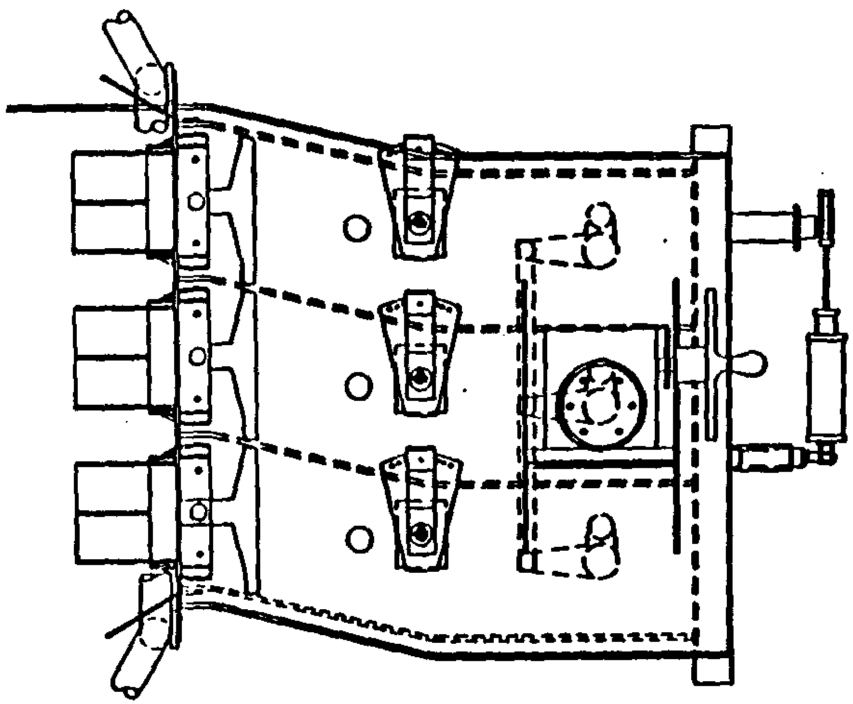
FIGURE K.



FRONT WALL
EXISTING BUCKSTAY EL. 91'-6
EL. 88'-7
REAR WALL
EXISTING BUCKSTAY EL. 85'-3
EL. 82'-5
NEW BUCK. EL. 80'-9
EXISTING BUCKSTAY EL. 79'-3
EL. 76'-7
WALL BLOWERS
WALL BLOWERS
EXISTING BUCKSTAY EL. 72'-4
NEW VERT. BUCKSTAY
NEW VERT. BUCKSTAY
TOP OF W.B. EL. 68'-10 1/16

FIGURE L

CE Separated Overfire Air Assembly



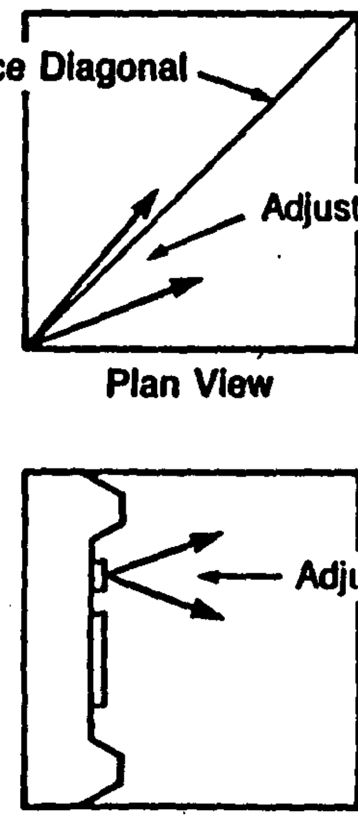
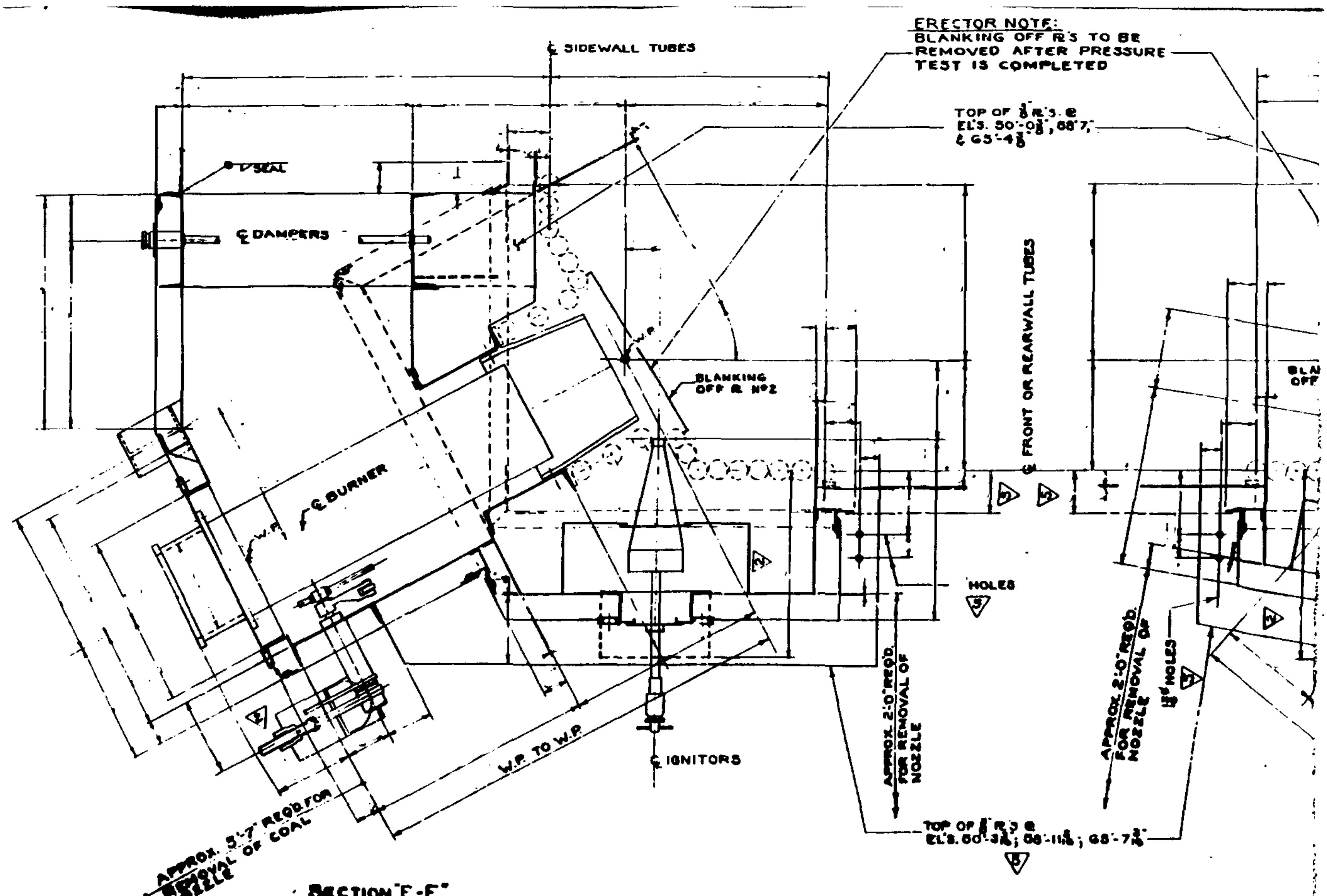
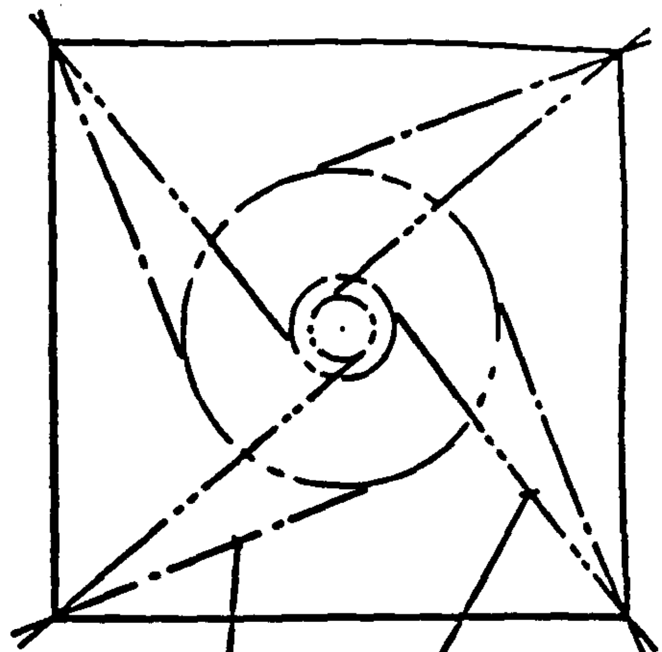


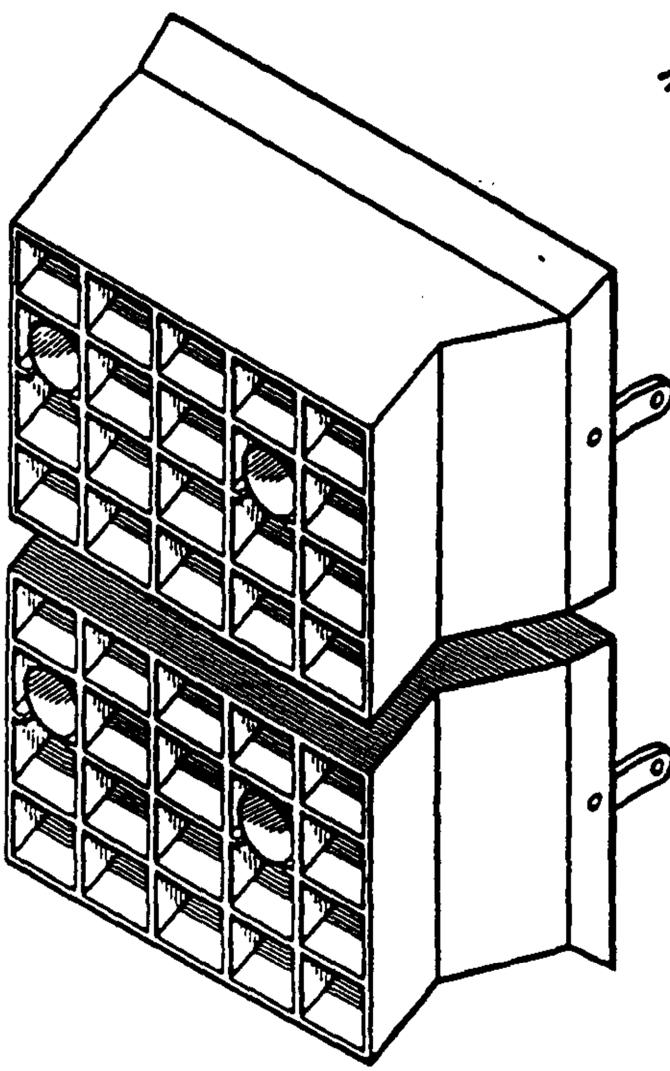
FIGURE 3



SECTION "E-E"
(BURNER Nº2)

C-E's new offset concentric firing





Offset Nozzle Tips

FIGURE 0

LOW NOx CONCENTRIC FIRING SYSTEM

AUXILIARY AIR NOZZLE OFFSET ANGLE STUDY

GULF POWER SMITH 2

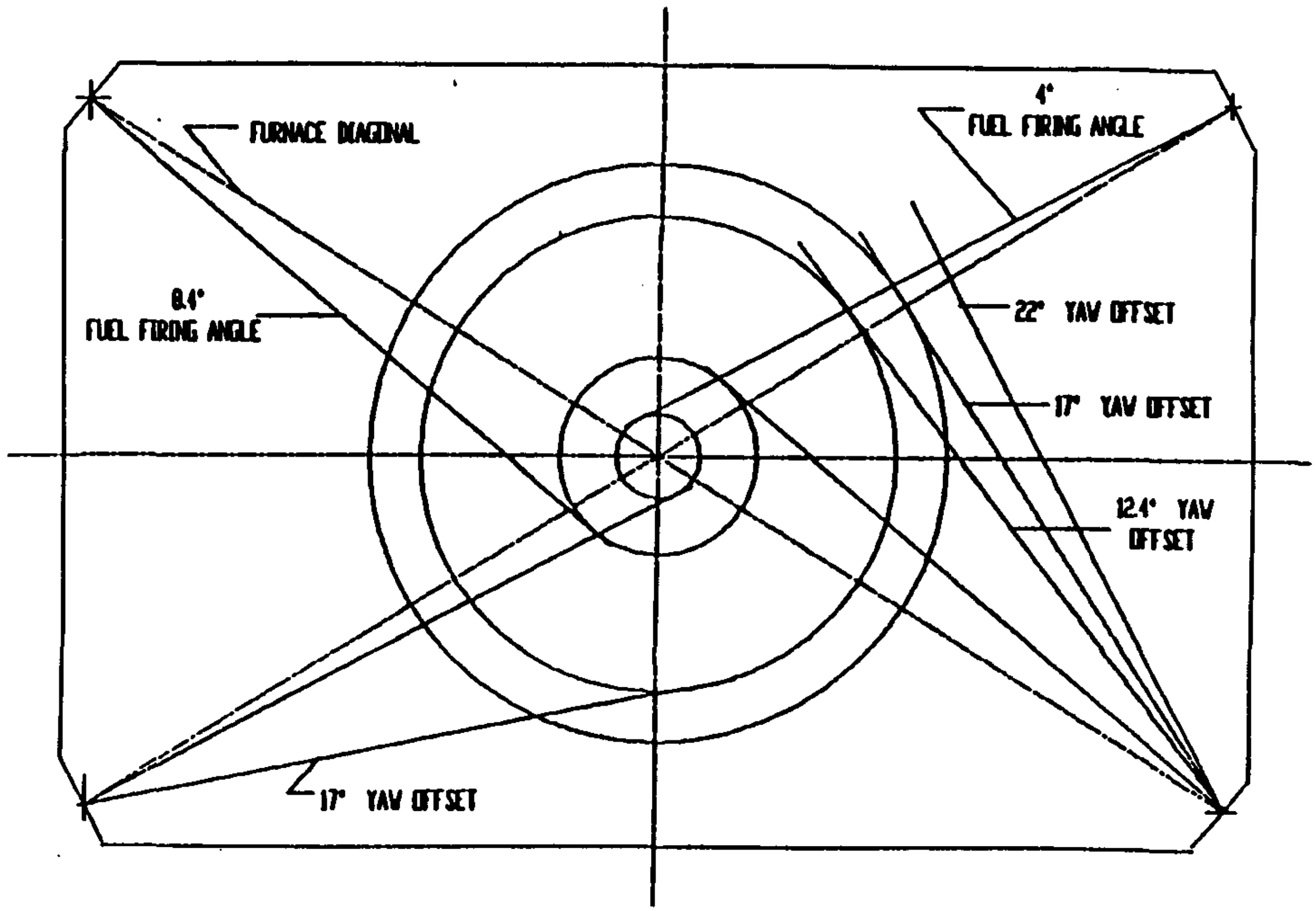


FIGURE [illegible]

LNCFS COAL NOZZLE - WITH AIR DIFFUSERS
X - SECTION VIEW

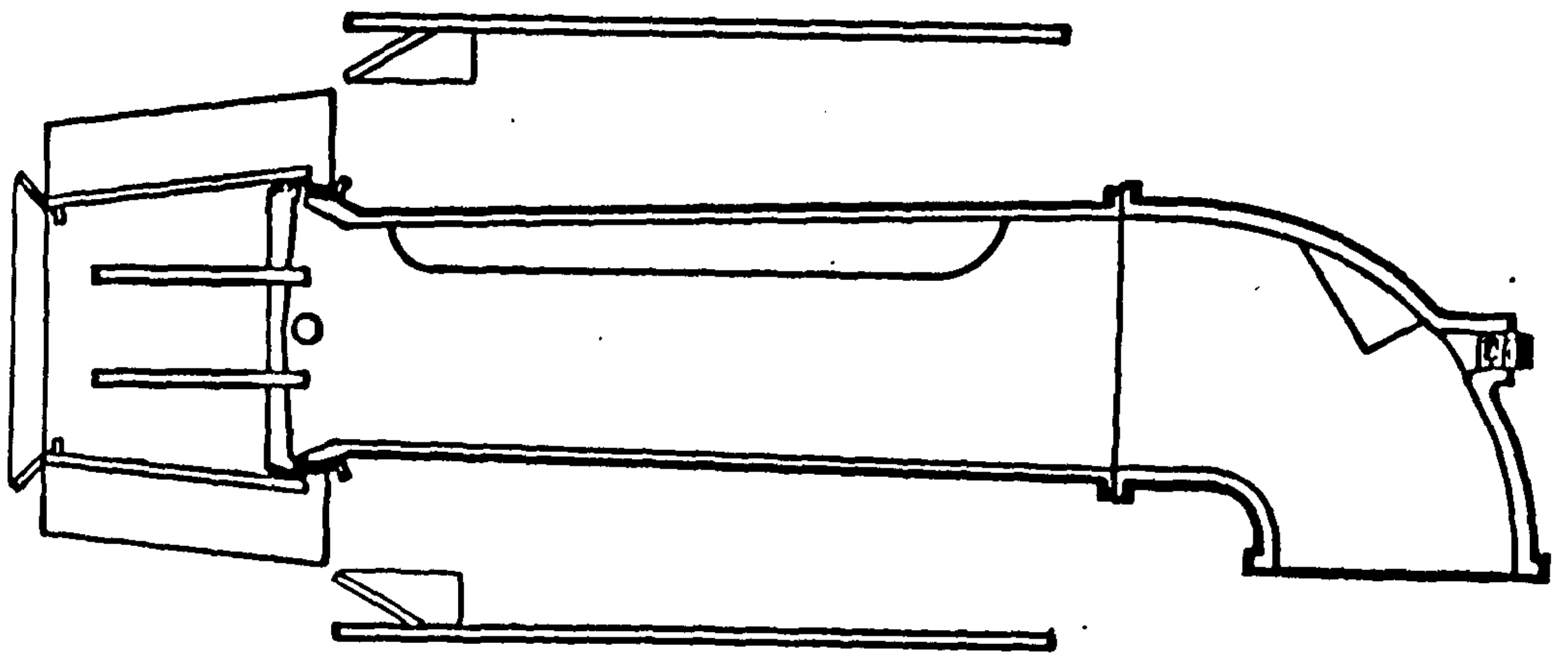


FIGURE Q

TWO-PIECE COAL NOZZLE TIP

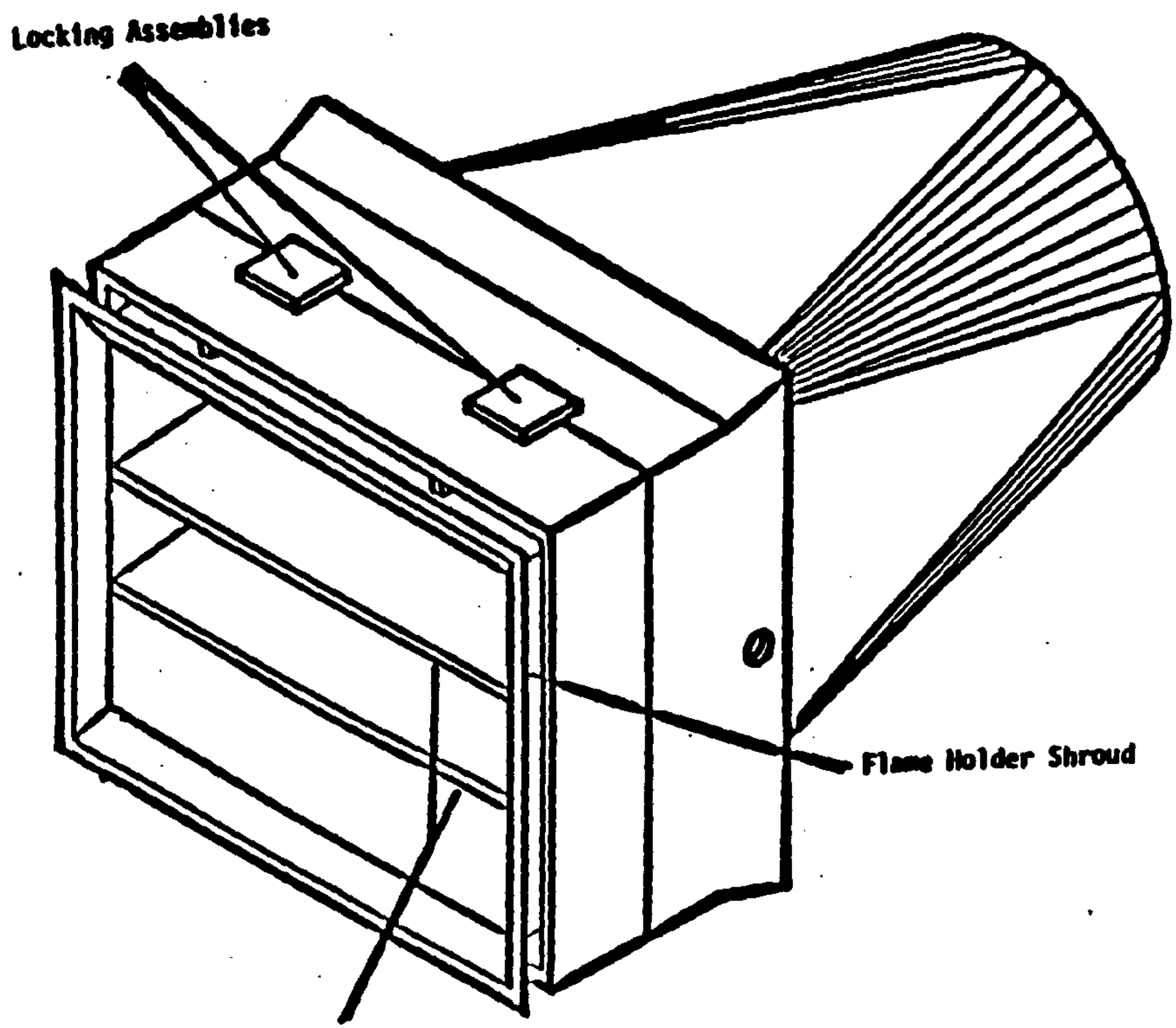
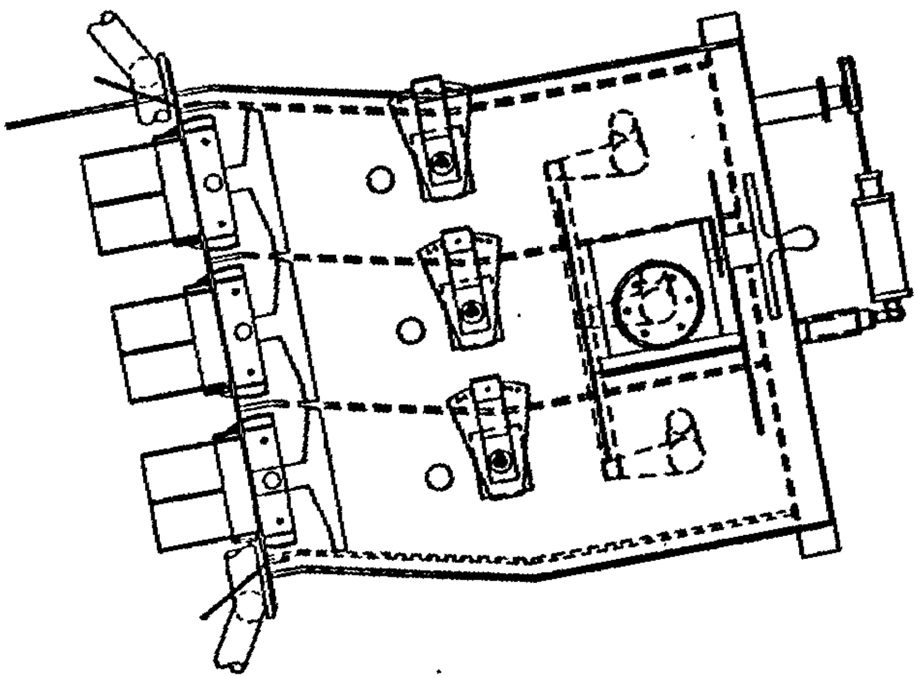
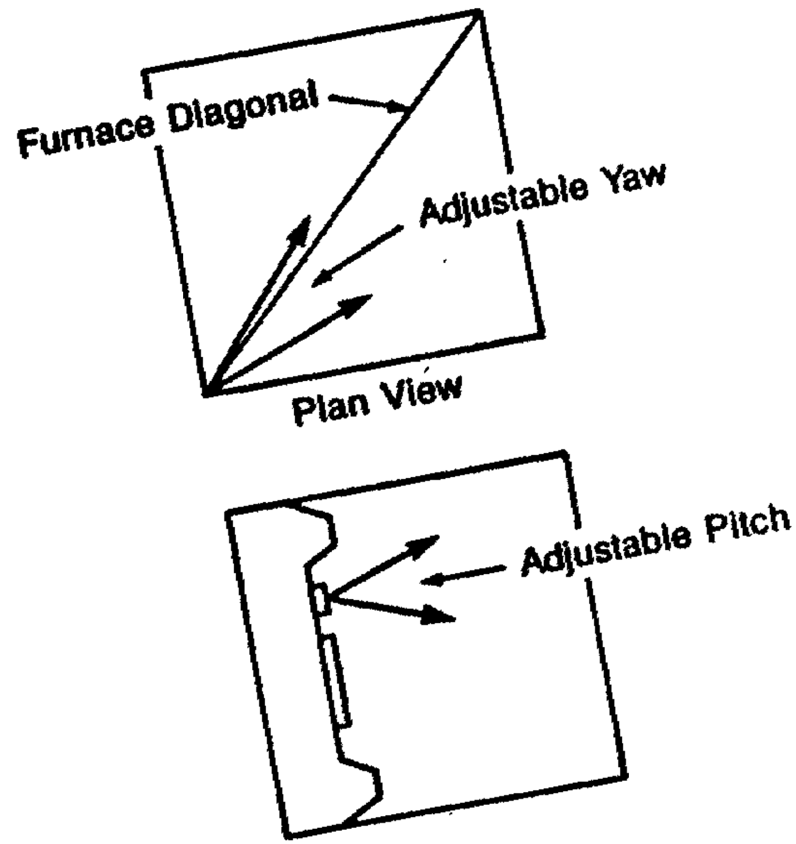


FIGURE R

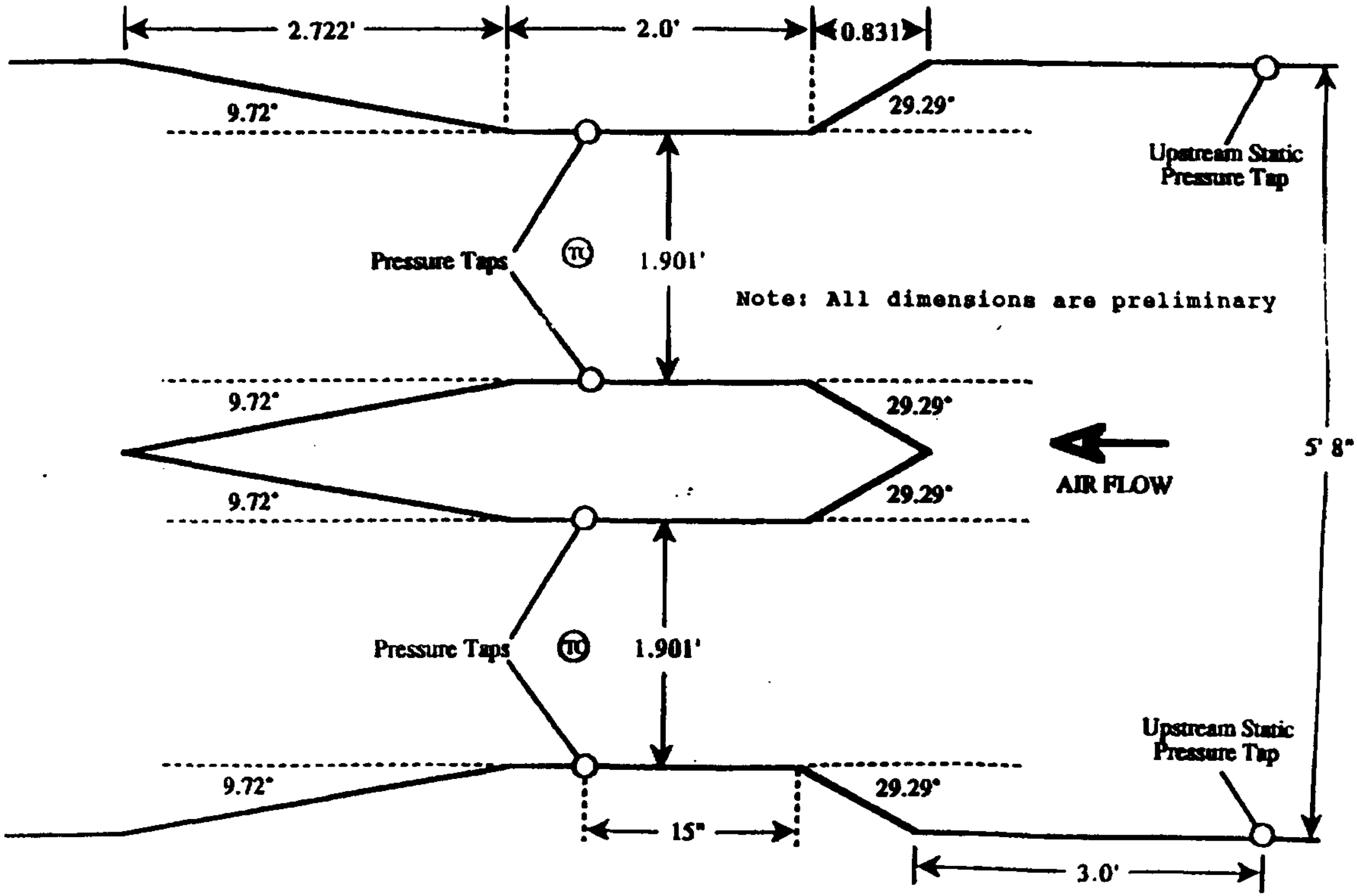
CE Separated Overfire Air Assembly





FI

Southern Company Services
OFA Duct Multi-cell Venturi



Top View

FIGURE 7

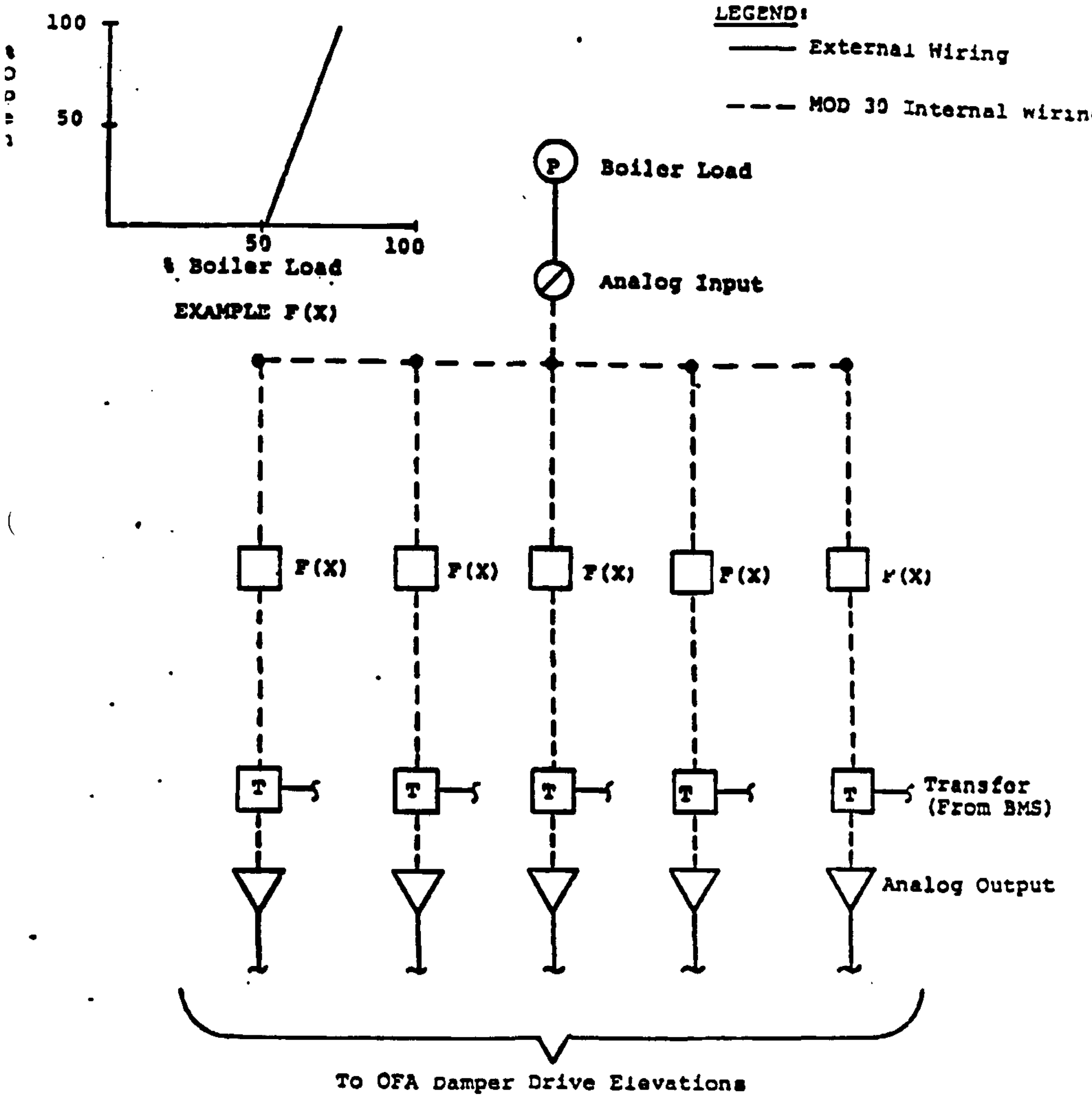
ORIGINAL DOCUMENTS CONTAIN
11" X 17" COPY OF FIGURE U

COMBUSTION ENGINEERING

COMBUSTION ENGINEERING, INC.
WINDSOR, CONN.

CUSTOMER Southern Company Services CONT. NO. ______ MADE BY ______ DATE ______

LOCATION Plant Smith Unit No 2 DWG. NO. ______ CHK'D BY ______ DATE ______



PROPOSED OFA SCHEMATIC

FIGURE U

GULF POWER UNIT 2

PROPOSED WINDBOX

PHASE 2 - LNCFS II ARRANGEMENT

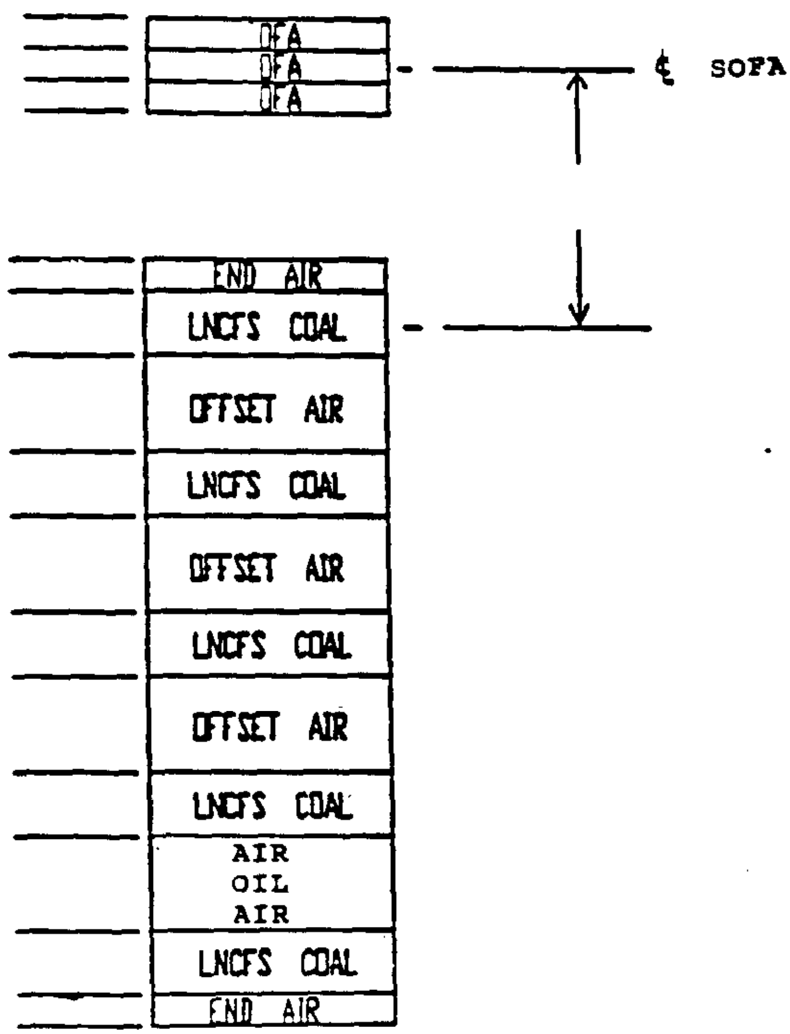


FIGURE V.

GULF POWER UNIT 2

PROPOSED WINDBOX

PHASE: 3 - LNCFS III ARRANGEMENT

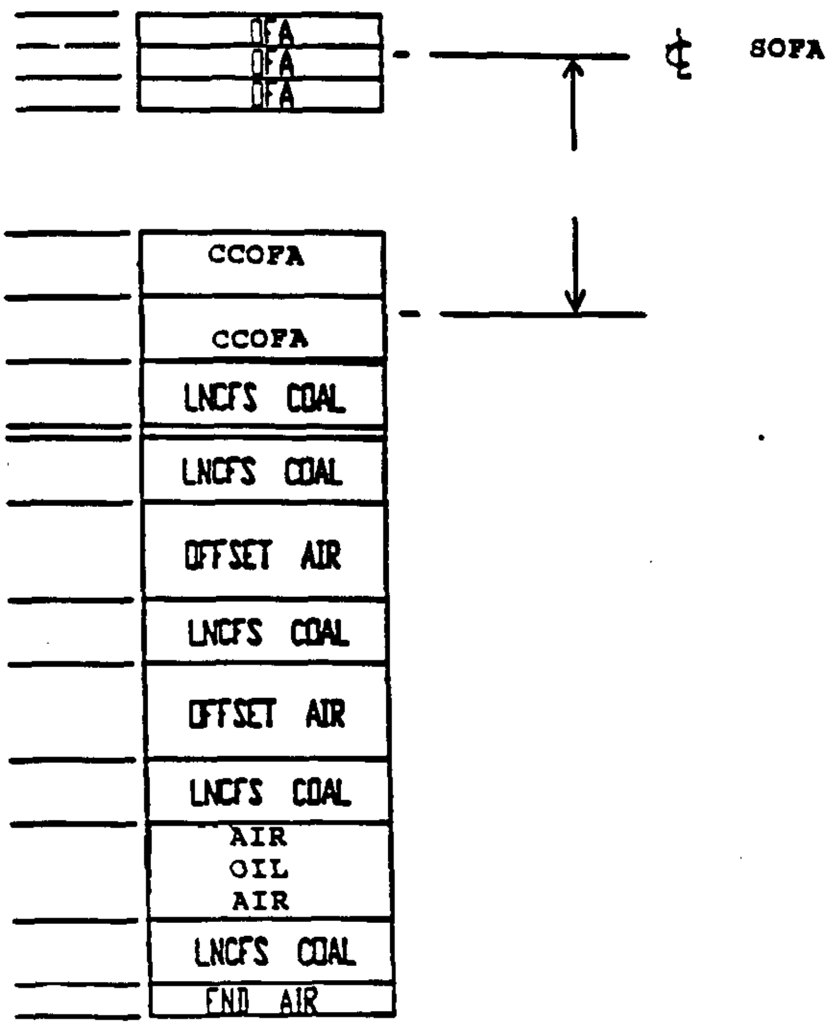


FIGURE W.

GULF POWER UNIT 2
PHASE 3
PARTITION PLATE MODIFICATIONS

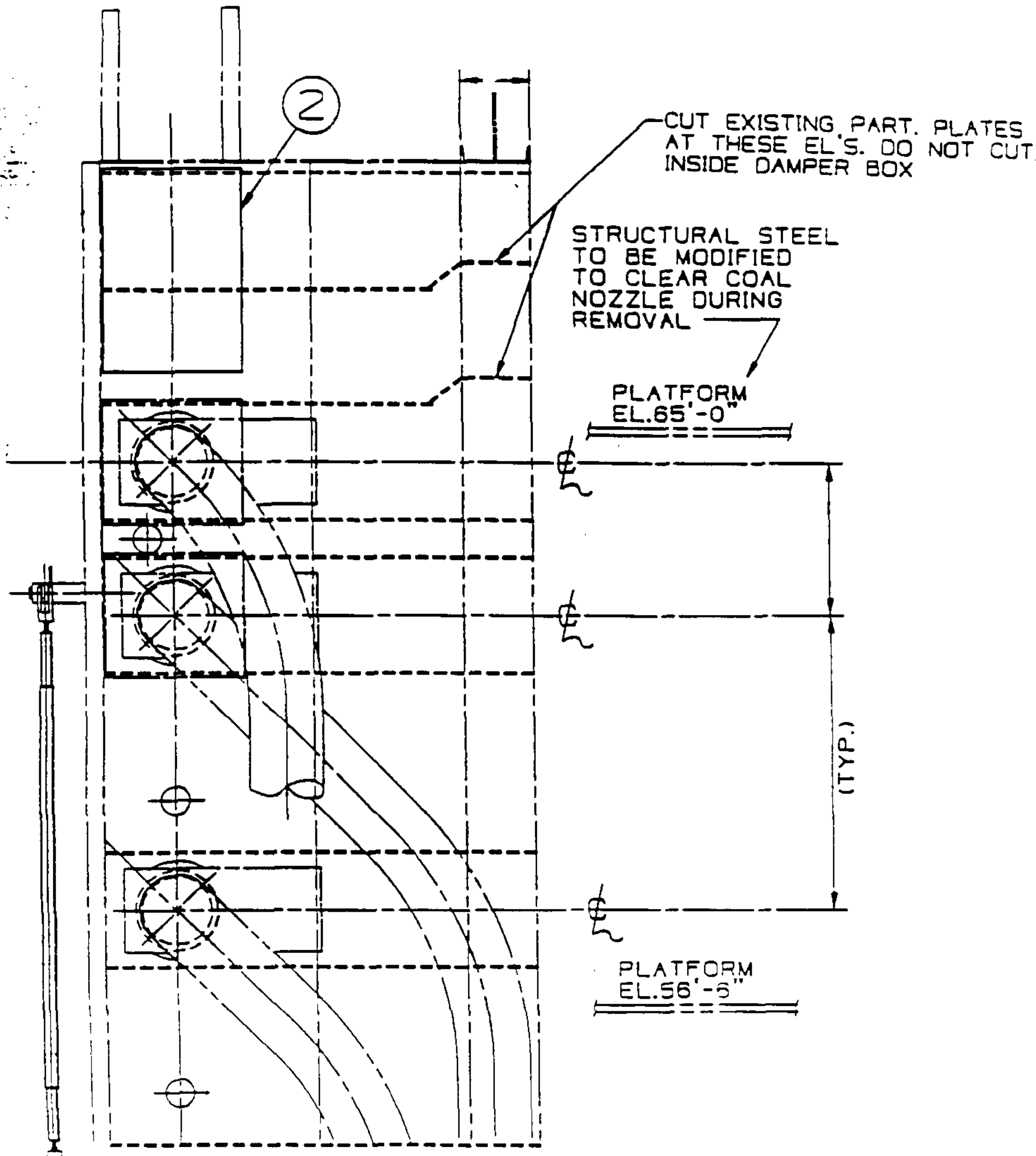


FIGURE X