

Full Scale Demonstration of
Low-NOx Cell Burner Retrofit

Public Design Report

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PUBLIC DESIGN REPORT

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(5) Phase III

DOE Share	\$ 1,277,447	48.6%
Participant Share	<u>\$ 1,351,903</u>	<u>51.4%</u>
Total	<u>\$ 2,629,350</u>	<u>100.0%</u>

(6) Total Estimated Project Cost

Total DOE Share of: Estimated Project Cost	\$4,746,204	48.4%
Total Participant Share of: Estimated Project Cost	\$5,050,000	51.6%
TOTAL ESTIMATED PROJECT COST	<u>\$9,796,204</u>	

The funding for the project is provided by the co-funders as follows:

B&W	\$ 500,000
DOE	4,746,204
EPRI	1,000,000
Ohio Coal Development Office	500,000
Dayton Power & Light	2,300,000
Utility Sponsors	<u>750,000</u>
TOTAL	\$ 9,796,204

The Utility Sponsors are:

Allegheny Power System
Centerior Energy Coporation
Duke Power Company
New England Power Company
Tennessee Valley Authority

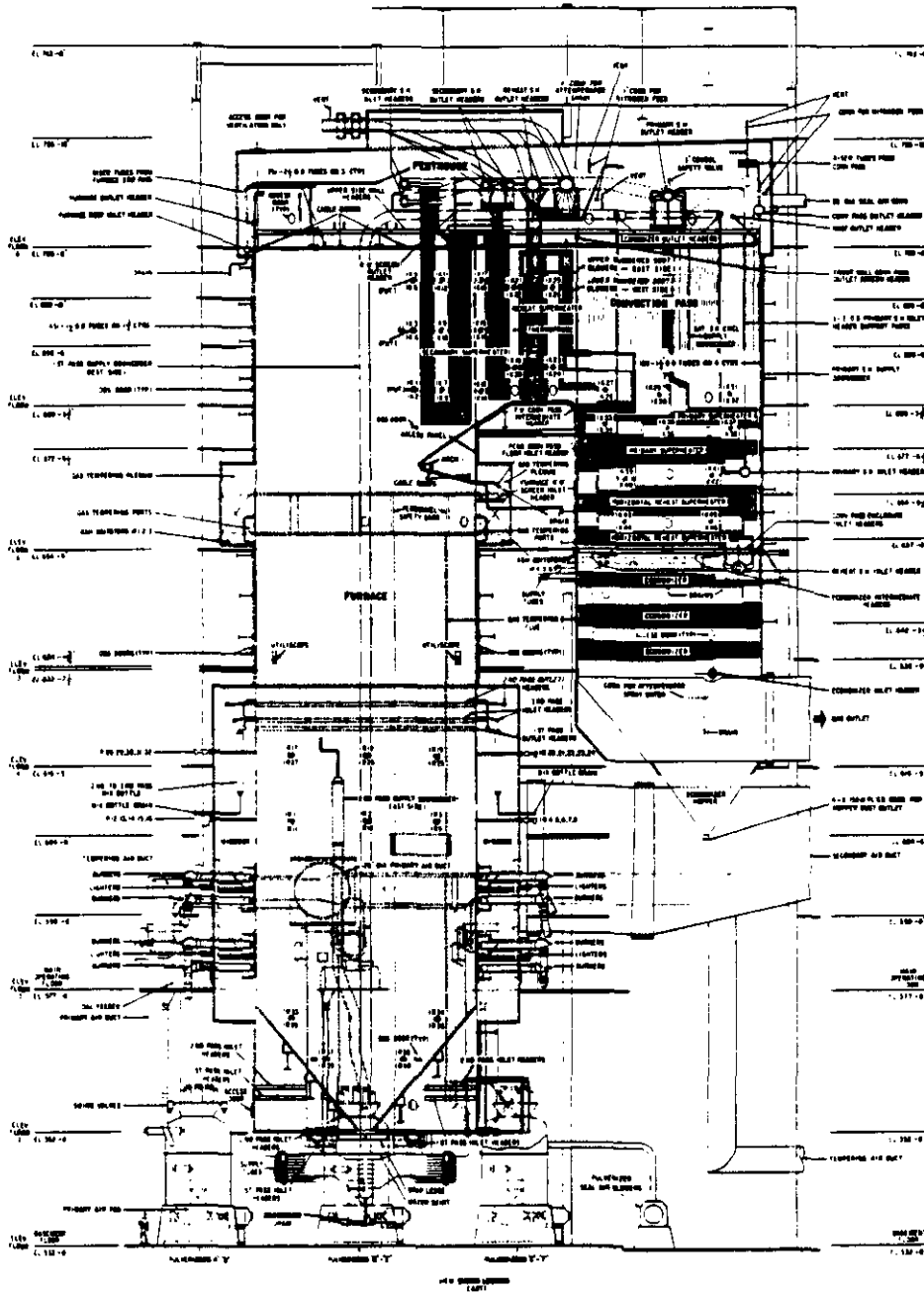


Figure 1a Boiler Side View

THE CINCINNATI GAS & ELECTRIC COMPANY
 COLUMBUS SOUTHERN POWER COMPANY
 THE DAYTON POWER & LIGHT COMPANY
 J.M. STUART ELECTRIC GENERATING STATION - UNIT NO. 4
 ABERDEEN, OHIO
 B&W CONTRACT NO. UP-106

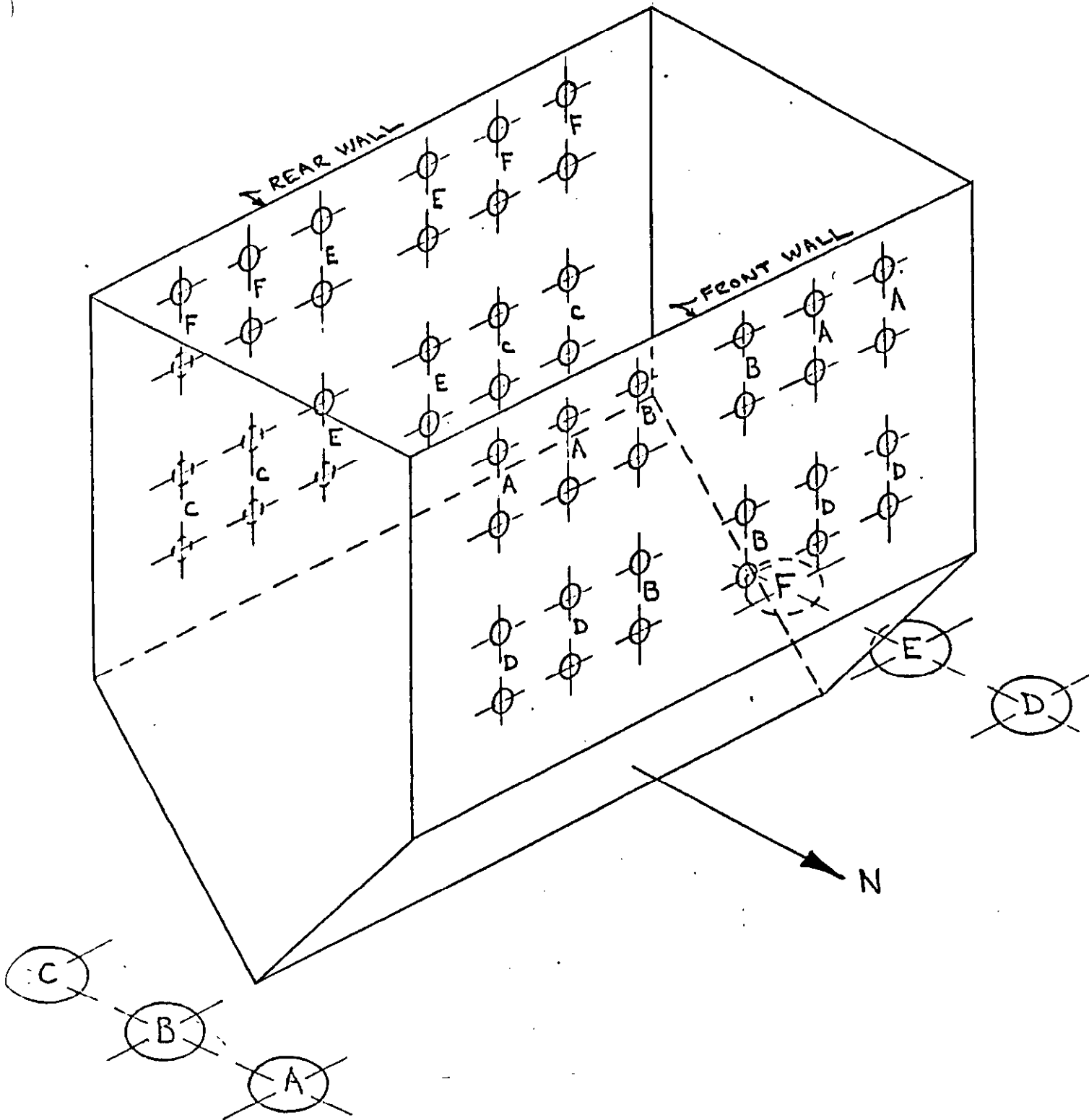
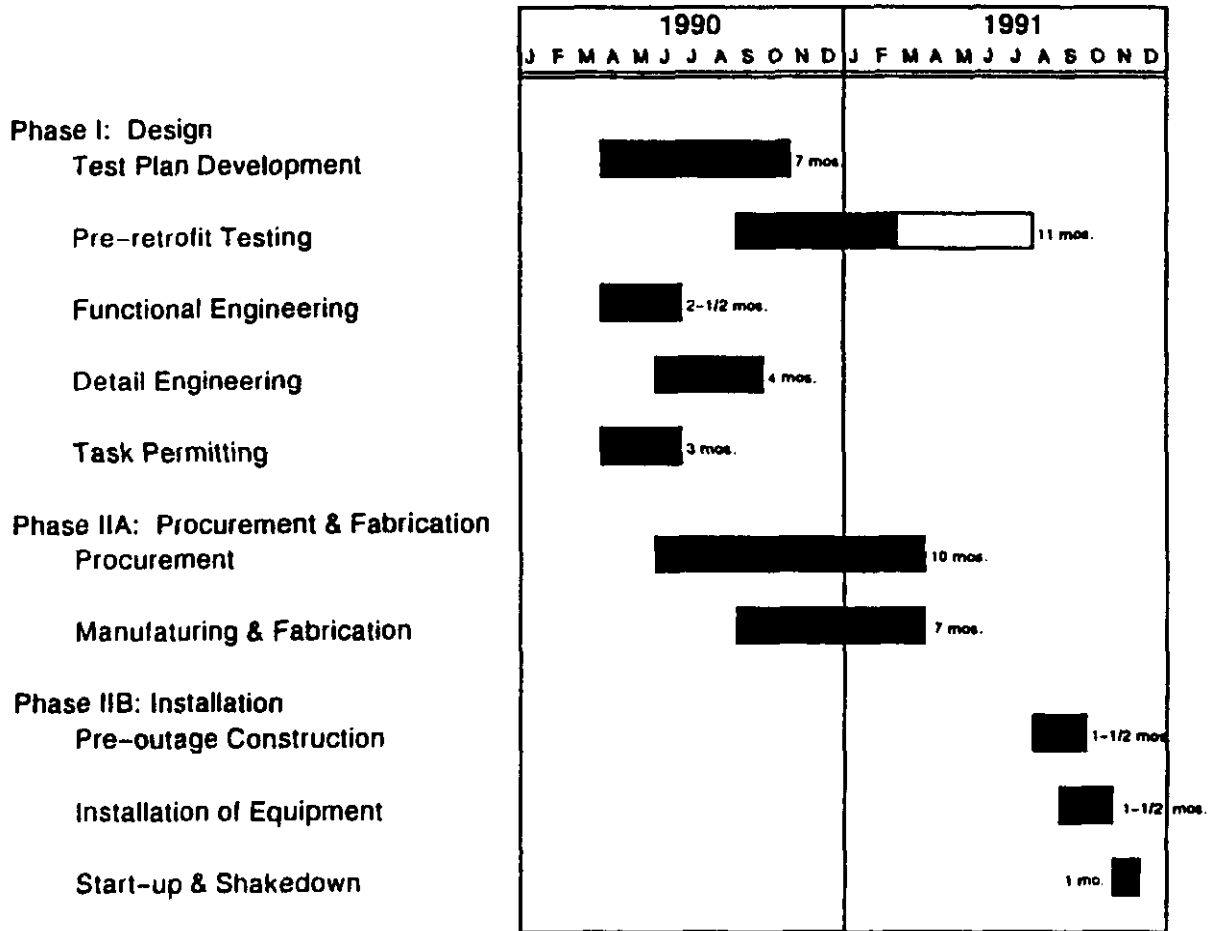


Figure 1b Burner/Pulverizer Arrangement

Low NOx Cell Burner Retrofit Revised Project Schedule



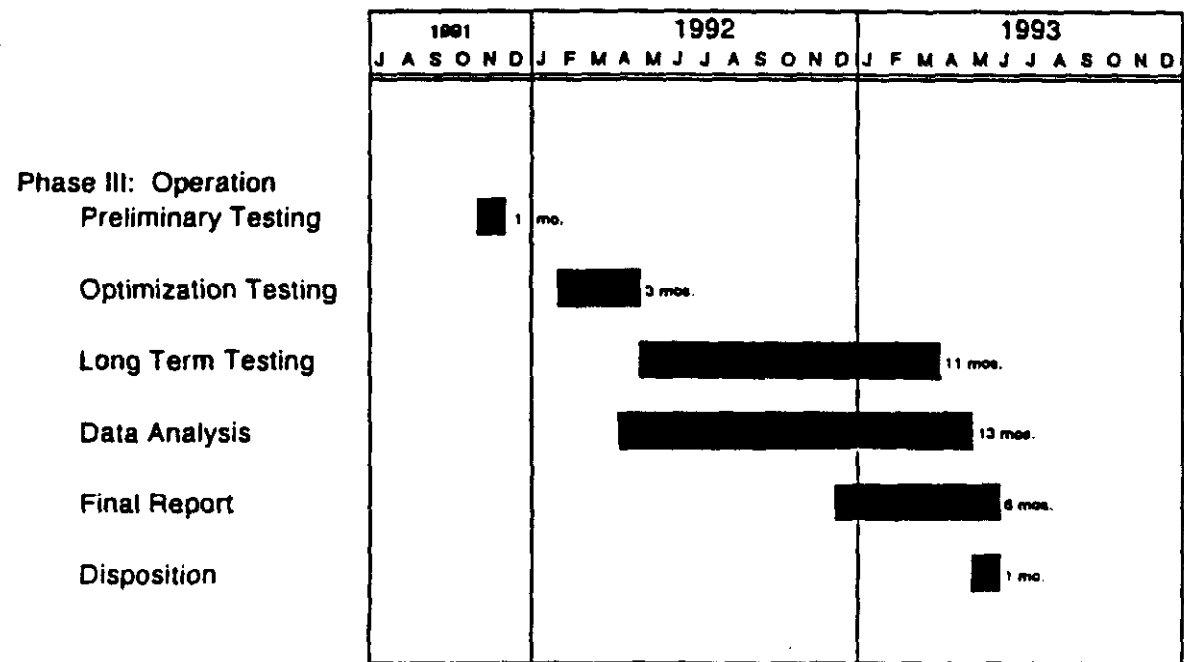
□ Represents Laboratory Testing

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Figure 1c Revised Project Schedule: Phase I, IIA, and IIB

Low NOx Cell Burner Retrofit

Revised Project Schedule



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Figure 1d Revised Project Schedule - Phase III

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SECTION II
PROJECT OBJECTIVE

II. PROJECT OBJECTIVE

The overall objective of the Full-Scale Demonstration of Low-NO_x Cell (LNC) Burner Retrofit project is to demonstrate the cost-effective reduction of NO_x generated by a large based-loaded (70% capacity factor or greater), coal-fired utility boiler. Specific objectives include:

- o At least 50% NO_x reduction over standard two-nozzle cell burners, without degradation of boiler performance or life.
- o Acquire and evaluate emission and boiler performance data before and after the retrofit to determine NO_x reduction and impact on overall boiler performance.
- o Demonstrate that the retrofit of Low-NO_x Cell Burners in boilers currently equipped with cell burners, is a cost-effective alternative to any other emerging, or commercially-available, NO_x control technology.

The focus of this demonstration is to determine maximum NO_x reduction capabilities without adversely impacting plant performance, operation or maintenance. In particular, the prototype evaluations will resolve many technical issues not possible to fully address in the previous pilot-scale work and the single full-scale burner installation. These include low-NO_x combustion system impact on:

- (1) boiler thermal efficiency
- (2) furnace temperature and heat absorption profiles
- (3) slagging and fouling
- (4) waterwall corrosion
- (5) gaseous and particulate constituents
- (6) boiler operation considerations

Both steady - state and transient operation will be evaluated.

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SECTION III
PROCESS DESCRIPTION

III. PROCESS DESCRIPTION

The standard cell burner boiler units were designed in the 1960s to provide a high heat release per unit volume. A typical standard cell burner, shown in Figure 2, consists of two circular register burners within one vertical assembly. This design promotes high velocity and turbulent mixing of the fuel and air to produce rapid combustion. The coal enters the burner at 90 degrees and is dispersed radially outward into the secondary air stream by an impeller located at the end of the coal nozzle. Secondary air from the windbox passes through an adjustable register into an annular passage around the coal nozzle. The register acts as both a flow control device and a swirl generator.

The inherent design features of the standard cell burner, however, result in high NO_x emissions. Typically, units equipped with these burners operate in the range of 1.0 to 1.8 lbs of NO_x per million Btu of heat input.

The use of conventional low-NO_x burners is not feasible in boilers equipped with cell burners, unless major boiler pressure part modifications are made. This is because the cell burner throat openings are too small to permit the low burner air velocities required for delayed combustion. Further, optimum NO_x reduction is achieved by the conventional low-NO_x burner when the heat release rate per unit volume is minimized. This is not readily achievable in a typical cell burner configuration which has closely spaced burners.

The LNC burner, however, was specifically designed to fit the standard two-nozzle cell burner opening and spacings without requiring major boiler pressure part modifications and, as such, constitutes the key attraction of this technology.

As shown in Figure 3, the LNC burner technology replaces the upper coal nozzle of the standard cell burner with a secondary-air port. The coal nozzle in the lower burner throat is enlarged to accommodate the same fuel input capability in one nozzle that was previously fired in two standard coal nozzles.

The LNC burner operates on the principle of staged combustion to reduce NO_x emissions. Approximately 70% of the total air (primary, secondary, and excess air) is supplied through or around the coal feed nozzle to produce locally substoichiometric combustion conditions at the nozzle. The remainder of the air is directed to the upper port of each cell to complete the combustion process. The substoichiometric conditions allow conversion of the fuel bound nitrogen compounds to nitrogen gas and the reduced flame temperature produced by the slower mixing of the fuel and the air minimizes the formation of thermal NO_x.

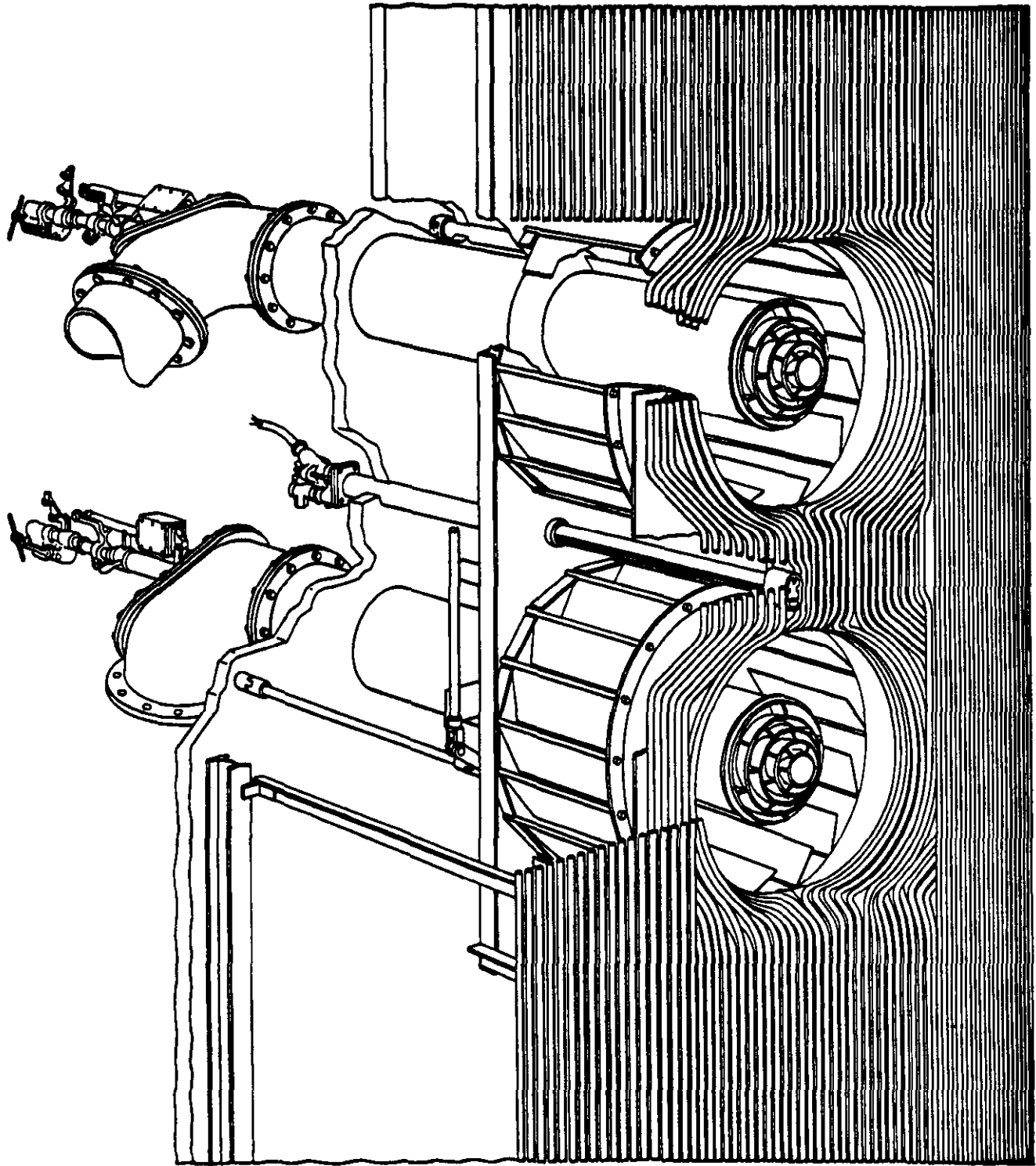
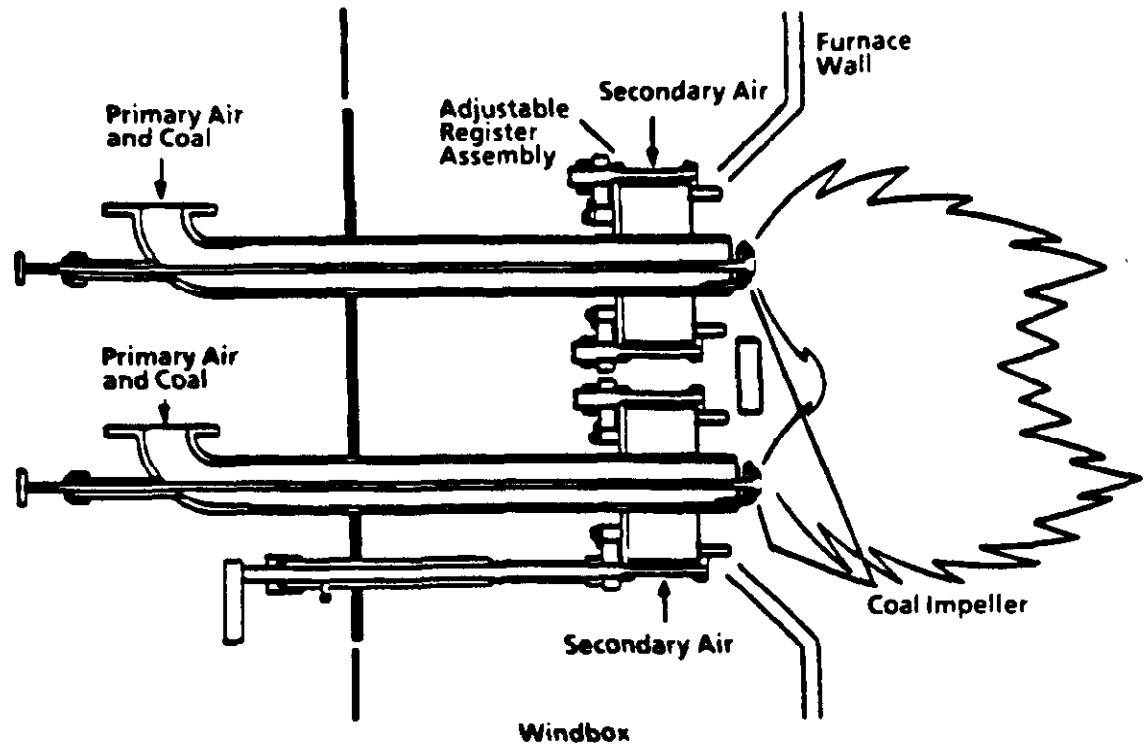
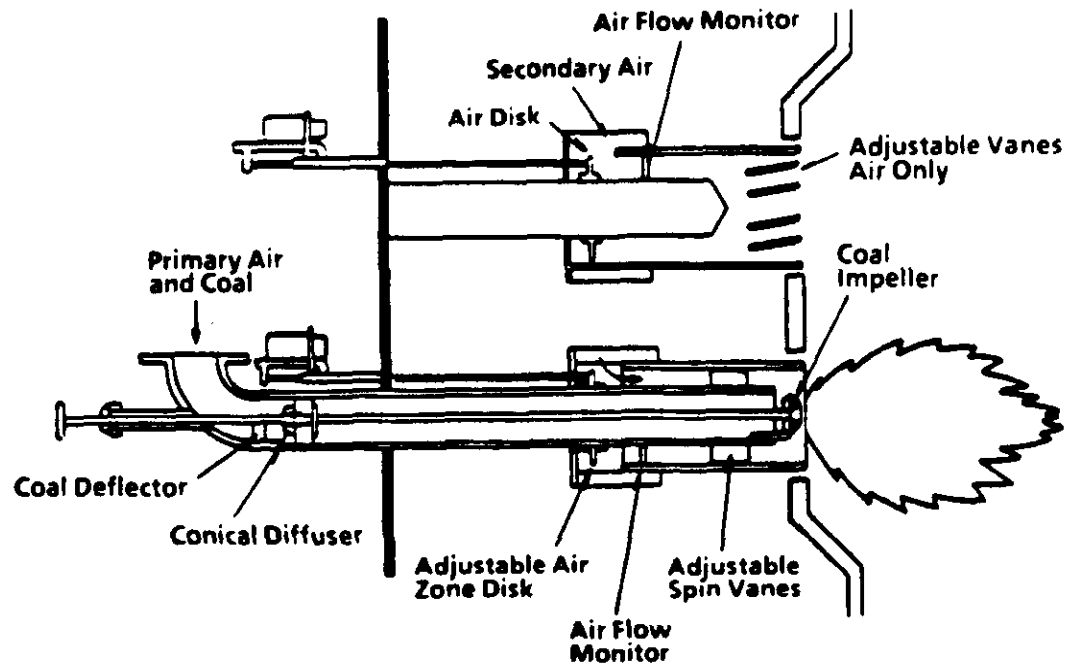


FIGURE 2. Typical Standard Two-Nozzle Cell Burner



Typical Standard Two-Nozzle Cell Burner



Typical LNC Burner

Figure 3 Skematic comparison of a typical LNC Burner versus a Two-Nozzle Cell Burner

The net effect of this technology is a 50% reduction in NOx formation with no boiler pressure part changes and minimal impact on boiler operation or performance. In terms of the reduction of total acid emissions, the expected reduction in NOx, on a tons removed basis, for the LNC burner technology results in the same environmental impact as an equivalent reduction in SO₂ emissions using another technology. In addition, the technology is compatible with several commercial and emerging SO₂ control technologies including Confined Zone Dispersion, Gas Suspension Absorption, duct injection, and advanced wet scrubbers.

The demonstration project will be conducted at a full-scale utility plant owned by Dayton Power and Light Company, Cincinnati Gas and Electric Company, and Columbus Southern Power Company. This plant is operated by Dayton Power & Light Company (for all three owners). The boiler unit is a B&W designed supercritical, once-through boiler equipped with an electrostatic precipitator. This unit contains 24 two-nozzle cell burners arranged in an opposed firing configuration. Twelve burners (arranged in two rows of six burners each) are mounted on each wall. The six existing MPS pulverizers provide pulverized coal, transported with primary air, to a total of eight coal pipes (4 two-nozzle cells) per mill. The Burner/Pulverizer relationship is shown in Figure 1b.

Aside from the burner replacement, modifications to the burner coal piping is the most significant material retrofit consideration. Provisions were necessary to combine the primary air/fuel mixture, previously transported from the pulverizers through two coal pipes per cell, into one larger coal pipe that feeds only the lower throat of each cell. This is accomplished by installing a Y-branch in the existing piping somewhere between the pulverizers and the burner front, preferably in a vertical run of pipe. Coal nozzle elbows must also be replaced to accommodate the larger coal nozzle. Ceramic lining is used as an added precaution against erosion from abrasive coals and serves to increase the wear life of the elbow. The overall method of transporting air and coal to the combustion process is otherwise unchanged.

The demonstration will require the removal of all 24 standard cell burners and the installation of 24 new LNC burners. Figure 4 depicts a typical retrofit installation of one cell.

Secondary air from the FD fans, provided to a windbox common to all burners, will be proportioned between the lower burner and overfire air port of each LNC to achieve optimum NOx reduction and combustion efficiency. During operation, the lower nozzle of each LNC burner operates at a sub-stoichiometric air level with the balance of air required for complete combustion entering through the upper ports. Adjustable burner controls will be used to proportion air accordingly between the burner and integral overfire air port. Therefore, the burner controls will require modification to accommodate the LNC burner electric actuators. Air flow monitors will be located on the LNC burner to ensure uniform air distribution to each burner.

The LNC burner arrangement can potentially increase the pressure loss on the secondary air system. Therefore, early in the project an engineering evaluation of the Dayton Power & Light Stuart #4 forced draft fans was completed to determine if sufficient capacity exists to handle an air resistance increase. Results of that evaluation are found in Section 4B entitled "Low-NOx Burner Component Design".

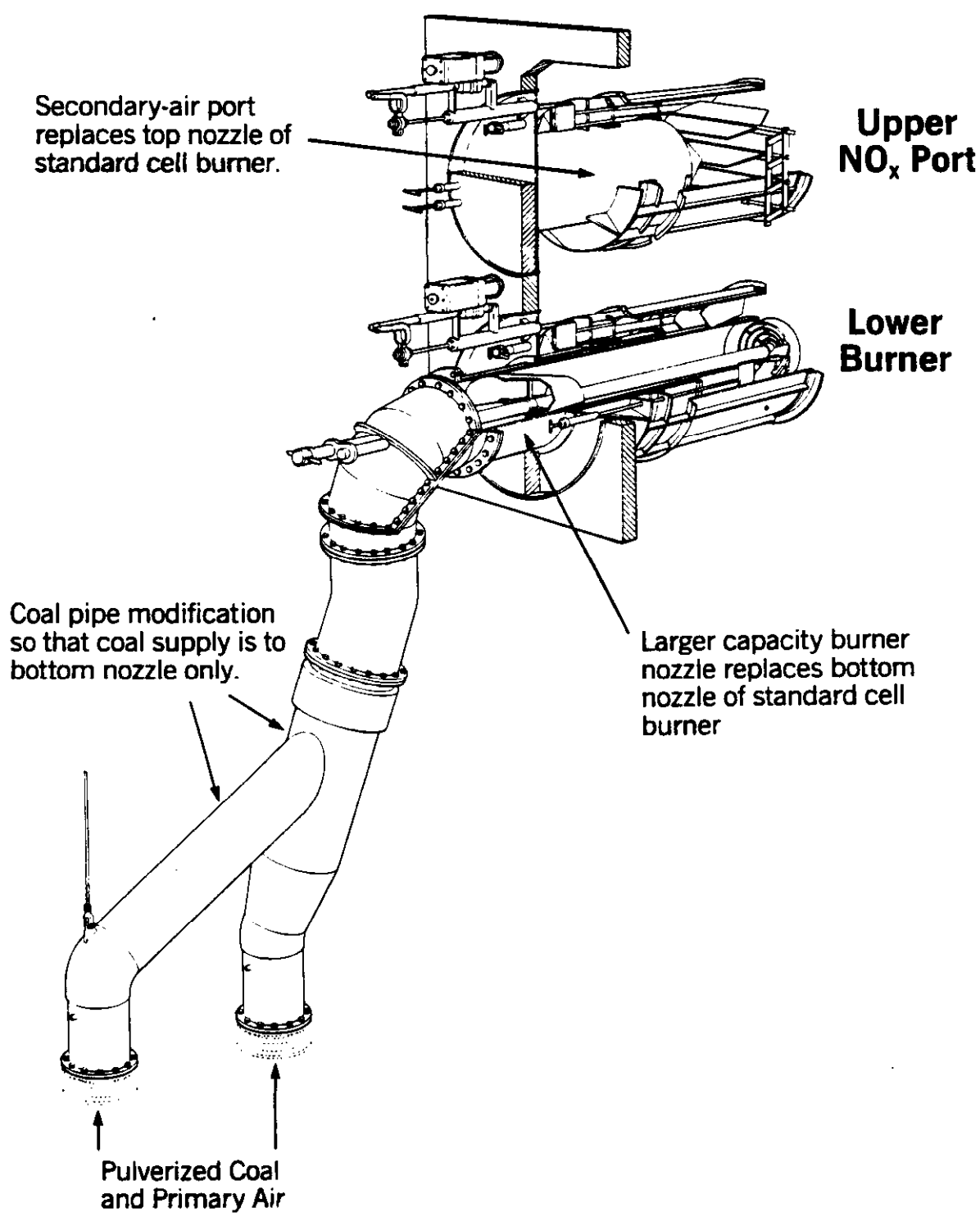


FIGURE 4. Single LNC Burner Retrofit.

SECTION IV

EQUIPMENT DESCRIPTION - LOW-NO_x CELL BURNER

IV. EQUIPMENT DESCRIPTION - LOW-NO_x CELL BURNER

The Low-NO_x Cell Burners supplied for this project are a result of many years of design experience in combustion technology. In order to present the design criteria used in producing these particular burners, an understanding of the development history is necessary. With the knowledge gained during development, the design criteria for the individual burner components become significantly simplified and typical to Low-NO_x Coal Burners. A brief discussion of the Low-NO_x Cell Burner development history is presented, in the paragraphs below, followed by a discussion of the design criteria used for the individual components.

A. LOW-NO_x CELL BURNERS DEVELOPMENT HISTORY

The Low-NO_x Cell Burner was developed for retrofit to existing cell burners with the specific objectives of reducing NO_x emissions by a minimum of 50% with little or no impact on the boiler life and its operation. Several tasks were performed over a three-year period to accomplish this goal: (1) pilot combustion tests were conducted at two scales to develop and characterize the best equipment for NO_x reduction, (2) verification of hardware reliability through a full-scale retrofit of a single LNC burner on a utility boiler, (3) furnace corrosion potential was evaluated based on laboratory-scale corrosion experiments and in-furnace gaseous species measurements taken during combustion tests, (4) numerical analysis was performed to predict full-scale performance, and (5) a feasibility study was conducted to assess economic and technical risks.

To accomplish our first goal, burner screening tests at the small scale were performed on three different burners: standard cell burners for baseline comparison, and two candidate low NO_x cell burners. The primary design criteria for the Low-NO_x Cell Burner was that it be retrofittable without requiring furnace pressure part modifications. Of the two LNC candidate designs, the LNC1, pictured in Figure 5, was designed to fire all the fuel through the lower throat of each cell with the balance of secondary air through the upper throat. The elements of the lower throat assembly closely resembled a B&W commercial design currently used for mechanical enhancements without the benefit of NO_x reduction. The second burner design, or the LNC2, consisted of two modified B&W Low-NO_x Dual Register Burner (DRB) designs sized to fit the cell configuration (reference Figure 6). The coal nozzle sizing forced higher than normal throat velocities for the LNC2 burner.

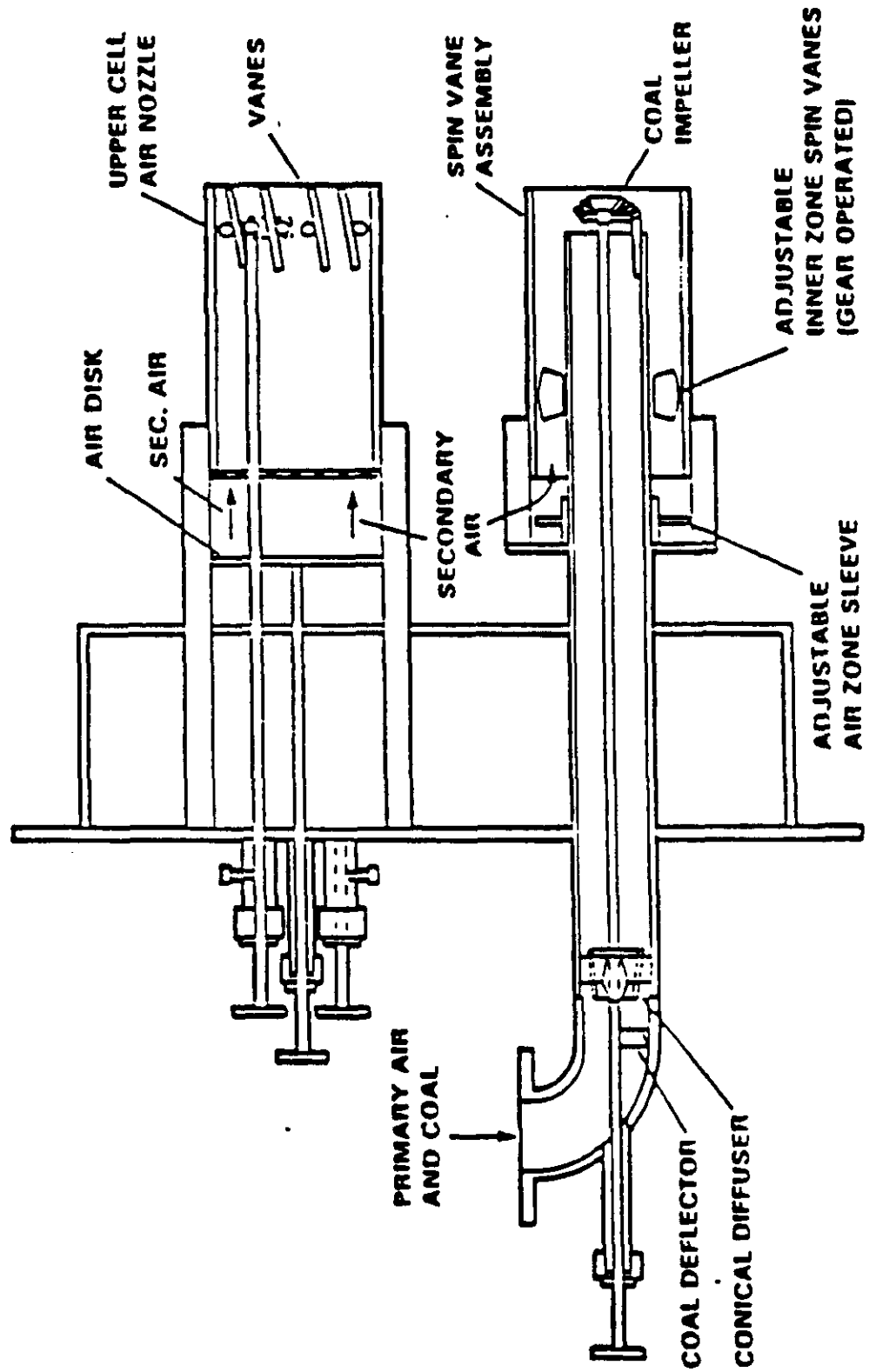


FIGURE 5. Low-NO_x Cell Burner No. 1.

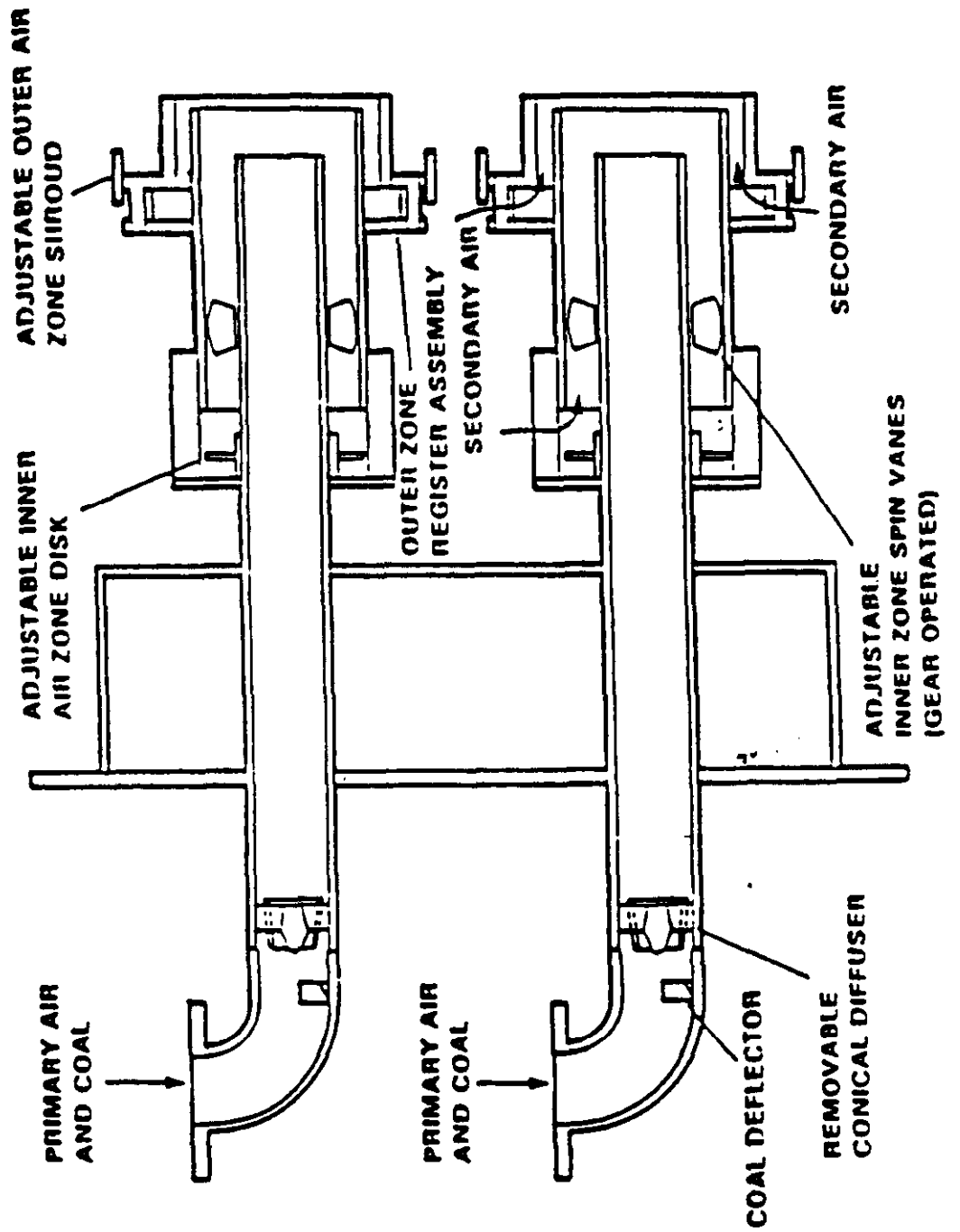


FIGURE 6. Low-NOx Cell Burner No. 2.

Based on results of the screening tests the LNC1, with integral NOx port, was selected as the most promising design. NOx results for the standard cell at full load (5.6 million Btu per hour) and 3% O₂ were 1.4 lbs NO per million Btu. These results compared favorably to emissions expected with this burner design in a large utility boiler. The preferred LNC1 burner under similar load and excess air conditions, but without the use of an impeller for coal dispersion which is an impractical situation for a normal utility boiler installation, reduced NOx by 75%. The LNC2, also without impellers, reduced NOx by only 50%. NOx sensitivity to excess air was relatively low for all three burners. CO emissions were very low for all three burners and comparable to cell burner field performance. Unburned carbon loss was low for the standard cell and the preferred LNC1 design. The LNC2 design exhibited higher unburned carbon levels.

Several other performance criteria were also evaluated as part of the small-scale screening tests. No changes in furnace exit gas temperature were measured for the LNC1 and LNC2 in comparison to the standard cell. Flame stability at lower loads was best with the LNC1 burner. Flame length for the standard cell was about three feet at full load. Because of the lack of coal impellers, both low-NOx burner flames impinged on the back wall of the 6-foot deep furnace. This raised concerns about slagging and corrosion. Burner adjustments were somewhat effective in shortening flame length but with some sacrifice in NOx reduction.

Subsequent to the small-scale screening and characterization tests, the preferred low-NOx cell design was scaled to test in a larger combustion facility capable of 100 million Btu per hour input. The LNC1 and the standard cell burner were tested in this facility with burners arranged in a 2x2 array. Each cell was therefore designed for 25-million Btu per hour heat input. The vertical and horizontal spacing between burners was scaled directly from a cell-equipped utility boiler to account for flame interactions occurring in actual practice.

Similar to the screening tests, Ohio No. 6 and Lower Kittanning coals were tested in the large-scale cell burners. An extensive test series was conducted to characterize Low-NOx Cell Burner performance. The test series demonstrated the sensitivity of the burner to a number of its adjustable parameters: coal impeller design and position, spin vane position, lower damper position, directional vane position, and upper damper position. Similar effects were obtained for each configuration tested and are summarized as follows:

- o Impeller Design: The design of the coal impeller was a critical parameter in determining flame shape, flame length, and burner operating characteristics. As the included angle of the impeller was increased to a steeper angle, shorter flames with correspondingly higher NOx emissions were produced. The steeper angle was more effective in dispersing the coal into the swirling combustion air stream. Impeller position with respect to the end of the coal nozzle had no significant effect over the range investigated.

- o Spin Vane Position: The spin vane position was the dominant parameter used during this test program to control the air flow distribution between the upper and lower throat of each cell. Closing the spin vanes and increasing the angle to the flow not only increased the degree of swirl but also increased the pressure drop across the lower throat. This forced more air to be diverted to the upper throat, the integral staged air port. This reduced the burner zone stoichiometry and thus decreased NOx emissions.
- o Lower Damper Position: The lower damper adjustments were limited during these tests. However, this device did demonstrate that it could provide a similar degree of control on NOx as the spin vanes, but at higher burner pressure drop conditions.
- o Directional Vane Position: The upper throat air vanes proved to be an effective tool for flame shaping and NOx control. Diverting the staging air away from the flames tended to decrease NOx emissions and increase flame length. In particular, the upper cell burner directional vanes were most effective.
- o Upper Damper Position: Upper damper adjustments were limited during these tests due to excessive windbox-to-furnace differential when closed 50% or more. Closing the upper damper, in any case, was not desirable from an emission standpoint. By increasing the restriction of air through the upper throat, the burner zone stoichiometry increased as did the NOx emissions.

The burner variables evaluated during these tests produced a wide range of NOx emissions and flame lengths. A close relationship of NOx to flame length was developed for full-load operation at an overall stoichiometry of 1.17. The optimum impeller angle for flame length, reduced NOx emissions by 50 to 60% versus levels for the standard cell burners.

To accomplish our second and third goals, a single full-scale, two-nozzle cell burner was replaced with a Low-NOx Cell Burner. This burner, installed (in March 1985) at Dayton Power & Light's Stuart Station, Unit No. 3, has now been in operation for over six years. Evaluations of the burner included mechanical reliability, potential for furnace wall tube corrosion surrounding the cell opening, visual observation of the flame, secondary air flow measurement through the burner, and temperature measurements of burner components. To date, all adjustable burner hardware continues to operate satisfactorily and all burner component temperatures remain well below maximum temperature use limits of the material.

Perhaps the most significant uncertainty and potential risk associated with installation of Low-NO_x Cell Burners is the possibility of increased fireside corrosion of furnace wall tubes in proximity of the burner throats. Through staged combustion with the Low-NO_x Cell Burner, reducing atmospheres will be present that can increase corrosion rates on furnace wall tubes. Because of concerns about corrosion, ultrasonic thickness (UT) measurements of the furnace tubes were taken to document metal thickness before installation of the prototype burner at DP&L's Stuart Station. This unit has had a history of tube wastage in the furnace due to reducing atmospheres, especially along the sidewalls. Typical of most cell-burner-equipped boilers, the windbox design and lack of proper secondary air control with the cell registers causes air to bypass the sidewall burners, thus creating a reducing atmosphere in this area of the furnace. The prototype burner installed at DP&L was located on the upper row of frontwall burners nearest the lefthand sidewall. The air flow measurement device integral to the LNC design indicated, as expected, that this burner was being starved for air, operating at a total stoichiometry of 0.81, a worst case scenario from the standpoint of corrosion. However, after one year of operation, DP&L's own nondestructive test team measured tube thicknesses around the throat openings of the LNC and found that virtually no tube wastage had occurred during that interval. DP&L felt that no steps would need to be taken to prevent corrosion due to the burner.

To accomplish our fourth goal, the FORCE and FURMO models (B&W proprietary) were used. FORCE solves conservation equations for the particle gas mixture including mass, momentum, and turbulence. FURMO solves the conservation equations for combustion and heat transfer in a particle-laden flow. Briefly, the methods are finite difference descriptions of the three-dimensional conservation equations. The physical domain of the furnace is subdivided into control volumes (typically 10,000 - 50,000) and the finite difference form of each conservation equation is formulated for each of the control volumes. Solving the equations for the control volumes results in distributions for the flow velocities, temperatures, heat fluxes, and major species concentrations (CO₂, CO, O₂, H₂O, and N₂).

The objective of the numerical modeling is to provide an evaluation of the retrofit system which can be used as an engineering tool in concert with operational experience and design methods as a means of assessing the retrofit operating characteristics of the Stuart Station.

Existing experimental studies and numerical analyses indicate that all low-NO_x burners tend to produce longer flame structures and may delay carbon burnout more than conventional burners, e.g., standard cell burners. Concern exists whether Low-NO_x Cell Burners could produce higher temperatures at the secondary superheater, etc., than in the current operating unit. Three-dimensional numerical furnace flow, heat transfer, and combustion models have been developed at B&W. These engineering tools will be used to provide a method of evaluating the impact on flow, combustion and heat transfer for changes in operating conditions, burner type, fuel fineness, etc. These tools can be used to indicate if any major operating problems exist before installation and enable engineers to use the modeling results, experience and design methods to focus on these issues prior to Low-NO_x Cell Burner installation.

The results of the numerical analysis indicate: (1) There will be a slightly more uniform furnace flow with Low-NOx Cell Burners (see Figures 7 & 8), (2) an immeasurable increase in average furnace exit gas temperature (FEGT) (7-10°F) with the LNCB, (3) a more uniform FEGT distribution with the LNCB (see Figures 9 & 10), (4) lower peak temperatures at the furnace exit with the LNCB (Figure 10), (5) good mixing in the burner zone with the LNCB (Figure 8), and (6) lower average combustion zone temperatures (Figure 11).

To accomplish our fifth goal, a study was conducted to establish the technical feasibility of retrofitting an entire boiler with Low-NOx Cell Burners. The study considered performance, operations, and maintenance impact with a proposed retrofit of the Low-NOx Cell Burner.

Of utmost importance to any utility is the ability of its boilers to convert heat available in the fuel to steam. Since carbon contributes the majority of heat in coal, its utilization must be maximized. Unburned carbon in ash is estimated at 1 to 3 percent for a standard cell burner unit equipped with Low-NOx Cell Burners. This is based on the combustion tests at two scales and known data from standard cell burner units.

The main goal of the new burner is to reduce NOx by at least 50 percent. At both pilot scales, this level of reduction was achieved with acceptable increases in flame lengths. A field unit could expect a reduction in NOx emissions of this magnitude with this new burner. Combustion tests also showed no appreciable change in furnace exit gas temperature.

Based on UT measurements taken around the Low-NOx Cell Burner at Stuart Station and gaseous species measurements in the pilot combustion tests, corrosion problems are not anticipated with a full-unit retrofit. Maintenance costs associated with corrosion are therefore not expected to increase.

If the flame of the Low-NOx Cell Burner is too long, it may impinge on the furnace walls, causing slagging and possible corrosion. Based on the combustion tests, flame length in a full-scale boiler are expected to be easily accommodated within the confines of the furnace.

Another consideration when retrofitting new burners is the added resistance of the burners. The reserve fan capacity of a unit must be able to overcome the added pressure drop and maintain the quantity of air flow desired. The Low-NOx Cell Burner can have higher resistance than the standard cell requiring 2 to 3 inches W.G. additional pressure in many cases.

In a full-scale application, the following performance is anticipated: (1) NOx emission reductions comparable on a percentage basis to results obtained from pilot-scale tests, i.e., 50%; (2) similar flame length trends as observed at pilot scale; (3) unburned carbon and CO emissions less than those obtained at pilot scale and probably at least as good as current operation with the standard cells, since fuel and air flow distribution will be balanced as part of the retrofit; and (4) no significant increase in furnace corrosion.

Velocity Vector Plots Standard Cell Burners

200.0 ft/sec equals 

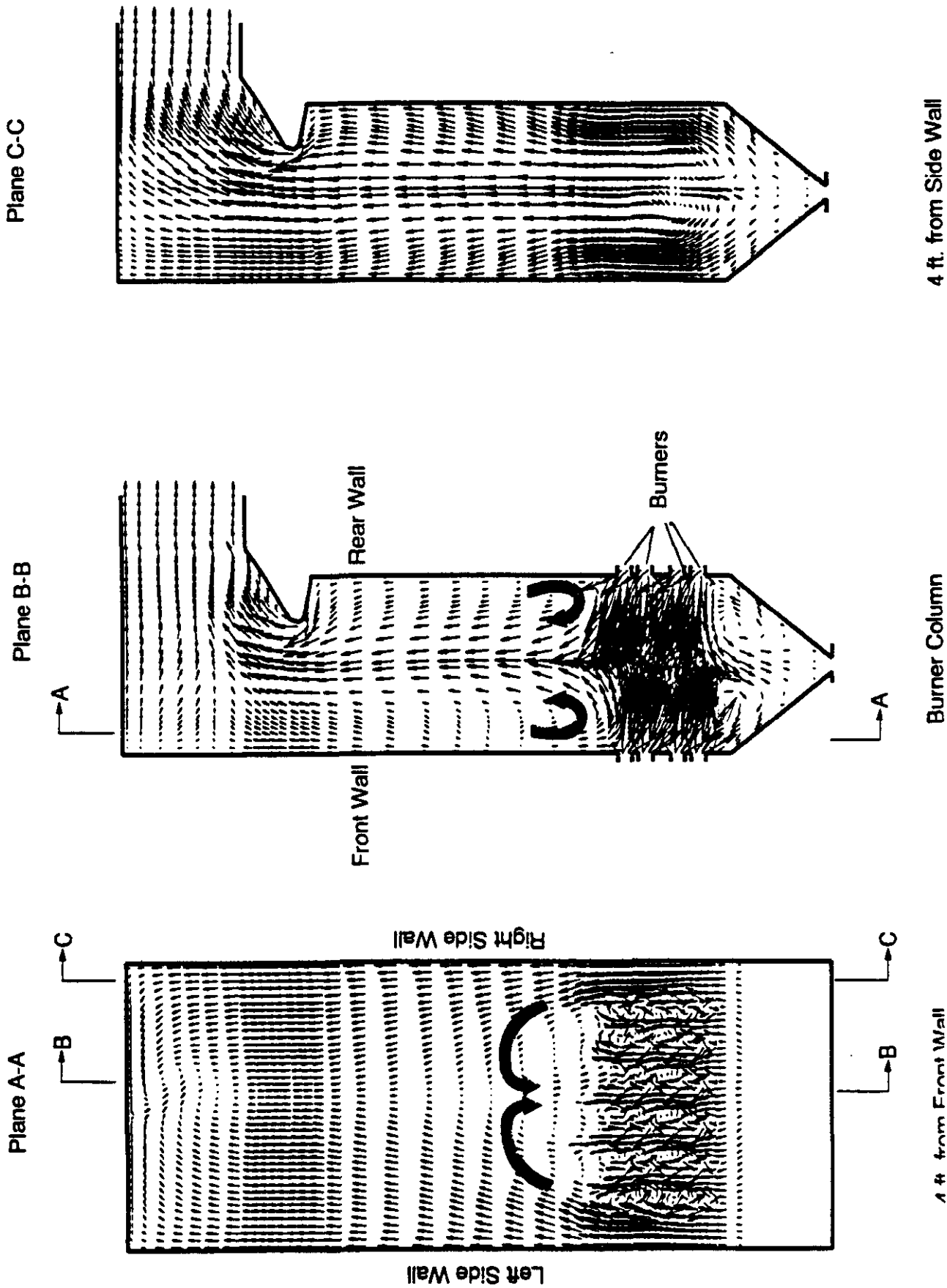


FIGURE 7

Velocity Vector Plots Low-NOx Cell Burners

200.0 ft/sec equals 

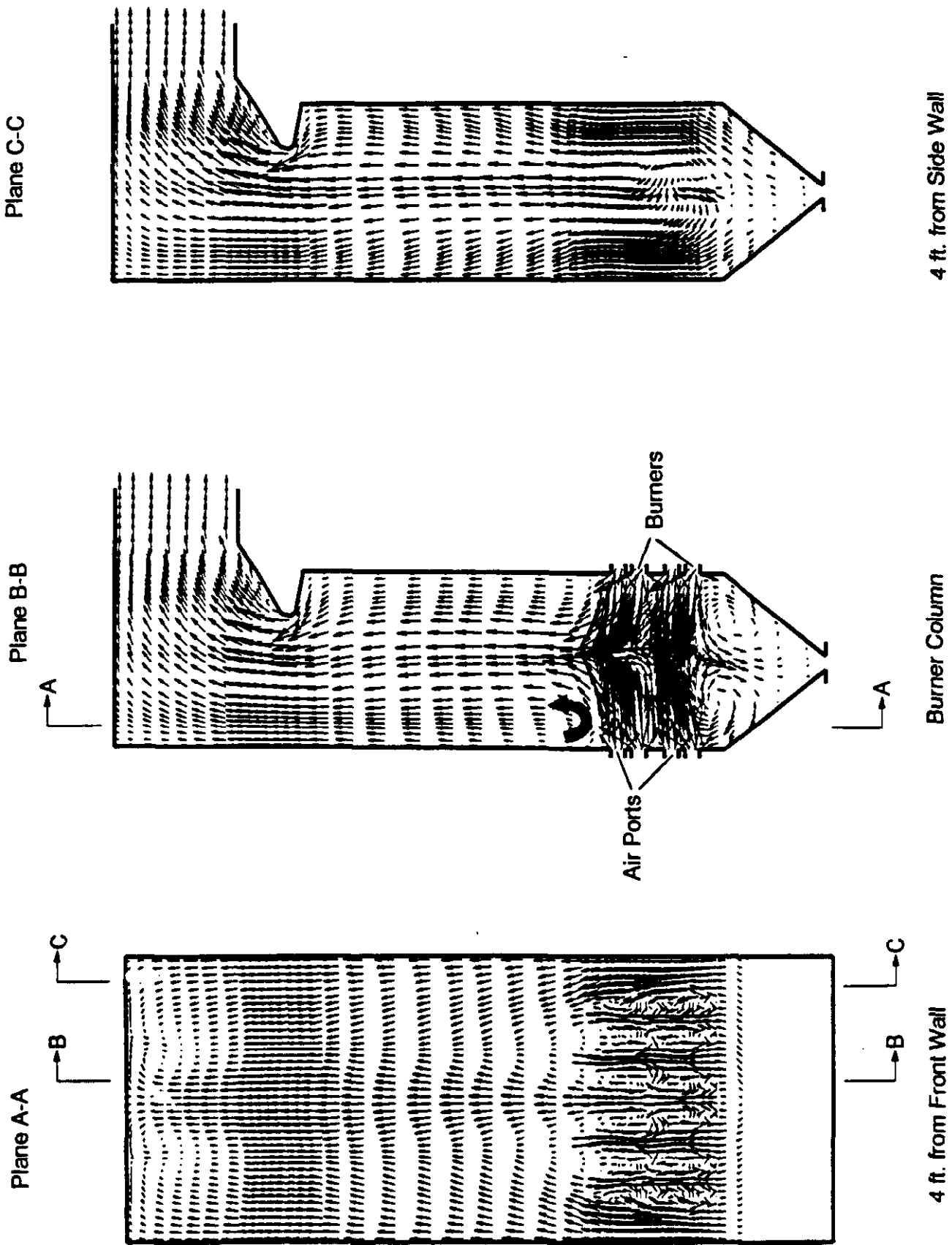
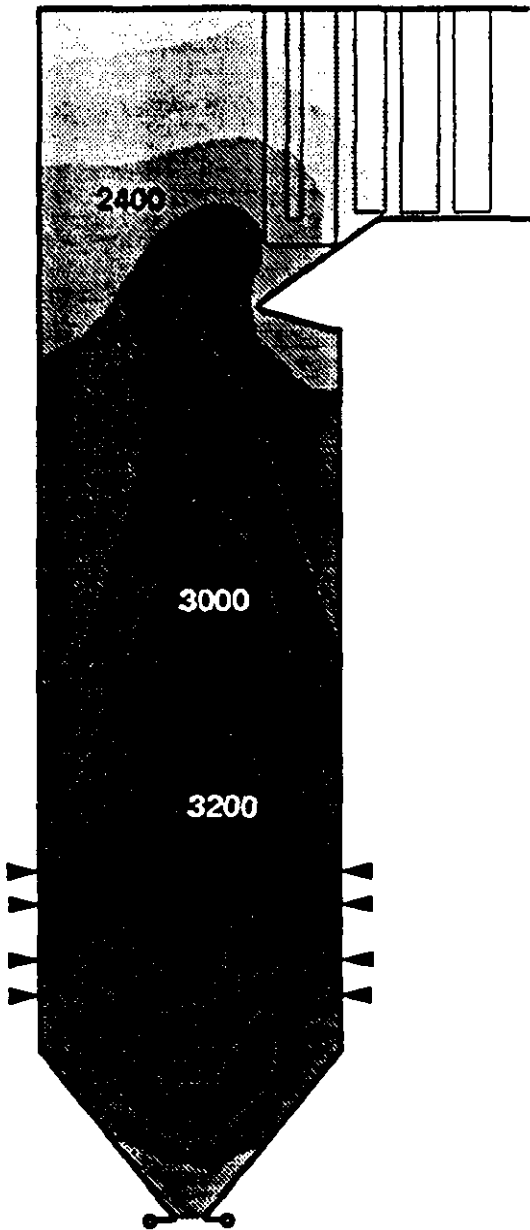


FIGURE 8

Gas Temperatures at the Furnace Centerline

(Contour Interval 200 F)

Standard Cell Burners



Low-NOx Cell Burners

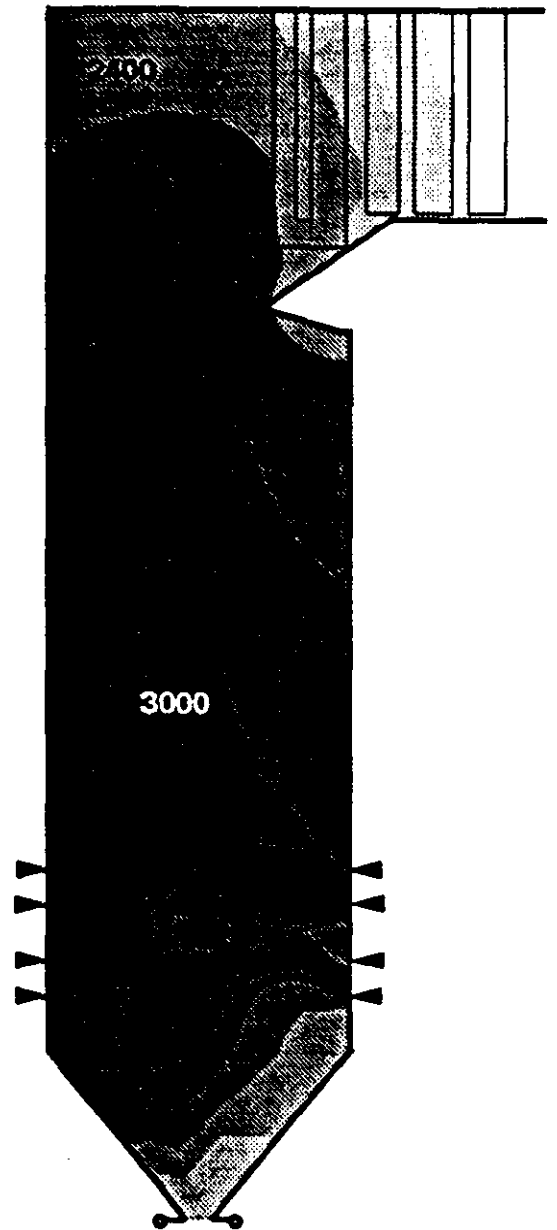
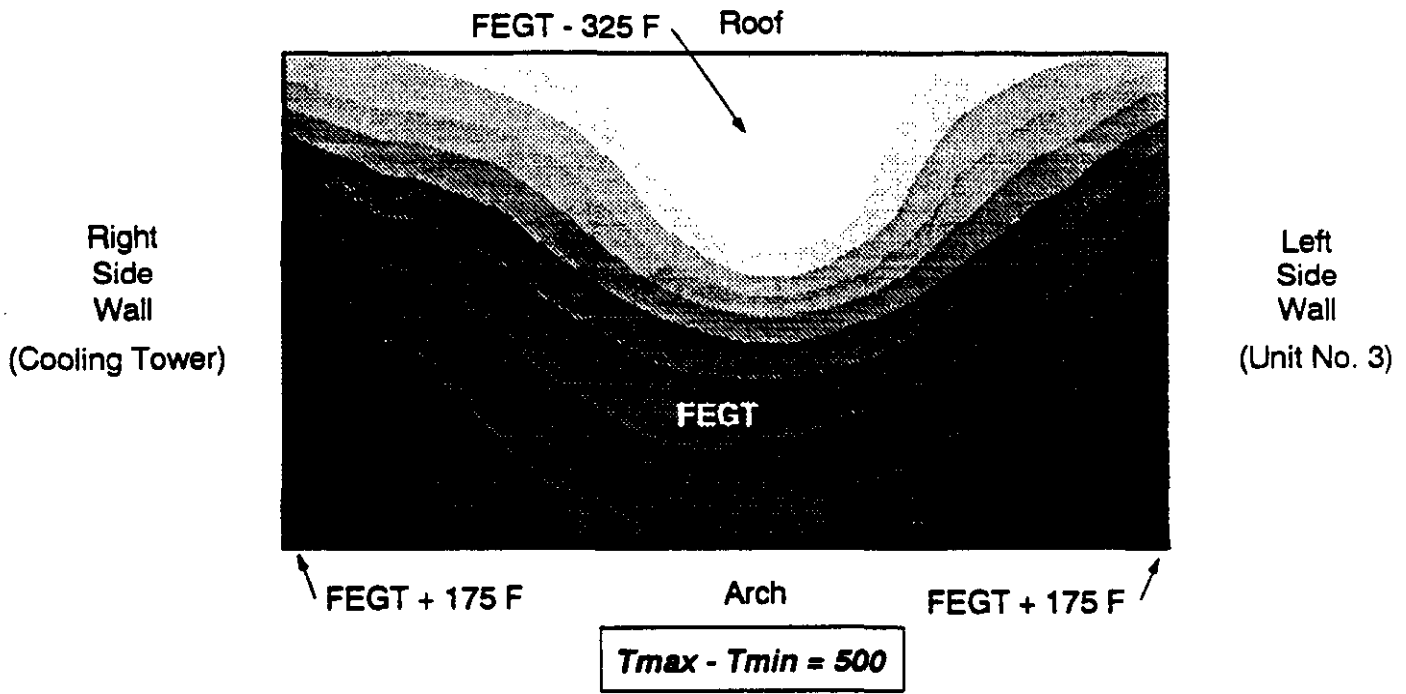


FIGURE 9

Furnace Exit Gas Temperature Distributions

(Contour Interval 50 F)

Standard Cell Burner



Low-NOx Cell Burner

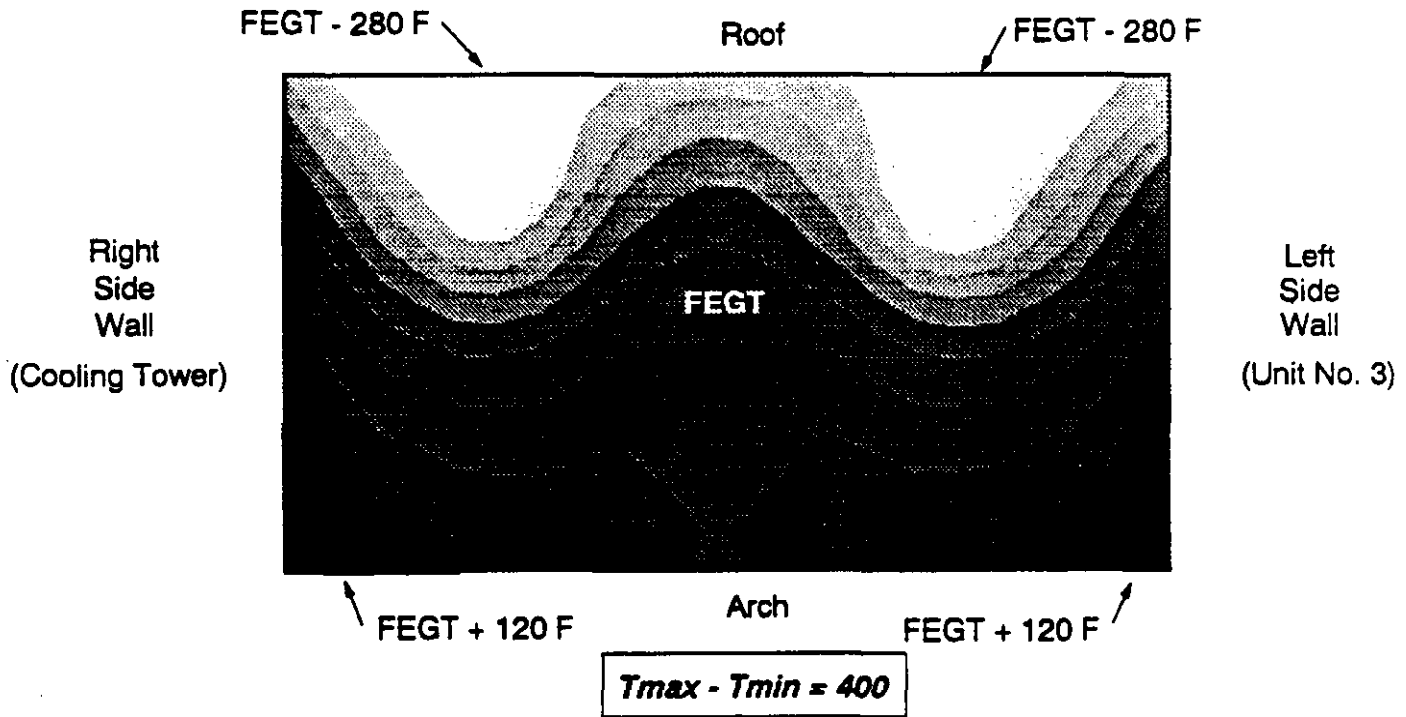
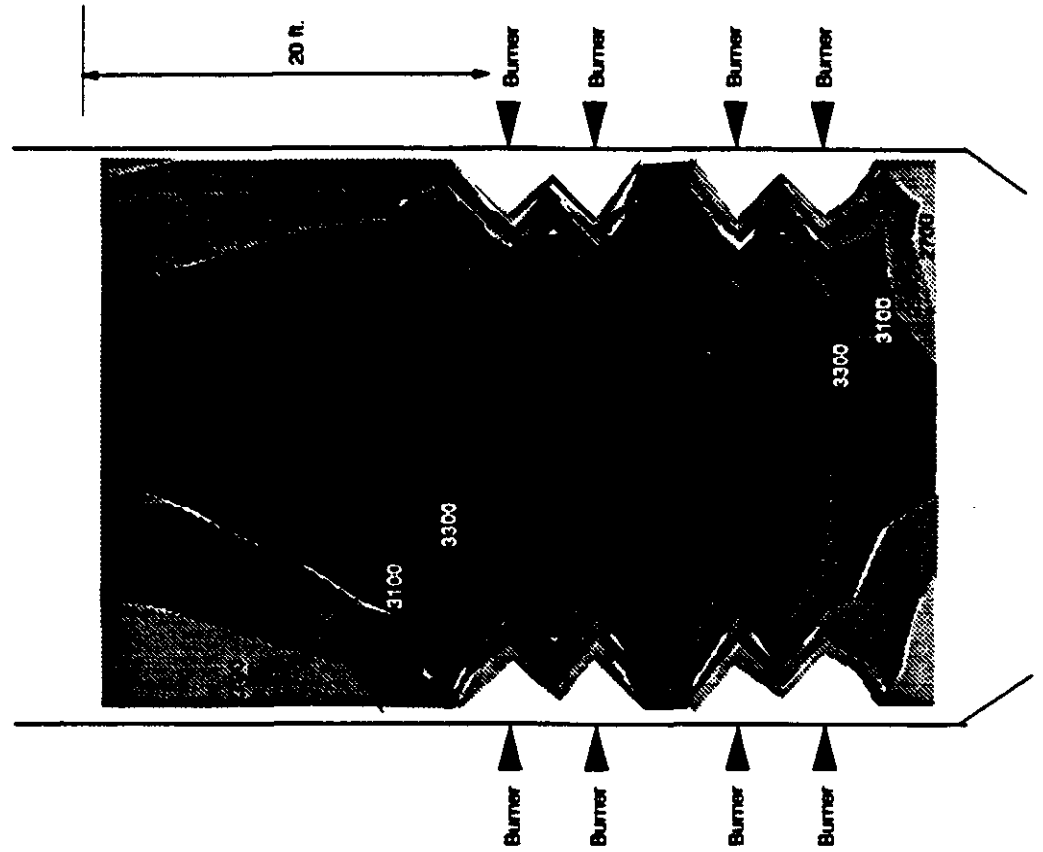


FIGURE 10

Burner Zone Temperatures

Standard Cell Burners



Low-NOx Cell Burners

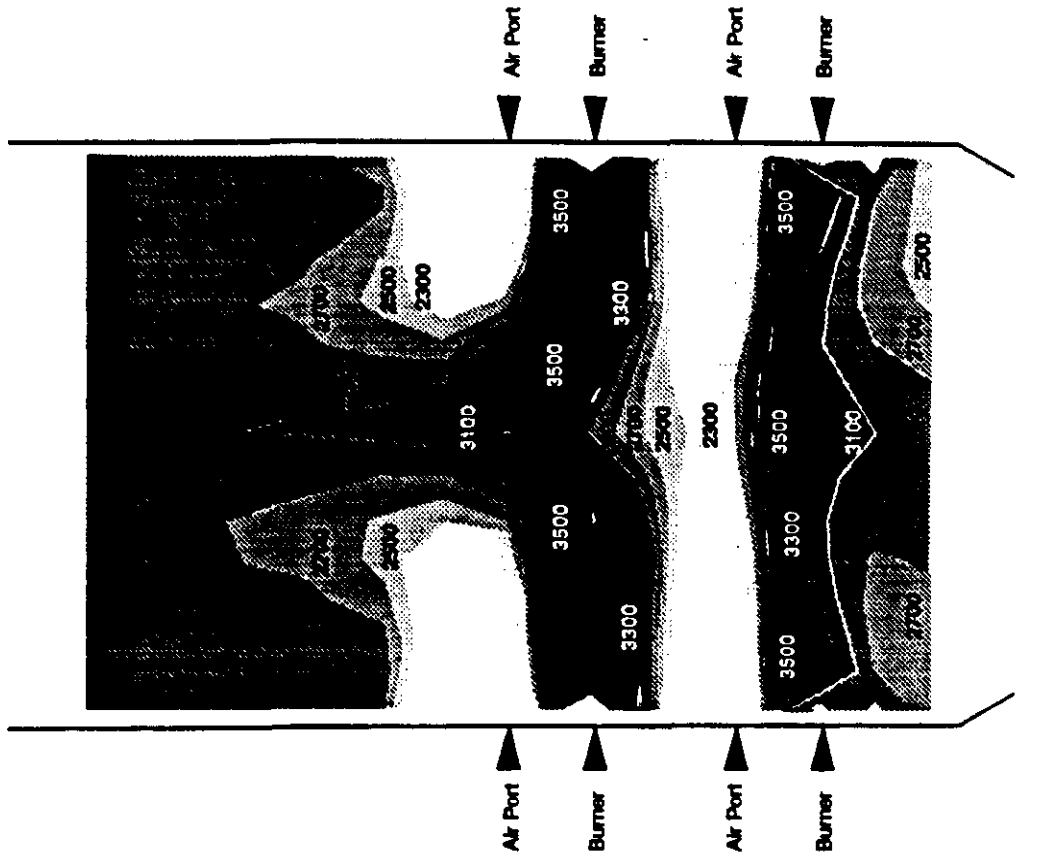


FIGURE 11

B. LOW NO_x BURNER COMPONENT DESIGN

As previously stated, the primary design requirement for the Low-NO_x Cell Burner is to duplicate the existing burner's functionality without requiring costly pressure part (or other) modifications. This is to be accomplished while reducing NO_x emissions by a minimum of 50% with little or no impact on boiler life or its operation. To comply with this requirement, certain design criteria, such as total burner heat input, burner wall tube opening size, etc., cannot be altered.

The Low-NO_x Cell Burner, as it is to be applied to J.M. Stuart Unit 4, is shown in Figure 12. Mass flows for coal and combustion air are shown in Figure 13. The diagram in Figure 13, as shown, is for the boiler full-load condition of 4,400,000 lb/hr main steam flow with all burners and pulverizers in service. The full-load burner input for each Low-NO_x Cell Burner is 220 million Btu/hr with all 24 Low-NO_x Cell Burners balanced for equal heat input.

General design specifications which apply for the retrofit hardware is the National Fire Protection Association (NFPA) code for multiple-burner, pulverized-coal-fired steam generators. General industry standards and manufacturers standards for the supplied hardware will also apply.

The Low-NO_x Cell Burner is not intended to use any unique or specialized design specification for fabrication or procurement of material which is not currently available on the open marketplace. The design criteria and sizing of the Low-NO_x Cell Burner and its major components is described below:

This project requires, twenty-four (24) - Low-NO_x Cell Burners with 38-inch diameter throats. This throat size matches the existing boiler tube wall throat diameter so that modifications to the boiler throat tubes are not required during installation. The burner portion of the low NO_x cell burners consist of the following major components:

- Burner mounting plates (wallboxes). The burner mounting plate is the mechanism which attaches the burner to the furnace wall tubes. The design of the existing cell burner wallbox is identical to that needed for the LNC Burners. So, conceivably, the existing mounting plates can be re-used. However, it is frequently the case in burner retrofit applications that the existing mounting plate is warped as a result of long-term overhear. To ease installation and insure proper tolerances of the burner with respect to the furnace wall tubes, a new burner mounting plate will be supplied for this installation.
- Coal Nozzles (22-inch O.D., 21-inch I.D.). These nozzles are required to handle the fuel input previously accomplished by two smaller coal nozzles. The large nozzle is installed in the lower throat of the Low-NO_x Cell Burner and is essentially twice the area of the nozzle it replaces.

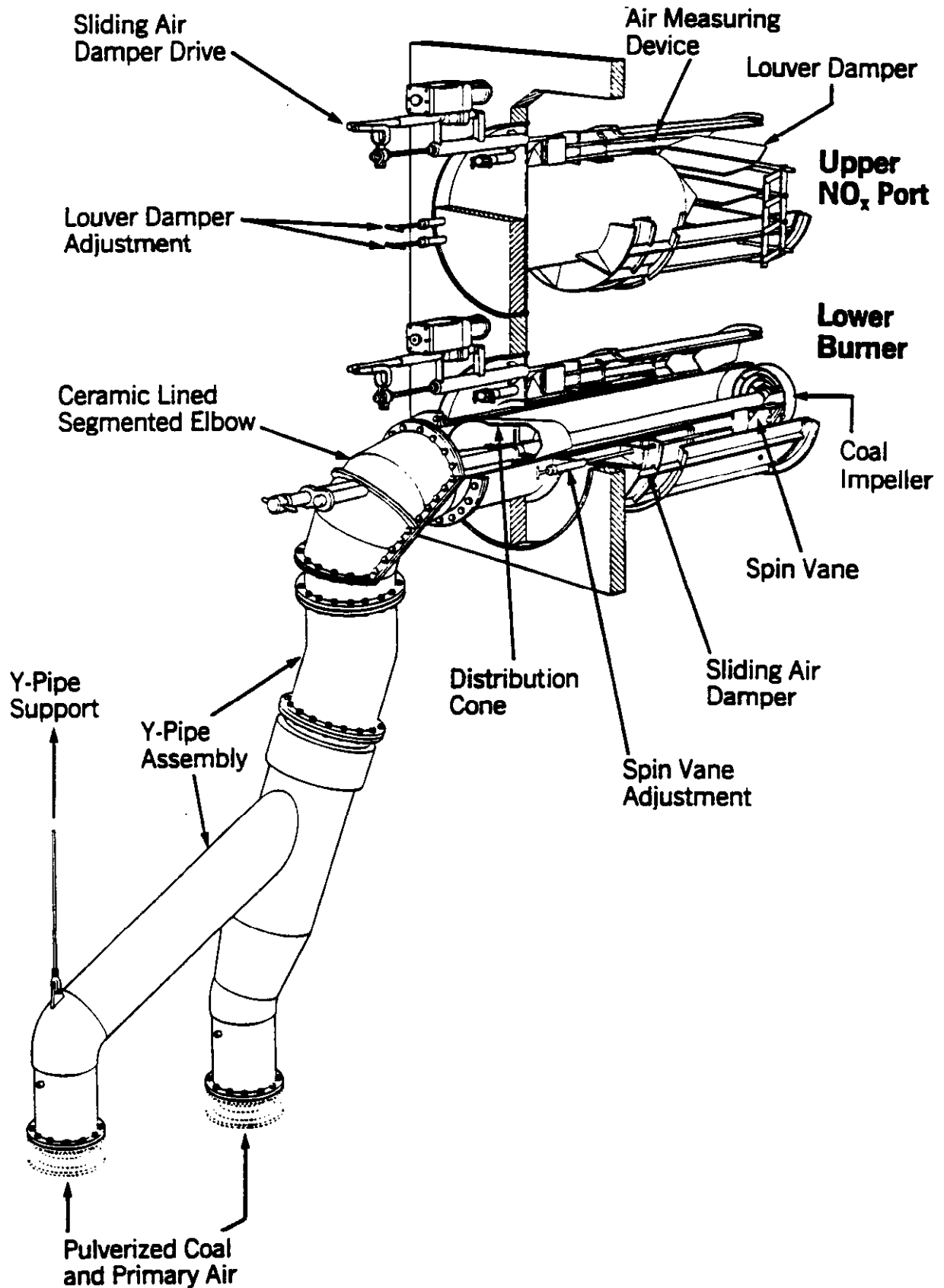


FIGURE 12. Stuart Unit 4 LNCB
 (One Low-NO_x Cell Burner Shown, Typical of 24 Total)

4 Low-NOx Cell Burners/Pulverizer

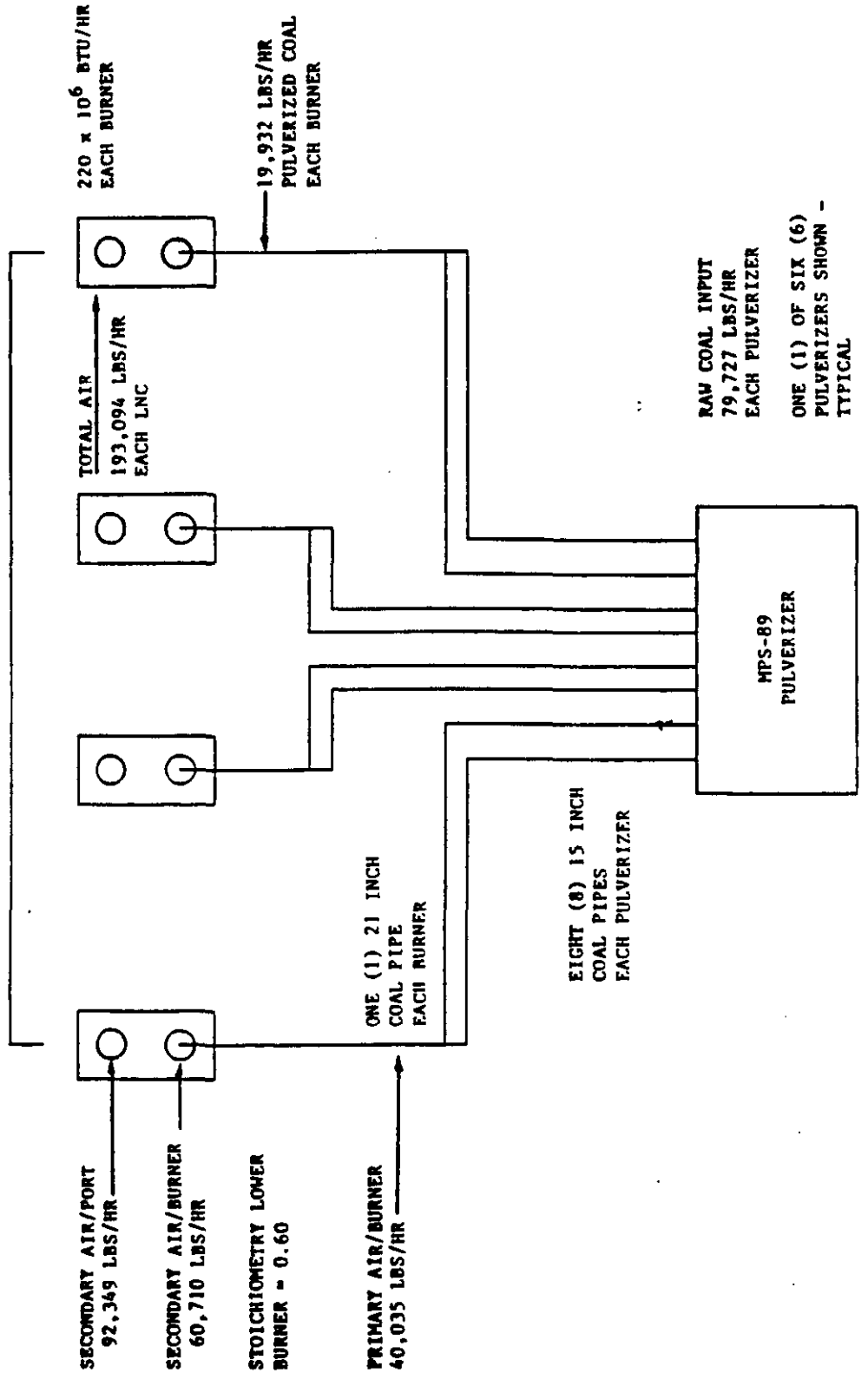


FIGURE 13. Stuart Unit 4 - Full-Load PC Flow Schematic
(4 Low-NOx Cell Burners/Pulverizer)

- Coal Impellers and regulating rods. The impellers are used to radially disperse the coal/air mixture leaving the coal nozzle, and are compatible in size to the nozzle in which they are installed. The angle of dispersion determines flame shape and length and has a direct impact on potential NO_x reduction. A direct correlation exists between flame length and NO_x formation. The impeller regulating rod permits adjustments to the position of the impeller with respect to the end of the coal nozzle.
- Sliding Air Dampers are used to control secondary air flow to the burner throats. During preliminary testing following start-up of the LNC Burners, the position of these dampers will be adjusted to balance the airflow through each LNC Burner to provide proper air/fuel mixing.
- Sliding Air Damper Drives are provided to automatically position the dampers. The three set points for these electrically-operated drives are: out-of-service cooling position, burner light-off position, and normal operating position.
- Spin Vanes are designed to serve a two-fold purpose. The adjustable vanes have an effect upon air flow distribution between the upper and lower throat of each cell as well as impart a swirl to the secondary air passing through the lower throat.
- Ceramic Lined Coal Nozzle Elbows must be replaced to accommodate the larger coal nozzle. Ceramic lining is used as an added precaution against erosion from abrasive coals and serves to increase the wear life of the elbow.

The 38-inch diameter NO_x port portion of the Low-NO_x Cell Burners consist of the following major components:

- Sliding Air Dampers are used to control secondary air flow to the NO_x port throats. These dampers are identical to the burner sliding air dampers, and are similarly used to balance the airflow through each NO_x port in the boiler.
- Sliding Air Damper Drives are provided to automatically position the dampers for the out-of-service, light-off, and normal operating positions.
- Louver Dampers are provided at the NO_x port throat openings. These adjustable dampers provide the means to direct the secondary air stream through the NO_x port either divergent from the flame, parallel to the flame, or convergent to the flame.

In addition to these minimum design criterion the following parameters were used in finalizing the design of the Low-NO_x Cell Burner.

The physical size of the burner was preset by the existing boiler/windbox geometry. The burner wall tube openings set the throat diameter at 38". The windbox depth was set at 7'-6". Heat input required remained the same and the original design/performance fuel analysis (see Table 1) was used to determine coal flow requirements for the new LNCB's. B&W Standards were used to match the coal nozzle inside diameter with the coal flow requirement.

Given the fuel flow requirements, the coal nozzle size, and assuming a burner air sleeve inside diameter which matches the burner throat diameter, calculations were made to insure that air velocities and burner pressure drop remained within desirable limits. The effect of spin vane position (full closed to full open) was also analyzed in these calculations.

To eliminate concern, the FD fan static capacity was reviewed to insure a good margin still existed using the higher burner pressure drop inherent to the LNCB. Results of the review indicated that fan capacity was more than adequate for the retrofit for two reasons:

- (1) Data shows that DP&L currently operates the Stuart #4 boiler at 3.5% O_2 leaving the economizer at full boiler load, to enhance combustion and assist in slag control. With the installation of the LNC Burners, DP&L will be able to operate closer to the recommended 3.1% O_2 level for LNC Burners, thus reducing air system flow requirements and proportionately reducing air resistance through the balance of the secondary air system equipment.
- (2) DP&L Stuart #4 forced draft fans were designed for significantly high test block flow and static margins above expected operating conditions. Even neglecting any potential O_2 reduction, the expected air resistance increase is well within the test block capabilities of the forced draft fans.

The effect of the oversized FD fan capacity is somewhat reduced, however, by a problem with pluggage of the Ljungstrom Air Heater. As a result, air heater cleanliness will need to be monitored more closely with the retrofit of the LNCB.

The new burners will include the capability for independently measuring and adjusting the relative secondary air flow through the upper and lower throat of each cell burner.

The following parameters will be independently adjustable on each burner.

- o Coal impeller axial position.
- o Air swirl in the coal-firing throat, via adjustment of spin vanes.
- o Air flow to each throat, via adjustment of a sliding disk damper.
- o Direction of the air jet emanating from the air-only throat, via adjustment of air louvers.

TABLE 1 COAL ANALYSIS - DAYTON POWER & LIGHT STUART STATION
 SINGLE LOW-NO_x CELL BURNER RETROFIT
 (ORIGINAL DESIGN/PERFORMANCE FUEL)

	<u>As Received</u>	<u>Dry</u>
Total Moisture %	6.00	--
<u>Proximate Analysis %</u>		
Moisture	6.00	--
Volatile Matter	35.71	37.99
Fixed Carbon	45.81	48.73
Ash	12.48	13.28
Gross Heating Value Btu/lb	11,000	11,702
<u>Ultimate Analysis</u>		
Moisture	6.00	--
Carbon	61.43	65.35
Hydrogen	4.55	4.84
Nitrogen	1.00	1.07
Sulfur	3.54	3.76
Ash	12.48	13.28
Oxygen	<u>11.00</u>	<u>11.7</u>
Total	100.00	100.00

SECTION V

EQUIPMENT DESCRIPTION - PULVERIZED COAL (PC) PIPING

V. EQUIPMENT DESCRIPTION - PULVERIZED COAL (PC) PIPING

Application of the Low-NO_x Cell Burner as a retrofit technology will not require changes in coal and/or coal sourcing. The Low-NO_x Cell Burner is compatible with all coals currently being fired in this boiler that was originally equipped with the standard two-nozzle cell burner. There is no impact on storage, handling (before the pulverizer) and fuel preparation as a result of a Low-NO_x Cell Burner retrofit. Furthermore, this project does not preclude the use of emerging technologies for SO₂ abatement, such as limestone injection, nor does it preclude the use of coal cleaning for sulfur reduction, and/or post-combustion cleanup equipment such as scrubbers and precipitators.

Modifications to the pulverized coal piping after the pulverizer were necessary to retrofit the LNCB's. These modifications consisted of new sections of ceramic lined pulverized coal piping, couplings, and supports needed to install twenty-four (24) coal pipe "Y-branch" assemblies.

The Y-branch serves to join the existing two coal pipes that originally feed the two coal nozzles of the standard cell burner into one larger coal pipe feeding the lower "burner portion" of the LNCB. This section of pipe is installed in the vertical run of pipe near the LNCB. Placement of the Y-branch in a vertical run of pipe is necessary to avoid a possible accumulation of coal dust in the pipe where the two coal streams join. A typical arrangement of the Y-branch assembly is shown in Figure 14.

Also shown in Figure 14, is one of twenty-four (24) - 21 inch Dresser couplings. Dresser couplings are required for each of the new, larger, coal nozzles to permit differential movement between the coal piping which is fixed to structural steel and the boiler, which, by virtue of being top supported, is allowed to expand downward.

As previously stated, the arrangement of the twenty-four (24) cell burners on this unit is two (2) rows (upper and lower), six (6) burners in a row (left to right), on the front and rear walls of the boiler. Because of the close proximity of the platform and the lower cell burners, (4'-2") it was necessary to specify twelve (12) new 21-inch slide gate valves to be installed at the end of coal elbows to allow for operator access.

Low-NO_x Cell Burner Y-Pipe Assembly

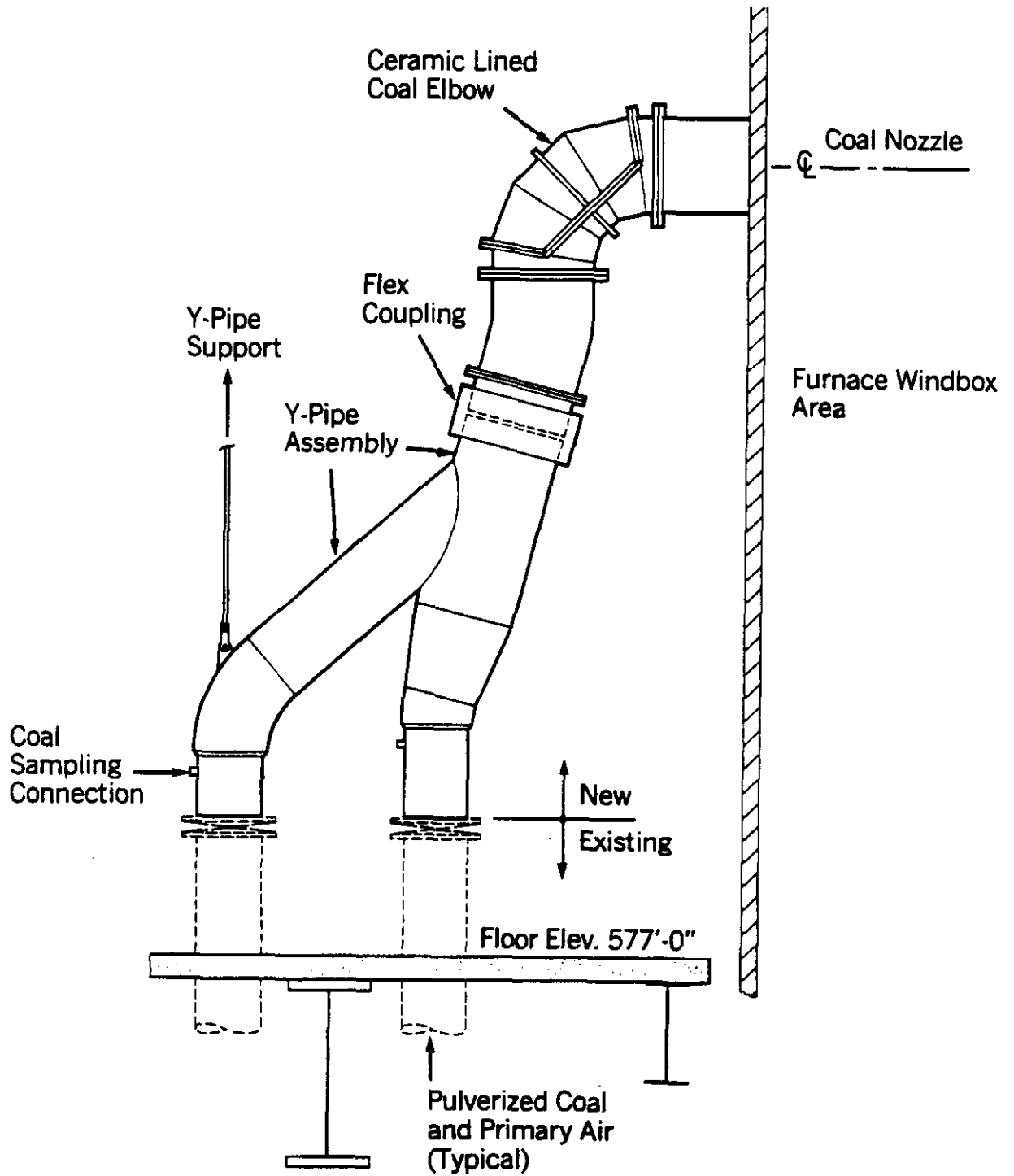


FIGURE 14

Slide gates near the burners are a requirement on pressurized units to permit isolation of the pulverizer from the burner, thereby permitting on-line maintenance of the pulverizers. Twelve (12) of the existing slide gate valves were retained because installation of the Y-branch assemblies on the upper cell burners is at a higher elevation than the slide gates.

To insure an even distribution of coal to LNCB's will be possible, B&W's Performance Engineering Department calculated the flow resistance of each piping run between the LNCB's and the pulverizers. Since flow resistance varies depending on the number of bends and lengths of pipe from the pulverizer to the burner, coal pipe restrictors are necessary to insure balanced primary air flow between pipes fed by the same pulverizer. The optimum location (within the limitations of the existing design) of the coal pipe restrictors was specified by engineering.

The location, size, and quantity of coal pipe supports was specified by B&W's Stress Engineering Department. Pipe hangers, brackets, and support steel was added as needed to support PC Piping. No unusual situations were encountered for this retrofit.

Platform steel was modified as needed at the 577'-0", 590'-0", and 604'-0" elevations to allow clearance around the new pulverized coal piping.

SECTION VI

ELECTRICAL & CONTROL SYSTEMS MODIFICATIONS (DP&L)

VI. ELECTRICAL & CONTROL SYSTEMS MODIFICATIONS (DP&L)

To accommodate the LNCB retrofit, the unit's electrical and control systems must be modified to accept the forty-eight (48) sliding air damper drives. Each Low-NOx Cell Burner has two (2) sliding air damper drives, one (1) on the lower "burner" portion and one (1) on the upper "NOx Port" portion (see Figure 15).

The sliding air damper drive is a motorized Jordan Drive with a 10-inch stroke. Limit switches are provided to stop the drive motor at the out-of-service cooling, burner light-off, and normal operating positions. A control signal (momentary pulse) will start the drive motor and advance (or retract) the air damper to the next position in sequence. The operation of the drives on the burner portion and the NOx Port portion coincide with each other.

Pushbuttons mounted in the control room provide the control signal to the motor starters (mounted in the MCC) for the drives. The control signals are interlocked with the pulverizer and burner management control systems.

Burner Air Registers

The old system consisted of one Air Register Drive (ARD) to operate a pair of burner air registers. The control of the air registers was operator initiated (not part of an automated burner control system). The operator initiated the commands for the drives to position the registers in CLOSED, LIGHT-OFF, or OPEN position from the control room, via push buttons. The operating limits and feedback to the operator indication panel came from 13 position and limit switches in the Limitorque Air Register Drives.

There were some operating limits and permissives associated with the old register control system; such as, the air register positioning was limited from going closed with the coal feeder in service; the air registers were required to be in the light-off position to allow starting of igniters; the registers were required to be open for purge, etc.

There will now be one ARD per burner or NOx port register for a total of 48. The control of the new air registers will be essentially the same. The only exceptions are that DP&L has decided to add local push buttons near the burners, (see Figure 16) and that it will become an operator function to ensure that the registers are in the proper position for a boiler purge.

The new drives being furnished only have four position switches. In order to minimize the installation costs and achieve a high degree of reliability, a Programmable Logic Controller (PLC) is being incorporated to interface the old operator push button system and the contactors used to operate the new drives. Figure 17 shows the Control System Logic Diagram. This allows control of the contactors and provides operator indications with the limited number of position switches available.

The use of PLC also reduces field installation time and costs, when compared to installing and wiring the many relays that would be required to accomplish the same control scheme. Since the PLC is being used as described above, it was decided to move as much of the logic as possible into the PLC and eliminate some mechanical relays. The present plans are to use one PLC per set of pulverizer air registers (six PLCs total).

The PLC programming is being done by DP&L.

Low-NO_x Cell Burner

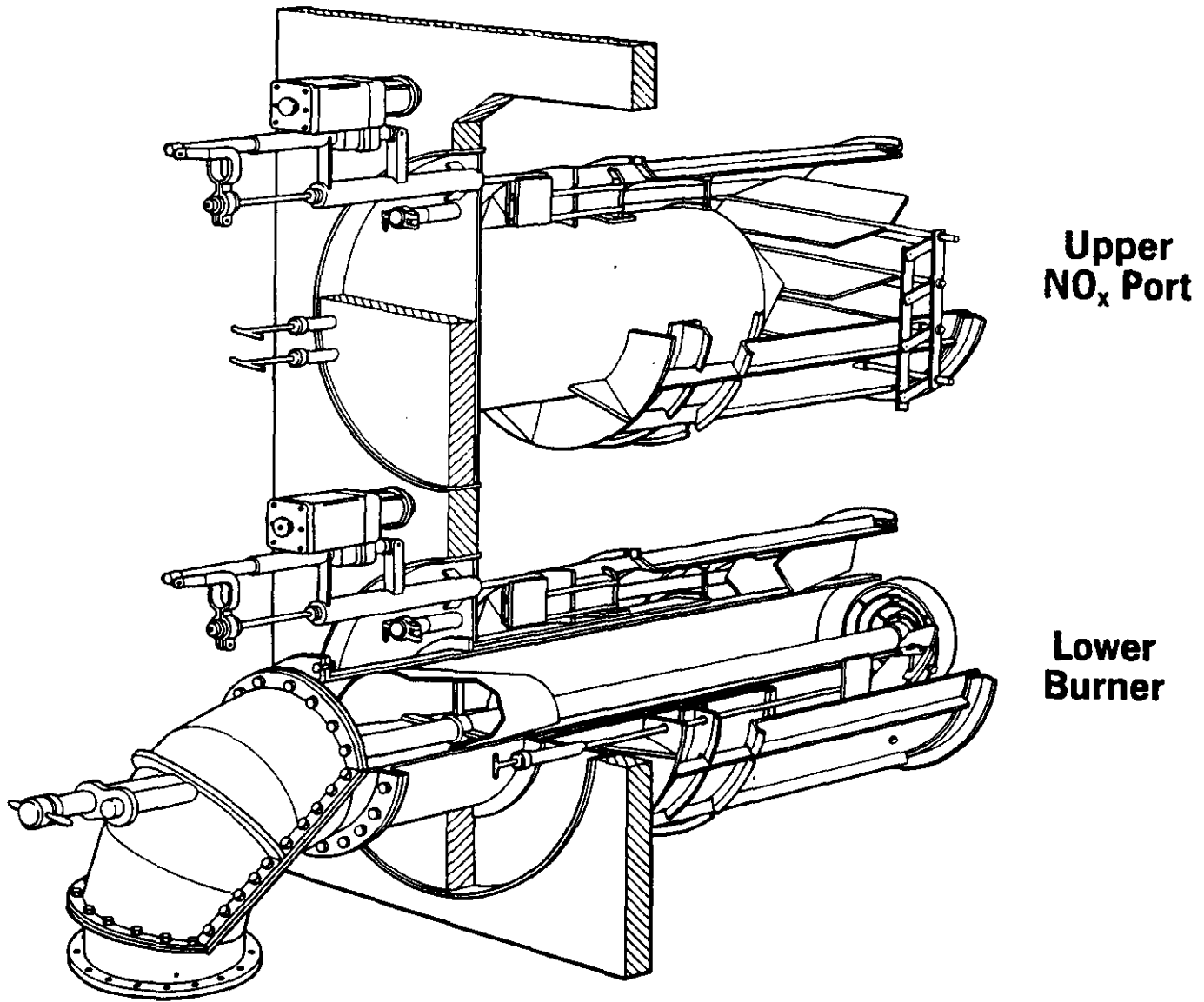


FIGURE 15

AIR REGISTERS 24 EACH

HOFFMAN TYPE BOX NEAR BURNER

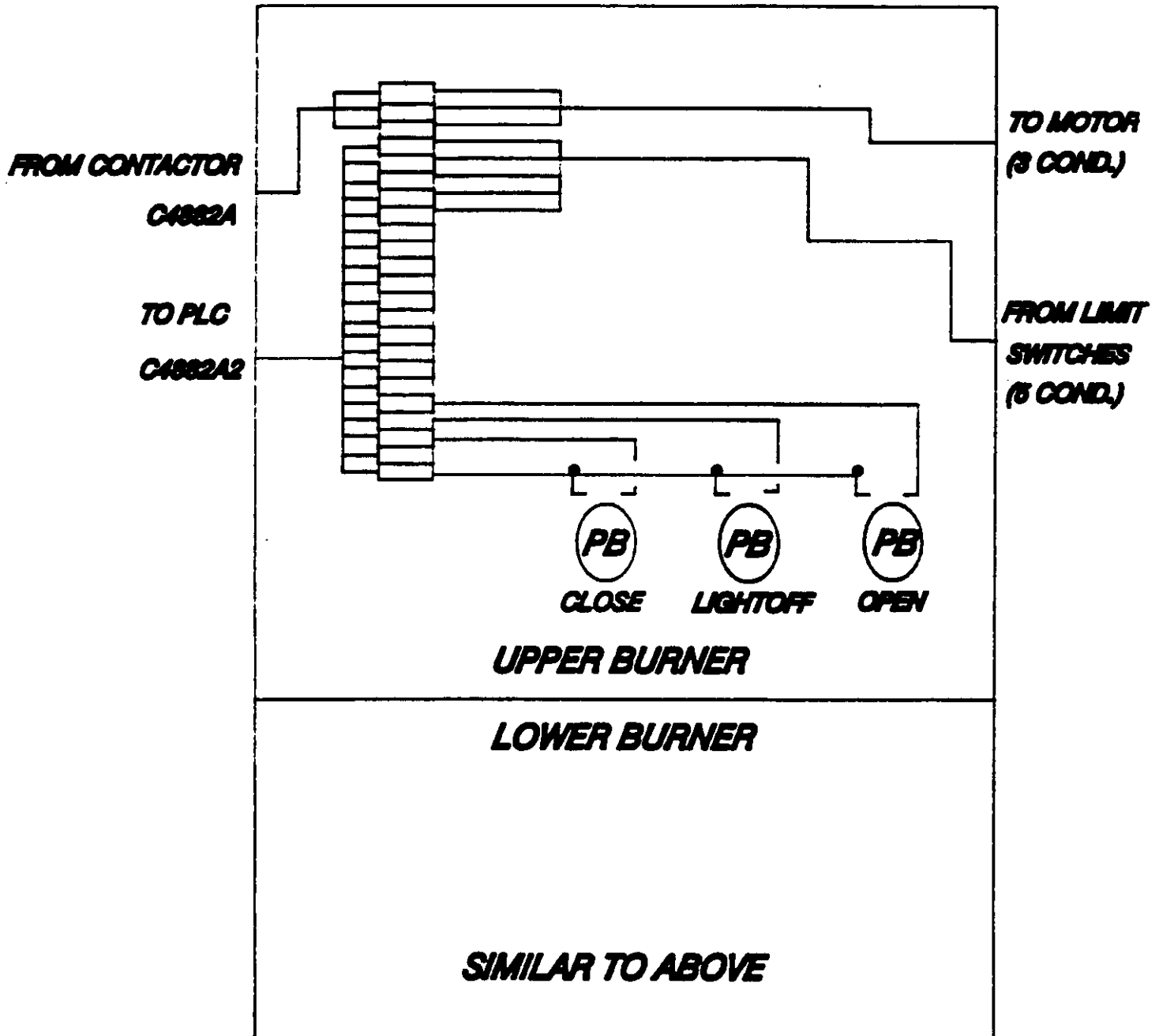
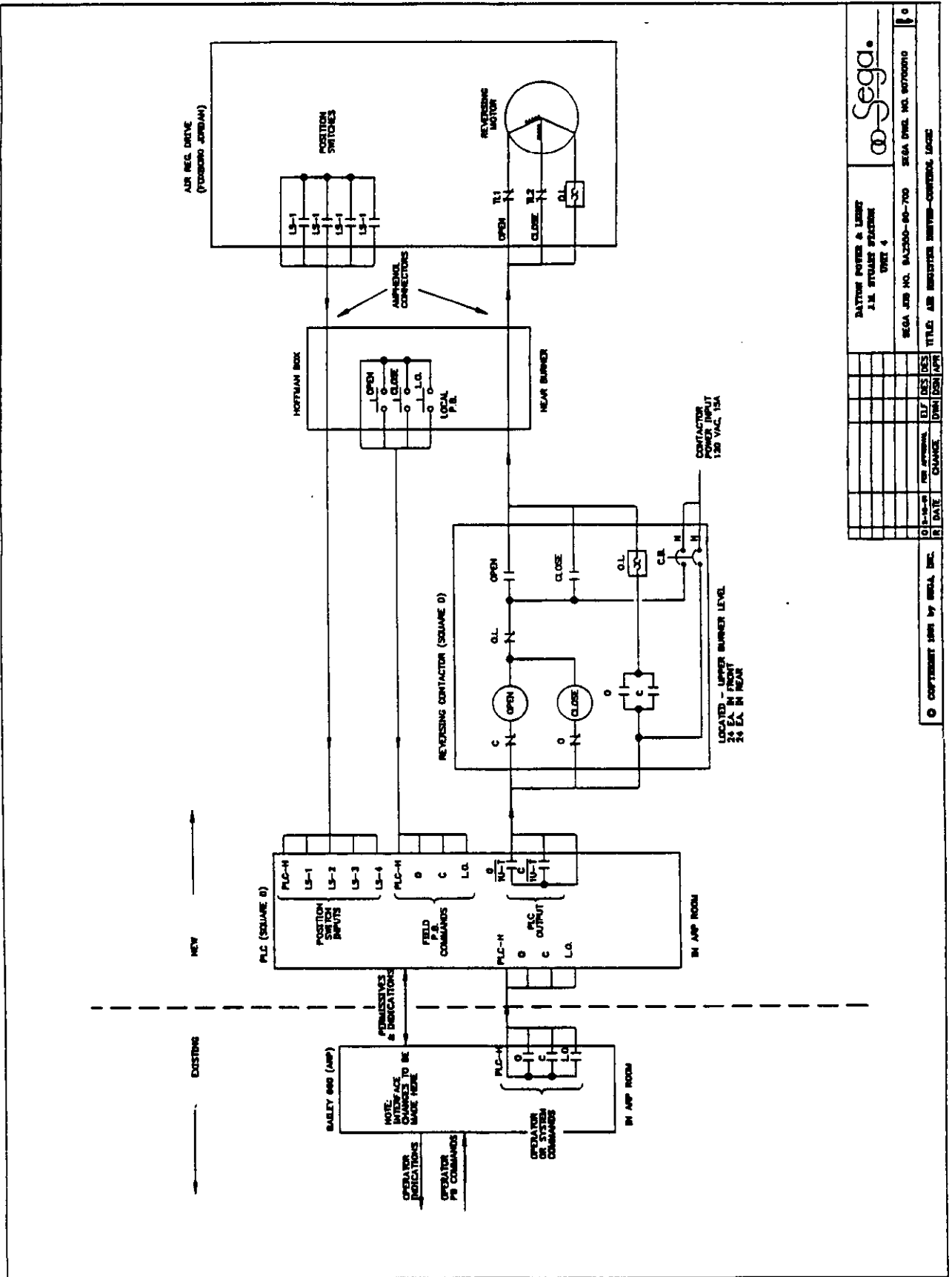


FIGURE 16 Air Register Control System-
Local Hoffman Controller



BAYTON POWER & LIGHT 118 STUART STATION UNIT 4		
SEGA JOB NO. BA2300-90-700	SEGA DWG. NO. 80700010	0
TITLE: AIR REGISTER MECHANIC-CONTROL LOGIC		
DESIGNED BY	DATE	
CHECKED BY	DATE	
APPROVED BY	DATE	
OPERATOR	DATE	

FIGURE 17 Air Register Control System-Control Logic Diagram

SECTION VII

DESCRIPTIONS OF MISCELLANEOUS MODIFICATIONS

VII. DESCRIPTIONS OF MISCELLANEOUS MODIFICATIONS

In order to properly evaluate the impact of the Low-NO_x Cell Burner retrofit, additional modifications were specified for this unit. These modifications are not required for installation and/or operation of the LNCB's but, consist mainly of test ports, instrumentation, and instrumentation primary elements required to monitor thermal performance and emissions of the boiler. A view of the emissions test port locations is shown in Figure 18.

Orifice plates and differential pressure taps were specified for the inlet duct of the primary air fan. Differential pressure measurements will be taken and a calibration curve representative of primary air flow will be developed.

A 40-point test grid provided by B&W will be located within each of the two economizer outlet ducts (15' x 27') as shown in Figure 19. These probes will be constructed of carbon steel material and supplied with 5/16" stainless steel tubing to connect up with the Test Contractor's flexible tubing. Ten (10) ports (schedule 40, 4" diameter x 12" long pipe nipple threaded on one end with cap) across each duct have been installed during the April, 1990 unit outage to provide access for 4-point probes to be installed through each port and will be used to measure temperature, O₂, CO, CO₂, and NO_x. This economizer gas outlet grid will be available to the Test Contractor for continuous gaseous emissions monitoring. Positive gas pressure within these ducts are approximately 6-10 in. w.g. at full load.

An additional 10 ports (schedule 40, 4" diameter x 12" long pipe nipple threaded on one end with cap) have been installed approximately 4 feet upstream of the gas sampling ports for the purpose of particulate sampling. These ports are available to the Test Contractor to perform traverses to collect particulate samples, during three specified test runs.

Twelve equally-spaced test ports are located across each of the two air heater gas outlet ducts as shown in Figure 19. B&W will fabricate probes to be installed at these port locations to obtain the necessary temperature and O₂ data in order to determine air heater leakage and overall air heater thermal performance. The data obtained by B&W from this grid and other temperature grids are essential to perform a heat balance of the air heater to provide an accurate measure of total air flow to the unit. A tee connection will be provided at this location to be used by B&W for obtaining the gas samples to be analyzed for N₂O concentration. These 36-point grids will be used to obtain gas samples for B&W's CO, O₂, and NO_x continuous analyzers as well.

Eight point temperature grids exist in each of the two air ducts at the entrance to the regenerative air heaters. These grids will be used by B&W to measure the temperature of the secondary air to the regenerative air heaters, including heat input from the steam coil air pre-heaters and the heat of compression of the forced draft fans. B&W will tap into the these 16 sensing lines to provide air inlet temperature readings to the data acquisition system to determine boiler performance, air heater performance, and a basis for calculating total air flow to the unit.

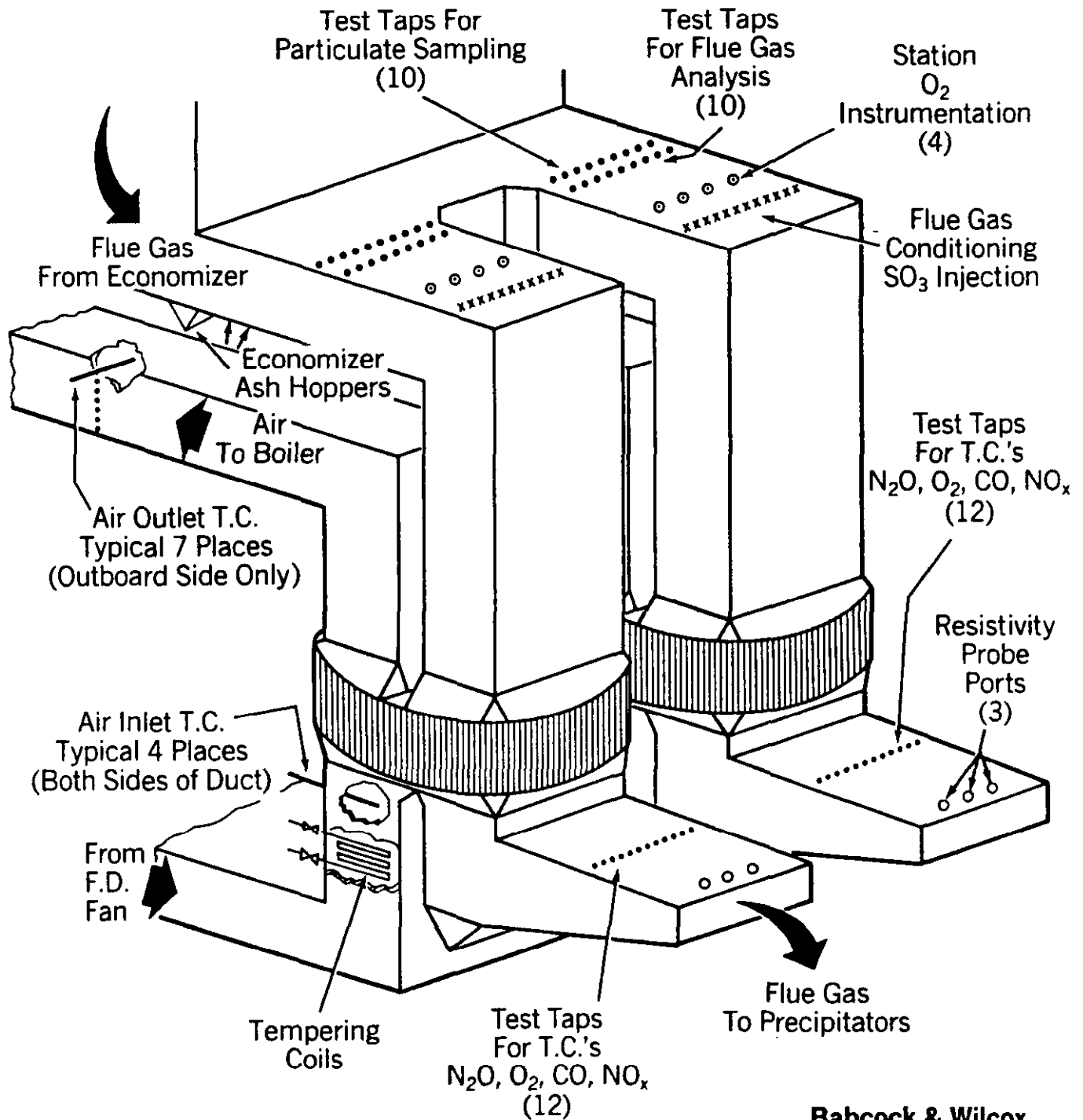
Four new 2" test connections were installed midway between the three existing test connections on each of the two secondary air ducts at the outlet of each air heater just ahead of the air foils. B&W will provide the temperature probes which will provide a temperature grid of seven levels on each duct to account for any temperature stratification within these ducts. B&W will send the temperature readings from these instruments through the data acquisition system.

Ten observation door insert panels were installed during the April, 1990 outage. Six were installed on the east and west sidewalls. Two at elevation 635'-7 1/2", two at elevation 683'-0", and two at elevation 702'-3". Four observation door insert panels were installed at the front corners of the boiler. Two on the east/front wall corner at elevation 579'-0" and two on the west/front wall corner at elevation 581'-0". These observation doors were added to facilitate monitoring burner flame characteristics.

Four test ports were installed at elevation 577'-0" to enable gas sampling which will be tested for H₂S concentration. The purpose of this testing is to evaluate the current corrosion potential within the furnace region. DP&L is currently experiencing waterwall tube wastage located primarily along the sidewalls of the furnace. The results of our furnace probing work will be compared to post-retrofit probing work at this location to document any change in corrosion potential of the gas species.

To supplement this data, ultrasonic thickness (U.T.) measurements of the tube walls were taken during the unit outage in April, 1990. Subsequent U.T. measurements will be taken during the retrofit outage in the fall of 1991 and 18 months later in the spring of 1993. These measurements will give indications of the tube wall wastage under similar periods of time for standard cell burner operation and Low-NOx Cell Burner operation.

Emissions Test Port Locations on Stuart Unit #4

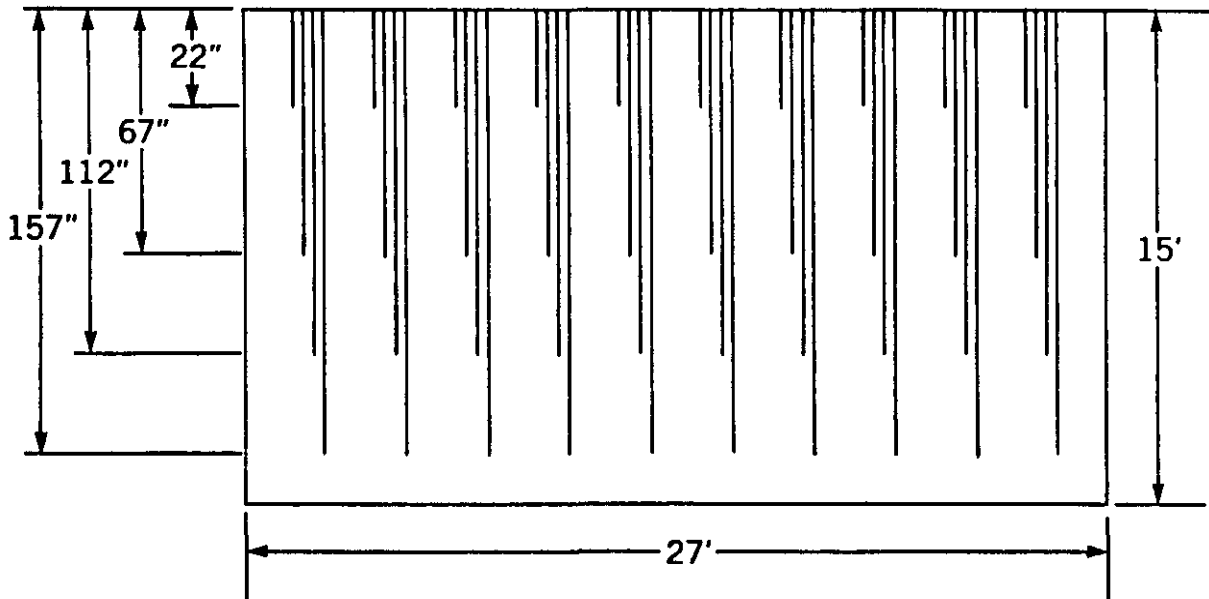


Babcock & Wilcox
a McDermott company
September 1990

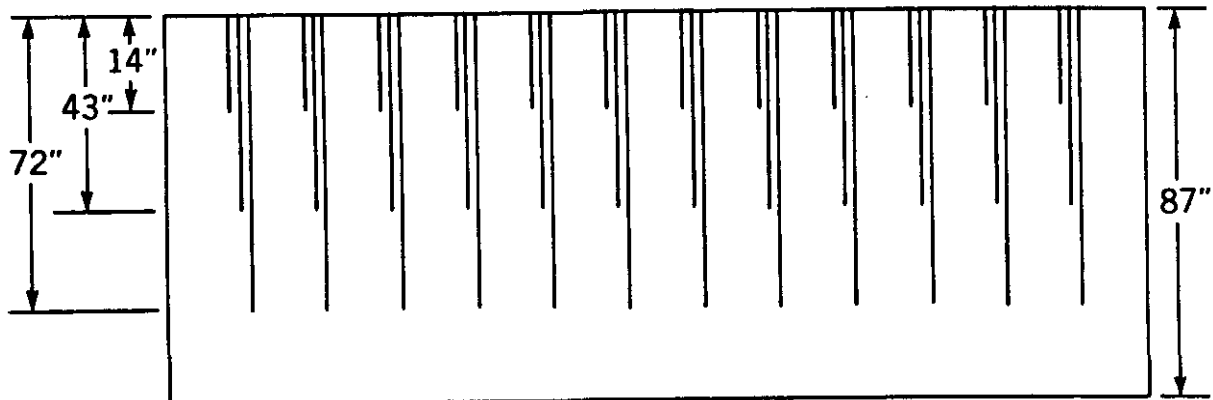
Figure 18 Stuart Unit 4 - Emissions Test Port Locations

Economizer Outlet Gas Sampling Grid (1 of 2)

5/16 in. tubing connections to sample lines



Air Heater Outlet Gas Sampling Grid (1 of 2)



Babcock & Wilcox
a McDermott company
August 1990

Figure 19 Stuart Unit 4 - Schematic of Gas Sampling Grids

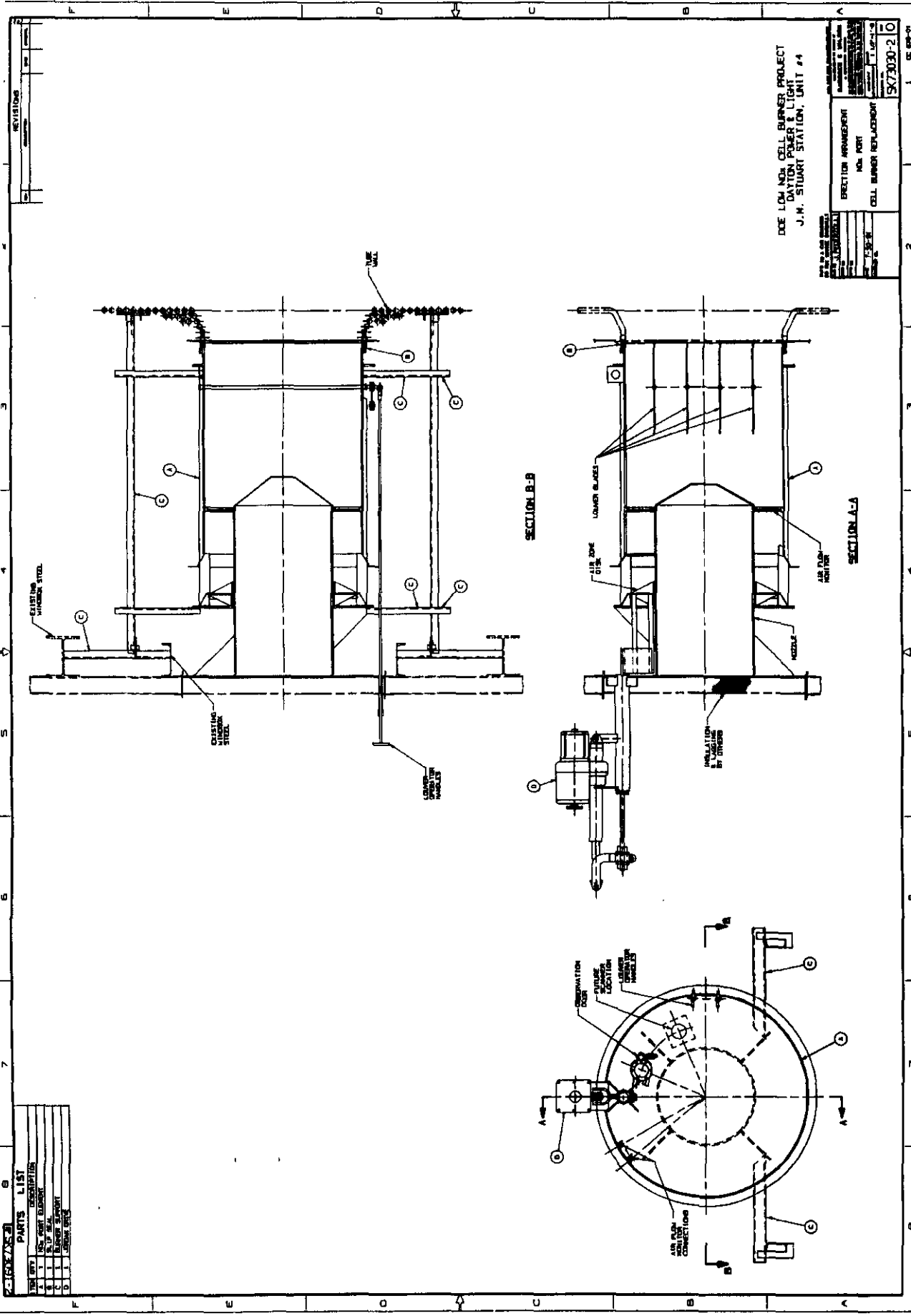
SECTION VIII
SIGNIFICANT DRAWINGS

VIII. Significant Drawings

Significant drawings which are representative of the arrangement of equipment supplied for this project are included in this section. Half of the burners are designed to impart a clockwise swirl to the secondary air passing through the throat, and half are designed for counter-clockwise swirl. Only the counter clockwise burner erection arrangement is included to represent the burner. Similarly, the lower level NOx port sliding damper linear actuators were required to be rotated 90° to provide clearance to structural steel when the unit is cold. Only the upper (vertically mounted) NOx port erection arrangement drawing is included as representative for the NOx ports.

Representative Significant Drawings are as follows:

<u>Drawing No.</u>	<u>Title</u>
SK73091-1	Erection Arrangement C.C.W. S-Type Burner
SK73030-2	Erection Arrangement NOx Port
12229J-2	Arrangement S-Type Burners & NOx Ports - Front Wall
12230J-2	Arrangement S-Type Burners & NOx Ports - Rear Wall
12232J-0	Burner Wallboxes - Front & Rearwall
14646J-2	Arrangement PC Piping Front Wall
14647J-2	Arrangement PC Piping Rear Wall
304310C-0	Erection Arrangement - Burner Pipe Hanger BPS-1
210539D-0	Erection Arrangement - Burner Pipe Hanger BPS-2
304313C-0	Erection Arrangement - Burner Pipe Hanger BPS-9
14668J-0	Erection Arrangement Ceramic Coal Piping-Pulverizer's A, B, & C
14669J-0	Erection Arrangement Ceramic Coal Piping-Pulverizer's D, E, & F
430795E-0	Erection Arrangement - Windbox Steel Modification
12695J-1	Field Alteration Boiler Platform Framing El. 577'-0" & El. 604'-0"
12696J-0	Field Alteration Boiler Platform Framing El. 590'-0"



DOE LOW-NOX CELL BURNER PROJECT
 DAYTON POWER & LIGHT
 J.M. STURM STATION, UNIT #4

PROJECT NO.	57300-210	
DATE	12-18-97	
REVISIONS		
NO.	DATE	DESCRIPTION
1		ISSUED FOR CONSTRUCTION
2		REVISION
3		REVISION
4		REVISION
5		REVISION
6		REVISION
7		REVISION
8		REVISION
9		REVISION
10		REVISION

SECTION A

NO.	DESCRIPTION
1	NO. 1000 ELEMENT
2	NO. 1000 ELEMENT
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4	NO. 1000 ELEMENT
5	NO. 1000 ELEMENT
6	NO. 1000 ELEMENT
7	NO. 1000 ELEMENT
8	NO. 1000 ELEMENT
9	NO. 1000 ELEMENT
10	NO. 1000 ELEMENT

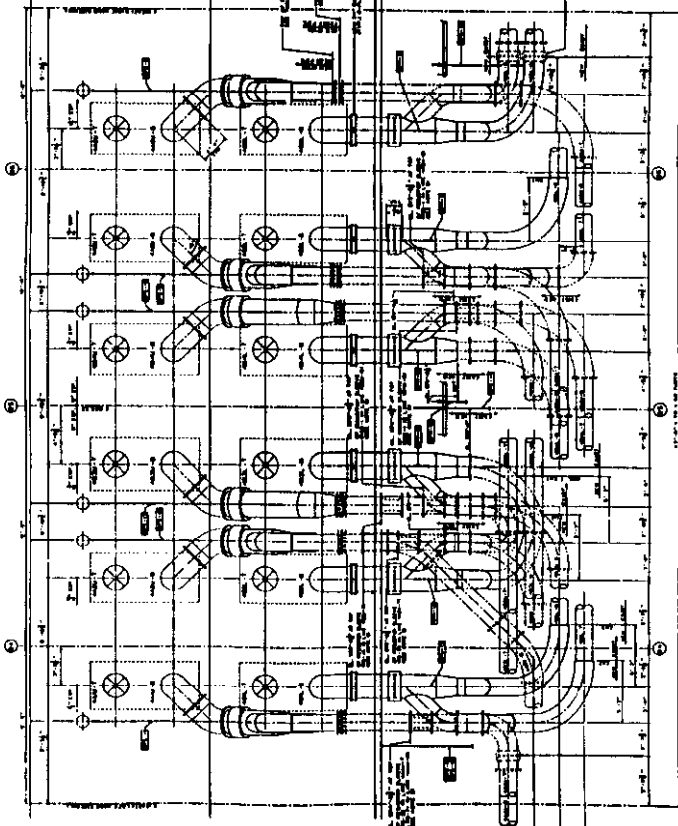
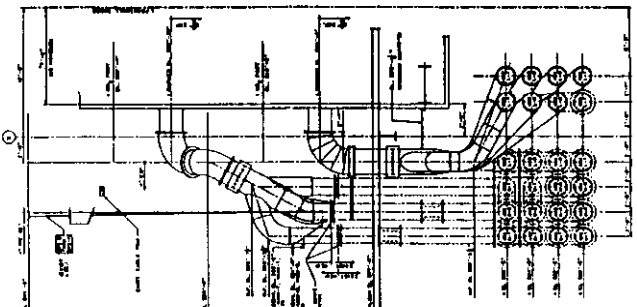
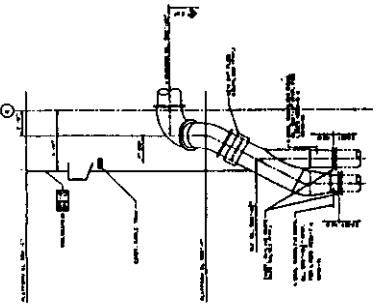
APPROVED BY:
 DATE:
 SHEET NO.:
 TOTAL SHEETS:
 PROJECT NO.:
 CLIENT:

NO.	REVISION	DATE	BY	CHECKED
1	ISSUED FOR PERMIT	10/10/11	J.M.	
2	REVISED PER COMMENTS	10/15/11	J.M.	

ITEM	DESCRIPTION	QTY	UNIT
1	PIPE 12" DIA. SCHEDULE 40	100	FEET
2	PIPE 8" DIA. SCHEDULE 40	200	FEET
3	PIPE 6" DIA. SCHEDULE 40	150	FEET
4	PIPE 4" DIA. SCHEDULE 40	100	FEET
5	FLANGES 12" DIA.	10	PAIRS
6	FLANGES 8" DIA.	20	PAIRS
7	FLANGES 6" DIA.	15	PAIRS
8	FLANGES 4" DIA.	10	PAIRS
9	ELBOWS 12" DIA.	10	PIECES
10	ELBOWS 8" DIA.	20	PIECES
11	ELBOWS 6" DIA.	15	PIECES
12	ELBOWS 4" DIA.	10	PIECES
13	TEES 12" DIA.	5	PIECES
14	TEES 8" DIA.	10	PIECES
15	TEES 6" DIA.	10	PIECES
16	TEES 4" DIA.	10	PIECES
17	VALVES 12" DIA.	5	PIECES
18	VALVES 8" DIA.	10	PIECES
19	VALVES 6" DIA.	10	PIECES
20	VALVES 4" DIA.	10	PIECES

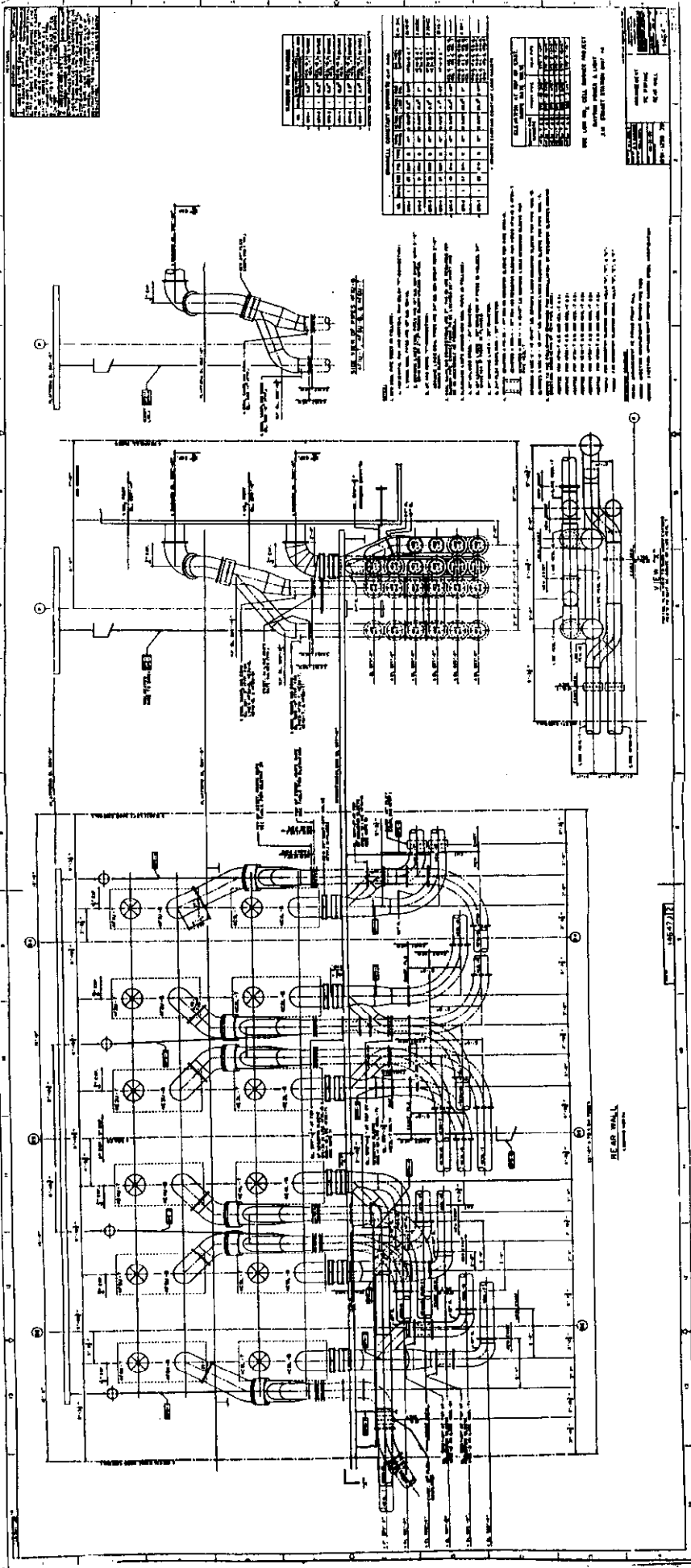
THE JOB NO. SHALL REMAIN PROTECTED
 BY THE COMPANY AND SHALL NOT BE
 REPRODUCED OR TRANSMITTED IN ANY
 FORM OR BY ANY MEANS, ELECTRONIC,
 MECHANICAL, PHOTOCOPYING, RECORDING,
 OR BY ANY INFORMATION STORAGE AND
 RETRIEVAL SYSTEM, WITHOUT THE
 WRITTEN PERMISSION OF THE COMPANY.

ALL DIMENSIONS ARE IN FEET AND INCHES
 UNLESS OTHERWISE SPECIFIED
 DIMENSIONS ARE TO FACE UNLESS
 OTHERWISE SPECIFIED
 ALL MATERIALS SHALL BE NEW UNLESS
 OTHERWISE SPECIFIED
 ALL WORK SHALL BE ACCORDING TO
 THE LATEST EDITIONS OF THE
 MACHANICAL CODES AND STANDARDS
 OF THE AMERICAN SOCIETY OF MECHANICAL
 ENGINEERS (ASME) AND THE
 NATIONAL BOARD OF BOILER AND PRESSURE
 VESSEL INSPECTION (NBIB).



FRONT WALL
 PIPING

SHEET NO. 1
 OF 1



NOTES:
 1. ALL DIMENSIONS ARE IN FEET AND INCHES.
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 3. ...
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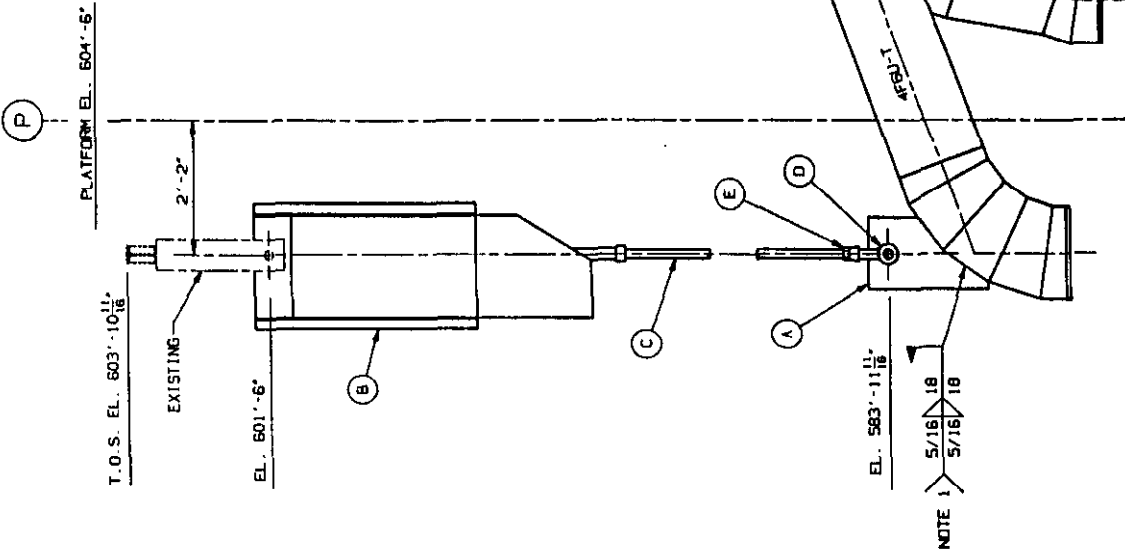
NO.	DESCRIPTION	QTY.	UNIT
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SEE LISTING, GEAR SHEDS PROJECT
 DRAWING, PUMP & LIGHT
 FOR PUMP & LIGHT

NO.	DESCRIPTION	QTY.	UNIT
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JULIEN



NOTES:

1. FIELD WELD TO CERAMIC LINED PIPE PER WELDING PROCEDURE DNG. 174460A.
2. FOR SUPPORT DATA & LOCATION, SEE ARRGT.

ITEM QTY	DESCRIPTION	DWG. NO.	PART NO.
E 1	NUT, HEX JAM 1 3/4" STL	4604260	
D 1	CLEVIS, ASSY 1 3/4" #4S	447488	4605239
C 1	ROD, 1 3/4" DIA. X 11'-3" LG TBE-5	4605283	
B 1	SPRING HANGER	2033809	
A 1	DET. SUPPORT PLATE	304286C	4605091

PARTS LIST

THIS IS A CAD DRAWING
DO NOT REVISE
DRAWN BY J. PEDERZOLLI
CHECKED BY B. S. BASSONE
DATE 9-28-90
CONTRACT NO. 891-1250-39

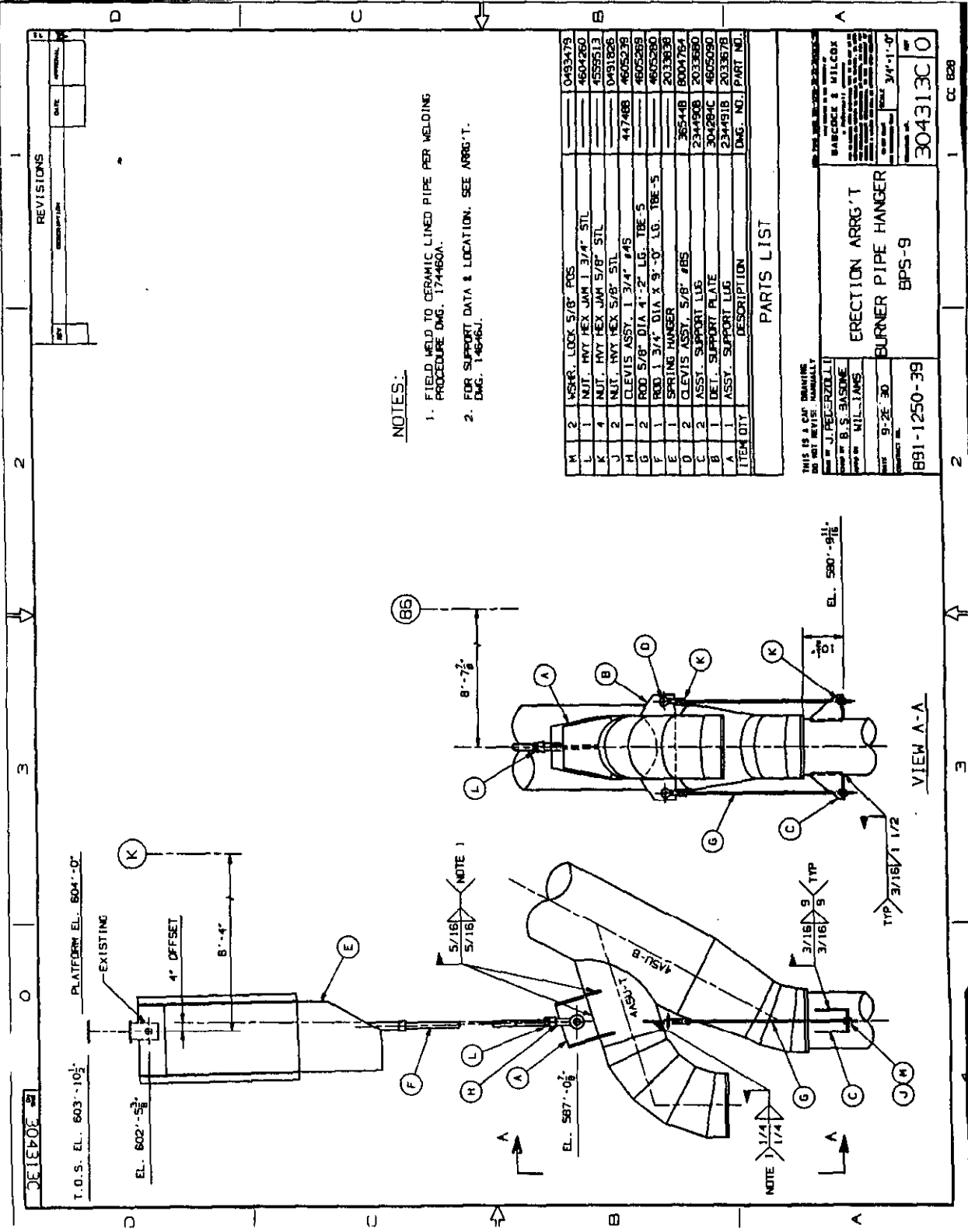
SAFAROCK & MILCOX
ERECTOR ARRGT
BURNER PIPE HANGER
BPS-1
304310C 0

CC 828

1

2

3



REVISIONS

NO.	DATE	DESCRIPTION

NOTES:

1. FIELD WELD TO CERAMIC LINED PIPE PER WELDING PROCEDURE DWG. 174460A.
2. FOR SUPPORT DATA & LOCATION. SEE ARR'G'T. DWG. 14646J.

ITEM NO.	DESCRIPTION	DWG. NO.	PART NO.
M 2	WASHER, LOCK 5/8" POS		0493479
L 1	NUT, RHY HEX JAM 1 3/4" STL		4604260
K 4	NUT, RHY HEX JAM 5/8" STL		4595113
J 2	NUT, RHY HEX 5/8" STL		0491826
H 1	CLEVIS ASSY, 1 3/4" #45		447468
D 2	ROD 5/8" DIA 4'-2" LG. TBE-5		4605269
G 1	ROD 1 3/4" DIA X 9'-0" LG. TBE-5		4605260
F 1	SPRING HANGER		2033638
E 1	CLEVIS ASSY, 5/8" #85		365448
C 2	ASST. SUPPORT LUG		2344908
B 1	DET. SUPPORT PLATE		304264C
A 1	ASST. SUPPORT LUG		2344918
			2033678

PARTS LIST

THIS IS A SHOP DRAWING
DO NOT REUSE MANUALLY

DESIGNED BY J. PETERSON
CHECKED BY B. S. SANSONE
DRAWN BY WILKINS

DATE 9-28-30

PROJECT NO. 304313C

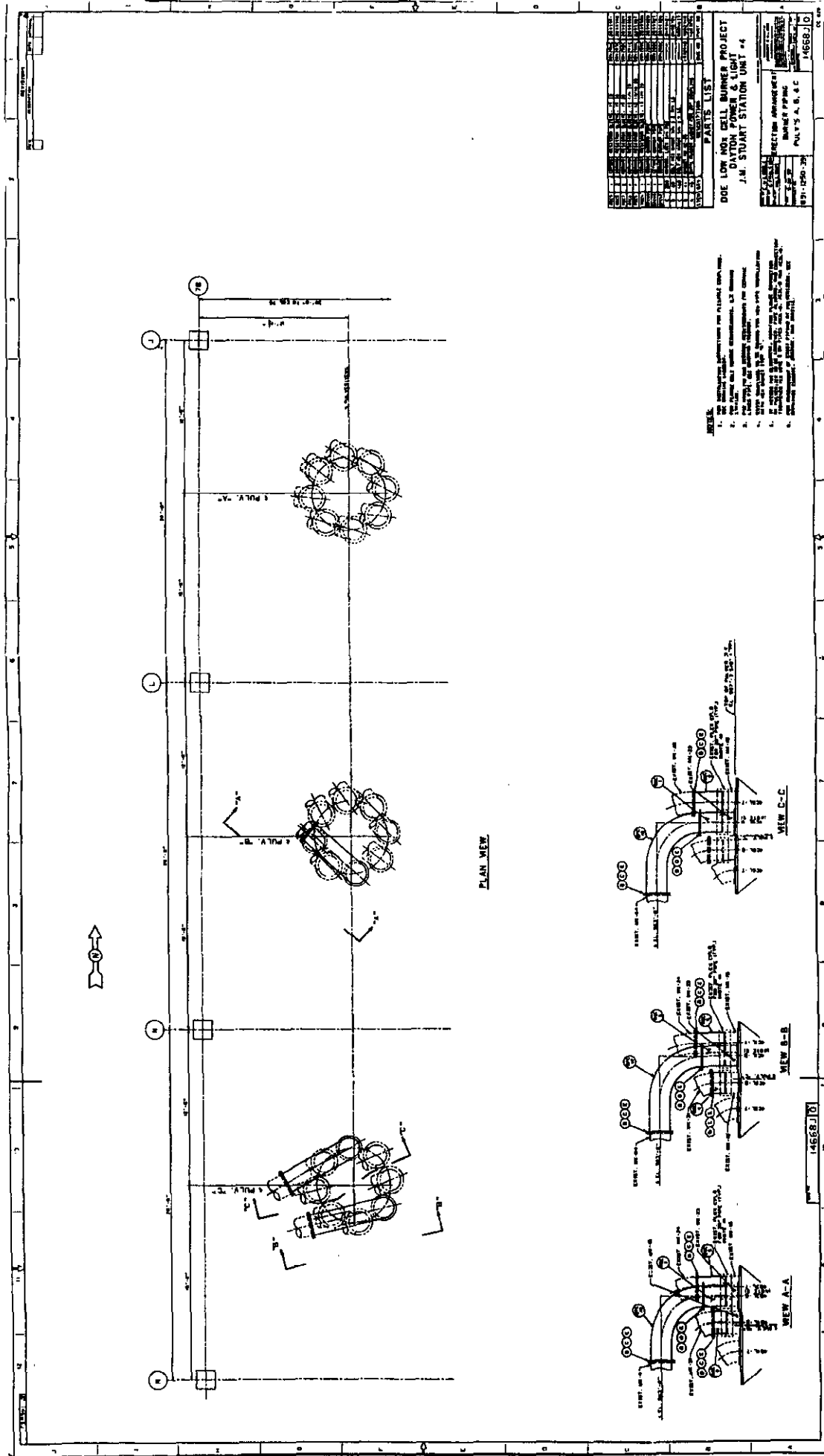
SCALE 3/4"=1'-0"

BARCODE & WILCOX

ERECTOR ARR'G'T
BURNER PIPE HANGER
BPS-9

891-1250-39

CC 838



PLAN NEW

PARTS LIST	
NO. 1	NO. 1
NO. 2	NO. 2
NO. 3	NO. 3
NO. 4	NO. 4
NO. 5	NO. 5
NO. 6	NO. 6
NO. 7	NO. 7
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NO. 50	NO. 50

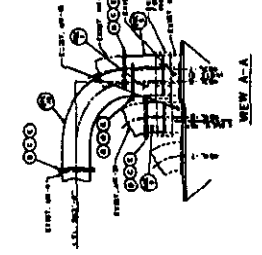
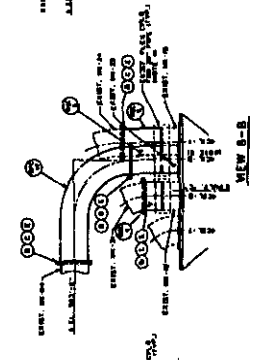
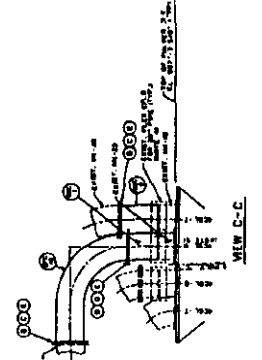
DOE LOW NOX CELL BURNER PROJECT
 DAYTON POWER & LIGHT
 J.M. STUART STATION UNIT #4

DESIGNED BY: [Name]
 CHECKED BY: [Name]
 DATE: [Date]

SCALE: 1/8" = 1'-0"

PROJECT NO. 14668 J10

- NOTES:
1. SEE DRAWING FOR DIMENSIONS AND MATERIAL SPECIFICATIONS.
 2. ALL DIMENSIONS ARE UNLESS OTHERWISE SPECIFIED.
 3. MATERIALS AND FABRICATION REQUIREMENTS ARE GIVEN IN THE SPECIFICATIONS.
 4. THIS DRAWING IS THE PROPERTY OF THE U.S. GOVERNMENT AND IS TO BE USED ONLY FOR THE PURPOSES AND IN THE MANNER AND UNDER THE CONDITIONS SPECIFIED IN THE CONTRACT DOCUMENTS.
 5. THIS DRAWING IS NOT TO BE USED FOR ANY OTHER PURPOSES WITHOUT THE WRITTEN PERMISSION OF THE U.S. GOVERNMENT.
 6. THIS DRAWING IS NOT TO BE USED FOR ANY OTHER PURPOSES WITHOUT THE WRITTEN PERMISSION OF THE U.S. GOVERNMENT.



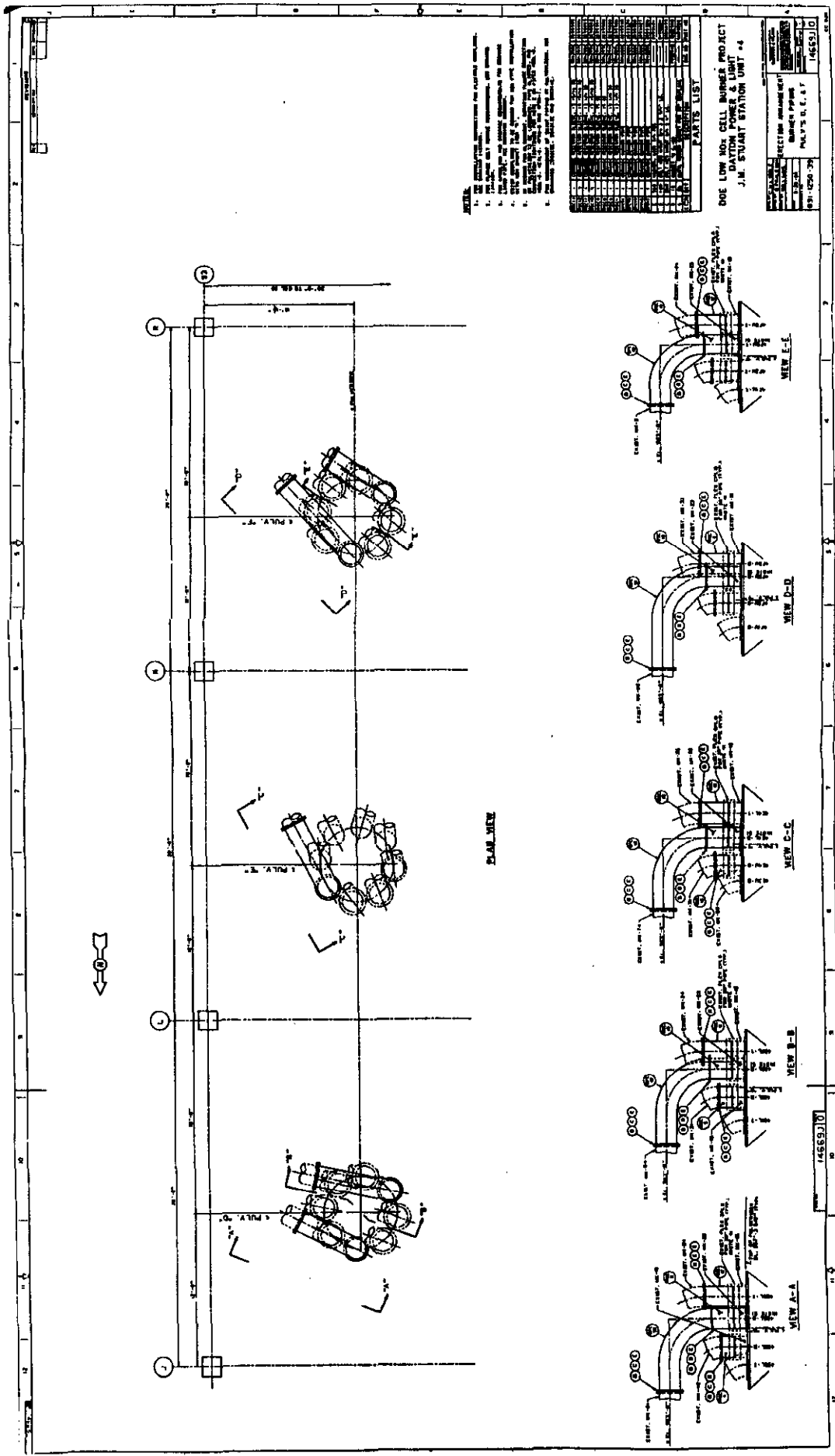
MEW C-C

MEW B-B

MEW A-A

SCALE: 1/8" = 1'-0"

PROJECT NO. 14668 J10



- NOTES:**
1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.
 2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.
 3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.
 4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.
 5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.
 6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.

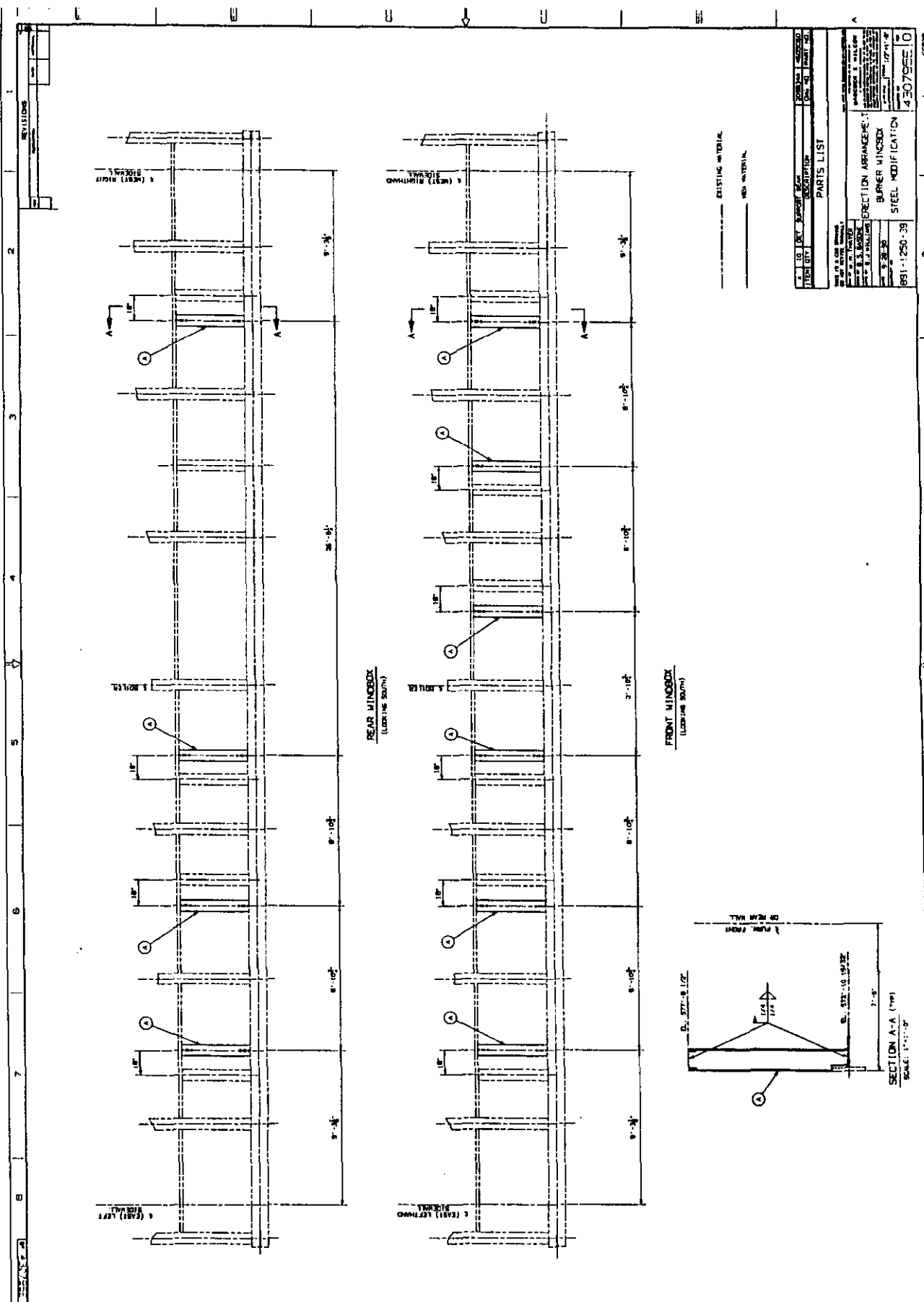
2. PARTS LIST

NO.	DESCRIPTION	QTY.	UNIT
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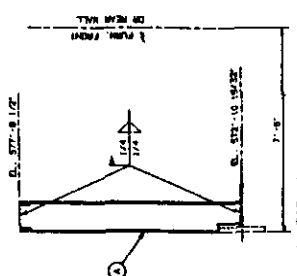
DOE LOW NOX CELL BURNER PROJECT
 BAYVIEW STATION UNIT LIGHT
 J.M. STUART STATION UNIT #4

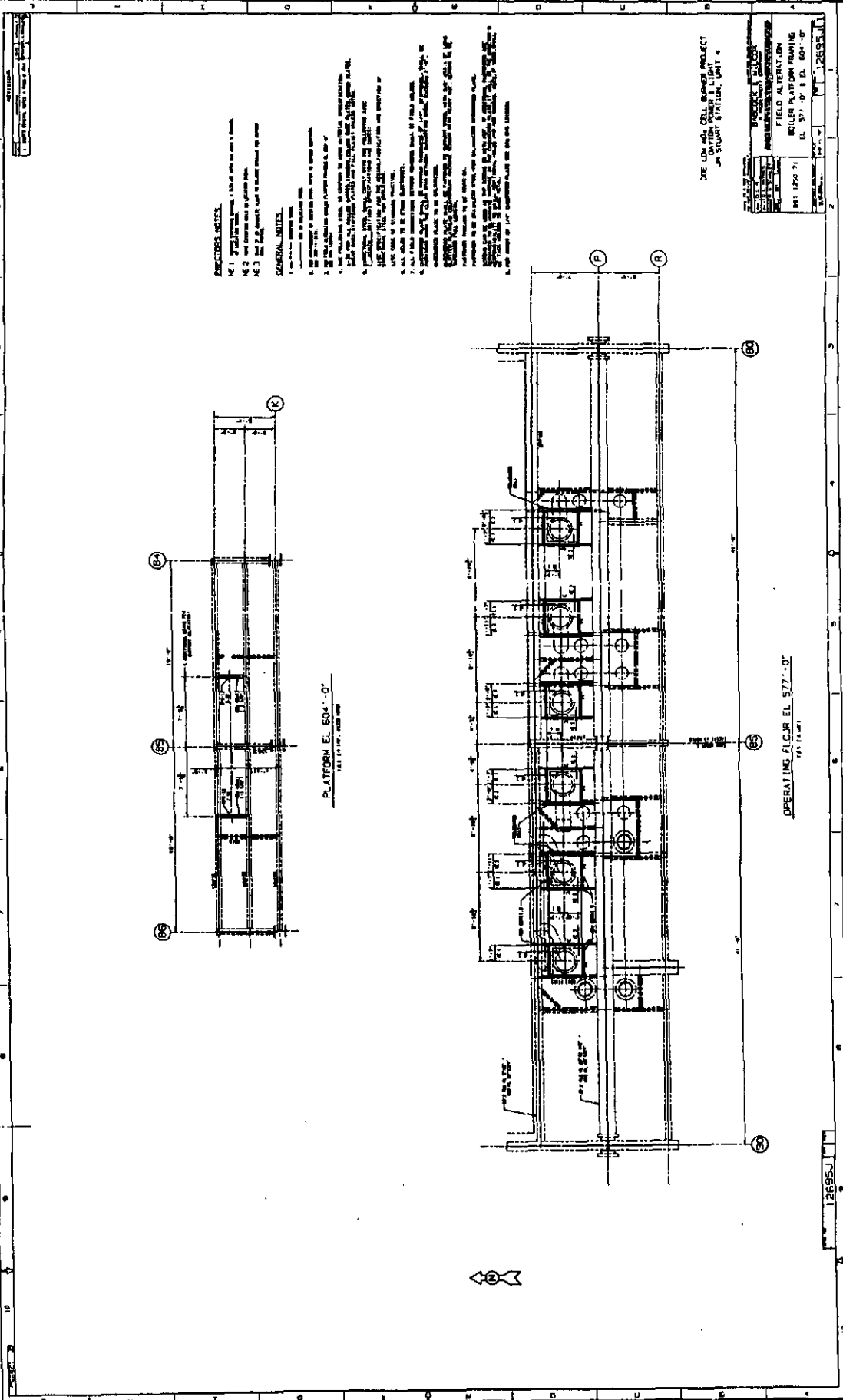
PROJECT NO. 1465310
 SHEET NO. 1465310-1
 DATE: 08/11/03
 DRAWN BY: J.M. STUART
 CHECKED BY: J.M. STUART
 APPROVED BY: J.M. STUART





1	TO	LOC.	BLANK	NO.	DATE	BY	CHKD.
2	BY	DATE	DESCRIPTION	QTY.	NO.	UNIT	NO.
PARTS LIST							
DIRECTION ARRANGEMENT: BURNER HOODS STEEL MODIFICATION							
881-1250-39 430795E10							





FUNCTIONAL NOTES

1. ALL DIMENSIONS ARE IN FEET AND INCHES.
2. ALL DIMENSIONS ARE TO FACE UNLESS OTHERWISE NOTED.
3. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE NOTED.

GENERAL NOTES

1. ALL DIMENSIONS ARE IN FEET AND INCHES.
2. ALL DIMENSIONS ARE TO FACE UNLESS OTHERWISE NOTED.
3. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE NOTED.
4. ALL DIMENSIONS ARE TO FACE UNLESS OTHERWISE NOTED.
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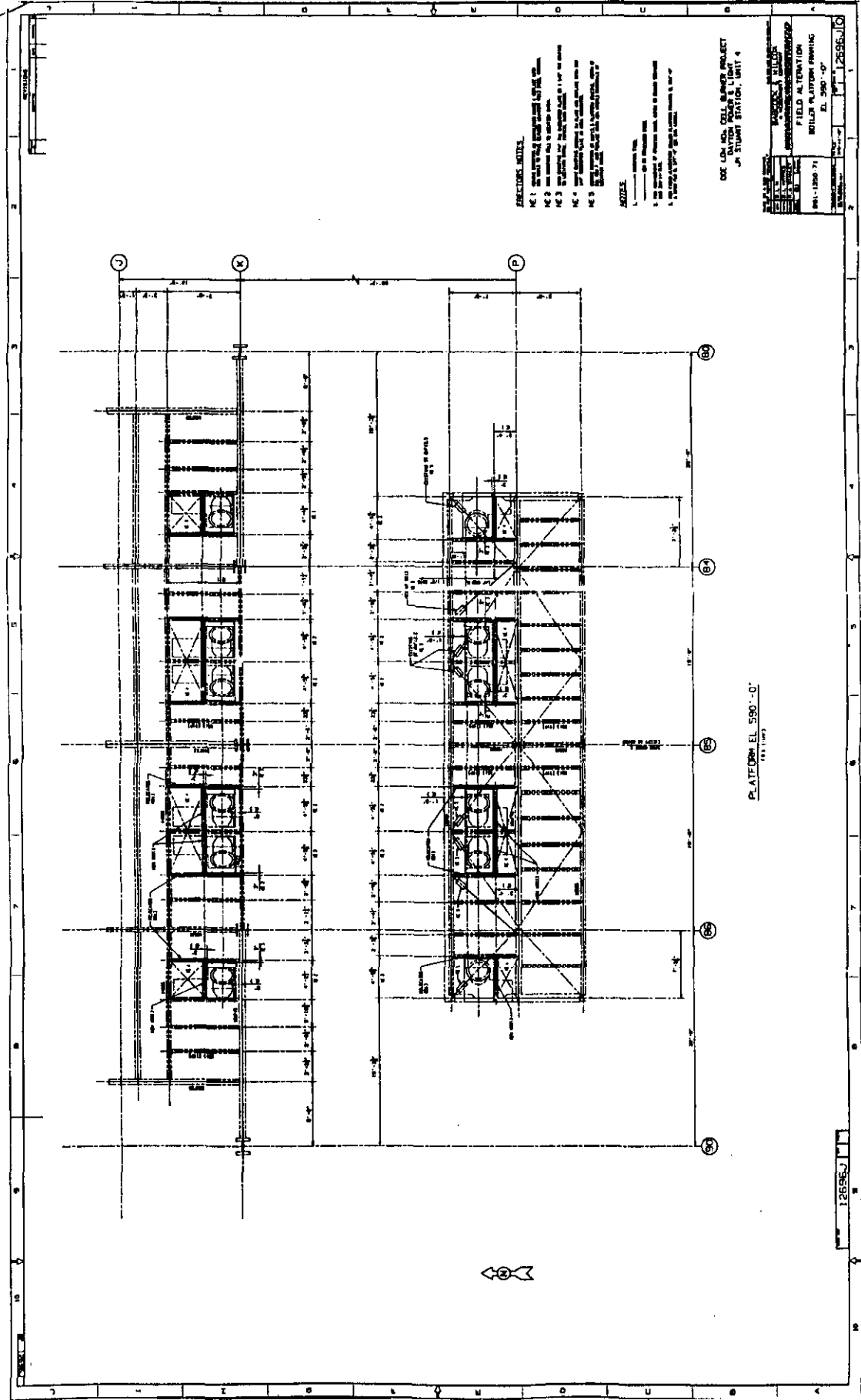
SEE PLAN NO. 12695J PROJECT
 STATION STATION UNIT 4

PROJECT NO.	12695J
FIELD ALTERNATION	
BRIDGE PLATFORM FRAMING	
EL. 577'-0" & EL. 604'-0"	
DATE	12/28/51
BY	
CHECKED BY	
APPROVED BY	

PLATFORM E. 504'-0"
 ALL DIMENSIONS IN FEET

OPERATING FLOOR EL. 577'-0"
 ALL DIMENSIONS IN FEET

12695J



- REVISIONS:**
- NO. 1 CORRECTED DIMENSIONS AND NOTES.
 - NO. 2 ADD DIMENSIONS AND NOTES.
 - NO. 3 CORRECTED DIMENSIONS AND NOTES.
 - NO. 4 CORRECTED DIMENSIONS AND NOTES.
 - NO. 5 CORRECTED DIMENSIONS AND NOTES.

- NOTES:**
- 1. ALL DIMENSIONS ARE IN FEET AND INCHES.
 - 2. ALL DIMENSIONS ARE TO FACE UNLESS OTHERWISE NOTED.
 - 3. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE NOTED.
 - 4. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE NOTED.
 - 5. ALL DIMENSIONS ARE TO CENTER UNLESS OTHERWISE NOTED.

DESIGN NO. CELL NUMBER PROJECT
 DRAWING NUMBER & UNIT
 IN STATION UNIT 4

DATE	12/26/55
BY	J. J. JONES
CHECKED BY	J. J. JONES
APPROVED BY	J. J. JONES
FIELD ALTERNATION	
NOTED PLATFORM FINISHING	
NO. 1-12696-71	
EL. 590'-0"	
12696.5	

PLATFORM EL. 590'-0"
 12696.5

SECTION 9
DRAWING INDEX

IX. DRAWING INDEX:

A. B&W Boiler Setting & Arrangement Drawings:

<u>Drawing No.</u>	<u>Title</u>
23801F-8	B&W Universal Pressure Boiler Outside View
23802F-9	B&W Universal Pressure Boiler Section A-A
23803F-7	B&W Universal Pressure Boiler Section B-B
23804F-8	B&W Universal Pressure Boiler Section C-C
23805F-9	B&W Universal Pressure Boiler Sectional Side View
23806F-7	B&W Universal Pressure Boiler Air Heater, Flue, & Duct Views
23807F-8	B&W Universal Pressure Boiler Plan Sections D-D & E-E
23808F-7	B&W Universal Pressure Boiler Plan Sections F-F & G-G
23809F-8	B&W Universal Pressure Boiler Plan Section H-H

B. B&W Low-NOx Burner & NOx Port Arrangement Drawings

432252E-2	Erection Arrangement C.W. S-Type Burner
432253E-2	Erection Arrangement C.C.W. S-Type Burner
432254E-1	Erection Arrangement Section & Views S-Type Burner
432255E-1	Erection Arrangement Section & Views S-Type Burner
432258E-2	Erection Arrangement NOx Port
432259E-2	Erection Arrangement NOx Port
432260E-1	Sections & Views NOx Port
432271E-2	Erection Arrangement NOx Port
432272E-2	Erection Arrangement NOx Port
432273E-1	Sections & Views NOx Port
432297E-1	Erection Arrangement C.W. S-Type Burner
432298E-1	Erection Arrangement C.C.W. S-Type Burner
12229J-2	Arrangement S-Type Burners & NOx Ports - Front Wall
12230J-2	Arrangement S-Type Burners & NOx Ports - Rear Wall
12232J-0	Burner Wallboxes - Front & Rearwall

C. B&W P.C. Piping

<u>Drawing No.</u>	<u>Title</u>
143363A-2	Flexible Connection Installation Instruction
174418A-0	Pulverizer Coal Piping Flange Bolt Torque Std.
174460A-0	Field Welding Ceramic Lined Pipe
304299C-0	Modification of Existing Support BPS-14
304304C-0	Modification to Existing Support WPH-14
304305C-0	Modification of Existing Support WPH-15
304308C-0	Erection Arrangement - Burner Pipe Hanger BPS-12
304309C-0	Erection Arrangement - Burner Pipe Hanger BPS-13
304310C-0	Erection Arrangement - Burner Pipe Hanger BPS-1
304311C-0	Erection Arrangement - Burner Pipe Hanger BPS-4
304312C-0	Erection Arrangement - Burner Pipe Hanger BPS-8
304313C-0	Erection Arrangement - Burner Pipe Hanger BPS-9
304314C-0	Erection Arrangement - Burner Pipe Hanger BPS-10
304315C-0	Erection Arrangement - Burner Pipe Hanger BPS-11
304316C-0	Erection Arrangement - Pipe Hanger WPH-1 thru WPH-3
304317C-0	Erection Arrangement - Pipe Hanger WPH-4
304318C-0	Erection Arrangement - Pipe Hanger WPH-7
304319C-0	Erection Arrangement - Pipe Hanger WPH-8 thru WPH-13
304324C-0	Erection Arrangement - Pipe Hanger WPH-6
210539D-0	Erection Arrangement - Burner Pipe Hanger BPS-2
210540D-0	Erection Arrangement - Burner Pipe Hanger BPS-3
210541D-0	Erection Arrangement - Burner Pipe Hanger BPS-6
430767E-0	Erection Arrangement - PC Pipes - Front Wall
430768E-0	Erection Arrangement - PC Pipes - Front Wall
430769E-0	Erection Arrangement - PC Pipes - Front Wall
430770E-0	Erection Arrangement - PC Pipes - Front Wall
430771E-0	Erection Arrangement - PC Pipes - Front Wall
430772E-0	Erection Arrangement - PC Pipes - Front Wall
430773E-0	Erection Arrangement - PC Pipes - Rear Wall
430774E-0	Erection Arrangement - PC Pipes - Rear Wall
430775E-0	Erection Arrangement - PC Pipes - Rear Wall
430776E-0	Erection Arrangement - PC Pipes - Rear Wall
430777E-0	Erection Arrangement - PC Pipes - Rear Wall
430778E-0	Erection Arrangement - PC Pipes - Rear Wall
430795E-0	Erection Arrangement - Windbox Steel Modification
14646J-2	Arrangement PC Piping Front Wall
14647J-2	Arrangement PC Piping Rear Wall
14668J-0	Erection Arrangement Ceramic Coal Piping-Pulverizer's A, B, & C
14669J-0	Erection Arrangement Ceramic Coal Piping-Pulverizer's D, E, & F
14680J-0	Erection Arrangement - Pipe Ties - Rear Wall

D. B&W Electrical & Controls

1. Burner & NOx Port TC Package

<u>Drawing No.</u>	<u>Title</u>
55440B-8	Detail Permanent Thermocouples
216371C-2	Erection Arrangement Burner & NOx Port TC Tabulation & Bill of Material
48001D-10	Details of Thermocouple Terminal Cabinet for 6-11, 12-23, & 24-47 Thermocouples
431317E-2	Erection Arrangement S-Type Burner & NOx Port TC's
431418E-0	Erection Arrangement Sections & Views of Burner & NOx Port TC's

2. Burner & NOx Port Differential Pressure Gages

431437E-1	Erection Arrangement S-Type Burner & NOx Port Differential Pressure Gages
431438E-1	Erection Arrangement Enlarged View "A", Bill of Material & General Notes

E. B&W Platform Drawings

12695J-1	Field Alteration Boiler Platform Framing El. 577'-0" & El. 604'-0"
12696J-0	Field Alteration Boiler Platform Framing El. 590'-0"
300-14-2171	Existing Operating Floor Framing Plan El. 577.00' Boiler Area
300-14-2172	Existing Boiler Platform Framing Plans El. 590.00' & 604.00'

F. B&W Observation Door Modification Drawings:

231639B-0	Field Pressure Parts Weld & NDE Schedule
218637C-2	Field Alteration 3" Observation Door Insert Panel
98024E-9	Arrangement of Wide Angle Pressure Inspection Door
432731E-2	Field Alteration 3" Observation Door Insert Panel

G. Vendor Drawings:

C16596-0	Stock 21" Sliding Gate Burner Line Valve
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